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A

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INITIALS USED IN VOLUME XXVI. TO IDENTIFY INDIVIDUAL CONTRIBUTORS,[1] WITH THE HEADINGS OF THE ARTICLES IN THIS VOLUME SO SIGNED.

A. A. R.	A. ADAMS REILLY. Joint-author of *Life and Letters of J. D. Forbes.*	**Tisserand, François.**
A. Bo.*	AUGUSTE BOUDINHON, D.D., D.C.L. Professor of Canon Law at the Catholic University of Paris. Honorary Canon of Paris. Editor of the *Canoniste contemporain.*	**Syllabus.**
A. B. Go.	ALFRED BRADLEY GOUGH, M.A., PH.D. Sometime Casberd Scholar of St John's College, Oxford. English Lector in the University of Kiel, 1896–1905.	**Swabian League.**
A. Ca.	ARTHUR CAYLEY, LL.D., F.R.S. See the biographical article: CAYLEY, ARTHUR.	**Surface** (*in part*).
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A. D. G.	ALFRED DENIS GODLEY, M.A. Fellow and Tutor of Magdalen College, Oxford, and Public Orator in the University. Author of *Socrates and Athenian Society*; &c. Editor of editions of Tacitus.	**Tacitus** (*in part*).
A. F. P.	ALBERT FREDERICK POLLARD, M.A., F.R.HIST.S. Professor of English History in the University of London. Fellow of All Souls College, Oxford. Assistant-editor of the *Dictionary of National Biography*, 1893–1901. Lothian Prizeman, Oxford, 1892; Arnold Prizeman, 1898. Author of *England under the Protector Somerset*; *Henry VIII.*; *Life of Thomas Cranmer*; &c.	**Taylor, Rowland; Tetzel.**
A. G.	MAJOR ARTHUR GEORGE FREDERICK GRIFFITHS (d. 1908). H.M. Inspector of Prisons, 1878–1896. Author of *The Chronicles of Newgate*: *Secrets of the Prison House*; &c.	**Ticket-of-Leave.**
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A. He.	ARTHUR HERVEY. Formerly Musical Critic to the *Morning Post* and to *Vanity Fair.* Author of *Masters of French Music*; *French Music in the Nineteenth Century.*	**Thomas, Charles.**
A. H.-S.	SIR A. HOUTUM-SCHINDLER, C.I.E. General in the Persian Army. Autnor of *Eastern Persian Irak.*	**Tabriz; Teheran.**
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A. L.	ANDREW LANG, LL.D. See the biographical article: LANG, ANDREW.	**Tale.**

[1] A complete list, showing all individual contributors, appears in the final volume.

A. Mü.	August Müller, Ph.D. (1848–1892). Formerly Professor of Semitic Languages in the University of Halle. Author of *Der Islam im Morgen- und Abendland*. Editor of *Orientalische Bibliographie*.	**Sunnites** (*in part*).
A. M. F.*	Arthur Mostyn Field, F.R.S., F.R.A.S., F.R.G.S., F.R.Met.S. Vice-Admiral R.N. Admiralty Representative on Port of London Authority. Acting Conservator of River Mersey. Hydrographer of the Royal Navy, 1904–1909. Author of *Hydrographical Surveying*; &c.	**Surveying:** *Nautical.*
A. N.	Alfred Newton, F.R.S. See the biographical article: Newton, Alfred.	**Sugar-bird; Sun-bird; Sun-bittern; Swallow; Swan; Swift; Tanager; Tapaculo; Teal; Tern; Thrush; Tinamou; Titmouse; Tody.**
A. P. H.	Alfred Peter Hillier, M.D., M.P. Author of *South African Studies*; *The Commonweal*; &c. Served in Kaffir War, 1878–1879. Partner with Dr L. S. Jameson in medical practice in South Africa till 1896. Member of Reform Committee, Johannesburg, and Political Prisoner at Pretoria, 1895–1896. M.P. for the Hitchin division of Herts, 1910.	**Swaziland** (*in part*).
A. R. S. K.	Rev. Archibald R. S. Kennedy, M.A., D.D. Professor of Hebrew and Semitic Languages in the University of Edinburgh. Professor of Hebrew in the University of Aberdeen, 1887–1894. Editor of "Exodus" in the *Temple Bible*.	**Tabernacle; Temple** (*in part*).
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A. Sp.	Archibald Sharp. Consulting Engineer and Chartered Patent Agent.	**Tire.**
A. S. C.	Alan Summerly Cole, C.B. Formerly Assistant Secretary, Board of Education, South Kensington. Author of *Ornament in European Silks*; *Catalogue of Tapestry, Embroidery, Lace and Egyptian Textiles in the Victoria and Albert Museum*; &c.	**Tapestry; Textile-Printing:** *Art and Archaeology.*
A. S. P.-P.	Andrew Seth Pringle-Pattison, M.A., LL.D., D.C.L. Professor of Logic and Metaphysics in the University of Edinburgh. Gifford Lecturer in the University of Aberdeen, 1911. Fellow of the British Academy. Author of *Man's Place in the Cosmos*; *The Philosophical Radicals*; &c.	**Theosophy** (*in part*).
A. Wa.	Arthur Waugh, M.A. Managing Director of Chapman & Hall, Ltd., Publishers. Formerly literary adviser to Kegan Paul & Co. Author of *Alfred Lord Tennyson*; *Legends of the Wheel*; *Robert Browning* in "Westminster Biographies." Editor of Johnson's *Lives of the Poets*.	**Symonds, John Addington.**
A. W. H.*	Arthur William Holland. Formerly Scholar of St John's College, Oxford. Bacon Scholar of Gray's Inn, 1900.	**Thegn.**
A. W. R.	Alexander Wood Renton, M.A., LL.B. Puisne Judge of the Supreme Court of Ceylon. Editor of *Encyclopaedia of the Laws of England*.	**Thurlow, Lord.**
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C. L. K.	Charles Lethbridge Kingsford, M.A., F.R.Hist.S., F.S.A. Assistant Secretary to the Board of Education. Author of *Life of Henry V*. Editor of *Chronicles of London*, and Stow's *Survey of London*.	**Suffolk, William de la Pole, Duke of.**

C. R. B.	CHARLES RAYMOND BEAZLEY, M.A., D.LITT., F.R.G.S., F.R.HIST.S. Professor of Modern History in the University of Birmingham. Formerly Fellow of Merton College, Oxford, and University Lecturer in the History of Geography. Lothian Prizeman, Oxford, 1889. Lowell Lecturer, Boston, 1908. Author of *Henry the Navigator*; *The Dawn of Modern Geography*; &c.	**Tasman**; **Thorfinn Karlsefni.**
C. S. S.	CHARLES SCOTT SHERRINGTON, D.SC., M.D., M.A., F.R.S., LL.D. Professor of Physiology, University of Liverpool. Foreign Member of Academies of Rome, Vienna, Brussels, Göttingen, &c. Author of *The Integrative Action of the Nervous System.*	**Sympathetic System.**
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D. F. T.	DONALD FRANCIS TOVEY. Author of *Essays in Musical Analysis*: comprising *The Classical Concerto*, *The Goldberg Variations*, and analyses of many other classical works.	**Suite:** *Music*; **Symphonic Poem**; **Symphony.**
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E. M. W.	Rev. Edward Mewburn Walker, M.A. Fellow, Senior Tutor and Librarian of Queen's College, Oxford.	**Theopompus.**
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E. Wh.	Emmanuel Wheeler, M.A.	**Theophrastus.**
F. C. B.	Francis Crawford Burkitt, M.A., D.D. Norrisian Professor of Divinity in the University of Cambridge. Fellow of the British Academy. Part-editor of *The Four Gospels in Syriac transcribed from the Sinaitic Palimpsest.* Author of *The Gospel History and its Transmission*; *Early Eastern Christianity*; &c.	**Thomas, St** (*in part*).
F. G. M. B.	Frederick George Meeson Beck, M.A. Fellow and Lecturer of Clare College, Cambridge.	**Suebi; Sussex, Kingdom of; Sweden:** *Early History*; **Teutoni.**
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F. G. P.*	Frank George Pope. Lecturer on Chemistry, East London College (University of London).	**Terpenes.**
F. H. H.	Franklin Henry Hooper. Assistant Editor of the *Century Dictionary.*	**Tammany Hall.**
F. J. G.	Major-General Sir Frederick John Goldsmid. See the biographical article: Goldsmid: Family.	**Timūr.**
F. J. H.	Francis John Haverfield, M.A., LL.D., F.S.A. Camden Professor of Ancient History in the University of Oxford. Fellow of Brasenose College. Fellow of the British Academy. Formerly Censor, Student, Tutor and Librarian of Christ Church, Oxford. Ford's Lecturer, 1906–1907. Author of Monographs on Roman History, especially Roman Britain, &c.	**Thule.**
F. Ll. G.	Francis Llewellyn Griffith, M.A., Ph.D., F.S.A. Reader in Egyptology, Oxford University. Editor of the Archaeological Survey and Archaeological Reports of the Egypt Exploration Fund. Fellow of Imperial German Archaeological Institute. Author of *Stories of the High Priests of Memphis*; &c.	**Thebes** (*Egypt*); **Thoth.**
F. P.	Frank Podmore, M.A. (1856–1910). Sometime Scholar of Pembroke College, Oxford. Author of *Modern Spiritualism*; *Mesmerism and Christian Science*; &c.	**Table-turning.**
F. Po.	Sir Frederick Pollock, Bart., LL.D., D.C.L. See the biographical article: Pollock: Family.	**Sword.**
F. Pu.	Frederick Purser, M.A. (1840–1910). Formerly Fellow of Trinity College, Dublin. Professor of Natural Philosophy in the University of Dublin. Member of the Royal Irish Academy.	**Surface** (*in part*).
F. R. C.	Frank R. Cana. Author of *South Africa from the Great Trek to the Union.*	**Sudan:** *Geography and Statistics, Archaeology* (*in part*) and *History*; **Swaziland** (*in part*); **Timbuktu; Tlemçen.**
F. V. B.	F. Vincent Brooks. Managing Director of Messrs Vincent Brooks, Day & Son, Ltd., Lithographic Printers, London.	**Sun Copying.**

F. W. Ga.	Frederick William Gamble, D.Sc., F.R.S. Professor of Zoology in the University of Birmingham. Formerly Assistant Director of the Zoological Laboratories and Lecturer in Zoology in the University of Manchester. Author of *Animal Life*. Editor of Marshall and Hurst's *Practical Zoology*; &c.	**Tapeworms.**
F. W. R.*	Frederick William Rudler, I.S.O., F.G.S. Curator and Librarian of the Museum of Practical Geology, London, 1879–1902. President of the Geologists' Association, 1887–1889.	**Talc.**
F. W. T.	Frank William Taussig. See the biographical article: Taussig, Frank William.	**Tariff.**
G. A. B.	George A. Boulenger, D.Sc., F.R.S. Keeper of the Collections of Reptiles and Fishes, Department of Zoology, British Museum. Vice-President of the Zoological Society of London.	**Tadpole; Teleostomes.**
G. G. P.*	George Grenville Phillimore, M.A., B.C.L. Christ Church, Oxford. Barrister-at-Law, Middle Temple.	**Tithes:** *English*.
G. H. Bo.	Rev. George Herbert Box, M.A. Rector of Sutton Sandy, Beds. Formerly Lecturer in the Faculty of Theology, University of Oxford, 1908–1909. Author of *Translation of the Book of Isaiah*; &c.	**Teraphīm** (*in part*).
G. H. C.	George Herbert Carpenter. Professor of Zoology in the Royal College of Science, Dublin. Author of *Insects: their Structure and Life*.	**Thysanoptera.**
G. H. D.	Sir George Howard Darwin, K.C.B., M.A., F.R.S., LL.D., D.Sc. Fellow of Trinity College, Cambridge, and Plumian Professor of Astronomy and Experimental Philosophy in the University. President of the British Association, 1905. Author of *The Tides and Kindred Phenomena in the Solar System*; &c.	**Tide.**
G. J. A.	George Johnston Allman, M.A., LL.D., F.R.S., D.Sc. (1824–1905). Professor of Mathematics in Queen's College, Galway, and in Queen's University of Ireland, 1853–1893. Author of *Greek Geometry from Thales to Euclid*; &c.	**Thales of Miletus.**
G. L.	Georg Lunge, Ph.D., D.Ing. See the biographical article: Lunge, G.	**Sulphuric Acid.**
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G. Sn.	Grant Showerman, A.M., Ph.D. Professor of Latin at the University of Wisconsin. Member of the Archaeological Institute of America. Member of the American Philological Association. Author of *With the Professor*; *The Great Mother of the Gods*; &c.	**Syncretism; Taurobolium.**
G. U.	Goji Ukita. Formerly Chancellor of the Japanese Legation, London. Author of *Wealth of Canada* (in Japanese).	**Tokyo.**
G. W. P.	George Walter Prothero, M.A., Litt.D., LL.D. Editor of the *Quarterly Review*. Honorary Fellow, formerly Fellow of King's College, Cambridge. Fellow of the British Academy. Professor of History in the University of Edinburgh, 1894–1899. Author of *Life and Times of Simon de Montfort*; &c. Joint-editor of the *Cambridge Modern History*.	**Temple, Sir William.**
G. W. T.	Rev. Griffithes Wheeler Thatcher, M.A., B.D. Warden of Camden College, Sydney, N.S.W. Formerly Tutor in Hebrew and Old Testament History at Mansfield College, Oxford.	**Suyutī; Ṭabarī; Tarafa; Thaʻālibī; Tirmidhī.**
H. B. Wa.	Henry Beauchamp Walters, M.A., F.S.A. Assistant to the Keeper of Greek and Roman Antiquities, British Museum. Author of *The Art of the Greeks*; *History of Ancient Pottery*; &c.	**Terracotta** (*in part*).
H. Ch.	Hugh Chisholm, M.A. Formerly Scholar of Corpus Christi College, Oxford. Editor of the 11th edition of the *Encyclopaedia Britannica*. Co-editor of the 10th edition.	**Sullivan, Sir Arthur; Tennent, Sir E.; Theatre:** *Modern* (*in part*); **Thompson, Francis.**
H. De.	Rev. Hippolyte Delehaye, S. J. Bollandist. Joint-editor of the *Acta Sanctorum* and the *Analecta Bollandiana*.	**Symeon Metaphrastes; Synaxarium; Thecla, St.**
H. D. T.	H. Dennis Taylor. Inventor of the *Cooke* Photographic Lens. Author of *A System of Applied Optics*.	**Telescope** (*in part*).
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H. Ja.	Henry Jackson, Litt.D., LL.D., O.M. Regius Professor of Greek in the University of Cambridge. Fellow of Trinity College. Fellow of the British Academy. Author of *Texts to Illustrate the History of Greek Philosophy from Thales to Aristotle*.	**Thales of Miletus:** *Philosophy*.

H. L. C.	HUGH LONGBOURNE CALLENDAR, F.R.S., LL.D. Professor of Physics, Royal College of Science, London. Formerly Professor of Physics in McGill College, Montreal, and in University College, London.	**Thermodynamics; Thermoelectricity; Thermometry.**
H. M. C.	HECTOR MUNRO CHADWICK, M.A. Fellow and Librarian of Clare College, Cambridge, and University Lecturer in Scandinavian. Author of *Studies on Anglo-Saxon Institutions.*	**Teutonic Languages; Teutonic Peoples; Thor.**
H. R. K.	HARRY ROBERT KEMPE, M.INST.C.E. Electrician to the General Post Office, London. Author of *The Engineer's Year Book*; &c.	**Telegraph; Telephone.**
H. S. J.	HENRY STUART JONES, M.A. Formerly Fellow and Tutor of Trinity College, Oxford, and Director of the British School at Rome. Member of the German Imperial Archaeological Institute. Author of *The Roman Empire*; &c.	**Theatre:** *Ancient* (*in part*).
H. Ti.	HENRY TIEDEMANN. London Editor of the *Nieuwe Rotterdamsche Courant.*	**Thorbecke.**
H. W. B.	SIR HILARO WILLIAM WELLESLEY BARLOW, Bart. Lieut.-Col. Royal Artillery. Superintendent of the Royal Laboratory, Woolwich.	**Sword:** *Modern Military* (*in part*).
H. W. C. D.	HENRY WILLIAM CARLESS DAVIS, M.A. Fellow and Tutor of Balliol College, Oxford. Fellow of All Souls College, Oxford, 1895–1902. Author of *England under the Normans and Angevins*; *Charlemagne.*	**Theobald.**
H. W. H.	HOPE W. HOGG, M.A. Professor of Semitic Languages and Literatures in the University of Manchester.	**Thapsacus.**
I. A.	ISRAEL ABRAHAMS, M.A. Reader in Talmudic and Rabbinic Literature in the University of Cambridge. Formerly President of the Jewish Historical Society of England. Author of *A Short History of Jewish Literature*; *Jewish Life in the Middle Ages*; *Judaism*; &c.	**Synagogue, United; Tam, Jacob ben Meir; Tanna.**
I. J. C.	ISAAC JOSLIN COX, PH.D. Assistant Professor of History in the University of Cincinnati. President of the Ohio Valley Historical Association. Author of *The Journeys of La Salle and his Companions*; &c.	**Taylor, Zachary.**
J. A. F.	JOHN AMBROSE FLEMING, M.A., D.SC., F.R.S. Pender Professor of Electrical Engineering in the University of London. Fellow of University College, London. Formerly Fellow of St John's College, Cambridge, and University Lecturer on Applied Mechanics. Author of *Magnets and Electric Currents.*	**Telegraph:** *Wireless Telegraphy.*
J. A. H.	JOHN ALLEN HOWE. Curator and Librarian of the Museum of Practical Geology, London. Author of *The Geology of Building Stones.*	**Tertiary.**
J. A. S.	JOHN ADDINGTON SYMONDS, LL.D. See the biographical article: SYMONDS, J. ADDINGTON.	**Tasso.**
J. Br.	RIGHT HON. JAMES BRYCE, D.C.L., D.LITT. See the biographical article: BRYCE, JAMES.	**Theodora.**
J. Bra.	JOSEPH BRAUN, S.J. Author of *Die liturgische Gewandung*; &c.	**Surplice; Tiara.**
J. Bt.	JAMES BARTLETT. Lecturer on Construction, Architecture, Sanitation, Quantities, &c., at King's College, London. Member of Society of Architects. Member of Institute of Junior Engineers.	**Timber.**
J. C. E.	JAMES COSSAR EWART, M.D., F.R.S. Regius Professor of Zoology in the University of Edinburgh. Swiney Lecturer on Geology at the British Museum, 1907. Author of *The Multiple Origin of Horses and Ponies*; &c.	**Telegony.**
J. D. Pr.	JOHN DYNELEY PRINCE, PH.D. Professor of Semitic Languages in Columbia University, New York. Took part in the Expedition to Southern Babylonia, 1888–1889.	**Sumer and Sumerian.**
J. E. F.	REV. JAMES EVERETT FRAME, A.M. Edward Robinson Professor of Biblical Theology in Union Theological Seminary, New York. Author of *Purpose of New Testament Theology.*	**Thessalonians, Epistles to the.**
J. F.-K.	JAMES FITZMAURICE-KELLY, LITT.D., F.R.HIST.S. Gilmour Professor of Spanish Language and Literature, Liverpool University. Norman McColl Lecturer, Cambridge University. Fellow of the British Academy. Member of the Royal Spanish Academy. Knight Commander of the Order of Alphonso XII. Author of *A History of Spanish Literature*; &c.	**Tamayo y Baus; Tirso de Molina.**
J. F. St.	JOHN FREDERICK STENNING, M.A. Dean, Fellow and Lecturer in Divinity and Hebrew, Wadham College, Oxford. University Lecturer in Aramaic.	**Targum.**
J. Ga.	JAMES GAIRDNER, C.B., LL.D. See the biographical article: GAIRDNER, JAMES.	**Talbot** (*Family*) (*in part*).
J. G. F.	SIR JOSHUA GIRLING FITCH, LL.D. See the biographical article: FITCH, SIR J. G.	**Thring, Edward.**

J. G. Fr.	James George Frazer, M.A., D.C.L., LL.D., Litt.D. Professor of Social Anthropology, Liverpool University. Fellow of Trinity College, Cambridge. Fellow of the British Academy. Author of *The Golden Bough*; &c.	**Thesmophoria** (*in part*).
J. G. M.	John Gray McKendrick, M.D., LL.D., F.R.S., F.R.S. (Edin.). Emeritus Professor of Physiology in the University of Glasgow. Professor of Physiology, 1876–1906. Author of *Life in Motion*; *Life of Helmholtz*; &c.	**Taste.**
J. G. Sc.	Sir James George Scott, K.C.I.E. Superintendent and Political Officer, Southern Shan States. Author of *Burma*; *The Upper Burma Gazetteer*.	**Theinni; Thibaw.**
J. H. M.	John Henry Middleton, M.A., Litt.D., F.S.A., D.C.L. (1846–1896). Slade Professor of Fine Art in the University of Cambridge, 1886–1895. Director of the Fitzwilliam Museum, Cambridge, 1889–1892. Art Director of the South Kensington Museum, 1892–1896. Author of *The Engraved Gems of Classical Times*; *Illuminated Manuscripts in Classical and Mediaeval Times*.	**Theatre:** *Ancient* (*in part*); *Modern* (*in part*); **Tiryns** (*in part*).
J. H. R.	John Horace Round, M.A., LL.D. Balliol College, Oxford. Author of *Feudal England*; *Studies in Peerage and Family History*; *Peerage and Pedigree*.	**Talbot** (*Family*) (*in part*).
J. Hl. R.	John Holland Rose, M.A., Litt.D. Christ's College, Cambridge. Lecturer on Modern History to the Cambridge University Local Lectures Syndicate. Author of *Life of Napoleon I.*; *Napoleonic Studies*; *The Development of the European Nations*; *The Life of Pitt*; &c.	**Talleyrand.**
J. Ja.	Joseph Jacobs, Litt.D. Professor of English Literature in the Jewish Theological Seminary, New York. Formerly President of the Jewish Historical Society of England. Corresponding Member of the Royal Academy of History, Madrid. Author of *Jews of Angevin England*; *Studies in Biblical Archaeology*; &c.	**Tabernacles, Feast of.**
J. K. I.	John Kells Ingram, LL.D. See the biographical article: Ingram, John Kells.	**Sumptuary Laws.**
J. K. L.	Sir John Knox Laughton, M.A., Litt.D. Professor of Modern History, King's College, London. Secretary of the Navy Records Society. Served in the Baltic, 1854–1855; in China, 1856–1859. Mathematical and Naval Instructor, Royal Naval College, Portsmouth, 1866–1873; Greenwich, 1873–1885. President, Royal Meteorological Society, 1882–1884. Honorary Fellow of Gonville and Caius College, Cambridge. Fellow of King's College, London. Author of *Physical Geography in its Relation to the Prevailing Winds and Currents*; *Studies in Naval History*; *Sea Fights and Adventures*; &c.	**Tegetthoff, Admiral.**
J. L. E. D.	John Louis Emil Dreyer. Director of Armagh Observatory. Author of *Planetary Systems from Thales to Kepler*; &c.	**Time, Measurement of.**
J. M.	Sir John Macdonell, M.A., C.B., LL.D. Master of the Supreme Court. Formerly Counsel to the Board of Trade and the London Chamber of Commerce; Quain Professor of Comparative Law, University College, London. Editor of *State Trials*; *Civil Judicial Statistics*; &c. Author of *Survey of Political Economy*; *The Land Question*; &c.	**Suzerainty.**
J. Mt.	Rev. James Moffatt, M.A., D.D. Minister of the United Free Church of Scotland. Jowett Lecturer, London, 1907. Author of *Historical New Testament*; &c.	**Timothy, First Epistle to; Timothy, Second Epistle to; Titus, Epistle to.**
J. McE.	John McEwan, F.R.G.S., F.R.Met.Soc.	**Tea.**
J. M. G.	John Miller Gray (1850–1894). Art Critic. Curator of the Scottish National Portrait Gallery, 1884–1894. Author of *David Scott, R.S.A.*; *James and William Tassie*.	**Tassie, James.**
J. M. M.	John Malcolm Mitchell. Sometime Scholar of Queen's College, Oxford. Lecturer in Classics, East London College (University of London). Joint-editor of Grote's *History of Greece*.	**Terramara; Themistocles; Thucydides** (*in part*).
J. Pu.	John Purser, M.A., LL.D. Formerly Professor of Mathematics in Queen's College, Belfast. Member of the Royal Irish Academy.	**Surface** (*in part*).
J. P. E.	Jean Paul Hippolyte Émmanuel Adhémar Esmein. Professor of Law in the University of Paris. Officer of the Legion of Honour. Member of the Institute of France. Author of *Cours élémentaire d'histoire du droit français*; &c.	**Taille.**
J. P. P.	John Percival Postgate, M.A., Litt.D. Professor of Latin in the University of Liverpool. Fellow of Trinity College, Cambridge. Fellow of the British Academy. Editor of the *Classical Quarterly*. Editor-in-Chief of the *Corpus poëtarum Latinorum*; &c.	**Textual Criticism; Tibullus, Albius.**
J. P. Pe.	John Punnett Peters, Ph.D., D.D. Canon Residentiary of the Protestant Episcopal Cathedral of St John the Divine, New York City. Formerly Professor of Hebrew in the University of Pennsylvania. In charge of the University Expedition to Babylonia, 1888–1895. Author of *Nippur, or Explorations and Adventures on the Euphrates*.	**Tigris.**
J. S. F.	John Smith Flett, D.Sc., F.G.S. Petrographer to the Geological Survey of the United Kingdom. Formerly Lecturer on Petrology in Edinburgh University. Neill Medallist of the Royal Society of Edinburgh. Bigsby Medallist of the Geological Society of London.	**Syenite; Tachylytes; Theralite.**

J. S. Ga.	JAMES SYKES GAMBLE, M.A., C.I.E., F.R.S., F.L.S. Indian Forest Service (retired). Formerly Director of the Imperial Forest School at Dehra Dun. Author of *A Manual of Indian Timbers*; &c.	**Teak** (*in part*).
J. S. R.	JAMES SMITH REID, M.A., LL.D., LITT.D. Professor of Ancient History and Fellow and Tutor of Gonville and Caius College, Cambridge. Honorary Fellow, formerly Fellow and Lecturer of Christ's College. Browne's and Chancellor's Medals. Editor of editions of Cicero's *Academia*: *De Amicitia*; &c.	**Tiberius.**
J. T. Be.	JOHN THOMAS BEALBY. Joint-author of Stanford's Europe. Formerly Editor of the *Scottish Geographical Magazine*. Translator of Sven Hedin's *Through Asia*, *Central Asia and Tibet*; &c.	**Syr-Darya** (*River*) (*in part*); **Syr-Darya** (*Province*) (*in part*); **Takla Makan; Tambov** (*in part*); **Tarim; Tian-Shan; Tiflis** (*Town*) (*in part*); **Tobolsk** (*Government*) (*in part*); **Tomsk** (*Government*) (*in part*).
J. T. C.	JOSEPH THOMAS CUNNINGHAM, M.A., F.Z.S. Lecturer on Zoology at the South-Western Polytechnic, London. Formerly Fellow of University College, Oxford. Assistant Professor of Natural History in the University of Edinburgh. Naturalist to the Marine Biological Association.	**Teredo.**
J. W.	JAMES WILLIAMS, M.A., D.C.L., LL.D. All Souls Reader in Roman Law in the University of Oxford, and Fellow of Lincoln College. Author of *Wills and Succession*; &c.	**Theatre:** *Law relating to Theatres*; **Tithes** (*Law*).
J. Wal.	JAMES WALKER, D.SC., PH.D., LL.D., F.R.S. Professor of Chemistry in the University of Edinburgh. Professor of Chemistry, University College, Dundee, 1894–1908. Author of *Introduction to Physical Chemistry.*	**Thermochemistry.**
J. W. G.	JOHN WALTER GREGORY, D.SC., F.R.S. Professor of Geology in the University of Glasgow. Professor of Geology and Mineralogy in the University of Melbourne, 1900–1904. Author of *The Dead Heart of Australia*; &c.	**Tasmania:** *Geology.*
J. W. He.	JAMES WYCLIFFE HEADLAM, M.A. Staff Inspector of Secondary Schools under the Board of Education, London. Formerly Fellow of King's College, Cambridge. Professor of Greek and Ancient History at Queen's College, London. Author of *Bismarck and the Foundation of the German Empire*; &c.	**Taaffe, Count; Thun-Hohenstein.**
J. W. L. G.	JAMES WHITBREAD LEE GLAISHER, M.A., D.SC., F.R.S. Fellow of Trinity College, Cambridge. Formerly President of the Cambridge Philosophical Society and the Royal Astronomical Society. Editor of *Messenger of Mathematics* and the *Quarterly Journal of Pure and Applied Mathematics*.	**Table, Mathematical.**
K. A. M.*	KATE A. MEAKIN (MRS BUDGETT MEAKIN).	**Tetuan; Sus.**
K. L.	REV. KIRSOPP LAKE, M.A. Lincoln College, Oxford. Professor of Early Christian Literature and New Testament Exegesis in the University of Leiden. Author of *The Text of the New Testament*; *The Historical Evidence for the Resurrection of Jesus Christ*; &c.	**Tatian.**
K. S.	KATHLEEN SCHLESINGER. Author of *The Instruments of the Orchestra*. Editor of *The Portfolio of Musical Archaeology.*	**Symphonia; Tambourine; Timbrel.**
L. A. W.	LAURENCE AUSTINE WADDELL, C.B., C.I.E., LL.D. Lieut.-Colonel I.M.S. (retired). Author of *Lhasa and its Mysteries*; &c.	**Tibet** (*in part*).
L. J. S.	LEONARD JAMES SPENCER, M.A. Assistant in the Department of Mineralogy, British Museum. Formerly Scholar of Sidney Sussex College, Cambridge, and Harkness Scholar. Editor of the *Mineralogical Magazine.*	**Sylvanite; Sylvite; Tetradymite; Tetrahedrite; Thorite.**
M. B.	MONTAGU BROWNE. Author of *Practical Taxidermy*; *Collecting Butterflies and Moths.*	**Taxidermy.**
M. Ba.	THE HON. MAURICE BARING. Sometime Scholar of Trinity College, Cambridge. War Correspondent for the *Morning Post* in Manchuria, 1904; and Special Correspondent in Russia, 1905–1908, and in Constantinople, 1909. Author of *Landmarks in Russian Literature*; *With the Russians in Manchuria*; *A Year in Russia*; &c.	**Taine.**
M. H. S.	MARION H. SPIELMANN, F.S.A. Formerly Editor of the *Magazine of Art*. Member of the Fine Art Committee of the International Exhibitions of Brussels, Paris, Buenos Aires, Rome and the Franco-British Exhibition, London. Author of *History of "Punch"*; *British Portrait-Painting to the Opening of the Nineteenth Century*; *Works of G. F. Watts, R. A.*; *British Sculpture and Sculptors of To-day*; *Henriette Ronner*; &c.	**Thornycroft, William Hamo.**
M. J. de G.	MICHAEL JAN DE GOEJE. See the biographical article: GOEJE, MICHAEL JAN DE.	**Thousand and one Nights.**
M. M. Bh.	SIR MANCHERJEE MERWANJEE BHOWNAGGREE, K.C.I.E. Fellow of Bombay University. M.P. for N.E. Bethnal Green, 1895–1906. Author of *History of the Constitution of the East India Company*; &c.	**Takhtsingji.**

M. O. B. C.	MAXIMILIAN OTTO BISMARCK CASPARI, M.A. Reader in Ancient History in London University. Lecturer in Greek in Birmingham University, 1905–1908.	**Tegea; Theodosius I.-III.; Theramenes; Thrasybulus.**
N. M.	NORMAN M'LEAN, M.A. Lecturer in Aramaic, Cambridge University. Fellow and Hebrew Lecturer, Christ's College, Cambridge. Joint-editor of the larger Cambridge *Septuagint*.	**Syriac Language; Syriac Literature; Thomas of Marga.**
N. M.*	NEILL MALCOLM, D.S.O., F.R.G.S. Major, Argyll and Sutherland Highlanders. Served N.W. Frontier, India, 1897–1898; South Africa, 1899–1900; Somaliland, 1903–1904; British Mission to Fez, 1905. Editor of *The Science of War*.	**Tactics.**
N. W. T.	NORTHCOTE WHITRIDGE THOMAS, M.A. Government Anthropologist to Southern Nigeria. Corresponding Member of the Société d'Anthropologie de Paris. Author of *Thought Transference*; *Kinship and Marriage in Australia*; &c.	**Taboo; Telepathy.**
O. H. D.	OSKAR HENRIK DUMRATH, PH.D. Formerly Editor of foreign news in the *Nya Dagligt Allehanda*.	**Sweden:** *History* (*in part*).
O. J. R. H.	OSBERT JOHN RADCLIFFE HOWARTH, M.A. Christ Church, Oxford. Geographical Scholar, Oxford, 1901. Assistant Secretary of the British Association.	**Sweden:** *Geography and Statistics*; **Tibet** (*in part*).
P. A. K.	PRINCE PETER ALEXEIVITCH KROPOTKIN. See the biographical article: KROPOTKIN, PRINCE P.A.	**Syr-Darya:** *River* (*in part*); **Syr-Darya:** *Province* (*in part*); **Tambov** (*in part*); **Tatars** (*in part*); **Tiflis:** *Town* (*in part*); **Tobolsk:** *Government* (*in part*); **Tomsk:** *Government* (*in part*).
P. Gi.	PETER GILES, M.A., LL.D., LITT.D. Fellow and Classical Lecturer of Emmanuel College, Cambridge, and University Reader in Comparative Philology. Formerly Secretary of the Cambridge Philological Society. Author of *Manual of Comparative Philology*.	**T.**
P. G. K.	PAUL GEORGE KONODY. Art Critic of the *Observer* and the *Daily Mail*. Formerly Editor of the *Artist*. Author of *The Art of Walter Crane*; *Velasquez, Life and Work*; &c.	**Teniers** (*in part*).
P. La.	PHILIP LAKE, M.A., F.G.S. Lecturer in Regional Geography in the University of Cambridge. Formerly of the Geological Survey of India. Author of *Monograph of British Cambrian Trilobites*. Translator and Editor of Keyser's *Comparative Geology*.	**Sweden:** *Geology*.
P. M.*	SIR PHILIP MAGNUS. M.P. for the University of London. Superintendent and Secretary of the City and Guilds of London Institute. President of Council of College of Preceptors; Chairman of Secondary Schools Association. Member of the Royal Commission on Technical Instruction, 1881–1884. Author of *Industrial Education*; &c.	**Technical Education.**
P. McC.	PRIMROSE MCCONNELL, F.G.S. Member of the Royal Agricultural Society. Author of *Diary of a Working Farmer*.	**Thrashing.**
P. Vi.	PAUL VINOGRADOFF, D.C.L., LL.D. See the biographical article: VINOGRADOFF, PAUL.	**Succession.**
R. A. N.	REYNOLD ALLEYNE NICHOLSON, M.A., LITT.D. Lecturer in Persian in the University of Cambridge. Sometime Fellow of Trinity College, Cambridge, and Professor of Persian at University College, London. Author of *Selected Poems from the Divani Shamsi Tabriz*; *A Literary History of the Arabs*; &c.	**Sūfiism; Sunnites** (*in part*).
R. A. Sa.	RALPH ALLEN SAMPSON, M.A., D.Sc., F.R.S. Astronomer Royal for Scotland. Formerly Professor of Mathematics and Astronomy in the University of Durham, and Fellow of St John's College, Cambridge. Author of *Tables of the Four Great Satellites of Jupiter*; &c.	**Sun.**
R. A. S. M.	ROBERT ALEXANDER STEWART MACALISTER, M.A., F.S.A. St John's College, Cambridge. Director of Excavations for the Palestine Exploration Fund.	**Tiberias.**
R. C. J.	SIR RICHARD CLAVERHOUSE JEBB, LL.D., D.C.L. See the biographical article: JEBB, SIR RICHARD CLAVERHOUSE.	**Thucydides** (*in part*).
R. G.	RICHARD GARNETT, LL.D. See the biographical article: GARNETT, RICHARD.	**Swift, Jonathan** (*in part*).
R. Gn.	SIR ROBERT GIFFEN, F.R.S. See the biographical article: GIFFEN, SIR ROBERT.	**Taxation.**
R. H. C.	REV. ROBERT HENRY CHARLES, M.A., D.D., LITT.D. (Oxon). Grinfield Lecturer and Lecturer in Biblical Studies, Oxford, and Fellow of Merton College. Fellow of the British Academy. Formerly Senior Moderator of Trinity College, Dublin. Author and Editor of *Book of Enoch*; *Book of Jubilees*; *Apocalypse of Baruch*; *Assumption of Moses*; *Ascension of Isaiah*; &c.	**Testaments of the Three Patriarchs; Testaments of the Twelve Patriarchs.**
R. I. P.	REGINALD INNES POCOCK, F.Z.S. Superintendent of the Zoological Gardens, London.	**Tarantula; Tardigrada; Ticks.**

R. J. M.	RONALD JOHN MCNEILL, M.A. Christ Church, Oxford. Barrister-at-Law. Formerly Editor of the *St James's Gazette* (London).	**Sussex, 3rd Earl of; Tandy, James Napper; Temple, Earl.**
R. L.*	RICHARD LYDEKKER, F.R.S., F.G.S., F.Z.S. Member of the Staff of the Geological Survey of India, 1874–1882. Author of *Catalogue of Fossil Mammals, Reptiles and Birds in the British Museum*; *The Deer of all Lands*; *The Game Animals of Africa*; &c.	**Swine; Tapir** (*in part*); **Tarsier; Tiger** (*in part*); **Tillodontia; Titanotheriidae.**
R. Ma.	REV. ROBERT MACKINTOSH, M.A., D.D. Tutor in Lancashire Independent College, Manchester.	**Theism; Theology.**
R. N. B.	ROBERT NISBET BAIN (d. 1909). Assistant Librarian, British Museum, 1883–1909. Author of *Scandinavia: the Political History of Denmark, Norway and Sweden, 1513–1900*; *The First Romanovs, 1613 to 1725*; *Slavonic Europe: the Political History of Poland and Russia from 1469 to 1796*; &c.	**Svane, Hans; Sweden:** *History* (*in part*); **Sweyn I.; Széchenyi, Istvan, Count; Szigligeti, Ede; Tarnowski, Jan; Tausen, Hans; Tessin, Count; Theodore I.-III. of Russia; Thököly, Imre; Tisza, Kálmán; Toll, Johan, Count; Tolstoy, Petr, Count.**
R. P. S.	R. PHENÉ SPIERS, F.S.A., F.R.I.B.A. Formerly Master of the Architectural School, Royal Academy, London. Past President of Architectural Association. Associate and Fellow of King's College, London. Corresponding Member of the Institute of France. Editor of *Fergusson's History of Architecture*. Author of *Architecture: East and West*; &c.	**Temple** (*in part*).
R. R.	REINHOLD ROST, C.I.E., LL.D. (1822–1896). Secretary of the Royal Asiatic Society, 1863–1869. Librarian at the India Office, London, 1869–1893. Editor of H. H. Wilson's *Essays on the Religions of the Hindus*; Hodgson's *Essays on Indian Subjects*; &c.	**Tamils; Thugs.**
S. A. C.	STANLEY ARTHUR COOK, M.A. Editor for the Palestine Exploration Fund. Lecturer in Hebrew and Syriac, and formerly Fellow, Gonville and Caius College, Cambridge. Examiner in Hebrew and Aramaic, London University, 1904–1908. Author of *Glossary of Aramaic Inscriptions*; *The Laws of Moses and Code of Hammurabi*; *Critical Notes on Old Testament History*; *Religion of Ancient Palestine*; &c.	**Talmud.**
S. Bl.	SIGFUS BLÖNDAL. Librarian of the University of Copenhagen.	**Thomsen, Grimur; Thóroddsen, Jón.**
St G. L. F.-P.	ST GEORGE LANE FOX-PITT, M.R.A.S. Associate of King's College, London. Treasurer and Vice-President of the Moral Education League and the International Moral Education Congress.	**Theosophy:** *Oriental.*
St G. S.	ST GEORGE STOCK, M.A. Pembroke College, Oxford. Lecturer in Greek in the University of Birmingham.	**Therapeutae; Tobit, The Book of.**
S. K.	STEN KONOW, PH.D. Professor of Indian Philology in the University of Christiania. Officier de l'Académie Française. Author of *Stamavidhana Brahmana*; &c.	**Tibeto-Burman Languages.**
S. N.	SIMON NEWCOMB, D.Sc., LL.D. See the biographical article: NEWCOMB, SIMON.	**Time, Standard.**
T. As.	THOMAS ASHBY, M.A., LITT.D. Director of the British School of Archaeology at Rome. Formerly Scholar of Christ Church, Oxford. Craven Fellow, 1897. Conington Prizeman, 1906. Member of the imperial German Archaeological Institute. Author of *The Classical Topography of the Roman Campagna*.	**Suessula; Sulci; Surrentum; Sutri; Sybaris; Syracuse** (*in part*); **Taormina; Taranto; Tarentum; Tarquinii; Teggiano; Tergeste; Termini Imerese; Terracina; Tharros; Thurii; Tibur; Tiburtina, Via; Ticinum.**
T. A. A.	THOMAS ANDREW ARCHER, M.A. Author of *The Crusade of Richard I.*; &c.	**Templars** (*in part*).
T. A. C.	TIMOTHY AUGUSTINE COGHLAN, I.S.O. Agent-General for New South Wales. Government Statistician, New South Wales, 1886–1905. Honorary Fellow of the Royal Statistical Society. Author of *Wealth and Progress of New South Wales*; *Statistical Account of Australia and New Zealand*; &c.	**Tasmania:** *Geography, Statistics* and *History.*
T. de L.	A. TERRIEN DE LACOUPERIE, LITT.D. Formerly Professor of Indo-Chinese at University College, London.	**Tibet** (*in part*).
T. H.	THOMAS HODGKIN, D.C.L., LITT.D. See the biographical article: HODGKIN, THOMAS.	**Theodoric.**
T. H. H.*	SIR THOMAS HUNGERFORD HOLDICH, K.C.M.G., K.C.I.E., D.Sc. Superintendent of Frontier Surveys, India, 1892–1898. Gold Medallist, R.G.S., London, 1887. Author of *The Indian Borderland*; *The Countries of the King's Award*; *India*; *Tibet*.	**Surveying** (*in part*); **Tibet** (*in part*).

T. H. W.	T. Hudson Williams. Professor of Greek in the University College of North Wales, Bangor.	**Theognis of Megara.**
T. L. B.	Sir Thomas Lauder Brunton, Bart., M.D., Sc.D., LL.D., F.R.S., F.R.C.P. Consulting Physician to St Bartholomew's Hospital, London. Author of *Modern Therapeutics*; *Therapeutics of the Circulation*; &c.	**Therapeutics.**
T. L. H.	Sir Thomas Little Heath, K.C.B., Sc.D. Assistant Secretary to the Treasury, London. Formerly Fellow of Trinity College, Cambridge. Author of *Apollonius of Perga*; *Treatise on Conic Sections*; *The Thirteen Books of Euclid's Elements*; &c.	**Theodosius of Tripolis.**
T. M. L.	Rev. Thomas Martin Lindsay, M.A., D.D. Principal and Professor of Church History, United Free Church College, Glasgow. Author of *Life of Luther*; &c.	**Thomas à Kempis.**
T. R. R. S.	Rev. Thomas Roscoe Rede Stebbing, M.A., F.R.S., F.L.S., F.Z.S. Fellow of King's College, London. Hon. Fellow, formerly Fellow and Tutor, of Worcester College, Oxford. Zoological Secretary of the Linnaean Society, 1903–1907. Author of *A History of Crustacea*; *The Naturalist of Cumbrae*; &c.	**Thyrostraca.**
T. Se.	Thomas Seccombe, M.A. Balliol College, Oxford. Lecturer in History, East London and Birkbeck Colleges, University of London. Stanhope Prizeman, Oxford, 1887. Assistant Editor of the *Dictionary of National Biography*, 1891–1901. Author of *The Age of Johnson*; &c.	**Swift, Jonathan** (*in part*); **Tichborne Claimant.**
V. W. Ch.	Valentine Walbran Chapman.	**Sugar:** *Sugar Manufacture* (*in part*).
W. Ay.	Wilfrid Airy, M.Inst.C.E. Sometime Scholar of Trinity College, Cambridge. Technical adviser to the Standards Department of the Board of Trade. Author of *Levelling and Geodesy*; &c.	**Tacheometry.**
W. A. B. C.	Rev. William Augustus Brevoort Coolidge, M.A., F.R.G.S., Ph.D. Fellow of Magdalen College, Oxford. Professor of English History, St David's College, Lampeter, 1880–1881. Author of *Guide du Haut Dauphiné*; *The Range of the Todi*; *Guide to Grindelwald*; *Guide to Switzerland*; *The Alps in Nature and in History*; &c. Editor of the *Alpine Journal*, 1880–1881; &c.	**Switzerland:** *Geography*, *Government*, &c., *History* and *Literature*; **Tell, William; Thun** (*Town*); **Thun, Lake of; Thurgau; Ticino** (*Canton*); **Tirol; Toggenburg, The.**
W. A. P.	Walter Alison Phillips, M.A. Formerly Exhibitioner of Merton College and Senior Scholar of St John's College, Oxford. Author of *Modern Europe*; &c.	**Surplice:** *Church of England*; **Templars** (*in part*); **Titles of Honour.**
W. B.*	William Burton, M.A., F.C.S. Chairman of the Joint Committee of Pottery Manufacturers of Great Britain. Author of *English Stoneware and Earthenware*; &c.	**Terracotta** (*in part*); **Tile.**
W. B. B.	W. Baker Brown. Lieut.-Colonel, Commanding Royal Engineers at Malta.	**Submarine Mines.**
W. B. S.*	William Barclay Squire, M.A., F.S.A., F.R.G.S. Assistant in charge of Printed Music, British Museum. Hon. Secretary of the Purcell Society. Formerly Musical Critic of the *Westminster Gazette*, the *Saturday Review* and the *Globe*.	**Thomas, Arthur Goring.**
W. E. Co.	Rt. Rev. William Edward Collins, D.D. Bishop of Gibraltar. Formerly Professor of Ecclesiastical History, King's College, London. Lecturer at Selwyn and St John's Colleges, Cambridge. Author of *The Study of Ecclesiastical History*; *Beginnings of English Christianity*; &c.	**Tait, Archbishop; Testamentum Domini.**
W. F. C.	William Feilden Craies, M.A. Barrister-at-Law, Inner Temple. Lecturer on Criminal Law, King's College, London. Editor of Archbold's *Criminal Pleading* (23rd edition).	**Summary Jurisdiction; Summons; Sunday** (*Law*).
W. G. F.	William George Freeman. Joint-author of *Nature Teaching*; *The World's Commercial Products*; &c. Joint-editor of *Science Progress in the Twentieth Century*.	**Tobacco.**
W. Hy.	William Henry. Founder and Chief Secretary to the Royal Life Saving Society. Associate of the Order of St John of Jerusalem. Joint-author of *Swimming* (Badminton Library); &c.	**Swimming.**
W. H. F.	Sir William Henry Flower, F.R.S. See the biographical article: Flower, Sir W. H.	**Tapir** (*in part*); **Tiger** (*in part*).
W. H. P.	Walter Herries Pollock, M.A. Trinity College, Cambridge. Editor of the *Saturday Review*, 1883–1894. Author of *Lectures on French Poets*; *Impressions of Henry Irving*; &c.	**Thackeray.**
W. J. B.	Rev. William Jackson Brodribb, M.A. Formerly Fellow of St John's College, Cambridge, and Rector of Wootton-Rivers, Wilts.	**Tacitus** (*in part*).
W. L.*	Walter Lehmann, M.D. Directorial Assistant of the Royal Ethnographical Museum, Munich. Conducted Exploring Expedition in Mexico and Central America, 1907–1909. Author of publications on Mexican and Central American Archaeology.	**Toltecs.**
W. McD.	William McDougall, M.A. Wilde Reader in Mental Philosophy in the University of Oxford. Formerly Fellow of St John's College, Cambridge.	**Suggestion.**

W. M. R.	William Michael Rossetti. See the biographical article: Rossetti, Dante Gabriel.	**Tintoretto; Titian.**
W. M. Ra.	Sir William Mitchell Ramsay, Litt.D., D.C.L. See the biographical article: Ramsay, Sir W. Mitchell.	**Tarsus.**
W. N. S.	William Napier Shaw, M.A., LL.D., D.Sc., F.R.S. Director of the Meteorological Office. Reader in Meteorology in the University of London. President of Permanent International Meteorological Committee. Member of Meteorological Council, 1897–1905. Hon. Fellow of Emmanuel College, Cambridge. Fellow of Emmanuel College, 1877–1906; Senior Tutor, 1890–1899. Joint Author of *Text-Book of Practical Physics*; &c.	**Sunshine.**
W. P. A.	Lieut.-Colonel William Patrick Anderson, M.Inst.C.E., F.R.G.S. Chief-Engineer, Department of Marine and Fisheries of Canada. Member of the Geographical Board of Canada. Past President of the Canadian Society of Civil Engineers.	**Superior:** *Lake.*
W. Ri.	William Ridgeway, M.A., D.Sc., Litt.D. Disney Professor of Archaeology, and Brereton Reader in Classics, in the University of Cambridge. Fellow of Gonville and Caius College. Fellow of the British Academy. President of the Royal Anthropological Institute, 1908. Author of *The Early Age of Greece*; &c.	**Thrace:** *Ancient Peoples.*
W. R. S.	William Robertson Smith, LL.D. See the biographical article: Smith, W. Robertson.	**Teraphim** (*in part*).
W. Sh.	William Sharp. See the biographical article: Sharp, William.	**Thoreau, Henry David.**
W. S. R.	William Smyth Rockstro. Author of *A Great History of Music from the Infancy of the Greek Drama to the Present Period*; &c.	**Tallis, Thomas.**
W. W. R.*	William Walker Rockwell, Lic.Theol. Assistant Professor of Church History, Union Theological Seminary, New York.	**Toledo, Councils of.**
W. Y. S.	William Young Sellar, LL.D. See the biographical article: Sellar, William Young.	**Terence** (*in part*).

PRINCIPAL UNSIGNED ARTICLES

Succession Duty.
Succinic Acid.
Suez Canal.
Suffolk, Earls and Dukes of.
Suffolk.
Sulphonic Acids.
Sulphur.
Sumatra.
Sunderland.
Sundew.
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Surgical Instruments and Appliances.
Surrey.
Sussex, Earls of.
Sussex.
Sutherland, Earls and Dukes of.
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Theseus.
Thorium.
Thuringia.
Tibbu.
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Tiglath-Pileser.
Timor.
Tin.
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SUBMARINE MINES. A submarine mine is a weapon of war used in the attack and defence of harbours and anchorages. It may be defined as "A charge of explosives, moored at or beneath the surface of the water, intended by its explosion to put out of action without delay a hostile vessel of the class it is intended to act against." It differs from the torpedo (*q.v.*) in being incapable of movement (except in the special form of drifting mines, which are not moored, but move with the tide or current). But this subdivision into two distinct classes was not made till 1870. Prior to that date the teim "torpedo" was used for all explosive charges fired in the water.

Submarine mines may be divided into two main classes, controllable and uncontrollable, or, as they are often classified, "electrical" or "mechanical." In the first class the method of firing is by electricity, the source of the electric power whether by battery or dynamo being contained in a firing station on shore and connected to the mines by insulated cables. By simply switching off the electricity in the firing station, such mines are rendered inert and entirely harmless. In the second class, the means of firing are contained in the mine itself, the source of power being a small electric battery, or being cbtained from a pistol, spring or suspended weight. In all mines of this class the impulse which actuates the firing gear is given by a ship or other floating object bumping against the mine. When mechanical mines have once been set for firing they are thus dangerous to friend and foe alike. Safety arrangements are employed to prevent the firing apparatus working while the mine is being laid, and clockwork is sometimes added to render the mine inactive after a certain definite time or in case the mine breaks away from its mooring. Their principal advantages, as compared with the electrically controlled mines, are cheapness and rapidity of laying. "Controllable" mines are absolutely under the control of the operator on shore, their condition is always accurately known, and if any break adrift not only is the fact at once known but the mines themselves are harmless. Another advantage is that when fired by "observation" as described below, they are placed at depths which will be well below the bottom of any vessels passing through the mine field. They can thus be used in channels which have to be kept open for traffic during hostilities.

Electrical mines take rather longer to prepare and lay out than the other class, as the electrical cables have to be laid and jointed, and they require rather more skill and training in the operators employed to lay and fire the mines. Such mines represent the highest development of this form of warfare, and the details given below refer mainly to this class of mine.

Electrical mines are arranged on two systems according to the method of ascertaining the proper moment to apply the firing current to the mine cables. These methods are by "observation" or by "circuit closer."

The "observation" system depends on two careful observations made by an operator on shore, one of the exact position in which the mines are laid, the other of the track of hostile ships passing over the mine field. The position of the mines when laid is marked on a special chart, on which the track of ships crossing the mine field can also be plotted. When the track is seen to be crossing the position of a mine, a switch is closed on shore and the mine is fired. To allow for errors in observation such mines are fitted with large charges of explosive and are usually arranged in lines of two, three or four mines placed across the channel, all the mines in a line being fired together. Observation mines are placed either resting on the bottom or moored at depths which are well below the bottom of any friendly vessels and (except that anchoring in the mine field must be forbidden for fear of injury to cables) such mines offer no obstruction to friendly traffic.

In the "circuit closer" or "C.C." system, each mine contains a small piece of apparatus which is set in action by tbe blow of a vessel or other object against the mine. When set in action, this apparatus completes an electrical circuit in the mine, through which the mine can be fired, if the main switch on shore is closed. If it is not wished to fire, the C.C. is restored to its ordinary condition either automatically by a spring in the mine, or by an electrical device operated from the shore.

Such mines are necessarily placed near the surface, and are to this extent an interference with friendly traffic. A vessel passing by mistake through a mine field of this class would run no risk of an explosion while the mines are inactive, but might do some damage to the mines.

This class of mine is used in side channels which it is intended to close entirely, or to reduce the width of navigable channels where too wide to be defended by observation mines. Their principal advantage is that if the firing switch is closed they are effective in fog or mist, when observation mines could not be worked, and when the guns of the defence would be equally out of action. As they are fired only when close against the side of a ship, the charge can be comparatively small and the mines themselves are handy and easy to lay.

Compared with observation mines they use much less cable, as the action of the C.C. is such that only the mine which is struck can be fired. Several mines of this class can therefore share one cable from the shore, though in practice details of mooring and arrangement limit the number connected to one cable to four. A set of mines on one cable is referred to as a "group."

The arrangements for firing the mines are contained in a firing station on shore, in which is the battery or other source of electrical power for firing, and the necessary apparatus for testing the system of mines, which is usually done daily. To let the operator in the firing station know when the C.C. of a mine has been struck and the mine is ready to fire, a small electrical apparatus is provided in the firing station for each group of mines. This arrangement strikes a bell when the C.C. is worked and also closes a break in the firing circuit. The operator can then close the main switch and fire the mine, or if acting on the order to "fire all mines that signal" he has already closed his main switch, the signalling apparatus, in the act of striking the bell, completes the firing circuit. A similar piece of apparatus is connected to each observing instrument, the completion of the circuit of any line at the observing station then gives a signal in the firing station and the firing circuit is completed.

The firing station can be on a vessel moored near the mine field, but is more usually on shore, where it can be made absolutely secure against any form of attack. But the observing stations must be on shore to give stability to the observing instruments, they cannot be entirely protected as they must have a small opening facing the mine field, but can be made very inconspicuous.

Any explosive can be used in submarine mines, provided adequate means are taken to explode the charge, but the explosive which is easiest to handle and is in most general use is wet gun-cotton with a small dry primer and detonator to start ignition. The detonators for electrical mines are on the "low tension" system, that is, firing is effected by the heating of a small length of wire called a "bridge," round which is placed a priming which ignites and detonates a small charge of fulminate of mercury.

The charge is contained in a steel mine-case, which has an "apparatus" inside to contain the electrical arrangements and the C.C. when used. Cases for observation mines are usually cylindrical in shape for mines to rest on the bottom and spherical for buoyant mines. The weight of charge is about 500 ℔ and the size of a buoyant case for this charge would be four feet in diameter. Cases for contact mines are spherical, about 39 in. in diameter, and can hold 100 ℔ of gun-cotton. They are always buoyant. Buoyancy is provided for by an air-space inside the case. Buoyant cases are moored to a heavy weight or "sinker," the connexion being by a steel wire rope, or in electrical mines, the cable itself. The cable is carefully insulated and protected with a layer of steel wires. An earth return is used for the electrical circuit.

The employment of mines in any defence must depend entirely on the general character of the defence adopted, which will itself depend on the size and importance of the harbour to be defended and other details (see Coast Defence). The rôle of mines in a defence is to act as an obstacle to detain ships under fire and compel them to engage the artillery of the defence. Thus mines find their greatest usefulness in the defence of harbours with long channels of approach. Mine fields can be destroyed by "creeping" for and cutting the electric cables, by "sweeping" for the mines themselves with long loops of chain or rope or by destroying the mines with "countermines." To guard against any of these, the mine field should be protected by gun fire and lit at night by electric lights. As vessels sunk by mines may obstruct the channel, mines should not be used in very narrow channels.

Although the scientific development of submarine mining is the work of the last fifty years, attempts to use drifting charges against ships and bridges are recorded as early as the 16th century. Mines were used by the Americans in 1777, and in 1780 Robert Fulton produced an explosive machine which he called a "torpedo," and which was experimented with, not very successfully, up to 1815. In 1854 the Russians used mechanical mines in the Baltic, but without any marked success.

The first application of electricity to the explosion of submerged charges was made by Sir Charles Pasley in the destruction of wrecks in the Thames and of the wreck of the "Royal George" at Spithead in 1839 and subsequent years. The first military use of electrically-fired mines was made in the American Civil War of 1861–65 when several vessels were sunk or damaged by mines or torpedoes. From this date onwards most European nations experimented with mines, and they were actually used during the Franco-German War of 1870, the Russo-Turkish War of 1878 and the Spanish-American War of 1898. But the most interesting example of mine warfare was in the attack and defence of Port Arthur during the Russo-Japanese War (*q.v.*) of 1904–05. Both sides used mechanical mines only, and both suffered heavy losses from the mine warfare. Mines and torpedoes were first introduced into the English service about 1863, defence mines being placed in the charge of the Royal Engineers, while torpedoes were developed by the Royal Navy. Up to 1904 there were mine defences at most of the British ports, but in that year the responsibility of mines was placed on the navy, and since then the mine defences have been much reduced. (W. B. B.)

SUBSIDY (through Fr. from Lat. *subsidium*, reserve troops, aid, assistance, from *subsidere*, literally "to sit or remain behind or in reserve"), an aid, subvention, assistance granted especially in money. The word has a particular use in economic history and practice. In English history it is the general term for a tax granted to the king by parliament, and so distinguished from those dues, such as the customs dues, which were raised by the royal prerogative; of these subsidies there were many varieties; such was the subsidy in excess of the customs on wool, leather, wine or cloth exported or imported by aliens, later extended to other articles and to native exporters and importers (see Tonnage and Poundage); there was also the subsidy which in the 14th century took the place of the old feudal levies. Apart from this application the term, in modern times, is particularly applied to the pecuniary assistance by means of bounties, &c., given by the state to industrial undertakings (see Bounty). Subsidies granted by the state to literary, dramatic or other artistic institutions, societies, &c., are generally styled "subventions" (Lat. *subvenire*, to come to the aid of).

SUCCESSION (Lat. *successio*, from *succedere*, to follow after) the act of succeeding or following, as of events, objects, places in a series, &c., but particularly, in law, the transmission or passing of rights from one to another.

In every system of law provision has to be made for a readjustment of *things* or goods on the death of the human beings who owned and enjoyed them. Succession to *rights* may be considered from two points of view: in some ways they depend on the personality of those who are concerned with them: if you hire a servant, you acquire a claim against a certain person and your claim will disappear on his death. But personal relations are commonly implicated in the arrangement of property: if a person borrows money, the creditor expects to be paid even should the debtor die, and the actual payment will depend to a great extent on the rules as to inheritance. Succession, in the sense of the partition or redistribution of the property of a former owner is, in modern systems of law, the subject of many rules. Such rules may be based on the will of a deceased person. They will be found in such articles as Administration; Assets; Executors and Administrators; Inheritance; Intestacy; Legacy; Will; &c. There are cases, however, in which a will cannot be expressed; this eventuality is discussed in the present article, and there can be no doubt that it is the most characteristic one from the point of view of social conditions. It represents the view of society at large as to what *ought to be* the *normal* course of succession in the readjustment of property after the death of a citizen. We shall dwell chiefly on the customs of succession among the nations of Aryan stock. Other customs are noticed in the articles on Village Communities; Mahommedan Law; &c.

We have to start from a distinction between personal goods and the property forming the economic basis of existence for the family which is strongly expressed in early law. War booty, proceeds of hunting, clothes and ornaments, implements fashioned by personal skill, are taken to belong to a man in a more personal way than the land on which he dwells or the cattle of a herd.

It is characteristic that even in the strict law of paternal power formulated by the Romans an unemancipated son was protected in his rights in regard to things acquired in the camp (*peculium castrense*) and later on this protection spread to other chattels (*peculium quasi-castrense*). The personal character of this kind of property has a decisive influence on the modes of succession to it. This part of the inheritance is widely considered in early law as still in the power of the dead even after demise. We find that many savage tribes simply destroy the personal belongings of the dead: this is done by several Australian and Negro tribes (Post, *Grundriss der ethnologischen Jurisprudenz*, pp. 174–5). Sometimes this rule is modified in the sense that the goods remaining after deceased persons have to be taken away by strangers, which leads to curious customs of looting the house of the deceased. Such customs were prevalent, for example, among the North American Indians of the Delaware and Iroquois tribes. Evidently the nearer relations dare not take over such things on account of a *tabu* rule, while strangers may appropriate them, as it were, by right of conquest.

The continuance of the relation of the deceased to his own things gives rise in most cases to provisions made for the dead out of his personal succession. The habit of putting arms, victuals, clothes and ornaments in the grave seems almost universal, and there can be no doubt that the idea underlying such usages consists in the wish to provide the deceased with all matters necessary to his existence after death. A very characteristic illustration of this conception may be given from the customs of the ancient Russians, as described about 921 by the Arabian traveller Ibn Fadhlan. The whole of the personal property was divided into three parts: one-third went to the family, the second third was used for making clothes and other ornaments for the dead, while the third was spent in carousing on the day when the corpse was cremated. The ceremony itself consisted in the following: the corpse was put into a boat and was dressed up in the most gorgeous attire. Intoxicating drinks, fruit, bread and meat were put by its side; a dog was cut into two parts, which were thrown into the boat. Then, all the weapons of the dead man were brought in, as well as the flesh of two horses, a cock and a chicken. The concubine of the deceased was also sacrificed, and ultimately all these objects were burned in a huge pile, and a mound thrown up over the ashes. This description is the more interesting because it starts from a division of the goods of the deceased, one part of them being affected, as it were, to his personal usage. This rule continues to be observed in Germanic law in later times and became the starting point of the doctrine of succession to personal property in English law. According to Glanville (vii. 5, 4) the chattels of the deceased have to be divided into three equal parts, of which one goes to his heir, one to his wife and one is reserved to the deceased himself. The same reservation of the third to the deceased himself is observed in Magna Charta (c. 26) and in Bracton's statement of Common Law (fol. 60), but in Christian surroundings the reservation of " the dead man's part " was taken to apply to the property which had to be spent for his soul and of which, accordingly, the Church had to take care. This lies at the root of the common law doctrine observed until the passing of the Court of Probate Act 1857. On the strength of this doctrine the bishop was the natural administrator of this part of the personalty of the deceased.

The succession to real property, if we may use the English legal expression, is not governed by such considerations or the needs of the dead. Roughly speaking, three different views may be taken as to the proper readjustment in such cases. Taking the principal types in a logical sequence, which differs from the historical one, we may say that the aggregate of things and claims relinquished by a deceased person may: (1) pass to relatives or other persons who stood near him in a way determined by law. Should several persons of the kind stand equally near in the eye of the law the consequence would be a division of the inheritance. The personal aspect of succession rules in such systems of inheritance. (2) The deceased may be considered as a subordinate member of a higher organism—a kindred, a village, a state, &c. In such a case there can be no succession proper as there has been no individual property to begin with. The cases of succession will be a relapse of certain goods used by the member of a community to that community and a consequent rearrangement of rights of usage. The law of succession will again be constructed on a personal basis, but this basis will be supplied not by the single individual whose death has had to be recorded but by some community or union to which this individual belonged. (3) The aggregate of goods and claims constituting what is commonly called an inheritance may be considered as a unit having an existence and an object of its own. The circumstance of the death of an individual owner will, as in case 2, be treated as an accidental fact. The unity of the inheritance and the social part played by it will constitute the ruling considerations in the arrangement of succession. The personal factor will be subordinated to the real one.

In practice pure forms corresponding to these main conceptions occur seldom, and the actual systems of succession mostly appear as combinations of these various views. We shall try to give briefly an account of the following arrangements: (1) the *joint family* in so far as it bears on succession; (2) *voluntary associations* among co-heirs; (3) *division* of inheritance; (4) united succession in the shape of *primogeniture* and of *junior right*.

The large mass of Hindu juridical texts representing customs and doctrines ranging over nearly 5000 years contains many indications as to the existence of a *joint family* which was considered as the corporate owner of property and therefore did not admit in principle of the opening of succession through the death of any of its members. The father or head of such a joint family was in truth only the manager of its property during lifetime, and though on his demise this power and right of management had to be regulated anew, the property itself could not be said to pass by succession: it remained as formerly in the joint family itself. In stating this abstract doctrine we have to add that our evidence shows us in practice only characteristic consequences and fragments of it, but that we have not the means of observing it directly in a consistent and complete shape during the comparatively recent epochs which are reflected in the evidence. It is even a question whether such a doctrine was ever absolutely enforced in regard to chattels: even in the earliest period of Hindu law articles of personal apparel and objects acquired by personal will and strength fell to a great extent under the conception of separate property. Gains of science, art and craft are mentioned in early instances as subject to special ownership and corresponding rules of personal succession are framed in regard to them (Jolly, Tagore lectures on *Partition, Inheritance and Adoption*, 94). But on the other hand there are certain categories of movable goods which even in later law are considered as belonging to the family community and incapable of partition, *e.g.* water, prepared food, roads, vehicles, female slaves, property destined for pious uses and sacrifices, books. When law became rationalized these things had to be sold in order that the proceeds of the sale should be divided, but originally they seem to have been regarded as owned by the joint family though used by its single members. And as to immovables—land and houses—they were demonstrably excluded in ancient customary law from partition among co-heirs.

In Greek law the most drastic expression of the joint family system is to be found in the arrangements of Spartan households, where brothers clustered round the eldest or " keeper of the hearth "[1] (ἑστιαπάμιον), and not only the management of family property but even marriages were dependent on the unity of the shares and on the necessity of keeping down the offspring of the younger brothers. With the Romans there are hardly any traces of a primitive family community excluding succession, but the Celtic tribal system was to a great extent based on this fundamental conception (Seebohm, *Tribal System in Wales*).

[1] The term illustrates the intimate connexion between inheritance and household religion in ancient Aryan custom.

During three generations the offspring of father, grandfather and great-grandfather held together in regard to land. The consequence was that, although separate plots and houses were commonly reserved for the uses of the smaller families included within the larger unit, the death of the principal brought about an equalization of shares first *per stirpes* and ultimately *per capita* until the final break-up of the community when it reached the stage of the great-grandsons of the original founder. But the most elaborate system of family ownership is to be observed in the history of the latest comers among the Aryan races—the Slavs. In the backward mountain regions which they occupied in the Balkan Peninsula and in the wilderness of the forests and moors of Eastern Europe they developed many characteristic tribal institutions and, among these, the joint family, the *Zadruga, inokoshtina*. The huge family communities of the southern Slavs have been described at length by recent observers, and there can be no doubt that their roots go back to a distant past (see VILLAGE COMMUNITIES). There is no room in them for succession proper: what has to be provided for is the continuity of business management by elders and the repartition of rights of usage and maintenance, a repartition largely dependent on varying customs and on the policy of the above-mentioned elders. In Russia the so-called *large family* appears as a much less extensive application of the same idea. It extends rarely over more than three generations, but even as a cluster of members gathering around a grandfather or a great-uncle it presents an arrangement which hampers greatly private enterprise and staves off succession until the moment when the great household breaks up between the descendants of a great-grandfather.

In Germanic law we catch a glimpse of a state of things in which side relations were not admitted to succession at all. The Frankish Edict of Chilperic (A.D. 571) tells us that if somebody died without leaving sons or daughters, his brother was to succeed him and not his neighbours (*non vicini*). This has to be construed as a modification of the older rule according to which the neighbours succeeded and not the brother. Under "neighbours" we cannot understand merely people connected with a person by proximity of settlement, but rather his kinsmen in their usual capacity of neighbours. The fact that kinsmen forming a settlement have precedence of such near relations as the brothers is characteristic enough, especially, as even the succession of sons and daughters is mentioned in a way which shows that there was still some doubt whether neighbouring kinsmen should not take inheritance instead of the latter. These are systems of a very archaic arrangement based on a close tribal community between the members of a kindred. Such a community is not apparent in later legal custom, but there are many signs of a close union between members of the same family. The law of Scania, a province of southern Sweden, shows us a group settled around a grandfather. His sons even when married hold part of the property under him and it is with some difficulty that they and their wives succeed in separating some of the goods acquired by personal work or brought in by marriage from the rest of the household property (Scanian Law, Danish Text i. 5). The same arrangement appears in Lombard law as regards brothers who remain settled in a common house (Edict of Rothari c. 167). Of course, in all such cases, there could be no real inheritance and succession, but merely the stepping in of the next generation into the rights and duties of the representative of an older generation on the latter's demise. In legal terminology it is a case of accretion and not of succession.

The next stage in the development of succession is presented by an arrangement which was common in Germany, viz. by the management of property under the rule of so-called *Ganerbschaft*. *Ganerben* is the same as the Latin *coheredes, comparticipes, consortes*. A capitulary of 818 mentions such communities of heirs holding in common (cf. Boretius Capitularia, i. 282). While the community lasted none of the shareholders could dispose of any part of the property by his single will. Legally and economically all transactions had to proceed from common consent and common resolve. This did not preclude the possibility of any one among the shareholders claiming his own portion, in which case part of the property had to be meted out to him according to fair computation (*swascara*). There was no legal constraint over the shareholders to remain in common: division could be brought about either by common consent or by claims of individuals, and yet the constant occurrence of these settlements of co-heirs shows that as a matter of fact it was more profitable to keep together and not to break up the unit of property by division. The customary union of co-heirs appears in this way as a corrective of the strict legal principle of equal rights between heirs of the same degree. In English practice the joint management of co-heirs is not so fully described, but there can be no doubt that under the older Saxon rule admitting heirs of the same degree to equal rights in succession the interests of economic efficiency were commonly preserved by the carrying on of common husbandry without any realization of the concurrent claims which would have broken up the object of succession. This accounts for the fact that notwithstanding the prevalence among the early English of the rule admitting all the sons or heirs in the same position to equal shares in the inheritance, the organic units of hides, yardlands, &c. are kept up in the course of centuries. In the management of so-called *gavelkind* succession in Kent partition was legally possible and came sometimes to be effected, but there was the customary reaction against it in the shape of keeping up the "yokes" and "sulungs." A trace of the same kind of union between co-heirs appears in the so-called *parage* communities so often mentioned in Domesday Book.

In all these cases the principle of union and joint management is kept up by purely economic means and considerations. The legal possibility of partition is admitted by the side of it. It is interesting to watch two divergent lines of further development springing from this common source; on the one side we see the full realization of individual right resulting in frequent divisions; on the other side we watch the rise of legal restraints on subdivision resulting in the establishment, in respect of certain categories of property, of rules excluding the plurality of heirs for the sake of preserving the unity of the household. The first system is, of course, most easily carried out in countries where individualistic types of husbandry prevail. In Europe it is especially prevalent in the south with its intense cultivation of the arable and its habits of wine and olive growing. We shall not wonder, therefore, that the unrestricted subdivision among heirs is represented most completely by Roman law. Not to speak of the fact that already in the XII. Tables the principal mode of inheritance was considered to be inheritance by will while intestate succession came in as a subsidiary expedient, we have to notice that there is no check on the dispersion of property among heirs of the same degree. The only survival of a régime of family community may be found in the distinction between *heredes sui* (heirs of their own) and *heredes extranei* (outside heirs of the deceased). The first entered by their own right and took possession of property which had belonged to them potentially even during their ancestor's life. The latter drew their claims from their relationship to the deceased and this did not give them a direct hold on the property in question. Apart from that the civil law of ancient Rome favoured complete division and the same principle is represented in all European legislation derived from Roman law or strongly influenced by it. Sometimes, as in the French *Code Civil*, even the wish of the owner cannot alter the course of such succession as no person can make a will depriving any of his children of their legal share.

In full contrast with this mode of succession prevailing in romanized countries we find the nations proceeding from Germanic stock and strongly influenced by feudalism developing two different kinds of restraints on subdivision. In Scandinavian law this point of view is expressed by the Norwegian customs as to Odal. The principal estates of the country, which, according to the law of the Gulathing have descended through five generations in the same family, cannot be dispersed and alienated at pleasure. They are considered as rightly belonging to the kindred with which a historical connexion has been established. In order to keep these estates within the kindred they are to descend chiefly to men: women are admitted to property in them only in exceptional cases. Originally it is only the daughter of a man who has left no sons and the sister of one who has left no children and no brothers that are admitted to take Odal as if they were men. Nieces and first-cousins are admitted in the sense that they have to pass the property to their nearest male heir. They may, in certain eventualities, be bought out by the nearest male relative. A second peculiarity of Odal consists in the right of relations descending from one of the common ancestors to prevent strangers from acquiring Odal estate. Any holder of such an estate who wants to sell it in its entirety or in portion has first to apply to his relatives and they may acquire the estate at the price proposed by a stranger less one-fifth. Even if no relative has taken advantage of this privilege an Odal estate sold to a stranger may be bought back into the family by compulsory redemption if the relatives subsequently find the means and have the wish to resort to such redemption. Odal right does not curtail the claims of the younger sons or of any heirs in a similar position. As a matter of fact, however, customary succession in Norwegian peasant families sets great price on holding the property of the household well together. It is keenly felt that a *gaard* (farm) ought not to be parcelled up into smaller holdings, and in the common case of several heirs succeeding to the farm, they generally make up among themselves who is to remain in charge of the ancestral household: the rest are compensated in money or helped to start on some other estate or perhaps in a cottage by the side of the principal house. In medieval England, France and Germany the same considerations of economic efficiency are felt as regards the keeping up of united holdings, and it may be said that the lower we get in the scale of property the stronger these considerations become. If it is possible, though not perhaps profitable, to divide the property of a large farm, it becomes almost impossible to break-up the smaller units—so-called yardlands and oxgangs. Through being parcelled up into small plots, land loses in value, and, as to cattle, it is impossible to divide one ox or one horse *in specie* without selling them. No wonder that we find practices and customs of united succession arising in direct contradiction with the ancient rule that all heirs of the same degree should be admitted to equal shares. Glanville mentions expressly that the socagers of his time held partly by undivided succession and partly by divided inheritance. The relations of feudalism and serfdom contributed strongly towards creating such individual tenancies. It was certainly in the interest of the lord that his men, whether holding a military fief or an agricultural farm, should not weaken the value of their tenancies by dispersing the one or the other among heirs. But apart from these interests of over-lords there was the evident self-interest of the tenants themselves and therefore the point of view of unification of holdings is by no means confined to servile tenements or to military fiefs. The question whether the successor should be the eldest son or the youngest son is a secondary one. The latter practice was very prevalent all through Europe and produced in England what is termed the Borough English rule. The quaint name has been derived from the contrast in point of succession between the two parts of the borough of Nottingham. The French burgesses transmitted their tenements by primogeniture, while in the case of the English tenants the youngest sons succeeded. A usual explanation of this passage of the holdings to the youngest is found in the fact that the youngest son remains longest in his father's house, while the elder brothers have opportunities of going out into the world at a time when the father is still alive and able to take care of his land. This is well in keeping with the view that customs of united succession arise in connexion with compensation provided for co-heirs waiving their claims in regard to settlement in the original household. The succession of the youngest appears also very characteristic in so far as it illustrates the break up into small tenancies, as the youngest in the family is certainly not a fit representative of hierarchy and authority and could not have been meant to rule anything but his own restricted household.

One more feature of the ancient law of succession has to be noticed in conclusion, viz. the exclusion of women from inheritance in land. There can be no doubt that as regards movable goods women held property and transmitted it on a par with males right from the earliest time. According to Germanic conception personal ornaments and articles of household furniture are specially effected to their use and follow a distinct line of succession from woman to woman (Gerade). Norse law puts women and men on the same footing as to all forms of property equated to "movable money" (Lösöre); but as to land there is a prevalent idea that men should be privileged. Women are admitted to a certain extent, but always placed behind men of equal degree. Frankish and Lombard law originally excluded women from inheritance in land, and this exclusion seems as ancient as the patriarchial system itself, whatever we may think about the position of affairs in prehistoric times when rules of matriarchy were prevalent. A common-sense explanation of one side of this doctrine is tendered by the law of the Thuringians (*Lex Anglorum et Werinorum*, c. 6). It is stated there that inheritance in land goes with the duty of taking revenge for the homicide of relatives and with the power of bearing arms. One of the most potent adversaries of this system of exclusion proved to be the Church. It favoured all through the view that land should be transmitted in the same way as money or chattels. A Frankish formula (Marculf) shows us a father who takes care to endow his daughter with a piece of land according to natural affection in spite of the strict law of his tribe. Such instruments were strongly backed by the Church, and the view that women should be admitted to hold land on certain occasions had made its way in England as early as Anglo-Saxon times.

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(P. Vi.)

SUCCESSION DUTY, in the English fiscal system, "a tax placed on the gratuitous acquisition of property which passes on the death of any person, by means of a transfer from one person (called the predecessor) to another person (called the successor)." In order properly to understand the present state of the English law it is necessary to describe shortly the state of affairs prior to the Finance Act 1894—an act which effected a considerable change in the duties payable and in the mode of assessment of those duties.

The principal act which first imposed a succession duty in England was the Succession Duty Act 1853. By that act a duty varying from 1 to 10 % according to the degree of consanguinity between the predecessor and successor was imposed upon every succession which was defined as "every past or future disposition of property by reason whereof any person has or shall become beneficially entitled to any property, or the income thereof, upon the death of any person dying after the time appointed for the commencement of this act, either immediately or after any interval, either certainly or contingently, and either originally or by way of substitutive limitation and every devolution by law of any beneficial interest in property, or the income thereof, upon the death of any person dying after the time appointed for the commencement of this act to any other person in possession or expectancy." The property which is liable to pay the duty is in realty or leasehold estate in the United Kingdom and personalty—not subject to legacy duty—which the beneficiary claims by virtue of English, Scottish or Irish law. Personalty in England bequeathed by a person domiciled abroad is not subject to succession duty. Successions of a husband or a wife, successions where the principal value is under £100, and individual successions under £20, are exempt from duty. Leasehold property and personalty directed to be converted into real estate are liable to succession, not to legacy duty. Special provision is made for the collection of duty in the cases of joint tenants and where the successor is also the predecessor. The duty is a first charge on property, but if the property be parted with before the duty is paid the liability of the successor is transferred to the alienee. It is, therefore, usual in requisitions on title before conveyance, to demand for the protection of the purchaser the production of receipts for succession duty, as such receipts are an effectual protection notwithstanding any suppression or misstatement in the account on the footing of which the duty was assessed or any insufficiency of such assessment. The duty is by this act directed to be assessed as follows: on personal property, if the successor takes a limited estate, the duty is assessed on the principal value of the annuity or yearly income estimated according to the period during which he is entitled to receive the annuity or yearly income, and the duty is payable in four yearly instalments free from interest. If the successor takes absolutely he pays in a lump sum duty on the principal value. On real property the duty is payable in eight half-yearly instalments without interest on the capital value of an annuity equal to the annual value of the property. Various minor changes were made. By the Customs and Inland Revenue Act 1881, personal estates under £300 were exempted. By the Customs and Inland Revenue Act 1888 an additional ½% was charged on successions already paying 1% and an additional 1½% on successions paying more than 1%. By the Customs and Inland Revenue Act 1889 an additional duty of 1% called estate duty was payable on successions over £10,000.

The Finance Acts 1894 and 1909 effected large changes in the duties payable on death (for which see ESTATE DUTY; LEGACY). As regards the succession duties they enacted that payment of the estate duties thereby created should include payment of the additional duties mentioned above. Estates under £1000 (£2000 in the case of widow or child of deceased) are exempted from payment of any succession duties. The succession duty payable under the Succession Duty Act 1853 was in all cases to be calculated according to the principal value of the property, *i.e.* its selling value, and though still payable by instalments interest at 3% is chargeable. The additional succession duties are still payable in cases where the estate duty is not charged, but such cases are of small importance and in practice are not as a rule charged.

United States.—The United States imposed a succession duty by the War Revenue Act of 1898 on all legacies or distributive shares of personal property exceeding $10,000. It is a tax on the privilege of succession. Devises or distributions of land are not affected by it. The rate of duty runs from 75 cents on the $100 to $5 on the $100, if the legacy or share in question does not exceed $25,000. On those of over that value the rate is multiplied 1½ times on estates up to $100,000, twofold on those from $100,000 to $500,000, 2½ times on those from $500,000 to a million, and threefold for those exceeding a million. This statute has been supported as constitutional by the Supreme Court. Many of the states also impose succession duties, or transfer taxes; generally, however, on collateral and remote successions; sometimes progressive, according to the amount of the succession. The state duties generally touch real estate successions as well as those to personal property. If a citizen of state A owns registered bonds of a corporation chartered by state B, which he has put for safe keeping in a deposit vault in state C, his estate may thus have to pay four succession taxes, one to state A, to which he belongs and which, by legal fiction, is the seat of all his personal property; one to state B, for permitting the transfer of the bonds to the legatees on the books of the corporation; one to state C, for allowing them to be removed from the deposit vault for that purpose; and one to the United States.

SUCCINIC ACID, $C_2H_4(CO_2H)_2$. Two acids corresponding to this empirical formula are known—namely ethylene succinic acid, $HO_2C\cdot CH_2\cdot CH_2\cdot CO_2H$ and ethylidene succinic acid $CH_3\cdot CH(CO_2H)_2$.

Ethylene succinic acid occurs in amber, in various resins and lignites, in fossilized wood, in many members of the natural orders of Papaveraceae and Compositae, in unripe grapes, urine and blood. It is also found in the thymus gland of calves and in the spleen of cattle. It may be prepared by the oxidation of fats and of fatty acids by nitric acid, and is also a product of the fermentation of malic and tartaric acids. It is usually obtained by the distillation of amber, or by the fermentation of calcium malate or ammonium tartrate. Synthetically it may be obtained by reducing malic or tartaric acids with hydriodic acid (R. Schmitt, *Ann.*, 1860, 114, p. 106; V. Dessaignes, ibid., 1860, 115, p. 120; by reducing fumaric and maleic acids with sodium amalgam; by heating bromacetic acid with silver to 130° C.; in small quantity by the oxidation of acetic acid with potassium persulphate (C. Moritz and R. Wolffenstein, *Ber.*, 1899, 32, p. 2534); by the hydrolysis of succinonitrile (from ethylene dibromide) $C_2H_4 \rightarrow C_2H_4Br_2 \rightarrow C_2H_4(CN)_2 \rightarrow C_2H_4(CO_2H)_2$; by the hydrolysis of β-cyanpropionic ester; and by the condensation of sodiomalonic ester with monochloracetic ester and hydrolysis of the resulting ethane tricarboxylic ester $(RO_2C)_2CH\cdot CH_2\cdot CO_2R$; this method is applicable to the preparation of substituted succinic acids. It is also produced by the electrolysis of a concentrated solution of potassium ethyl malonate.

It crystallizes in prisms or plates which melt at 185° C. and boil at 235° C. with partial conversion into the anhydride. It is readily soluble in water. Aqueous solutions of the acid are decomposed in sunlight by uranium salts, with evolution of carbon dioxide and the formation of propionic acid. Potassium permanganate, in acid solution, oxidizes it to carbon dioxide and water. The sodium salt on distillation with phosphorus trisulphide gives thiophene. The esters of the acid condense readily with aromatic aldehydes and ketones to form γ-di-substituted itaconic acids and γ-alkylen pyrotartaric acids (H. Stobbe, *Ann.*, 1899, 308, p. 71). γ-Oxyacids are formed when aldehydes are heated with sodium succinate and sodium acetate. Numerous salts of the acid are known, the basic ferric salt being occasionally used in quantitative analysis for the separation of iron from aluminium.

Succinyl chloride, obtained by the action of phosphorus pentachloride on succinic acid, is a colourless liquid which boils at 190° C. In many respects it behaves as though it were dichlorbutyro-lactone,

$C_2H_4{<}\genfrac{}{}{0pt}{}{CCl_2}{CO}{>}O$; *e.g.* on reduction it yields butyro-lactone, and when

condensed with benzene in the presence of aluminium chloride it yields chiefly γ-diphenylbutyro-lactone. *Succinic anhydride*, $C_2H_4(CO)_2O$, is obtained by heating the acid or its sodium salt with acetic anhydride; by the action of acetyl chloride on the barium salt; by distilling a mixture of succinic acid and succinyl chloride, or by heating succinyl chloride with anhydrous oxalic acid. It crystallizes in plates which melt at 120° C., and distils without decomposition. It is slowly dissolved by water with the formation of the acid. It combines readily with the meta-aminophenols to form rhodamines, which are valuable dyestuffs. Heated in a current of ammonia it gives *succinimide*, which is also obtained on heating acid ammonium succinate. It crystallizes in colourless octahedra which melt at 125–126° C., and is easily soluble in water. When warmed with baryta water it yields succinamic acid, $HO_2C\cdot CH_2\cdot CH_2\cdot CONH_2$; and with alcoholic ammonia at 100° C. it gives succinamide. The imino hydrogen atom is easily replaced by metals. Distillation with zinc dust gives pyrrol (*q.v.*). By the action of bromine in alkaline solution it is converted into β-aminopropionic acid. *Succinamide*, $C_2H_4(CONH_2)_2$, best obtained by the action of ammonia on diethyl succinate, crystallizes in needles which melt at 242–243° C., and is soluble in hot water. *Succinonitrile*, $C_2H_4(CN)_2$, is obtained by the action of potassium cyanide on ethylene dibromide or by the electrolysis of a solution of potassium cyanacetate. It is an amorphous solid which melts at 54–55° C. On reduction with sodium in alcoholic solution it yields tetraethylene diamine (putrescein) and pyrollidine.

Methyl succinic acid (pyrotartaric acid), $HO_2C\cdot CH_2\cdot CH(CH_3)\cdot CO_2H$, is formed by the dry distillation of tartaric acid; by heating pyruvic acid with concentrated hydrochloric acid to 180° C.; by the reduction of citraconic and mesaconic acids with sodium amalgam; and by the hydrolysis of β-cyanbutyric acid. It crystallizes in small prisms which melt at 112° C. and are soluble in water. It forms an anhydride when heated. The sodium salt on heating with phosphorus trisulphide yields methylthiophen.

Ethylidene succinic acid or *isosuccinic acid*, $CH_3 \cdot CH(CO_2H)_2$, is produced by the hydrolysis of α-cyanpropionic acid and by the action of methyl iodide on sodio-malonic ester. It crystallizes in prisms which melt at 120° C. (T. Salzer, *Journ. prak. Chem.*, 1898 [2], 57, p. 497), and dissolve in water. It does not yield an anhydride, but when heated loses carbon dioxide and leaves a residue of propionic acid. It may be distinguished from the isomeric ethylene succinic acid by the fact that its sodium salt does not give a precipitate with ferric chloride.

SUCHER, ROSA (1849–), German opera singer, *née* Hasselbeck, was the wife of Josef Sucher (1844–1908), a well-known conductor and composer. They were married in 1876, when she had already had various engagements as a singer and he was conductor at the Leipzig city theatre. Frau Sucher soon became famous for her performances in Wagner's operas, her seasons in London in 1882 and 1892 proving her great capacity both as singer and actress; in 1886 and 1888 she sang at Bayreuth, and in later years she was principally associated with the opera stage in Berlin, retiring in 1903. Her magnificent rendering of the part of Isolde in Wagner's opera is especially remembered.

SUCHET, LOUIS GABRIEL, Duc D'Albufera da Valencia (1770–1826), marshal of France, one of the most brilliant of Napoleon's generals, was the son of a silk manufacturer at Lyons, where he was born on the 2nd of March 1770. He originally intended to follow his father's business; but having in 1792 served as volunteer in the cavalry of the national guard at Lyons, he manifested military abilities which secured his rapid promotion. As *chef de bataillon* he was present at the siege of Toulon in 1793, where he took General O'Hara prisoner. During the Italian campaign of 1796 he was severely wounded at Cerea on the 11th of October. In October 1797 he was appointed to the command of a demi-brigade, and his services, under Joubert in the Tirol in that year, and in Switzerland under Brune in 1797–98, were recognized by his promotion to the rank of general of brigade. He took no part in the Egyptian campaign, but in August was made chief of the staff to Brune, and restored the efficiency and discipline of the army in Italy. In July 1799 he was made general of division and chief of staff to Joubert in Italy, and was in 1800 named by Masséna his second in command. His dexterous resistance to the superior forces of the Austrians with the left wing of Masséna's army, when the right and centre were shut up in Genoa, not only prevented the invasion of France from this direction but contributed to the success of Napoleon's crossing the Alps, which culminated in the battle of Marengo on the 14th of June. He took a prominent part in the Italian campaign till the armistice of Treviso. In the campaigns of 1805 and 1806 he greatly increased his reputation at Austerlitz, Saalfeld, Jena, Pultusk and Ostrolenka. He obtained the title of count on the 19th of March 1808, married Mlle de Saint Joseph, a niece of Joseph Bonaparte's wife, and soon afterwards was ordered to Spain. Here, after taking part in the siege of Saragossa, he was named commander of the army of Aragon and governor of the province, which, by wise and (unlike that of most of the French generals) disinterested administration no less than by his brilliant valour, he in two years brought into complete submission. He annihilated the army of Blake at Maria on the 14th of June 1809, and on the 22nd of April 1810 defeated O'Donnell at Lerida. After being made marshal of France (July 8, 1811) he in 1812 achieved the conquest of Valencia, for which he was rewarded with the title of duc d'Albufera da Valencia (1812). When the tide set against the French Suchet defended his conquests step by step till compelled to retire into France, after which he took part in Soult's defensive campaign. By Louis XVIII. he was on the 4th of June made a peer of France, but, having during the Hundred Days commanded one of Napoleon's armies on the Alpine frontier, he was deprived of his peerage on the 24th of July 1815. He died near Marseilles on the 3rd of January 1826. Suchet wrote *Mémoires* dealing with the Peninsular War, which were left by the marshal in an unfinished condition, and the two volumes and atlas appeared in 1829–1834 under the editorship of his former chief staff officer, Baron St Cyr-Nogués.

See C. H. Barault-Roullon, *Le Maréchal Suchet* (Paris, 1854); Choumara, *Considerations militaires sur les mémoires du Maréchal Suchet* (Paris, 1840), a controversial work on the last events of the Peninsular War, inspired, it is supposed, by Soult; and Lieutenant-General Lamarque's obituary notice in the *Spectateur militaire* (1826). See also bibliography in article Peninsular War.

SU-CHOW. There are in China three cities of this name which deserve mention.

1. Su-chow-Fu, in the province of Kiang-su, formerly one of the largest cities in the world, and in 1907 credited still with a population of 500,000, on the Grand Canal, 55 m. W.N.W. of Shanghai, with which it is connected by railway. The site is practically a cluster of islands to the east of Lake Tai-hu. The walls are about 10 m. in circumference and there are four large suburbs. Its silk manufactures are represented by a greater variety of goods than are produced anywhere else in the empire; and the publication of cheap editions of the Chinese classics is carried to great perfection. There is a Chinese proverb to the effect that to be perfectly happy a man ought to be born in Su-chow, live in Canton and die in Lien-chow. The nine-storeyed pagoda of the northern temple is one of the finest in the country. In 1860 Su-chow was captured by the T'aip'ings, and when in 1863 it was recovered by General Gordon the city was almost a heap of ruins. It has since largely recovered its prosperity, and besides 7000 silk looms has cotton mills and an important trade in rice. Of the original splendour of the place some idea may be gathered from the beautiful plan on a slab of marble preserved since 1247 in the temple of Confucius and reproduced in Yule's *Marco Polo*, vol. i. Su-chow was founded in 484 by Ho-lu-Wang, whose grave is covered by the artificial "Hill of the Tiger" in the vicinity of the town. The literary and poetic designation of Su-chow is Ku-su, from the great tower of Ku-su-tai, built by Ho-lu-Wang. Su-chow was opened to foreign trade by the Japanese treaty of 1895. A Chinese and European school was opened in 1900.

2. Su-chow, formerly Tsiu-tsuan-tsiun, a free city in the province of Kan-suh, in 39° 48′ N., just within the extreme north-west angle of the Great Wall, near the gate of jade. It is the great centre of the rhubarb trade. Completely destroyed in the great Mahommedan or Dungan insurrection (1865–72), it was recovered by the Chinese in 1873 and has been rebuilt.

3. Su-chow, a commercial town situated in the province of Sze-ch'uen at the junction of the Min River with the Yang-tse-Kiang, in 28° 46′ 50″ N. Population (1907) about 50,000.

SUCKLING, SIR JOHN (1609–1642), English poet, was born at Whitton, in the parish of Twickenham, Middlesex, and baptized there on the 10th of February 1609. His father, Sir John Suckling (1569–1627), had been knighted by James I. and was successively master of requests, comptroller of the household and secretary of state. He sat in the first and second parliaments of Charles I.'s reign, and was made a privy councillor. During his career he amassed a considerable fortune, of which the poet became master at the age of eighteen. He was sent to Trinity College, Cambridge, in 1623, and was entered at Gray's Inn in 1627. He was intimate with Thomas Carew, Richard Lovelace, Thomas Nabbes and especially with John Hales and Sir William Davenant, who furnished John Aubrey with information about his friend. In 1628 he left London to travel in France and Italy, returning, however, before the autumn of 1630, when he was knighted. In 1631 he volunteered for the force raised by the marquess of Hamilton to serve under Gustavus Adolphus in Germany. He was back at Whitehall in May 1632; but during his short service he had been present at the battle of Breitenfeld and in many sieges. He was handsome, rich and generous; his happy gift in verse was only one of many accomplishments, but it commended him especially to Charles I. and his queen. He says of himself ("A Sessions of the Poets") that he "prized black eyes or a lucky hit at bowls above all the trophies of wit." He was the best card-player and the best bowler at court. Aubrey says that he invented the game of cribbage, and relates that his sisters came weeping to the bowling green at Piccadilly to dissuade him from play, fearing that he would lose their portions. In 1634 great scandal was caused in his old circle by a beating which he received at the hands of Sir John Digby, a rival suitor for the hand of the daughter of Sir John Willoughby; and it has been suggested that this incident, which is narrated at length in a letter (Nov. 10, 1634) from George Garrard[1] to Strafford, had something to do with his beginning to seek more serious society. In 1635 he retired to his country estates in obedience to the proclamation of the 20th of June 1632 enforced by the Star Chamber[2] against absentee landlordism, and employed his leisure in literary pursuits. In 1637 "A Sessions of the Poets" was circulated in MS., and about the same time he wrote a tract on Socinianism entitled *An Account of Religion by Reason* (pr. 1646).

As a dramatist Suckling is noteworthy as having applied to regular drama the accessories already used in the production of masques. His *Aglaura* (pr. 1638) was produced at his own expense with elaborate scenery. Even the lace on the actors' coats was of real gold and silver. The play, in spite of its felicity of diction, lacks dramatic interest, and the criticism of Richard Flecknoe (*Short Discourse of the English Stage*),[3] that it seemed "full of flowers, but rather stuck in than growing there," is not altogether unjustified. *The Goblins* (1638, pr. 1646) has some reminiscences of *The Tempest*; *Brennoralt, or the Discontented Colonel* (1639, pr. 1646) is a satire on the Scots, who are the Lithuanian rebels of the play; a fourth play, *The Sad One*, was left unfinished owing to the outbreak of the Civil War. Suckling raised a troop of a hundred horse, at a cost of £12,000, and accompanied Charles on the Scottish expedition of 1639. He shared in the earl of Holland's retreat before Duns, and was ridiculed in an amusing ballad (pr. 1656), in *Musarum deliciae*, "on Sir John Suckling's most warlike preparations for the Scottish war."[4] He was elected as member for Bramber for the opening session (1640) of the Long Parliament; and in that winter he drew up a letter addressed to Henry Jermyn, afterwards earl of St Albans, advising the king to disconcert the opposition leaders by making more concessions than they asked for. In May of the following year he was implicated in an attempt to rescue Strafford from the Tower and to bring in French troops to the king's aid. The plot was exposed by the evidence of Colonel George Goring, and Suckling fled beyond the seas. The circumstances of his short exile are obscure. He was certainly in Paris in the summer of 1641. One pamphlet related a story of his elopement with a lady to Spain, where he fell into the hands of the Inquisition. The manner of his death is uncertain, but Aubrey's statement that he put an end to his life by poison in May or June 1642 in fear of poverty is generally accepted.

Suckling's reputation as a poet depends on his minor pieces. They have wit and fancy, and at times exquisite felicity of expression. "Easy, natural Suckling," Millamant's comment in Congreve's *Way of the World* (Act IV., sc. i.) is a just tribute to their spontaneous quality. Among the best known of them are the "Ballade upon a Wedding," on the occasion of the marriage of Roger Boyle, afterwards earl of Orrery, and Lady Margaret Howard, "I prithee, send me back my heart," "Out upon it, I have loved three whole days together," and "Why so pale and wan, fond lover?" from *Aglaura*. "A Sessions of the Poets," describing a meeting of the contemporary versifiers under the presidency of Apollo to decide who should wear the laurel wreath, is the prototype of many later satires.

A collection of Suckling's poems was first published in 1646 as *Fragmenta aurea*, the so-called *Selections* (1836) published by the Rev. Alfred Inigo Suckling, author of the *History and Antiquities of Suffolk* (1846–1848) with *Memoirs* based on original authorities and a portrait after Van Dyck, is really a complete edition of his works, of which W. C. Hazlitt's edition (1874; revised ed., 1892) is little more than a reprint with some additions. *The Poems and Songs of Sir John Suckling*, edited by John Gray and decorated with woodcut border and initials by Charles Ricketts, was artistically printed at the Ballantyne Press in 1896. In 1910 Suckling's works in prose and verse were edited by A. Hamilton Thompson. For anecdotes of Suckling's life see John Aubrey's *Brief Lives* (Clarendon Press ed., ii. 242).

[1] Strafford's *Letters and Despatches* (1739), i. 336.

[2] For an account of the proceedings see *Historical Collections*, ed. by Rushworth (1680), 2nd pt., pp. 288–293.

[3] Reprinted in *Eng. Drama and Stage*, ed. W. C. Hazlitt, Roxburghe Library (1869), p. 277.

[4] Attributed by Aubrey to Sir John Mennis (1599–1671). See also a song printed in the tract, *Vox borealis* (Harl. Misc. iii. 235).

SUCRE, or CHUQUISACA, a city of Bolivia, capital of the department of Chuquisaca and nominal capital of the republic, 46 m. N.E. of Potosí in 19° 2′ 45″ S., 65° 17′ W. Pop. (1900), 20,967; (1906, estimate), 23,416, of whom many are Indians and cholos. The city is in an elevated valley opening southward on the narrow ravine through which flows the Cachimayo, the principal northern tributary of the Pilcomayo. Its elevation, 8839 ft., gives it an exceptionally agreeable climate. There are fertile valleys in the vicinity which provide the city's markets with fruit and vegetables, while the vineyards of Camargo (formerly known as Cinti), in the southern part of the department, supply wine and spirits of excellent quality. The city is laid out regularly, with broad streets, a large central plaza and a public garden, or promenade, called the *prado*. Among its buildings are the cathedral, dating from 1553 and once noted for its wealth; the president's palace and halls of congress, which are no longer occupied as such by the national government; the cabildo, or town-hall; a mint dating from 1572; the courts of justice, and the university of San Xavier, founded in 1624, with faculties of law, medicine and theology. There is a pretty chapel called the "Rotunda," erected in 1852 at the lower end of the *prado* by President Belzú, on the spot where an attempt had been made to assassinate him. Sucre is the seat of the archbishop of La Plata and Charcas, the primate of Bolivia. It is not a commercial town, and its only noteworthy manufacture is the "clay dumplings" which are eaten with potatoes by the inhabitants of the Bolivian uplands. Although the capital of Bolivia, Sucre is one of its most isolated towns because of the difficult character of the roads leading to it. It is reached from the Pacific by way of Challapata, a station on the Antofagasta & Oruro railway.

The Spanish town, according to Velasco, was founded in 1538 by Captain Pedro Angules on the site of an Indian village called Chuquisaca, or Chuquichaca (golden bridge), and was called Charcas and Ciudad de la Plata by the Spaniards, though the natives clung to the original Indian name. It became the capital of the province of Charcas, of the comarca of Chuquisaca, and of the bishopric of La Plata and Charcas, and in time it became the favourite residence and health resort of the rich mine-owners of Potosí. The bishopric dates from 1552 and the archbishopric from 1609. In the latter year was created the Real Audiencia de la Plata y Charcas, a royal court of justice having jurisdiction over Upper Peru and the La Plata provinces of that time. Sucre was the first city of Spanish South America to revolt against Spanish rule—on the 25th of May 1809. In 1840 the name Sucre was adopted in honour of the patriot commander who won the last decisive battle of the war, and then became the first president of Bolivia. The city has suffered much from partisan strife, and the removal of the government to La Paz greatly diminished its importance.

SUCZAWA (Rumanian, *Suceava*), a town in Bukovina, Austria, 50 m. S. of Czernowitz by rail. Pop. (1900), 10,955. It is situated on the river Suczawa, which forms there the boundary between Bukovina and Rumania. One of its two churches, dating from the 14th century, contains the grave of the patron saint of Bukovina. The principal industry is the tanning and leather trade. Not far from Suczawa lies the monastery of Dragomirna, in Byzantine style, built at the beginning of the 17th century. Suczawa is a very old town and was until 1565 the capital of the principality of Moldavia. It was many times besieged by Poles, Hungarians, Tatars and Turks. In 1675 it was besieged by Sobieski, and in 1679 it was plundered by the Turks.

SUDAN (Arabic *Bilad-es-Sudan*, country of the blacks), that region of Africa which stretches, south of the Sahara and Egypt, from Cape Verde on the Atlantic to Massawa on the Red Sea. It is bounded S. (1) by the maritime countries of the west coast of Africa, (2) by the basin of the Congo, and (3) by the equatorial lakes, and E. by the Abyssinian and Galla highlands. The name is often used in Great Britain in a restricted sense to designate only the eastern part of this vast territory, but it is properly applied to the whole area indicated, which corresponds roughly to that portion of negro Africa north of the equator under Mahommedan influence. The terms Nigritia and Negroland, at one time current, referred to the same region.

The Sudan has an ethnological rather than a physical unity, and politically it is divided into a large number of states, all now under the control of European powers. These countries being separately described, brief notice only is required of the Sudan as a whole.

Within the limits assigned it has a length of about 4000 m., extending southwards at some points 1000 m., with a total area of over 2,000,000 sq. m., and a population, approximately, of 40,000,000. Between the arid and sandy northern wastes and the well-watered and arable Sudanese lands there is a transitional zone of level grassy steppes (partly covered with mimosas and acacias) with a mean breadth of about 60 m. The zone lies between 17° and 18° N., but towards the centre reaches as far south as 15° N. Excluding this transitional zone, the Sudan may be described as a moderately elevated region, with extensive open or rolling plains, level plateaus, and abutting at its eastern and western ends on mountainous country. Crystalline rocks, granites, gneisses and schists, of the Central African type, occupy the greater part of the country. Towards the south-east, slates, quartzites and iron-bearing schists occur, but their age is not known. The Congo sandstones do not appear to extend as far north. The Nubian sandstone borders the Libyan desert on the south and south-west, but it is doubtful if this sandstone is of Cretaceous or earlier date.

The Sudan contains the basin of the Senegal and parts of three other hydrographic systems, namely: the Niger, draining southwards to the Atlantic; the central depression of Lake Chad; and the Nile, flowing northwards to the Mediterranean. Lying within the tropics and with an average elevation of not more than 1500 to 2000 ft. above the sea, the climate of the Sudan is hot and in the river valleys very unhealthy. Few parts are suitable for the residence of Europeans. Cut off from North Africa by the Saharan desert, the inhabitants, who belong in the main to the negro family proper, are thought to have received their earliest civilization from the East. Arab influence and the Moslem religion began to be felt in the western Sudan as early as the 9th century and had taken deep root by the end of the 11th. The existence of native Christian states in Nubia hindered for some centuries the spread of Islam in the eastern Sudan, and throughout the country some tribes have remained pagan. It was not until the last quarter of the 19th century that the European nations became the ruling force.

The terms western, central and eastern Sudan are indicative of geographical position merely. The various states are politically divisible into four groups: (1) those west of the Niger; (2) those between the Niger and Lake Chad; (3) those between Lake Chad and the basin of the Nile; (4) those in the upper Nile valley.

The first group includes the native states of Bondu, Futa Jallon, Masina, Mossi and all the tribes within the great bend of the Niger. In the last quarter of the 19th century they fell under the control of France, the region being styled officially the French Sudan. In 1900 this title was abandoned. The greater part of what was the French Sudan is now known as the Upper Senegal and Niger Colony (see SENEGAL, FRENCH WEST AFRICA, &c.).

The second group of Sudanese states is almost entirely within the British protectorate of Northern Nigeria. It includes the sultanate of Sokoto and its dependent emirates of Kano, Bida, Zaria, &c., and the ancient sultanate of Bornu, which, with Adamawa, is partly within the German colony of Cameroon (see NIGERIA and CAMEROON).

The third or central group of Sudanese states is formed of the sultanates of Bagirmi (*q.v.*) with Kanem and Wadai (*q.v.*). Wadai was the last state of the Sudan to come under European influence, its conquest being effected in 1909. This third group is included in French Congo (*q.v.*).

The fourth group consists of the states conquered during the 19th century by the Egyptians and now under the joint control of Great Britain and Egypt. These countries are known collectively as the Anglo-Egyptian Sudan (see below).

For the regions west of Lake Chad the standard historical work is the *Travels* of Dr Heinrich Barth (5 vols., London, 1857–1858). Consult also P. C. Meyer, *Erforschungsgeschichte und Staatenbildungen des Westsudan* (Gotha, 1897), an admirable summary with bibliography and maps; Karl Kumm, *The Sudan* (London, 1907); Lady

Lugard, *A Tropical Dependency* (London, 1905); and the bibliographies given under the various countries named. For sources and history see TIMBUKTU. For the central Sudan the most important work is that of Gustav Nachtigal, *Sahara und Sudan* (3 vols., Berlin 1879–1889). See also Boyd Alexander, *From the Niger to the Nile* (2 vols., London, 1907); Karl Kumm, *From Haussaland to Egypt* (London, 1910). For the eastern Sudan see the bibliographies under the following section. A good general work is P. Paulitschke's *Die Sudânländer* (Freiburg, 1885).

THE ANGLO-EGYPTIAN SUDAN

The region which before the revolt of the Arabized tribes under the Mahdi Mahommed Ahmed in 1881–84 was known as the Egyptian Sudan has, since its reconquest by the Anglo-Egyptian expeditions of 1896–98, been under the joint sovereignty of Great Britain and Egypt. The limits of this condominium differ slightly from those of the Egyptian Sudan of the pre-Mahdi period. It is bounded N. by Egypt (the 22nd parallel of N. lat. being the dividing line), E. by the Red Sea, Eritrea and Abyssinia, S. by the Uganda Protectorate and Belgian Congo, W. by French Congo. North of Darfur is the Libyan Desert, in which the western and northern frontiers meet. Here the boundary is undefined.[1]

Boundaries and Area.

As thus constituted the Anglo-Egyptian Sudan forms a compact territory which, being joined southwards by the Uganda Protectorate, brings the whole of the Nile valley from the equatorial lakes to the Mediterranean under the control of Great Britain. The Anglo-Egyptian Sudan extends north to south about 1200 m. in a direct line, and west to east about 1000 m. also in a direct line. It covers 950,000 sq. m., being about one-fourth the area of Europe. In what follows the term Sudan is used to indicate the Anglo-Egyptian condominium only.

Physical Features.—The Sudan presents many diversified features. It may be divided broadly into two zones. The northern portion, from about 16° N., is practically the south-eastern continuation of the Saharan desert; the southern region is fertile, abundantly watered, and in places densely forested. West of the Nile there is a distinctly marked intermediate zone of steppes. In the southern district, between 5° and 10° N., huge swamps extend on either side of the Nile and along the Bahr-el-Ghazal.

From south to north the Sudan is traversed by the Nile (*q.v.*), and all the great tributaries of that river are either partly or entirely within its borders. The most elevated district is a range of mountains running parallel to the Red Sea. These mountains, which to the south join the Abyssinian highlands, present their steepest face eastward, attaining heights within the Sudan of 4000 to over 7000 ft. Jebel Erba, 7480 ft., and Jebel Soturba, 6889 ft. (both between 21° and 22° N.), the highest peaks, face the Red Sea about 20 m. inland. Westward the mountains slope gradually to the Nile valley, which occupies the greater part of the country and has a general level of from 600 to 1600 ft. In places, as between Suakin and Berber and above Roseires on the Blue Nile, the mountains approach close to the river. Beyond the Nile westward extend vast plains, which in Kordofan and Dar Nuba (between 10° and 15° N.) are broken by hills reaching 2000 ft. Farther west, in Darfur, the country is more elevated, the Jebel Marra range being from 5000 to 6000 ft. high. In the south-west, beyond the valley of the Bahr-el-Ghazal, the country gradually rises to a ridge of hills, perhaps 2000 ft. high, which running south-east and north-west form the water-parting between the Nile and the Congo.

Apart from the Nile system, fully described elsewhere, the Sudan has two other rivers, the Gash and the Baraka. These are intermittent streams rising in the eastern chain of mountains in Eritrea and flowing in a general northerly direction. The Gash enters the Sudan near Kassala and north of that town turns west towards the Atbara, but its waters are dissipated before that river is reached. The Gash nevertheless fertilizes a considerable tract of country. The Khor Baraka lies east of the Gash. It flows towards the Red Sea in the neighbourhood of Trinkitat (some 50 m. south of Suakin), but about 30 m. from the coast forms an inland delta. Except in seasons of great rain its waters do not reach the sea.

The Coast Region.—The coast extends along the Red Sea north to south from 22° N. to 18° N., a distance following the indentations of the shore of over 400 m. These indentations are numerous but not deep, the general trend of the coast being S.S.E. The most prominent headland is Ras Rawaya (21° N.) which forms the northern shore of Dokhana Bay. There are few good harbours, Port Sudan and Suakin being the chief ports. South of Suakin is the shallow bay of Trinkitat. A large number of small islands lie off the coast. A belt of sandy land covered with low scrub stretches inland ten to twenty miles, and is traversed by khors (generally dry) with ill-defined shifting channels. Beyond this plain rise the mountain ranges already mentioned. Their seaward slopes often bear a considerable amount of vegetation.

The Desert Zone.—The greater part of the region between the coast and the Nile is known as the Nubian Desert. It is a rugged, rocky, barren waste, scored with khors or wadis, along whose beds there is scanty vegetation. The desert character of the country increases as the river is neared, but along either bank of the Nile is a narrow strip of cultivable land. West of the Nile there are a few oases—those of Selima, Zaghawa and El Kab—but this district, part of the Libyan Desert, is even more desolate than the Nubian Desert.

The Intermediate Zone and the Fertile Districts.—East of the Nile the region of absolute desert ceases about the point of the Atbara confluence. The country enclosed by the Nile, the Atbara and the Blue Nile, the so-called Island of Meroë, consists of very fertile soil, and along the eastern frontier, by the upper courses of the rivers named, is a district of rich land alternating with prairies and open forests. The fork between the White and Blue Niles, the Gezira, is also fertile land. South of the Gezira is Sennar, a well-watered country of arable and grazing land.

West of the Nile the desert zone extends farther south than on the east, and Kordofan, which comes between the desert and the plains of the Bahr-el-Ghazal, is largely barren and steppe land. South of 10° N. there is everywhere abundance of water. Darfur is mainly open, steppe-like country with extensive tracts of cultivable land and a central mountain massif, the Jebel Marra (see SENNAR KORDOFAN, DARFUR).

Climate.—The country lies wholly within the tropics, and as the greater part of it is far removed from the ocean and less than 1500 ft. above the sea it is extremely hot. The heat is greatest in the central regions, least in the desert zone, where the difference between summer and winter is marked. Even in winter, however, the day temperatures are high. Of this region the Arabs say "the soil is like fire and the wind like a flame." Nevertheless, the dryness of the air renders the climate healthy. The steppe countries, Kordofan and Darfur, are also healthy except after the autumn rains. At Khartum, centrally situated, the minimum temperature is about 40° F., the maximum 113°, the mean annual temperature being 80°. January is the coldest and June the hottest month. Violent sand-storms are frequent from June to August. Four rain zones may be distinguished. The northern (desert) region is one of little or no rain. There are perhaps a few rainy days in winter and an occasional storm in the summer. In the central belt, where "the rainy season" is from mid-June to September, there are some 10 in. of rain during the year. The number of days on which rain falls rarely exceeds, however, fifteen. The rainfall increases to about 20 in. per annum in the eastern and south-eastern regions. In the swamp district and throughout the Bahr-el-Ghazal heavy rains (40 in. or more a year) are experienced. The season of heaviest rain is from April to September. In the maritime district there are occasional heavy rains between August and January. In the sudd region thunderstorms are frequent. Here the temperature averages about 85° F., the air is always damp and fever is endemic.

Flora.—In the deserts north of Khartum vegetation is almost confined to stunted mimosa and, in the less arid districts, scanty herbage. Between the desert and the cultivated Nile lands is an open growth of samr, hashab (*Acacia verek*) and other acacia trees. Between Khartum and 12° N. forest belts line the banks of the rivers and khors, in which the most noteworthy tree is the sant or sunt (*Acacia arabica*). Farther from the rivers are open woods of heglig (*Balanites aegyptiaca*), hashab, &c., and dense thickets of laot (*Acacia nubica*) and kittr (*Acacia mellifera*). These open woods cover a considerable part of Kordofan, the hashab and talh trees being the chief producers of gum arabic. South of 12° N. the forest lands of the White Nile as far south as the sudd region are of similar character to that described. On the Blue Nile the forest trees alter, the most abundant being the babanus (Sudan ebony) and the silag (*Anogeissus leiocarpus*), while gigantic baobabs, called tebeldi in the Sudan, and tarfa (*Sterculia cinerea*) are numerous. In southern Kordofan and in the higher parts of the Bahr-el-Ghazal the silag and ebony are also common, as well as African mahogany (homraya, *Khaya senegalensis*) and other timber trees. In the Ghazal province also are many rubber-producing lianas, among them the *Landolphia owariensis*. There are also forest regions in the Bahr-el-Jebel, in the Mongalla mudiria and along the Abyssinian-Eritrean frontier. East of the Bahr-el-Jebel and north of the Bahr-el-Ghazal are vast prairies covered with tall coarse grass. Cotton is indigenous in the valley of the Blue Nile, and in some districts bamboos are plentiful. The castor-oil plant grows in almost every province. (See also § *Agriculture*, and, for the vegetation of the swamp region, NILE.)

Fauna.—Wild animals and birds are numerous. Elephants are abundant in the Bahr-el-Ghazal and Bahr-el-Jebel forests, and are found in fewer numbers in the upper valley of the Blue Nile.

[1] It was supposed to be indicated by the line which, according to the Turkish firman of 1841, describes a semicircle from the Siwa Oasis to Wadai, approaching the Nile between the Second and Third Cataracts. This line is disregarded by the Sudan government.

The hippopotamus and crocodile abound in the swamp regions, which also shelter many kinds of water-fowl. The lion, leopard, giraffe and various kinds of antelope are found in the prairies and in the open woods. In the forests are numerous bright-plumaged birds and many species of monkeys, mostly ground monkeys—the trees being too prickly for climbing. Snakes are also plentiful, many poisonous kinds being found. In the steppe regions of Kordofan, Darfur, &c., and in the Nubian Desert ostriches are fairly plentiful. Insect life is very abundant, especially south of 12° N., the northern limit of the tsetse fly. The chief pests are mosquitoes, termites and the serut, a brown fly about the size of a wasp, with a sharp stab, which chiefly attacks cattle. Locusts are less common, but, especially in the eastern districts, occasionally cause great destruction. For domestic animals see § *Agriculture.*

Inhabitants.—The population, always sparse in the desert and steppe regions, was never dense even in the more fertile southern districts. During the Mahdia the country suffered severely from war and disease. Excluding Darfur the population before the Mahdist rule was estimated at 8,500,000. In 1905 an estimate made by the Sudan government put the population at 1,853,000 only, including 11,000 foreigners, of whom 2800 were Europeans. Since that year there has been a considerable natural increase and in 1910 the population was officially estimated at 2,400,000. There has also been a slight immigration of Abyssinians, Egyptians, Syrians and Europeans—the last named chiefly Greeks.

The term "Bilad-es-Sudan" ("country of the blacks") is not altogether applicable to the Anglo-Egyptian condominium, the northern portion being occupied by Hamitic and Semitic tribes, chiefly nomads, and classed as Arabs. In the Nile valley north of Khartum the inhabitants are of very mixed origin. This applies particularly to the so-called Nubians who inhabit the Dongola mudiria (see NUBIA). Elsewhere the inhabitants north of 12° N. are of mixed Arab descent. In the Nubian Desert the chief tribes are the Ababda and Bisharin, the last named grazing their camels in the mountainous districts towards the Red Sea. In the region south of Berber and Suakin are the Hadendoa. The Jaalin, Hassania and Shukria inhabit the country between the Atbara and Blue Nile; the Hassania and Hassanat are found chiefly in the Gezira. The Kabbabish occupy the desert country north of Kordofan, which is the home of the Baggara tribes. In Darfur the inhabitants are of mixed Arab and negro blood.

Of negro Nilotic tribes there are three or four main divisions. The Shilluks occupy the country along the west side of the Nile northward from about Lake No. The country east of the Nile is divided between the Bari, Nuer and Dinka tribes. The Dinkas are also widely spread over the Bahr-el-Ghazal province. South of Kordofan and west of the Shilluk territory are the Nubas, apparently the original stock of the Nubians. In the south-west of the Bahr-el-Ghazal are the Bongos and other tribes, and along the Nile-Congo water-parting are the A-Zande or Niam-Niam, a comparatively light-coloured race. (All the tribes mentioned are separately noticed.)

Social Conditions.—In contrast with the Egyptians, a most industrious race, the Sudanese tribes, both Arab and negro, are as a general rule indolent. Where wants are few and simple, where houses need not be built nor clothes worn to keep out the cold, there is little stimulus to exertion. Many Arabs "clothed in rags, with only a mat for a house, prefer to lead the life of the free-born sons of the desert, no matter how large their herds or how numerous their followings" (*Egypt*, No. 1 [1904], p. 147). Following the establishment of British control slave-raiding and the slave trade were stopped, but domestic slavery continues. A genuine desire for education is manifest among the Arabic-speaking peoples and slow but distinct moral improvement is visible among them. Among the riverain "Arabs" some were found to supply labour for public works, and with the money thus obtained cattle were bought and farms started. The Dongolese are the keenest traders in the country. The Arab tribes are all Mahommedans, credulous and singularly liable to fits of religious excitement. Most of the negro tribes are pagan, but some of them who live in the northern regions have embraced Islam.

Divisions and Chief Towns.—Darfur is under native rule. The rest of the Sudan is divided into mudirias (provinces) and these are subdivided into mamuria. The mudirias are Halfa, Red Sea, Dongola and Berber in the north (these include practically all the region known as Nubia); Khartum, Blue Nile and White Nile in the centre; Kassala and Sennar in the east; Kordofan in the west; and Bahr-el-Ghazal, Upper Nile (formerly Fashoda) and Mongalla in the south. The mudirias vary considerably in size.

The capital, Khartum (*q.v.*), pop. with suburbs about 70,000, is built in the fork formed by the junction of the White and Blue Niles. Opposite Khartum, on the west bank of the White Nile, is Omdurman (*q.v.*), pop. about 43,000, the capital of the Sudan during the Mahdia. On the Nile north of Khartum at the towns of Berber, Abu Hamed, Merawi (Merowe), Dongola and Wadi Halfa. On the Red Sea are Port Sudan and Suakin. Kassala is on the river Gash east of the Atbara and near the Eritrean frontier. (These towns are separately noticed.) On the Blue Nile are Kamlin, Sennar, Wad Medani (*q.v.*), pop. about 20,000, a thriving business centre and capital of the Blue Nile mudiria, and Roseires, which marks the limit of navigability by steamers of the river. Gallabat is a town in the Kassala mudiria close to the Abyssinian frontier, and Gedaref lies between the Blue Nile and Atbara a little north of 14° N. El Obeid, the chief town of Kordofan, is 230 m. south-west by south of Khartum. Duiem, capital of the White Nile mudiria, is the river port for Kordofan. El Fasher, the capital of Darfur, is 500 m. W.S.W. of Khartum. All the towns named, except Roseires, are situated north of 13° N. In the south of the Sudan there are no towns properly so called. The native villages are composed of straw or palm huts; the places occupied by Europeans or Egyptians are merely "posts" where the administrative business of the district is carried on. Fashoda (*q.v.*), renamed Kodok, is the headquarters of the Upper Nile mudiria.

Communications.—North of Khartum the chief means of communication is by railway; south of that city by steamer. There are two trunk railways, one connecting the Sudan with Egypt, the other affording access to the Red Sea. The first line runs from the Nile at Wadi Halfa across the desert in a direct line to Abu Hamed, and from that point follows more or less closely the right (east) bank of the Nile to Khartum. At Khartum the Blue Nile is bridged and the railway is continued south through the Gezira to Sennar. Thence it turns west, crosses the White Nile near Abba Island, and is continued to El Obeid. The length of the line from Halfa to Khartum is 575 m.; from Khartum to Obeid 350 m. The railway from the Nile to the Red Sea starts from the Halfa-Khartum line at Atbara Junction, a mile north of the Atbara confluence. It runs somewhat south of the Berber-Suakin caravan route. At Sallom, 278 m. from Atbara Junction, the line divides, one branch going north to Port Sudan, the other south to Suakin. The total distance to Port Sudan from Khartum is 493 m., the line to Suakin being 4 m. longer. Besides these main lines a railway, 138 m. long, runs from Abu Hamed on the right bank of the Nile to Kareima (opposite Merawi) in the Dongola mudiria below the Fourth Cataract. (The railway which started from Halfa and followed the right bank of the Nile to Kerma, 201 m. from Halfa, was abandoned in 1903.) The railways are owned and worked by the state.

In connexion with the Khartum-Halfa railway steamers ply on the Nile between Halfa and Shellal (Assuan) where the railway from Alexandria ends. The distance by rail and steamer between Khartum and Alexandria is about 1490 m. Steamers run on the Nile between Kerma and Kareima, and above Khartum the government maintains a regular service of steamers as far south as Gondokoro in the Uganda Protectorate. During flood season there is also a steamship service on the Blue Nile. Powerful dredgers and sudd-cutting machines are used to keep open communications in the upper Nile and Bahr-el-Ghazal.

The ancient caravan routes Korosko-Abu Hamed and Berber-Suakin have been superseded by the railways, but elsewhere wells and rest-houses are maintained along the main routes between the towns and the Nile. On some of these roads a motor car service is maintained.

From Port Sudan and Suakin there is a regular steamship service to Europe via the Suez Canal. There are also services to Alexandria, the Red Sea ports of Arabia, Aden and India.

There is an extensive telegraphic system. Khartum is connected by land lines with Egypt and Uganda, thus affording direct telegraphic connexion between Alexandria and Mombasa (2500 m.). From Khartum other lines go to Kassala and the Red Sea ports. In some places the telegraph wires are placed 16 ft. 6 in. above the ground to protect them from damage by giraffes.

Agriculture and other Industries.—North of Khartum agricultural land is confined to a narrow strip on either side of the Nile and to the few oases in the Libyan Desert. In the Gezira and in the plains of Gedaref between the Blue Nile and the Atbara there are wide areas of arable land, as also in the neighbourhood of Kassala along the banks of the Gash. In Kordofan and Darfur cultivation is confined to the khors or valleys. The chief grain crop is durra, the staple food of the Sudanese. Two crops are obtained yearly in several districts. On lands near the rivers the durra is sown after the flood has gone down and also at the beginning of the rainy season. Considerable quantities of wheat and barley are also grown. Other foodstuffs raised are lentils, beans, onions and melons. The date-palm is cultivated along the Nile valley below Khartum, especially on the west bank in the Dongola mudiria and in the neighbouring oases. Dates are also a staple product in Darfur and Kordofan. Ground-nuts and sesame are grown in large quantities for the oil they yield, and cotton of quality equal to that grown in the Delta is produced. The Sudan was indeed the original home of Egyptian cotton.

For watering the land by the river banks sakias (water-wheels) are used, oxen being employed to turn them. There are also a few irrigation canals. In 1910, apart from the date plantations, about 1,500,000 acres were under cultivation. In 1910 a system of basin irrigation was begun in Dongola mudiria.

Gum and rubber are the chief forest products. The gum is obtained from eastern Kordofan and in the forests in the upper valley of the Blue Nile, the best gum coming from Kordofan. It is of two kinds, *hashab* (white) and *talh* (red), the white being the most valuable. Rubber is obtained from the Bahr-el-Ghazal—where there are Para and Ceara rubber plantations—and in the Sobat district. The wood of the sunt tree is used largely for boat-building and for fuel, and the mahogany tree yields excellent timber. Fibre is made from several trees and plants. Elephants are hunted for the sake of their ivory. The wealth of the Arab tribes consists largely in their herds of camels, horses and cattle. They also keep ostrich farms, the feathers being of good quality. The Dongola breed of horses is noted for its strength and hardness. The camels are bred in the desert north of Berber, between the Nile and Red Sea, in southern Dongola, in the Hadendoa country and in northern Kordofan. The Sudanese camel is lighter, faster and better bred than the camel of Egypt. The camel, horse and ostrich are not found south of Kordofan and Sennar. The negro tribes living south of those countries possess large herds of cattle, sheep and goats. The cattle are generally small and the sheep yield little wool. The Arabs use the cattle as draught-animals as well as for their milk and flesh; the negro tribes as a rule do not eat their oxen. Fowls are plentiful, but of poor quality. Donkeys are much used in the central regions; they make excellent transport animals.

Mineral Wealth.—In ancient times Nubia, *i.e.* the region between the Red Sea and the Nile south of Egypt and north of the Suakin-Berber line, was worked for gold. Ruins of an extensive gold-mine exist near Jebel Erba at a short distance from the sea. In 1905 gold mining recommenced in Nubia, in the district of Um Nabardi, which is in the desert, about midway between Wadi Halfa and Abu Hamed. A light railway, 30 m. long, opened in June 1905, connects Um Nabardi with the government railway system. The producing stage was reached in 1908, and between September 1908 and August 1909 the mines yielded 4500 oz. of gold. Small quantities of gold-dust are obtained from Kordofan, and gold is found in the Beni-Shangul country south-west of Sennar, but this region is within the Abyssinian frontier (agreement of the 15th of May 1902). There is lignite in the Dongola mudiria and iron ore is found in Darfur, southern Kordofan and in the Bahr-el-Ghazal. In the last-named mudiria iron is worked by the natives. The district of Hofrat-el-Nahas (the copper mine) is rich in copper, the mines having been worked intermittently from remote times.

Trade.—The chief products of the Sudan for export are gum, ivory, ostrich feathers, dates and rubber. Cotton, cotton-seed and grain (durra, wheat, barley) sesame, livestock, hides and skins, beeswax, mother-of-pearl, senna and gold are also exported. Before the opening (1906) of the railway to the Red Sea the trade was chiefly with Egypt via the Nile, and the great cost of carriage hindered its development. Since the completion of the railway named goods can be put on the world's markets at a much cheaper rate. Besides the Egyptian and Red Sea routes there is considerable trade between the eastern mudirias and Abyssinia and Eritrea, and also some trade south and west with Uganda and the Congo countries. The Red Sea ports trade largely with Arabia and engage in pearl fishery. The principal imports are cotton goods, food-stuffs (flour, rice, sugar, provisions), timber, tobacco, spirits (in large quantities), iron and machinery, candles, cement and perfumery. The value of the trade, which during the Mahdist rule (1884–1898) was a few thousands only, had increased in 1905 to over £1,500,000. In 1908 the exports of Sudan produce were valued at £E515,000[1]; the total imports at £E1,892,000.

Government.—The administration is based on the provisions of a convention signed on the 19th of January 1899 between the British and Egyptian governments. The authority of the sovereign powers is represented by a governor-general appointed by Egypt on the recommendation of Great Britain. In 1910 a council consisting of four *ex officio* members and from two to four non-official nominated members was created to advise the governor-general in the exercise of his executive and legislative functions. Subject to the power of veto retained by the governor-general all questions are decided by a majority of the council. Each of the mudirias into which the country is divided is presided over by a mudir (governor) responsible to the central government at Khartum. The governor-general, the chiefs of the various departments of state and the mudirs are all Europeans, the majority being British military officers. The minor officials are nearly all Egyptians or Sudanese. Revenue is derived as to about 60% from the customs and revenue-earning departments (*i.e.* steamers, railways, posts and telegraphs), and as to the rest from taxes on land, date-trees and animals, from royalties on gum, ivory and ostrich feathers, from licences to sell spirits, carry arms, &c., and from fees paid for the shooting of game. Expenditure is largely on public works, education, justice and the army. Financial affairs are managed from Khartum, but control over expenditure is exercised by the Egyptian financial department. The revenue, which in 1898 was £E35,000, for the first time exceeded a million in 1909, when the amount realized was £E1,040,200. The expenditure in 1909 was £E1,153,000. Financially the government had been, up to 1910, largely dependent upon Egypt. In the years 1901–1909 £E4,378,000 was advanced from Cairo for public works in the Sudan; in the same period a further sum of about £E2,750,000 had been found by Egypt to meet annual deficits in the Sudan budgets (see *Egypt*, No. 1 [1910], pp. 5-6).

Justice.—The Sudan judicial codes, based in part on those of India and in part on the principles of English law and of Egyptian commercial law, provide for the recognition of "customary law" so far as applicable and "not repugnant to good conscience." In each mudiria criminal justice is administered by a court, consisting of the mudir (or a judge) and two magistrates, which has general competence. The magistrates are members of the administrative staff, who try minor cases without the help of the mudir (or judge). The governor-general possesses revising powers in all cases. Civil cases of importance are heard by a judge (or where no judge is available by the mudir or his representative); minor civil cases are tried by magistrates. From the decision of the judges an appeal lies to the legal secretary of the government, in his capacity of judicial commissioner. Jurisdiction in all legal matters as regards personal status of Mahommedans is administered by a grand cadi and a staff of subordinate cadis. The police force of each mudiria is independently organized under the control of the mudirs.

Education.—Education is in charge of the department of public instruction. Elementary education, the medium of instruction being Arabic, is given in *kuttabs* or village schools. There are primary schools in the chief towns where English, Arabic, mathematics, and in some cases land-measuring is taught. There are also government industrial workshops, and a few schools for girls. The Gordon College at Khartum trains teachers and judges in the Mahommedan courts and has annexed to it a secondary school. The college also contains the Wellcome laboratories for scientific research. Among the pagan negro tribes Protestant and Roman Catholic missions are established. These missions carry on educational work, special attention being given to industrial training.

Defence.—The defence of the country is entrusted to the Egyptian army, of which several regiments are stationed in the Sudan. The governor-general is sirdar (commander-in-chief) of the army. A small force of British troops is also stationed in the Sudan—chiefly at Khartum. They are under the command of the governor-general in virtue of an arrangement made in 1905, having previously been part of the Egyptian command.

For topography, &c., see *The Anglo-Egyptian Sudan*, a compendium prepared by officers of the Sudan government and edited by Count Gleichen (2 vols., London, 1905); for administration, finance and trade the annual *Reports* [by the British agent at Cairo] *on Egypt and the Sudan*, since 1898; and the special report (Blue Book *Egypt*, No. ii., 1883) by Colonel D. H. Stewart. Consult also J. Petherick, *Travels in Central Africa* (2 vols., London, 1862); W. Junker, *Travels in Africa, 1875–1886* (3 vols., London, 1890–1892); G. Schweinfurth *The Heart of Africa* (2 vols., London, 1873); J. Baumgarten, *Ostafrika, der Sudan und das Seengebiet* (Gotha, 1890); E. D. Schoenfeld, *Erythräa und der ägyptische Sudân* (Berlin, 1904); C. E. Muriel, *Report on the Forests of the Sudan* (Cairo, 1901); H. F. Witherby, *Bird Hunting on the White Nile* (London, 1902). For ethnology,

[1] A £E(pound Egyptian) is equal to £1, 0s. 6d. British currency.

&c., see A. H. Keane, *Ethnology of the Egyptian Sudan* (London, 1884); H. Frobenius, *Die Heiden-Neger des ägyptischen Sudan* (Berlin, 1893). Scientific and medical subjects are dealt with in the *Reports of the Wellcome Research Laboratories*, Gordon College, Khartum. The *Sudan Almanac* is a valuable official publication. (F. R. C.)

Archaeology.—Archaeological study in the Sudan was retarded for many years by political conditions. The work which had been begun by Cailliaud, Champollion, Lepsius and others was interrupted by the rise of the Mahdist power; and with the frontiers of Egypt itself menaced by dervishes, the country south of Aswan (Assuan) was necessarily closed to the student of antiquity. Even after the dervishes had been overthrown at the battle of Omdurman (1898) it was some time before archaeologists awoke to a sense of the historical importance of the regions thus made accessible to them. Dr Wallis Budge visited several of the far southern sites and made some tentative excavations, but no extensive explorations were undertaken until an unexpected event produced a sudden outburst of activity. This was the resolution adopted by the Egyptian government to extend the great reservoir at the First Cataract by raising the height of the Aswan dam. As a result of this measure all sites bordering the river banks from Aswan to Abu Simbel were threatened with inundation and the scientific world took alarm. A large sum of money was assigned by the government, partly for the preservation of the visible temples in the area to be submerged, partly for an official expedition under the charge of Dr G. A. Reisner which was to search for all remains of antiquity hidden beneath the ground. At the same time the university of Pennsylvania despatched the Eckley B. Coxe, jun., expedition, which devoted its attention to the southern half of Lower Nubia from Halfa to Korosko, while the government excavators explored from Korosko to Aswan. Thus in the five years 1907–1911 inclusive an immense mass of new material was acquired which throws a flood of light on the archaeology at once of Egypt and the Sudan. For it must be clearly appreciated that though all except the southern twenty miles of Lower Nubia has been attached for purposes of administration of Egypt proper, yet this political boundary is purely artificial. The natural geographical and ethnical southern frontier of Egypt is the First Cataract; Egyptian scribes of the Old Empire recognized this truth no less clearly than Diocletian, and Juvenal anticipates the verdict of every modern observer when he describes the "porta Syenes" as the gate of Africa. It is the more necessary to emphasize this fact as the present article must unavoidably be concerned principally with the most northern regions of the country of the Blacks—for since the days of Lepsius there has been little new investigation south of Halfa. The hasty reconnaissances of Dr Wallis Budge, Professor A. H. Sayce, Mr Somers Clarke and Professor J. Garstang must be followed by more thorough and intensive study before it can be possible to write in more than very general terms of anything but the well-known monuments left by Egyptian kings whose history is already tolerably familiar from other sources. The inscriptions of these kings and their officials have been collected by Professor J. H. Breasted and some account of the temples and fortresses from Halfa to Khartum will be found in the following section, *Ancient Monuments south of Halfa*, while the history of the early and medieval Christian kingdoms is outlined in the articles Ethiopia and Dongola. The central and southern Sudan is therefore almost a virgin field for the archaeologist, but the exploration of Lower Nubia has made it possible to write a tentative preface to the new chapters still unrevealed.

The Sudan was well named by the medieval Arab historians, for it is primarily and above all the country of the *black* races, of those Nilotic negroes whose birthplace may be supposed to have been near the Great Lakes. But upon this aboriginal stock were grafted in very early times fresh shoots of more vigorous and intellectual races coming probably from the East (cf. Africa: *Ethnology*). Lower Nubia was one of the crucibles in which several times was formed a mixed nation which defied or actually dominated Egypt. There is some scientific ground for dating the earliest example of such a fusion to the exact period of the Egyptian Old Empire. It is certain in any case that the process was constantly repeated at different dates and in different parts of the country from Aswan to Axum, and to the stimulation which resulted from it must be ascribed the principal political and intellectual movements of the Sudanese nations. Thus the Ethiopians who usurped the crown of the Pharaohs from 740–660 B.C. were of a mixed stock akin to the modern Barabra; the northern Nubians who successfully defied the Roman emperors were under the lordship of the Blemyes (Blemmyes), an East African tribe, and the empire of the Candace dynasty, no less than the Christian kingdoms which succeeded it, included many heterogeneous racial elements (see also Nubia). The real history of the Sudan will therefore be concerned with the evolution of what may be called East African or East Central African civilizations.

Up to the present, however, this aspect has been obscured, for until 1907 scholars had little opportunity of studying ancient Ethiopia except as a colonial extension of Egypt. From the purely Egyptological standpoint there is much of value to be learned from the Sudan. The Egyptian penetration of the country began, according to the evidence of inscriptions, as early as the Old Empire. Under the XIIth Dynasty colonies were planted and fortresses established down to the Batn-el-Hagar. During the XVIIIth Dynasty the political subjugation was completed and the newly won territories were studded with cities and temples as far south as the Fourth Cataract. Some two hundred years later the priests of Amen (Ammon), flying from Thebes, founded a quasi-Egyptian capital at Napata. But after this date Egypt played no part in the evolution of Ethiopia. Politically moribund, it succumbed to the attacks of its virile southern neighbours, who, having emerged from foreign tutelage, developed according to the natural laws of their own genius and environment. The history of Ethiopia therefore as an independent civilization may be said to date from the 8th century B.C., though future researches may be able to carry its infant origins to a remoter past.

Of the thousand years or more of effective Egyptian occupation many monuments exist, but on a broad general view it must be pronounced that they owe their fame more to the accident of survival than to any special intrinsic value. For excepting Philae, which belongs as much to Egypt as to Ethiopia, Abu Simbel is the only temple which can be ranked among first rate products of Egyptian genius. The other temples, attractive as they are, possess rather a local than a universal interest. Similarly while the exploration of the Egyptian colonies south of the First Cataract has added many details to our knowledge of political history, of local cults and provincial organization, yet with one exception it has not affected the known outlines of the history of civilization. This exception is the discovery made by Dr G. A. Reisner that the archaic culture first detected at Nagada and Abydos and then at many points as far north as Giza extended southwards into Nubia at least as far as Gerf Husein. This was wholly unexpected, and if, as seems probable, the evidence stands the test of criticism, it is a new historical fact of great importance. The government expedition found traces between Aswan and Korosko of all the principal periods from this early date down to the Christian era. The specimens obtained are kept in a separate room of the Cairo Museum, where they form a collection of great value.

The work of the Pennsylvanian expedition, however, while adding only a few details to the archaeology of the Egyptian periods, has opened a new chapter in the history of the African races. No records indeed were discovered of the founders of the first great Ethiopian kingdom from Piankhi to Tirhakah, nor has any fresh light been thrown upon the relations which that remarkable king Ergamenes maintained with the Egyptian Ptolemies. But the exploration of sites in the southern half of Lower Nubia has revealed the existence of a wholly unsuspected independent civilization which grew up during the first six centuries after Christ. The history of the succeeding periods, moreover, has been partially recovered and the study of architecture enriched by the excavation of numerous churches dating from the time of Justinian, when Nubia was first Christianized, down to the late medieval period when Christianity was extirpated by Mahommedanism.

The civilization of the first six centuries A.D. may be called "Romano-Nubian," a term which indicates its date and suggests something of its character. It is the product of a people living on the borders of the Roman Empire who inherited much of the Hellenistic tradition in minor arts but combined it with a remarkable power of independent origination. The sites on which it has been observed range from Dakka to Halfa, that is to say within the precise limits which late Latin and Greek writers assign to the Blemyes, and there is good reason to identify the people that evolved it with this hitherto almost unknown barbarian nation. Apart from this, however, the greatest value of the new discoveries will consist in the fact that they may lay the foundations for a new documentary record of past ages. For the graves yielded not only new types of statues, bronzes, ivory carvings and painted pottery—all of the highest artistic value—but also a large number of stone stelae inscribed with funerary formulae in the Meroitic script.

In the course of sixty years the small collection of Meroitic inscriptions made by Lepsius had not been enlarged and no progress had been made towards decipherment. But the cemeteries of Shablul and Karanog alone yielded 170 inscriptions on stone, besides some inscribed ostraka. This mass of material brought the task of decipherment within the range of possibility, and even without any bilingual record to assist him, Mr F. Ll. Griffith rapidly succeeded in the first stages of translation. As further explorations bring more inscriptions to light the records of Ethiopia will gradually be placed on a firm documentary basis and the names and achievements of its greatest monarchs will take their place on the roll of history.

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Ancient Monuments south of Halfa.—Ruins of pyramids, temples, churches and other monuments are found along both banks of the Nile almost as far south as the Fourth Cataract, and again in the "Island of Meroë." In the following list the ruins are named as met with on the journey south from Wadi Halfa. Opposite that town on the east bank are the remains of Bohon, where was found the stele, now at Florence, commemorating the conquest of the region by Senwosri (Usertesen) I. of Egypt (*c.* 2750 B.C.). Forty-three miles farther south are the ruins of the twin fortresses of Kumma and Semna. Here the Nile narrows and passes the Semna cataract, and graven on the rocks are ancient records of "high Nile." At Amara, some 80 m. above Semna, are the ruins of a temple with Meroitic hieroglyphics. At Sai Island, 130 m. above Halfa, are remains of a town and of a Christian church. Thirteen miles south of Sai at Soleb are the ruins of a fine temple commemorating Amenophis (Amenhotep) III. (*c.* 1414 B.C.) to whose queen Taia was dedicated a temple at Sedeinga, a few miles to the north. At Sesebi, 40 m. higher up the Nile, is a temple of the heretic king Akhenaton re-worked by Seti I. (*c.* 1327 B.C.). Opposite Hannek at the Third Cataract on Tombos Island are extensive ancient granite quarries, in one of which lies an unfinished colossus. On the east side of the river near Kerma are the remains of an Egyptian city. Argo Island, a short distance higher up, abounds in ruins, and those at Old Dongola, 320 m. from Halfa, afford evidence of the town having been of considerable size during the time of the Christian kingdom of Dongola. From Old Dongola to Merawi (a distance of 100 m. by the river) are numerous ruins of monasteries, churches and fortresses of the Christian era in Nubia—notably at Jebel Deka and Magal. In the immediate neighbourhood of Jebel Barkal (the "holy mountain" of the ancient Egyptians), a flat-topped hill which rises abruptly from the desert on the right bank of the Nile a mile or two above the existing village of Merawi (Merowe), are many pyramids and six temples, the pyramids having a height of from 35 to 60 ft. Pyramids are also found at Zuma and Kurru on the right bank, and at Tangassi on the left bank of the river, these places being about 20 m. below Merawi. That village is identified by some archaeologists with the ancient Napata, which is known to have been situated near the "holy mountain." On the left bank of the Nile opposite Merawi are the pyramids of Nuri, and a few miles distant in the Wadi Ghazal are the ruins of a great Christian monastery, where were found gravestones with inscriptions in Greek and Coptic. Ruins of various ages extend from Merawi to the Fourth Cataract.

Leaving the Nile at this point and striking direct across the Bayuda Desert, the river is regained at a point above the Atbara confluence. Thirty miles north of the town of Shendi are the pyramids of Meroë (or Assur) in three distinct groups. From one of these pyramids was taken "the treasure of Queen Candace," now in the Berlin Museum. Many of the pyramids have a small shrine on the eastern side inscribed with debased Egyptian or Meroite hieroglyphics. These pyramids are on the right bank of the Nile, that is in the "Island of Meroë." Portions (including a harbour) of the site of the city of Meroë, at Begerawia, not far from the pyramids named, were excavated in 1909–1910 (see MEROË). In this region, and distant from the river, are the remains of several cities, notably Naga, where are ruins of four temples, one in the Classic style. On the east bank of the Blue Nile, about 13 m. above Khartum at Soba, are ruins of a Christian basilica. Farther south still, at Ceteina on the White Nile (in 1904), and at Wad el-Hadad, some miles north of Sennar, on the Blue Nile (in 1908), Christian remains have been observed.

Between the Nile at Wadi Halfa and the Red Sea are the remains of towns inhabited by the ancient miners who worked the district. The most striking of these towns is Deraheib (Castle Beautiful), so named from the picturesque situation of the castle, a large square building with pointed arches. The walls of some 500 houses still stand.

For a popular account (with many illustrations) of these ruins see J. Ward, *Our Sudan: Its Pyramids and Progress* (London, 1905). (F. R. C.)

HISTORY

A. *From the Earliest Time to the Egyptian Conquest.*—The southern regions of the Anglo-Egyptian Sudan are without recorded history until the era of the Egyptian conquest in the 19th century. In the northern regions, known as Ethiopia or Nubia, Egyptian influence made itself felt as early as the Old Empire. In process of time powerful states grew up with capitals at Napata and Meroë (see *ante* § *Archaeology* and ETHIOPIA and EGYPT). The Nubians—that is the dwellers in the Nile valley between Egypt and Abyssinia—did not embrace Christianity until the 6th century, considerably later than their Abyssinian neighbours. The Arab invasion of North Africa in the 7th century, which turned Egypt into a Mahommedan country, had not the same effect in Nubia, the Moslems, though they frequently raided the country, being unable to hold it.

Christian Kingdoms of Nubia.

On the ruins of the ancient Ethiopian states arose the Christian kingdoms of Dongola and Aloa, with capitals at Dongola and Soba (corresponding roughly to Napata and Meroë). These kingdoms continued to exist until the middle of the 14th century or later (see DONGOLA: *Mudiria*). Meanwhile Arabs of the Beni Omayya tribe, under pressure from the Beni Abbas, had begun to cross the Red Sea as early as the 8th century and to settle in the district around Sennar on the Blue Nile, a region which probably marked the southern limits of the kingdom of Aloa. The Omayya, who during the following centuries were reinforced by further immigrants from Arabia, intermarried with the negroid races, and gradually Arab influence became predominant and Islam the nominal faith of all the inhabitants of Sennar. In this way a barrier was erected between the Christians of Nubia and those of Abyssinia. By the 15th century the Arabized negro races of the Blue Nile had grown into a powerful nation known as the Funj (*q.v.*), and during that century they extended their conquests north to the borders of Egypt. The kingdom of Dongola had already been reduced to a condition of anarchy by Moslem invasions from the north. Christianity was still professed by some of the Nubians as late as the 16th century, but the whole Sudan north of the lands of the pagan negroes (roughly 12° N.) was then under Moslem sway. At that time the sultans of Darfur (*q.v.*) in the west and the sultans or kings of Sennar (the Funj rulers) in the east were the most powerful of the Mahommedan potentates.

The Funj Empire.

The first of the Funj monarchs acknowledged king of the whole of the allied tribes, of which the Hameg were next in importance to the Funj, was Amara Dunkas, who reigned *c.* 1484–1526.[1] During the reign of Adlan, *c.* 1596–1603, the fame of Sennar attracted learned men to his court from such distant places as Cairo and Bagdad. Adlan's great-grandson Badi Abu Daku attacked the Shilluk negroes and raided Kordofan. This monarch built the great mosque at Sennar, almost the only building in the town to survive the ravages of the dervishes in the 19th century. In the early part of the 18th century there was war between the Sennari and the Abyssinians, in which the last named were defeated with great slaughter. It is said that the cause of quarrel was the seizure by the king of Sennar of presents sent by the king of France to the Negus. The victory over the "infidel" Abyssinians became celebrated throughout the Mahommedan world, and Sennar was visited by many learned and celebrated men from Egypt, Arabia and India. Towards the end of the 18th century the Hameg wrested power from the Funj and the kingdom fell into decay, many of the tributary princes refusing to acknowledge the king of Sennar. These disorders continued up to the time of the conquest of the country by the Egyptians.

Conquest by Egypt.

B. *From the Egyptian Conquest to the Rise of the Mahdi.*—The conquest of Nubia was undertaken in 1820 by order of Mehemet Ali, the pasha of Egypt, and was accomplished in the two years following. In its consequences this proved one of the most important events in the history of Africa. Mehemet Ali never stated the reasons which led him to order the occupation of the country, but his leading motive was, probably, the desire to obtain possession of the mines of gold and precious stones which he believed the Sudan contained. He also saw that the revenue of Egypt was falling through the diversion, since about 1800, of the caravan routes from the Nile to the Red Sea ports, and may have wished to recapture the trade, as well as to secure a country whence thousands of slaves could be brought annually. Mehemet Ali also wished to crush the remnant of the Mamelukes who in 1812 had established themselves at Dongola, and at the same time to find employment for the numerous Albanians and Turks in his army, of whose fidelity he was doubtful.

Mehemet Ali gave the command of the army sent to Nubia to his son Ismail, who at the head of some 4000 men left Wadi Halfa in October 1820. Following the Nile route he occupied Dongola without opposition, the Mamelukes fleeing before him. (Some of them went to Darfur and Wadai, others made their way to the Red Sea. This was the final dispersal of the Mamelukes.) With the nomad Shagia, who dominated the district, Ismail had two sharp encounters, one near Korti, the other higher up the river, and in both fights Ismail was successful. Thereafter the Shagia furnished useful auxiliary cavalry to the Egyptians. Ismail remained in the Dongola province till February 1821, when he crossed the Bayuda Desert and received the submission of the meks (kings) of Berber, Shendi and Halfaya, nominal vassals of the king of Sennar. Continuing his march south Ismail reached the confluence of the White and Blue Niles and established a camp at Ras Khartum. (This camp developed into the city of Khartum.) At this time Badi, the king of Sennar, from whom all real power had been wrested by his leading councillors, determined to submit to the Egyptians, and as Ismail advanced up the Blue Nile he was met at Wad Medani by Badi who declared that he recognized Mehemet Ali as master of his kingdom. Ismail and Badi entered the town of Sennar together on the 12th of June 1821, and in this peaceable manner the Egyptians became rulers of the ancient empire of the Funj. In search of the gold-mines reported to exist farther south Ismail penetrated into the mountainous region of Fazokl, where the negroes offered a stout resistance. In February 1822 he set out on his return to Sennar and Dongola, having received reports of risings against Egyptian authority. The Egyptian soldiery had behaved throughout with the utmost barbarity, and their passage up the Nile was marked by rapine, murder, mutilation and fire. Of the rulers who had submitted to Ismail, Nair Mimr, the mek of Shendi, had been compelled to follow in the suite of the Egyptians as a sort of hostage, and this man entertained deep hatred of the pasha. On Ismail's return to Shendi, October 1822, he demanded of the mek 1000 slaves to be supplied in two days. The mek, promising compliance, invited Ismail and his chief officers to a feast in his house, around which he had piled heaps of straw. Whilst the Egyptians were feasting the mek set fire to the straw and Ismail and all his companions were burnt to death.

Ismail's death was speedily avenged. A second Egyptian army, also about 4000 strong, had followed that of Ismail's up the Nile, and striking south-west from Debba had wrested, after a sharp campaign, the province of Kordofan (1821) from the sultan of Darfur. This army was commanded by Mahommed Bey, the Defterdar, son-in-law of Mehemet Ali. Hearing of Ismail's murder the Defterdar marched to Shendi, defeated the forces of the mek, and took terrible revenge upon the inhabitants of Metemma and Shendi, most of the inhabitants, including women and children, being burnt alive. Nair Mimr escaped to the Abyssinian frontier, where he maintained his independence. Having conquered Nubia, Sennar and Kordofan the Egyptians set up a civil government, placing at the head of the administration a governor-general with practically unlimited power.[2] About this period Mehemet Ali leased from the sultan of Turkey the Red Sea ports of Suakin and Massawa, and by this means got into his hands all the trade routes of the eastern Sudan. The pasha of Egypt practically monopolized the trade of the country except that in slaves, which became a vast "industry," the lands inhabited by negro tribes on the borders of the conquered territories being raided annually for the purpose. From the negro population the army was so largely recruited that in a few years the only non-Sudanese in it were officers. The Egyptian rule proved harmful to the country. The governors-general and the leading officials were nearly all Turks, Albanians or Circassians, and, with rare exceptions, the welfare of the people formed no part of their conception of government.[3] Numerous efforts were made to extend the authority of Egypt. In 1840—previous attempts having been unsuccessful—the fertile district of Taka, watered by the Atbara and Gash and near the Abyssinian frontier, was conquered and the town of

[1] Various lists and dates of reign of the rulers of Sennar are given; reference may be made in Stokvis's *Manuel d'histoire* vol. i. (Leiden, 1888), and to *The Anglo-Egyptian Sudan*, vol. i. (London, 1905).

[2] For a list of the governors-general see *The Anglo-Egyptian Sudan*, i. p. 280 (London, 1905).

[3] Khurshid Pasha, governor-general for 13 years (1826–1839), was one of these exceptions. He gained a great reputation both for rectitude and vigour. He led expeditions up the White Nile against the Dinkas as far as Fashoda; defeated the Abyssinians on the Sennar frontier, and taught the natives of Khartum to build houses of brick.

Kassala founded. In 1837 the pasha himself visited the Sudan, going as far as Fazokl, where he inspected the goldfields.

In 1849 Abd-el-Latif Pasha became governor-general and attempted to remedy some of the evils which disfigured the administration. He remained in office, however, little more than a year, too short a period to effect reforms. The Sudan was costing Egypt more money than its revenue yielded, though it must not be forgotten that large sums found their way illicitly into the hands of the pashas. The successors of Mehemet Ali, in an endeavour to make the country more profitable, extended their conquests to the south, and in 1853 and subsequent years trading posts were established on the Upper Nile, the pioneer European merchant being John Petherick, British consular agent at Khartum.[1] Petherick sought for ivory only, but those who followed him soon found that slave-raiding was more profitable than elephant hunting. The viceroy Said, who made a rapid tour through the Sudan in 1857, found it in a deplorable condition. The viceroy ordered many reforms to be executed and proclaimed the abolition of slavery. The reforms were mainly inoperative and slavery continued. The project which Said also conceived of linking the Sudan to Egypt by railway remained unfulfilled. The Sudan at this time (*c.* 1862) is described by Sir Samuel Baker as utterly ruined by Egyptian methods of government and the retention of the country only to be accounted for by the traffic in slaves. The European merchants above Khartum had sold their posts to Arab agents, who oppressed the natives in every conceivable fashion. Ismail Pasha, who became viceroy of Egypt in 1863, gave orders for the suppression of the slave trade, and to check the operations of the Arab traders a military force was stationed at Fashoda (1865), this being the most southerly point then held by the Egyptians. Ismail's efforts to put an end to the slave trade, if sincere, were ineffective, and, moreover, south of Kordofan the authority of the government did not extend beyond the posts occupied by their troops. Ismail, however, was ambitious to extend his dominions and to develop the Sudan on the lines he had conceived for the development of Egypt. He obtained (1865) from the sultan of Turkey a firman assigning to him the administration of Suakin and Massawa; the lease which Mehemet Ali had of these ports having lapsed after the death of that pasha. Ismail subsequently (1870–1875) extended his sway over the whole coast from Suez to Cape Guardafui and garrisoned the towns of Berbera, Zaila, &c., while in 1874 the important town of Harrar, the entrepôt for southern Abyssinia, was seized by Egyptian troops. The khedive had also seized Bogos, in the hinterland of Massawa, a province claimed by Abyssinia. This action led to wars with Abyssinia, in which the Egyptians were generally beaten. Egyptian authority was withdrawn from the coast regions south of Suakin in 1884 (see below and also ABYSSINIA; ERITREA and SOMALILAND).

At the same time that Ismail annexed the seaboard he was extending his sway along the Nile valley to the equatorial lakes, and conceived the idea of annexing all the country between the Nile and the Indian Ocean. An expedition was sent (1875) to the Juba River with that object, but it was withdrawn at the request of the British government, as it infringed the rights of the sultan of Zanzibar.[2] The control of all territories south of Gondokoro had been given (April 1, 1869) to Sir Samuel Baker, who, however, only left Khartum to take up his governorship in February 1870. Reaching Gondokoro on the 26th of May following, he formally annexed that station, which he named Ismailia, to the khedival domains. Baker remained as governor of the Equatorial Provinces until August 1873, and in March 1874 Colonel C. G. Gordon took up the same post. Both Baker and Gordon made strenuous efforts towards crushing the slave trade, but their endeavours were largely thwarted by the inaction of the authorities at Khartum. Under Gordon the Upper Nile region as far as the borders of Uganda came effectively under Egyptian control, though the power of the government extended on the east little beyond the banks of the rivers. On the west the Bahr-el-Ghazal had been overrun by Arab or semi-Arab slave-dealers. Nominally subjects of the khedive, they acted as free agents, reducing the country over which they terrorized to a state of abject misery. The most powerful of the slave traders was Zobeir Pasha, who, having defeated a force sent from Khartum to reduce him to obedience, invaded Darfur (1874). The khedive, fearing the power of Zobeir, also sent an expedition to Darfur, and that country, after a stout resistance, was conquered. Zobeir claimed to be made governor-general of the new province; his request being refused, he went to Cairo to urge his claim. At Cairo he was detained by the Egyptian authorities.

The Equatorial Regions: Darfur conquered.

Though spasmodic efforts were made to promote agriculture and open up communications the Sudan continued to be a constant drain on the Egyptian exchequer. The khedive Ismail revived Said's project of a railway, and a survey for a line from Wadi Halfa to Khartum was made (1871), while a branch line to Massawa was also contemplated. As with Said's project these schemes came to naught.[3] In October 1876 Gordon left the Equatorial Provinces and gave up his appointment. In February 1877, under pressure from the British and Egyptian governments, he went to Cairo, where he was given the governorship of the whole of the Egyptian territories outside Egypt; namely, the Sudan provinces proper, the Equatorial Provinces, Darfur, and the Red Sea and Somali coasts. He replaced at Khartum Ismail Pasha Eyoub, a Turk made governor-general in 1873, who had thwarted as much as he dared all Gordon's efforts to reform. Gordon remained in the Sudan until August 1879. During his tenure of office he did much to give the Sudanese the benefit of a just and considerate government. In 1877 Gordon suppressed a revolt in Darfur and received the submission of Suliman Zobeir (a son of Zobeir Pasha), who was at the head of a gang of slave-traders on the Bahr-el-Ghazal frontier. In 1878 there was further trouble in Darfur and also in Kordofan, and Gordon visited both these provinces, breaking up many companies of slave-hunters. Meantime Suliman (acting on the instructions of his father, who was still at Cairo) had broken out into open revolt against the Egyptians in the Bahr-el-Ghazal. The crushing of Suliman was entrusted by Gordon to Romolo Gessi (1831–1881), an Italian who had previously served under Gordon on the Upper Nile. Gessi, after a most arduous campaign (1878–79), in which he displayed great military skill, defeated and captured Suliman, whom, with other ringleaders, he executed. The slave-raiders were completely broken up and over 10,000 captives released. A remnant of Zobeir's troops under a chief named Rabah succeeded in escaping westward, (see RABAH). Having conquered the province Gessi was made governor of the Bahr-el-Ghazal and given the rank of pasha.

General Gordon Governor-general.

When Gordon left the Sudan he was succeeded at Khartum by Raouf Pasha, under whom all the old abuses of the Egyptian administration were revived. At this time the high European officials in the Sudan, besides Gessi, included Emin Pasha (*q.v.*)—then a bey only—governor of the Equatorial Province since 1878, and Slatin Pasha—then also a bey—governor of Darfur. Gessi, who had most successfully governed his province, found his position under Raouf intolerable, resigned his post in September 1880 and was succeeded by Frank Lupton, an Englishman, and formerly captain of a Red Sea merchant steamer, who was given the rank of bey. At this period (1880–1882) schemes for the reorganization and better administration of the Sudan were elaborated on paper, but the revolt in Egypt under Arabi (see EGYPT: *History*) and the appearance in the Sudan of a Mahdi prevented these schemes from being put into

[1] The government monopoly in trade ceased after the death of Mehemet Ali in 1849.

[2] The Juba was quite unsuitable as a means of communication between the Indian Ocean and the Nile. The proposal made to Ismail by Gordon was to send an expedition to Mombasa and thence up the Tana River, but for some unexplained reason, or perhaps by mistake, the expedition was ordered to the Juba (see *Col. Gordon in Central Africa*, 4th ed., 1885, pp. 65, 66, 150 and 151, and *Geog. Journ.*, Feb. 1, 1909, p. 150).

[3] Up to 1877, when the work was abandoned, some 50 m. of rails had been laid from Wadi Halfa at a cost of some £450,000.

execution (assuming that the Egyptian authorities were sincere in proposing reforms).

C. *The Rise and Power of Mahdism.*—The Mahdist movement, which was utterly to overthrow Egyptian rule, derived its strength from two different causes: the oppression under which the people suffered,[1] and the measures taken to prevent the Baggara (cattle-owning Arabs) from slave trading. Venality and the extortion of the tax-gatherer flourished anew after the departure of Gordon, while the feebleness of his successors inspired in the Baggara a contempt for the authority which prohibited them pursuing their most lucrative traffic. When Mahommed Ahmed (*q.v.*), a Dongolese, proclaimed himself the long-looked-for Mahdi (guide) of Islam, he found most of his original followers among the grossly superstitious villagers of Kordofan, to whom he preached universal equality and a community of goods, while denouncing the Turks[2] as unworthy Moslems on whom God would execute judgment. The Baggara perceived in this Mahdi one who could be used to shake off Egyptian rule, and their adhesion to him first gave importance to his "mission." Mahommed Ahmed became at once the leader and the agent of the Baggara. He married the daughters of their sheikhs and found in Abdullah, a member of the Taaisha section of the tribe, his chief supporter. The first armed conflict between the Egyptian troops and the Mahdi's followers occurred in August 1881. In June 1882 the Mahdi gained his first considerable success. The capture of El Obeid on the 17th of January 1883 and the annihilation in the November following of an army of over 10,000 men commanded by Hicks Pasha (Colonel William Hicks [*q.v.*] formerly of the Bombay army) made the Mahdi undisputed master of Kordofan and Sennar. The next month, December 1883, saw the surrender of Slatin in Darfur, whilst in February 1884 Osman Digna, his amir in the Red Sea regions, inflicted a crushing defeat on some 4000 Egyptians at El Teb near Suakin. In April following Lupton Bey, governor of Bahr-el-Ghazal, whose troops and officials had embraced the Mahdist cause, surrendered and was sent captive to Omdurman, where he died on the 8th of May 1888.

The Massacre of Hicks Pasha's Army.

On learning of the disaster to Hicks Pasha's army, the British government (Great Britain having been since 1882 in military occupation of Egypt) insisted that the Egyptian government should evacuate such parts of the Sudan as they still held, and General Gordon was despatched, with Lieut.-Colonel Donald H. Stewart,[3] to Khartum to arrange the withdrawal of the Egyptian civil and military population. Gordon's instructions, based largely on his own suggestions, were not wholly consistent; they contemplated vaguely the establishment of some form of stable government on the surrender of Egyptian authority, and among the documents with which he was furnished was a firman creating him governor-general of the Sudan.[4] Gordon reached Khartum on the 18th of February 1884 and at first his mission, which had aroused great enthusiasm in England, promised success. To smooth the way for the retreat of the Egyptian garrisons and civilians he issued proclamations announcing that the suppression of the slave trade was abandoned, that the Mahdi was sultan of Kordofan, and that the Sudan was independent of Egypt. He enabled some thousands of refugees to make their escape to Assuan and collected at Khartum troops from some of the outlying stations. By this time the situation had altered for the worse and Mahdism was gaining strength among tribes in the Nile valley at first hostile to its propaganda. As the only means of preserving authority at Khartûm (and thus securing the peaceful withdrawal of the garrison) Gordon repeatedly telegraphed to Cairo asking that Zobeir Pasha might be sent to him, his intention being to hand over to Zobeir the government of the country. Zobeir (*q.v.*), a Sudanese Arab, was probably the one man who could have withstood successfully the Mahdi. Owing to Zobeir's notoriety as a slave-raider Gordon's request was refused. All hope of a peaceful retreat of the Egyptians was thus rendered impossible. The Mahdist movement now swept northward and on the 20th of May Berber was captured by the dervishes and Khartum isolated. From this time the energies of Gordon were devoted to the defence of that town. After months of delay due to the vacillation of the British government a relief expedition was sent up the Nile under the command of Lord Wolseley. It started too late to achieve its object, and on the 25th of January 1885 Khartum was captured by the Mahdi and Gordon killed. Colonel Stewart, Frank Power (British consul at Khartum) and M. Herbin (French consul), who (accompanied by nineteen Greeks) had been sent down the Nile by Gordon in the previous September to give news to the relief force, had been decoyed ashore and murdered (Sept. 18, 1884). The fall of Khartum was followed by the withdrawal of the British expedition, Dongola being evacuated in June 1885. In the same month Kassala capitulated, but just as the Mahdi had practically completed the destruction of the Egyptian power[5] he died, in this same month of June 1885. He was at once succeeded by the khalifa Abdullah, whose rule continued until the 2nd of September 1898,[6] when his army was completely overthrown by an Anglo-Egyptian force under Sir H. (afterwards Lord) Kitchener. The military operations are described elsewhere (see EGYPT: *Military Operations*), and here it is only necessary to consider the internal situation and the character of the khalifa's government. The Mahdi had been regarded by his adherents as the only true commander of the faithful, endued with divine power to conquer the whole world. He had at first styled his followers dervishes (*i.e.* religious mendicants) and given them the *jibba* as their characteristic garment or uniform. Later on he commanded the faithful to call themselves *ansar* (helpers), a reference to the part they were to play in his career of conquest, and at the time of his death he was planning an invasion of Egypt. He had liberated the Sudanese from the extortions of the Egyptians, but the people soon found that the Mahdi's rule was even more oppressive than had been that of their former masters, and after the Mahdi's death the situation of the peasantry in particular grew rapidly worse, neither life nor property being safe. Abdullah set himself steadily to crush all opposition to his own power. Mahommed Ahmed had, in accordance with the traditions which required the Mahdi to have four khalifas (lieutenants), nominated, besides Abdullah, Ali wad Helu, a sheikh of the Degheim and Kenana Arabs, and Mahommed esh Sherif, his son-in-law, as khalifas. (The other khalifaship was vacant having been declined by the sheikh es Senussi [*q.v.*]). Wad Helu and Sherif were stripped of their power and gradually all chiefs and amirs not of the Baggara tribe were got rid of except Osman Digna, whose sphere of operations was on the Red Sea coast. Abdullah's rule was a pure military despotism which brought the country to a state of almost complete agricultural and commercial ruin. He was also almost constantly in conflict either with the Shilluks, Nuers and other negro tribes of the south; with the peoples of Darfur, where at one time an anti-Mahdi gained a great following; with the Abyssinians; with the Kabbabish and other Arab tribes who

Gordon at Khartum.

The Khalifa's Rule.

[1] Writing from Darfur in April 1879 Gordon said: "The government of the Egyptians in these far-off countries is nothing else but one of brigandage of the very worst description. It is so bad that all hope of ameliorating it is hopeless."

[2] The Sudanese spoke of all foreigners as "Turks." This arose from the fact that most of the higher Egyptian officials were of Turkish nationality and that the army was officered mainly by Turks, Albanians, Circassians, &c., and included in the ranks many Bashi-Bazuks (irregulars) of non-Sudanese origin.

[3] Colonel Stewart had been sent to Khartum in 1882 on a mission of inquiry, and he drew up a valuable report, *Egypt*, No. 11 (1883).

[4] It is unnecessary here to enter upon a discussion of the precise nature of Gordon's instructions or of the measure in which he carried them out. The material for forming a judgment will be found in Gordon's *Journals* (1885), Morley's *Life of Gladstone* (1903), Fitzmaurice's *Life of Granville* (1905), and Cromer's *Modern Egypt* (1908). (See also GORDON, CHARLES GEORGE.)

[5] Sennar town held out until the 19th of August, while the Red Sea ports of Suakin and Massawa never fell into the hands of the Mahdists. The garrisons of some other towns were rescued by the Abyssinians.

[6] This period in the history of the Sudan is known as the Mahdia.

had never embraced Mahdism, or with the Italians, Egyptians and British. Notwithstanding all this opposition the khalifa found in his own tribesmen and in his black troops devoted adherents and successfully maintained his position. The attempt to conquer Egypt ended in the total defeat of the dervish army at Toski (Aug. 3, 1889). The attempts to subdue the Equatorial Provinces were but partly successful. Emin Pasha, to whose relief H. M. Stanley had gone, evacuated Wadelai in April 1889. The greater part of the region and also most of the Bahr-el-Ghazal relapsed into a state of complete savagery.

In the country under his dominion the khalifa's government was carried on after the manner of other Mahommedan states, but pilgrimages to the Mahdi's tomb at Omdurman were substituted for pilgrimages to Mecca. The arsenal and dockyard and the printing-press at Khartum were kept busy (the workmen being Egyptians who had escaped massacre). Otherwise Khartum was deserted, the khalifa making Omdurman his capital and compelling disaffected tribes to dwell in it so as to be under better control. While Omdurman grew to a huge size the population of the country generally dwindled enormously from constant warfare and the ravages of disease, small-pox being endemic. The Europeans in the country were kept prisoners at Omdurman. Besides ex-officials like Slatin and Lupton, they included several Roman Catholic priests and sisters, and numbers of Greek merchants established at Khartum. Although several were closely imprisoned, loaded with chains and repeatedly flogged, it is a noteworthy fact that none was put to death. From time to time a prisoner made his escape, and from the accounts of these ex-prisoners knowledge of the character of Dervish rule is derived in large measure. The fanaticism with which the Mahdi had inspired his followers remained almost unbroken to the end. The khalifa after the fatal day of Omdurman fled to Kordofan where he was killed in battle in November 1899. In January 1900 Osman Digna, a wandering fugitive for months, was captured. In 1902 the last surviving dervish amir of importance surrendered to the sultan of Darfur. Mahdism as a vital force in the old Egyptian Sudan ceased, however, with the Anglo-Egyptian victory at Omdurman.[1]

D. *The Anglo-Egyptian Condominium.*—Of the causes which led to the reconquest of the Sudan—the natural desire of the Egyptian government to recover lost territory, the equally natural desire in Great Britain to "avenge" the death of Gordon were among them—the most weighty was the necessity of securing for Egypt the control of the Upper Nile, Egypt being wholly dependent on the waters of the river for its prosperity. That control would have been lost had a European power other than Great Britain obtained possession of any part of the Nile valley; and at the time the Sudan was reconquered (1896–98) France was endeavouring to establish her authority on the river between Khartum and Gondokoro, as the Marchand expedition from the Congo to Fashoda demonstrated. The Nile constitutes, in the words of Lord Cromer, the true justification of the policy of re-occupation, and makes the Sudan a priceless possession for Egypt.[2]

The Sudan having been reconquered by "the joint military and financial efforts" of Great Britain and Egypt, the British government claimed "by right of conquest" to share in the settlement of the administration and legislation of the country. To meet these claims an agreement (which has been aptly called the constitutional charter of the Sudan) between Great Britain and Egypt, was signed on the 19th of January 1899, establishing the joint sovereignty of the two states throughout the Sudan.[3] The reorganization of the country had already begun, supreme power being centred in one official termed the "governor-general of the Sudan." To this post was appointed Lord Kitchener, the sirdar (commander-in-chief) of the Egyptian army, under whom the Sudan had been reconquered. On Lord Kitchener going to South Africa at the close of 1899 he was succeeded as sirdar and governor-general by Major-General Sir F. R. Wingate, who had served with the Egyptian army since 1883. Under a just and firm administration, which from the first was essentially civil, though the principal officials were officers of the British army, the Sudan recovered in a surprising manner from the woes it suffered during the Mahdia. At the head of every *mudiria* (province) was placed a British official, though many of the subordinate posts were filled by Egyptians. An exception was made in the case of Darfur, which before the battle of Omdurman had thrown off the khalifa's rule and was again under a native sovereign. This potentate, the sultan Ali Dinar, was recognized by the Sudan government, on condition of the payment of an annual tribute.

The first duty of the new administration, the restoration of public order, met with comparatively feeble opposition, though tribes such as the Nuba mountaineers, accustomed from time immemorial to raid their weaker neighbours, gave some trouble. In 1906, in 1908, and again in 1910 expeditions had to be sent against the Nubas. In the Bahr-el-Ghazal the Niam-Niams at first disputed the authority of the government, but Sultan Yambio, the recalcitrant chief, was mortally wounded in a fight in February 1905 and no further disturbance occurred. The delimitation (1903–1904) of the frontier between the Sudan and Abyssinia enabled order to be restored in a particularly lawless region, and slave-raiding on a large scale ended in that quarter with the capture and execution of a notorious offender in 1904. In Kordofan, Darfur and the Bahr-el-Ghazal the slave trade continued however for some years later.

The Regenerative Work of Great Britain.

With good administration and public security the population increased steadily. The history of the country became one of peaceful progress marked by the growing contentment of the people. The Sudan government devoted much attention to the revival of agriculture and commerce, to the creation of an educated class of natives, and to the establishment of an adequate judicial system. Their task, though one of immense difficulty, was however (in virtue of the agreement of the 19th of January 1899) free from all the international fetters that bound the administration of Egypt. It was moreover rendered easier by the decision to govern, as far as possible, in accordance with native law and custom, no attempt being made to Egyptianize or Anglicize the Sudanese. The results were eminently satisfactory. The Arab-speaking and Mahommedan population found their religion and language respected, and from the first showed a marked desire to profit by the new order. To the negroes of the southern Sudan, who were exceedingly suspicious of all strangers—whom hitherto they had known almost exclusively as slave-raiders—the very elements of civilization had, in most cases, to be taught. In these pagan regions the Sudan government encouraged the work of missionary societies, both Protestant and Roman Catholic, while discouraging propaganda work among the Moslems.

In their general policy the Sudan government adopted a system of very light taxation; low taxation being in countries such as Egypt and the Sudan the keystone of the political arch. This policy was amply justified by results. In 1899 the revenue derived from the country was £E126,000, in 1909 it had risen to £E1,040,000, despite slight reductions in taxation, a proof of the growing prosperity of the land. This prosperity was brought about largely by improving the water-supply, and thus bringing more land under cultivation, by the creation of new industries, and by the improvement of means of communication. A shorter route to the sea than that through Egypt being essential for the

[1] In the autumn of 1903 Mahommed-el-Amin, a native of Tunis, proclaimed himself the Mahdi and got together a following in Kordofan. He was captured by the governor of Kordofan and publicly executed at El Obeid. In April 1908 Abd-el-Kader, a Halowin Arab and ex-dervish, rebelled in the Blue Nile province, claiming to be the prophet Issa (Jesus). On the 29th of that month he murdered Mr C. C. Scott-Moncrieff, deputy inspector of the province, and the Egyptian mamur. The rising was promptly suppressed, Abd-el-Kader was captured and was hanged on the 17th of May.

[2] *Egypt*, No. 1 (1905), p. 119.

[3] At first Suakin was excepted from some of the provisions of this agreement, but these exceptions were done away with by a supplementary agreement of the 10th of July 1899.

commercial development of the country, a railway from the Nile near Berber to the Red Sea was built (1904–1906). This line shortened the distance from Khartum to the nearest seaport by nearly 1000 m., and by reducing the cost of carriage of merchandise enabled Sudan produce to find a profitable outlet in the markets of the world. At the same time river communications were improved and the numbers of wells on caravan roads increased. Steps were furthermore taken by means of irrigation works to regulate the Nile floods, and those of the river Gash.

To the promotion of education and sanitation, and in the administration of justice, the government devoted much energy with satisfactory results. Indeed the regenerative work of Great Britain in the Sudan has been fully as successful and even more remarkable than that of Great Britain in Egypt. A large part of this work has been accomplished by officers of the British army. Some of the most valuable suggestions about such matters as land settlement, agricultural loans, &c., emanated from officers who a short time before were performing purely military duties.

Nevertheless civil servants gradually replaced military officers in the work of administration, army officers being liable to be suddenly removed for war or other service, often at times when the presence of officials possessed of local experience was most important. In efficiency and devotion to duty the Egyptian officials under the new régime also earned high praise.

The relations of the Sudan government with its Italian, Abyssinian and French neighbours was marked by cordiality, but with the Congo Free State difficulties arose over claims made by that state to the Bahr-el-Ghazal (see AFRICA, § 5). Congo State troops were in 1904 stationed in Sudanese territory. The difficulty was adjusted in 1906 when the Congo State abandoned all claims to the Ghazal province (whence its troops were withdrawn during 1907), and it was agreed to transfer the Lado enclave (*q.v.*) to the Sudan six months after the death of the king of the Belgians. Under the terms of this agreement the Lado enclave was incorporated in the Sudan in 1910. As to the general state of the country Sir Eldon Gorst after a tour of inspection declared in his report for 1909, "I do not suppose that there is any part of the world in which the mass of the population have fewer unsatisfied wants."

Bahr-el-Ghazal and Lado.

AUTHORITIES.—Summaries of ancient and medieval history will be found in E. A. Wallis Budge, *The Egyptian Sudan* (2 vols., 1907) and *The Anglo-Egyptian Sudan* (1095), edited by Count Gleichen. The story of the Egyptian conquest and events up to 1850 are summarized in H. Deherain's *Le Soudan égyptien sous Mehemet Ali* (Paris, 1898). For the middle period of Egyptian rule see Sir Samuel Baker's *Ismailia* (1874); *Col. Gordon in Central Africa*, edited by G. Birkbeck Hill (4th ed., 1885), being extracts from Gordon's diary, 1874–1880; *Seven Years in the Soudan*, by Romolo Gessi Pasha (1892); and *Der Sudan unter ägyptischer Herrschaft*, by R. Buchta (Leipzig, 1888). The rise of Mahdism and events down to 1900 are set forth in (Sir) F. R. Wingate's *Mahdiism and the Egyptian Sudan* (1891). This book contains translations of letters and proclamations of the Mahdi and Khalifa. For this period the *Journals of Major General Gordon at Khartoum* (1885); F. Power's *Letters from Khartoum during the Siege* (1885), and the following four books written by prisoners of the dervishes are specially valuable: Slatin Pasha, *Fire and Sword in the Sudan* (1896); Father J. Ohrwalder (from the MSS. of, by F. R. Wingate), *Ten Years' Captivity in the Mahdi's Camp (1882–1892)* (1892); Father Paolo Rosignoli, *I miei dodici anni di prigionia in mezzo ai dervice del Sudan* (Mondovi, 1898); C. Neufeldt, *A Prisoner of the Khaleefa* (1899). See also G. Dujarric, *L'État mahdiste du Soudan* (Paris, 1901). For the "Gordon Relief" campaign, &c., see the British official *History of the Sudan Campaign* (1890); for the campaigns of 1896–98, H. S. L. Alford and W. D. Sword, *The Egyptian Soudan, its Loss and Recovery* (1898); G. W. Steevens, *With Kitchener to Khartum* (Edinburgh, 1898); Winston S. Churchill, *The River War* (revised ed., 1902). The story of the Fashoda incident is told mainly in British and French official despatches; consult also for this period G. Hanotaux, *Fachoda* (Paris, 1910); A. Lebon, *La Politique de la France 1896–1898* (Paris, 1901); and R. de Caix, *Fachoda, la France et l'Angleterre* (Paris, 1899). Lord Cromer's *Modern Egypt* (1908) covers Sudanese history for the years 1881–1907. Consult also the authorities cited under EGYPT): *Modern History*, and H. Pensa, *L'Egypte et le Soudan égyptien* (Paris, 1895). Unless otherwise stated the place of publication is London. (F. R. C.)

SUDATORIUM, the term in architecture for the vaulted sweating-room (*sudor*, sweat) of the Roman thermae, referred to in Vitruvius (v. 2), and there called the *concamerata sudatio*. In order to obtain the great heat required, the whole wall was lined with vertical terra-cotta flue pipes of rectangular section, placed side by side, through which the hot air and the smoke from the suspensura passed to an exit in the roof.

SUDBURY, SIMON OF (d. 1381), archbishop of Canterbury, was born at Sudbury in Suffolk, studied at the university of Paris, and became one of the chaplains of Pope Innocent VI., who sent him, in 1356, on a mission to Edward III. of England. In October 1361 the pope appointed him bishop of London, and he was soon serving the king as an ambassador and in other ways. In 1375 he succeeded William Wittlesey as archbishop of Canterbury, and during the rest of his life was a partisan of John of Gaunt. In July 1377 he crowned Richard II., and in 1378 John Wycliffe appeared before him at Lambeth, but he only took proceedings against the reformer under great pressure. In January 1380 Sudbury became chancellor of England, and the revolting peasants regarded him as one of the principal authors of their woes. Having released John Ball from his prison at Maidstone, the Kentish insurgents attacked and damaged the archbishop's property at Canterbury and Lambeth; then, rushing into the Tower of London, they seized the archbishop himself. Sudbury was dragged to Tower Hill and, on the 14th of June 1381, was beheaded. His body was afterwards buried in Canterbury Cathedral. Sudbury rebuilt part of the church of St Gregory at Sudbury, and with his brother, John of Chertsey, he founded a college in this town; he also did some building at Canterbury. His father was Nigel Theobald, and he is sometimes called Simon Theobald or Tybald.

See W. F. Hook, *Lives of the Archbishops of Canterbury.*

SUDBURY, a post town and outport of Nipissing district, Ontario, Canada, on the Canadian Pacific railway, 443 m. W. of Montreal. Pop. (1901), 2027. It has manufactures of explosives, lumber and planing mills, and is the largest nickel mining centre in the world. Gold, copper and other minerals are also raised. Practically all the ore is shipped to the United States.

SUDBURY, a market town and municipal borough of England, chiefly in the Sudbury parliamentary division of Suffolk, but partly in the Saffron Walden division of Essex. Pop. (1901), 7109. It lies on the river Stour (which is navigable up to the town), 59 m. N.E. from London by the Great Eastern railway. All Saints' parish church, consisting of chancel, nave, aisles and tower, is chiefly Perpendicular—the chancel being Decorated. It possesses a fine oaken pulpit of 1490. The church was restored in 1882. St Peter's is Perpendicular, with a finely carved nave roof. St Gregory's, once collegiate, is Perpendicular. It has a rich spire-shaped font-cover of wood, gilt and painted. The grammar school was founded by William Wood in 1491. There are some old half-timbered houses, including one very fine example. The principal modern buildings are the town-hall, Victoria hall and St Leonard's hospital. Coco-nut matting is an important manufacture; silk manufactures were transferred from London during the 19th century, and horsehair weaving was established at the same time. There are also flour-mills, malt-kilns, lime-works, and brick and tile yards. The town is governed by a mayor, 4 aldermen and 12 councillors. The borough lies wholly in the administrative county of West Suffolk. Area, 1925 acres.

The ancient Saxon borough of Sudbury (Sudbyrig, Sudberi, Suthberia) was the centre of the southern portion of the East Anglian kingdom. Before the Conquest it was a borough owned by the mother of Earl Morcar, from whom it was taken by William I., who held it in 1086. It was alienated from the Crown to an ancestor of Gilbert de Clare, 9th earl of Gloucester. In 1271 the earl gave the burgesses their first charter confirming to them all their ancient liberties and customs. The earl of March granted a charter to the mayor and bailiffs of Sudbury in 1397. In 1440 and again in 1445 the men and tenants of Sudbury obtained a royal confirmation of their privileges. They were incorporated in 1553 under the name of the mayor, aldermen and burgesses of Sudbury, and charters were granted to the town by Elizabeth, Charles II. and James II. Its constitution was reformed by the act of 1835. It was represented in parliament by two burgesses from 1558 till its disfranchisement in

1844. The lord of the borough had a market and fair in the 13th century, and three fairs in March, July and December were held in 1792. Markets still exist on Thursdays and Saturdays. Weavers were introduced by Edward III., and the town became the chief centre of the Suffolk cloth industry after the Restoration.

SUDD, or SADD (an Arabic word meaning "to dam"), the name given to the vegetable obstruction which has at various dates closed the waters of the Upper Nile to navigation. It is composed of masses of papyrus and *um suf* (*Vossia procera*) and the earth adhering to the roots of those reeds. Mingled with the papyrus and *um suf* (Arabic for "mother-of-wool") are small swimming plants and the light brittle ambach. The papyrus and *um suf* grow abundantly along the Nile banks and the connected lagoons between 7° N. and 13° N. Loosened by storms these reeds drift until they lodge on some obstruction and form a dam across the channel, converted by fresh arrivals into blocks that are sometimes 25 m. in length, and extend 15 to 20 ft. below the surface. These masses of decayed vegetation and earth, resembling peat in consistency, are so much compressed by the force of the current that men can walk over them everywhere. In parts elephants could cross them without danger. The pressure of the water at length causes the formation of a side channel or the bursting of the sudd. (For sudd cutting see NILE.)

In the Bahr-el-Ghazal the sudd, being chiefly composed of small swimming plants, is of less formidable nature than that of the main stream.

Consult, O. Deuerling, *Die Pflanzenbarren der afrikanischen Flüsse* (Munich, 1909), a valuable monograph; and the bibliography under NILE, especially Captain H. G. Lyons, *The Physiography of the Nile and its Basin* (Cairo, 1906).

SUDERMANN, HERMANN (1857–), German dramatist and novelist, was born on the 30th of September 1857 at Matziken in East Prussia, close to the Russian frontier, of a Mennonite family long settled near Elbing. His father owned a small brewery in the village of Heydekrug, and Sudermann received his early education at the Realschule in Elbing, but, his parents having been reduced in circumstances, he was apprenticed to a chemist at the age of fourteen. He was, however, enabled to enter the Realgymnasium in Tilsit, and to study philosophy and history at Königsberg University. In order to complete his studies Sudermann went to Berlin, where he was tutor in several families. He next became a journalist, was from 1881–1882 editor of the *Deutsches Reichsblatt*, and then devoted himself to novel-writing. The novels and romances *Im Zwielicht* (1886), *Frau Sorge* (1887), *Geschwister* (1888) and *Der Katzensteg* (1890) failed to bring the young author as much recognition as his first drama *Die Ehre* (1889), which inaugurated a new period in the history of the German stage. Of his other dramas the most successful were *Sodoms Ende* (1891), *Heimat* (1893), *Die Schmetterlingsschlacht* (1894), *Das Glück im Winkel* (1895), *Morituri* (1896), *Johannes* (1898), *Die drei Reiherfedern* (1899), *Johannesfeuer* (1900), *Es lebe das Leben!* (1902), *Der Sturmgeselle Sokrates* (1903) and *Stein unter Steinen* (1905). Sudermann is also the author of a powerful social novel, *Es war* (1904), which, like *Frau Sorge* and *Der Katzensteg*, has been translated into English.

See W. Kawerau, *Hermann Sudermann* (1897); H. Landsberg, *Hermann Sudermann* (1902); H. Jung, *Hermann Sudermann* (1902); H. Schoen, *Hermann Sudermann, poète dramatique et romancier* (1905); and I. Axelrod, *Hermann Sudermann* (1907).

SUE, EUGÈNE [JOSEPH MARIE] (1804–1857), French novelist, was born in Paris on the 20th of January 1804. He was the son of a distinguished surgeon in Napoleon's army, and is said to have had the empress Josephine for godmother. Sue himself acted as surgeon both in the Spanish campaign undertaken by France in 1823 and at the battle of Navarino (1828). In 1829 his father's death put him in possession of a considerable fortune, and he settled in Paris. His naval experiences supplied much of the materials of his first novels, *Kernock le pirate* (1830), *Atar-Gull* (1831), *La Salamandre* (2 vols., 1832), *La Coucaratcha* (4 vols., 1832–1834), and others, which were composed at the height of the romantic movement of 1830. In the quasi-historical style he wrote *Jean Cavalier, ou Les Fanatiques des Cevennes* (4 vols., 1840) and *Latréaumont* (2 vols., 1837). He was strongly affected by the Socialist ideas of the day, and these prompted his most famous works: *Les Mystères de Paris* (10 vols., 1842–1843) and *Le Juif errant* (10 vols., 1844–1845), which were among the most popular specimens of the *roman-feuilleton*. He followed these up with some singular and not very edifying books: *Les Sept péchés capitaux* (16 vols., 1847–1849), which contained stories to illustrate each sin, *Les Mystères du peuple* (1849–1856), which was suppressed by the censor in 1857, and several others, all on a very large scale, though the number of volumes gives an exaggerated idea of their length. Some of his books, among them the *Juif errant* and the *Mystères de Paris*, were dramatized by himself, usually in collaboration with others. His period of greatest success and popularity coincided with that of Alexandre Dumas, with whom some writers have put him on an equality. Sue has neither Dumas's wide range of subject, nor, above all, his faculty of conducting the story by means of lively dialogue; he has, however, a command of terror which Dumas seldom or never attained. From the literary point of view his style is bad, and his construction prolix. After the revolution of 1848 he sat for Paris (the Seine) in the Assembly from April 1850, and was exiled in consequence of his protest against the *coup d'état* of the 2nd of December 1851. This exile stimulated his literary production, but the works of his last days are on the whole much inferior to those of his middle period. Sue died at Annecy (Savoy) on the 3rd of August 1857.

SUEBI, or SUEVI, a collective term applied to a number of peoples in central Germany, the chief of whom appear to have been the Marcomanni, Quadi, Hermunduri, Semnones and Langobardi. From the earliest times these tribes inhabited the basin of the Elbe. The Langobardic territories seem to have lain about the lower reaches of the river, while the Semnones lay south. The Marcomanni occupied the basin of the Saale, but under their king, Maroboduus, they moved into Bohemia during the early part of Augustus's reign, while the Quadi, who are first mentioned in the time of Tiberius, lay farther east towards the sources of the Elbe. The former home of the Marcomanni was occupied by the Hermunduri a few years before the Christian era. Some kind of political union seems to have existed among all these tribes. The Semnones and Langobardi were at one time subject to the dominion of the Marcomannic king Maroboduus, and at a much later period we hear of Langobardic troops taking part against the Romans in the Marcomannic War. The Semnones claimed to be the chief of the Suebic peoples, and Tacitus describes a great religious festival held in their tribal sanctuary, at which legations were present from all the other tribes.

Tacitus uses the name Suebi in a far wider sense than that defined above. With him it includes not only the tribes of the basin of the Elbe, but also all the tribes north and east of that river, including even the Swedes (Suiones). This usage, which is not found in other ancient writers, is probably due to a confusion of the Suebi with the agglomeration of peoples under their supremacy, which as we know from Strabo extended to some at least of the eastern tribes.

In early Latin writers the term Suebi is occasionally applied to any of the above tribes. From the 2nd to the 4th century, however, it is seldom used except with reference to events in the neighbourhood of the Pannonian frontier, and here probably means the Quadi. From the middle of the 4th century onward it appears most frequently in the regions south of the Main, and soon the names Alamanni and Suabi are used synonymously. The Alamanni (*q.v.*) seem to have been, in part at least, the descendants of the ancient Hermunduri, but it is likely that they had been joined by one or more other Suebic peoples, from the Danubian region, or more probably from the middle Elbe, the land of the ancient Semnones. It is probably from the Alamannic region that those Suebi came who joined the Vandals in their invasion of Gaul, and eventually founded a kingdom in north-west Spain. After the 1st century the term Suebi seems never to be applied to the Langobardi and seldom to the Baiouarii (Bavarians), the descendants of the ancient Marcomanni. But besides the Alamannic Suebi we hear also of a people called Suebi, who shortly after the middle of the 6th century settled north of the Unstrut. There is evidence also for a people called Suebi in the district above the mouth of the Scheldt. It is likely that both these settlements were colonies from the Suebi of whom we hear in the Anglo-Saxon poem *Widsith* as neighbours of the Angli, and whose name may possibly be preserved in Schwabstedt on the Treene. The question has recently been raised whether these Suebi should be identified with the people whom the Romans called Heruli. After the 7th century the name Suebi is practically only applied to the Alamannic Suebi (Schwaben), with whom it remains a territorial designation in Württemberg and Bavaria until the present day.

See Caesar, *De bello gallico*, i. 37, 51 sqq., iv. 1 sqq., vi. 9 sqq.; Strabo, p. 290 seq.; Tacitus, *Germania*, 38 sqq.; K. Zeuss, *Die Deutschen und die Nachbarstämme*, pp. 55 sqq., 315 sqq.; C. Bremer in Paul's *Grundriss* (2nd ed.), iii. 915–950; H. M. Chadwick, *Origin of the English Nation*, 216 sqq. (Cambridge, 1907). (F. G. M. B.)

SUECA, a town of eastern Spain, in the province of Valencia, near the left bank of the river Júcar, and on the Silla-Cullera railway. Pop. (1900), 14,435. Sueca is separated from the Mediterranean Sea (7 m. east) by the Sierra de Cullera. It is a modern town, although many of the houses have the flat roofs, view-turrets (*miradores*) and horseshoe arches characteristic of Moorish architecture. There are a few handsome public buildings, such as the hospital, town-hall and theatre. Sueca has a thriving trade in grain and fruit from the Júcar valley, which is irrigated by waterways created by the Moors.

SUESS, EDUARD (1831–), Austrian geologist, was born in London on the 20th of August 1831, his father, a native of Saxony, having settled there as a German merchant. Three years later the family removed to Prague, and in 1845 to Vienna. Eduard Suess was educated for commercial life, but early displayed a bent for geology. At the age of nineteen he published a short sketch of the geology of Carlsbad and its mineral waters; and in 1852 he was appointed an assistant in the Imperial museum of Vienna. There he studied the fossil Brachiopoda, and manifested such ability that in 1857 he was appointed professor of geology at the university. In 1862 he relinquished his museum duties, and gave his whole time to special research and teaching, retaining his professorship until 1901. Questions of ancient physical geography, such as the former connexion between northern Africa and Europe, occupied his attention; and in 1862 he published an essay on the soils and water-supply of Vienna. He was elected a member of the town council, and in 1869 to a seat in the Diet of Lower Austria, which he retained until 1896. Meanwhile he continued his geological and palaeontological work dealing with the Tertiary strata of the Vienna Basin, also turning his attention to the problems connected with the evolution of the earth's surface-features, on which he wrote a monumental treatise. This, the great task of his life, embodied the results of personal research and of a comprehensive study of the work of the leading geologists of all countries; it is entitled *Antlitz der Erde*, of which the first volume was published in 1885, the second in 1888, and pt. i. of the third volume in 1901. The work has been translated into French, and (in part) into English. Suess was elected a corresponding member of the Institute of France in 1889, and a foreign member of the Royal Society in 1894. In 1896 the Geological Society of London awarded to him the Wollaston medal.

Memoir (with portrait), by Sir A. Geikie, *Nature* (May 4, 1905).

SUESSULA, an ancient town of Campania, Italy, in the plain 1½ m. W. of the modern Cancello, 9 m. S.E. of the ancient Capua. Its earlier history is obscure. In 338 B.C. it obtained Latin rights from Rome. In the Samnite and Hannibalic wars it was strategically important as commanding the entrance to the Caudine pass. Sulla seems to have founded a colony here. It is frequently named as an episcopal see up till the 10th century A.D., and was for a time the chief town of a small Lombard principality. It was several times plundered by the Saracens, and at last abandoned by the inhabitants in consequence of the malaria. The ruins of the town lie within the Bosco d'Acerra, a picturesque forest. They were more conspicuous in the 18th century than they now are, but traces of the theatre may still be seen, and débris of other buildings. Oscan tombs were excavated there between 1878 and 1886, and important finds of vases, bronzes, &c., have been made. The dead were generally buried within slabs of tufa arranged to form a kind of sarcophagus (see F. von Duhn in *Römische Mitteilungen*, 1887, p. 235 sqq.). Suessula lay on the line of the Via Popillia, which was here intersected by a road which ran from Neapolis through Acerrae, and on to the Via Appia, which it reached just west of the Caudine pass. On the hills above Cancello to the east of Suessula was situated the fortified camp of M. Claudius Marcellus, which covered Nola and served as a post of observation against Hannibal in Capua. (T. As.)

SUET (M. Eng. *sewet*, a diminutive of O. Fr. *seu*, *suis*, mod. *suif*, lard, from Lat. *sebum*, or *sevum*, tallow, grease, probably allied to *sapo*, soap), the hard flaked white fat lying round the kidneys of the sheep or ox; that of the pig forms lard. Beef-suet is especially used in cookery.

SUETONIUS TRANQUILLUS, GAIUS, Roman historian, lived during the end of the 1st and the first half of the 2nd century A.D. He was the contemporary of Tacitus and the younger Pliny, and his literary work seems to have been chiefly done in the reigns of Trajan and Hadrian (A.D. 98–138). His father was military tribune in the XIIIth legion, and he himself began life as a teacher of rhetoric and an advocate. To us he is known as the biographer of the twelve Caesars (including Julius) down to Domitian. The lives are valuable as covering a good deal of ground where we are without the guidance of Tacitus. As Suetonius was the emperor Hadrian's private secretary (*magister epistolarum*), he must have had access to many important documents in the Imperial archives, *e.g.* the decrees and transactions of the senate. In addition to written and official documents, he picked up in society a mass of information and anecdotes, which, though of doubtful authenticity, need not be regarded as mere inventions of his own. They give a very good idea of the kind of court gossip prevalent in Rome at the time. He was a friend and correspondent of the younger Pliny, who when appointed governor of Bithynia took Suetonius with him. Pliny also recommended him to the favourable notice of the emperor Trajan, "as a most upright, honourable, and learned man, whom persons often remember in their wills because of his merits," and he begs that he may be made legally capable of inheriting these bequests, for which under a special enactment Suetonius was, as a childless married man, disqualified. Hadrian's biographer, Aelius Spartianus, tells us that Suetonius was deprived of his private secretaryship because he had not been sufficiently observant of court etiquette towards the emperor's wife during Hadrian's absence in Britain.

The *Lives of the Caesars* has always been a popular work. It is rather a chronicle than a history. It gives no picture of the society of the time, no hints as to the general character and tendencies of the period. It is the emperor who is always before us, and yet the portrait is drawn without any real historical judgment or insight. It is the personal anecdotes, several of which are very amusing, that give the lives their chief interest; but the author panders rather too much to a taste for scandal and gossip. None the less he throws considerable light on an important period, and next to Tacitus and Dio Cassius is the chief (sometimes the only) authority. The language is clear and simple. The work was continued by Marius Maximus (3rd century), who wrote a history of the emperors from Nerva to Elagabalus (now lost). Suetonius was a voluminous writer. Of his *De viris illustribus*, the lives of Terence and Horace, fragments of those of Lucan and the elder Pliny and the greater part of the chapter on grammarians and rhetoricians, are extant. Other works by him (now lost) were: *Prata* (= λειμῶνες = patch-work), in ten books, a kind of encyclopaedia; the *Roman Year*, *Roman Institutions and Customs*, *Children's Games among the Greeks*, *Roman Public Spectacles*, *On the Kings*, *On Cicero's Republic*.

Editio princeps, 1470; editions by great scholars: Erasmus, Isaac Casaubon, J. G. Graevius, P. Burmann; the best complete annotated edition is still that of C. G. Baumgarten-Crusius (1816); recent editions by H. T. Peck (New York, 1889); Leo Preud'homme (1906); M. Ihm (1907). Editions of separate lives: *Augustus*, by E. S. Shuckburgh (with useful introduction, 1896); *Claudius*, by H. Smilda (1896), with notes and parallel passages from other authorities. The best editions of the text are by C. L. Roth (1886), and A. Reifferscheid (not including the *Lives*, 1860). On the *De viris illustribus*, see

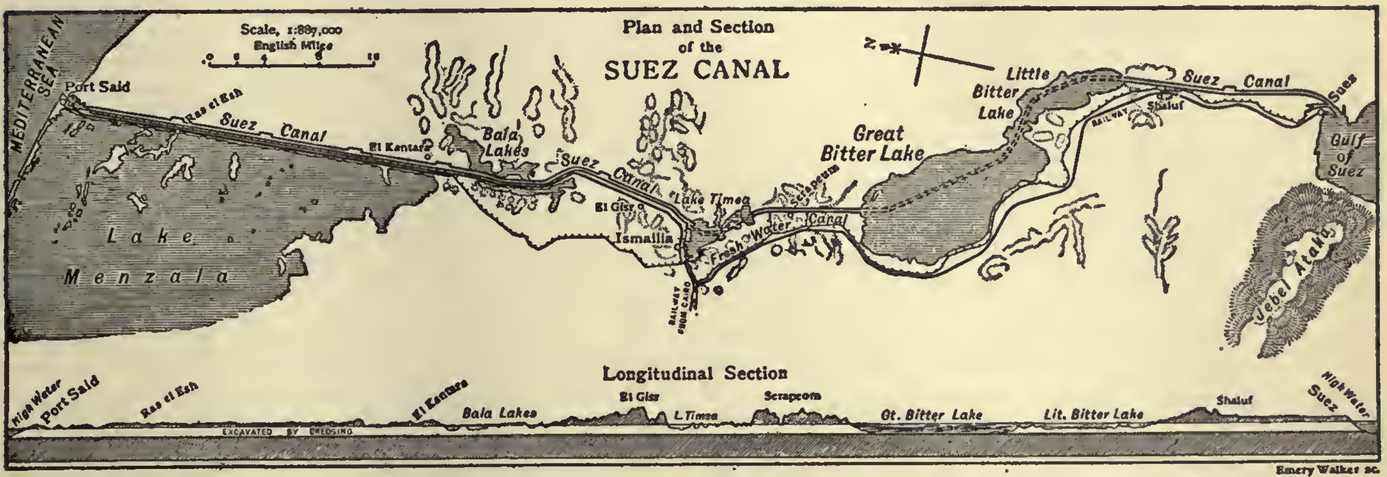
G. Körtge in *Dissert. philolog. halenses* (1900), vol. xiv.; and, above all, A. Macé, *Essai sur Suétone* (1900), with an exhaustive bibliography. There are English translations by Philemon Holland (reprinted in the *Tudor Translations*, 1900), and by Thomson and Forester (in Bohn's *Classical Library*).

SUEZ, a port of Egypt on the Red Sea and southern terminus of the Suez Canal (*q.v.*), situated at the head of the Gulf of Suez in 29° 58′ 37″ N., 32° 31′ 18″ E. It is 80 m. E. by S. of Cairo in a direct line but 148 m. by rail, and is built on the north-west point of the gulf. Pop. (1907), 18,347. From the heights to the north, where there is a khedival chalet, there is a superb view to the south with the Jebel Ataka on the right, Mt Sinai on the left and the waters of the gulf between. Suez is supplied with water by the fresh-water canal, which starts from the Nile at Cairo and is terminated at Suez by a lock which, north of the town, joins it to the gulf. Before the opening of this canal in 1863 water had to be brought from "the Wells of Moses," a small oasis 3 m. distant on the east side of the gulf. About 2 m. south of the town are the harbours and quays constructed on the western side of the Suez Canal at the point where the canal enters the gulf. The harbours are connected with the town by an embankment and railway built across a shallow, dry at low water save for a narrow channel. On one of the quays is a statue to Thomas Waghorn, the organizer of the "overland route" to India. The ground on which the port is built has all been reclaimed from the sea. The accommodation provided includes a dry dock 410 ft. long, 100 ft. broad and nearly 36 ft. deep. There are separate basins for warships and merchant ships, and in the roadstead at the mouth of the canal is ample room for shipping. Suez is a quarantine station for pilgrims from Mecca; otherwise its importance is due almost entirely to the ships using the canal.

In the 7th century a town called Kolzum stood, on a site adjacent to that of Suez, at the southern end of the canal which then joined the Red Sea to the Nile. Kolzum retained some of the trade of Egypt with Arabia and countries farther east long after the canal was closed, but by the 13th century it was in ruins and Suez itself, which had supplanted it, was also, according to an Arab historian, in decay. On the Ottoman conquest of Egypt in the 16th century Suez became a naval as well as a trading station, and here fleets were equipped which for a time disputed the mastery of the Indian Ocean with the Portuguese. According to Niebuhr, in the 18th century a fleet of nearly twenty vessels sailed yearly from Suez to Jidda, the port of Mecca and the place of correspondence with India. When the French occupied Suez in 1798 it was a place of little importance, and the conflicts which followed its occupation in 1800 by an English fleet laid the greater part in ruins. The overland mail route from England to India by way of Suez was opened in 1837. The regular Peninsular & Oriental steamer service began a few years later, and in 1857 a railway was opened from Cairo through the desert. This line is now abandoned in favour of the railway which follows the canal from Suez to Ismailia, and then ascends the Wadi Tumilat to Zagazig, whence branches diverge to Cairo and Alexandria.

SUEZ CANAL. Before the construction of the Suez Canal there was no direct water communication between the Mediterranean and the Red Sea, but at various eras such communication existed by way of the Nile. Trade between Egypt and countries to the east was originally overland to ports south of the Gulf of Suez; the proximity of the roadstead at the head of that gulf to Memphis and the Delta nevertheless marked it as the natural outlet for the Red Sea commerce of Lower Egypt. The fertile Wadi Tumilat extending east of the Nile valley almost to the head of the gulf (which in ancient times reached north to the Bitter Lakes) afforded an easy road between the Nile and the Red Sea, while the digging of a navigable canal connecting the river and the gulf gave the northern route advantages not possessed by the desert routes farther south, *e.g.* that between Coptos and Kosseir. Aristotle, Strabo and Pliny attribute to the legendary Sesostris (*q.v.*) the distinction of being the first of the pharaohs to build a canal joining the Nile and the Red Sea. From an inscription on the temple at Karnak it would appear that such a canal existed in the time of Seti I. (1380 B.C.). This canal diverged from the Nile near Bubastis and was carried along the Wadi Tumilat to Heroopolis, near Pithom, a port at the head of the Heroopolite Gulf (the Bitter Lakes of to-day). The channel of this canal is still traceable in parts of the Wadi Tumilat, and its direction was frequently followed by the engineers of the fresh-water canal. Seti's canal appears to have fallen into decay or to have been too small for later requirements, for Pharaoh Necho (609 B.C.) began to build another canal; possibly his chief object was to deepen the channel between the Heroopolite Gulf and the Red Sea, then probably silting up. Necho's canal was not completed—according to Herodotus 120,000 men perished in the undertaking. Darius (520 B.C.) continued the work of Necho, rendering navigable the channel of the Heroopolite Gulf, which had become blocked. Up to this time there appears to have been no connexion between the waters of the Red Sea and those of the Bubastis-Heroopolis canal; vessels coming from the Mediterranean ascended the Pelusiac arm of the Nile to Bubastis and then sailed along the canal to Heroopolis, where their merchandise had to be transferred to the Red Sea ships. Ptolemy Philadelphus (285 B.C.) connected the canal with the waters of the sea, and at the spot where the junction was effected he built the town of Arsinoe. The dwindling of the Pelusiac branch of the Nile rendered this means of communication impossible by the time of Cleopatra (31 B.C.). Trajan (A.D. 98) is said to have repaired the canal, and, as the Pelusiac branch was no longer available for navigation, to have built a new canal between Bubastis and Babylon (Old Cairo), this new canal being known traditionally as Amnis Trajanus or Amnis Augustus. According to H. R. Hall, however, "It is very doubtful if any work of this kind, beyond repairs, was undertaken in the times of the Romans; and it is more probable that the new canal was the work of ʽAmr" (the Arab conqueror of Egypt in the 7th century). The canal was certainly in use in the early years of the Moslem rule in Egypt; it is said to have been closed *c.* A.D. 770 by order of Abū Jaʽfar (Mansur), the second Abbasid caliph and founder of Bagdad, who wished to prevent supplies from reaching his enemies in Arabia by this means. ʽAmr's canal (of which the Khalig which passed through Cairo and was closed in 1897 is said to have formed part) had its terminus on the Red Sea south of the Heroopolite Gulf near the present town of Suez. In this neighbourhood was the ancient city of Clysma, to which in ʽAmr's time succeeded Kolzum, perhaps an Arabic corruption of Clysma. The exact situation of Clysma is unknown, but Kolzum occupied the site of Suez, the hills north of which are still called Kolzum. After the closing of the canal in the 8th century it does not appear for certain that it was ever restored, although it is asserted that in the year 1000 Sultan Hakim rendered it navigable. If so it must speedily have become choked up again. Parts of the canal continued to be filled during the Nile inundations until Mehemet Ali (A.D. 1811) ordered it to be closed; the closing, however, was not completely effected, for in 1861 the old canal from Bubastis still flowed as far as Kassassin. This part of the canal, after over 2500 years of service, was utilized by the French engineers in building the fresh-water canal from Cairo to Suez in 1861–1863. This canal follows the lines of that of ʽAmr (or Trajan).

Maritime Canal Projects.—Apart from water communication between the Mediterranean and the Red Sea by way of the Nile, the project of direct communication by a canal piercing the isthmus of Suez was entertained as early as the 8th century A.D. by Hārūn al-Rashīd, who is said to have abandoned the scheme, being persuaded that it would be dangerous to lay open the coast of Arabia to the Byzantine navy. After the discovery of the Cape route to India at the close of the 15th century, the Venetians, who had for centuries held the greater part of the trade of the East with Europe via Egypt and the Red Sea, began negotiations with the Egyptians for a canal across the isthmus, but the conquest of Egypt by the Turks put an end to these designs. In 1671 Leibnitz in his proposals to Louis XIV. of France regarding an expedition to Egypt recommended the making of a maritime canal, and the Sheikh al-Balad Ali Bey (*c.* 1770) wished to carry out the project. Bonaparte when in Egypt in 1798 ordered the isthmus to be surveyed as a preliminary to the digging of a canal across it, and the engineer he employed, J. M. Lepère, came to the conclusion that there was a difference in level of 29 ft. between the Red Sea and the Mediterranean. This view was combated at the time by Laplace and Fourier on general grounds, and was finally disproved in 1846–1847 as the result of surveys made at the instance of the Société d'Études pour le Canal de Suez. This society was organized in 1846 by Prosper Enfantin, the Saint Simonist, who thirteen years before had visited Egypt in connexion with a scheme for making a canal across the isthmus of Suez, which, like the canal across the isthmus of Panama, was part of the Saint Simonist programme for the regeneration of the world. The expert commission appointed by this society reported by a majority in favour of Paulin Talabot's plan, according to which the canal would have run from Suez to Alexandria by way of Cairo.



(Topography only from *L'Isthme et le Canal de Suez*, by G. Charles-Roux, by permission of Messrs Hachette & Co.)

For some years after this report no progress was made; indeed, the society was in a state of suspended animation when in 1854 Ferdinand de Lesseps came to the front as the chief exponent of the idea. He had been associated with the Saint Simonists and for many years had been keenly interested in the question. His opportunity came in 1854 when, on the death of Abbas Pasha, his friend Said Pasha became viceroy of Egypt. From Said on the 30th of November 1854 he obtained a concession authorizing him to constitute the Compagnie Universelle du Canal Maritime de Suez, which should construct a ship canal through the isthmus, and soon afterwards in concert with two French engineers, Linant Bey and Mougel Bey, he decided that the canal should run in a direct line from Suez to the Gulf of Pelusium, passing through the depressions that are now Lake Timsa and the Bitter Lakes, and skirting the eastern edge of Lake Menzala. In the following year an international commission appointed by the viceroy approved this plan with slight modifications, the chief being that the channel was taken through Lake Menzala instead of along its edge, and the northern termination of the canal moved some 17½ m. westward where deep water was found closer to the shore. This plan, according to which there were to be no locks, was the one ultimately carried out, and it was embodied in a second and amplified concession, dated the 5th of January 1856, which laid on the company the obligation of constructing, in addition to the maritime canal, a fresh-water canal from the Nile near Cairo to Lake Timsa, with branches running parallel to the maritime canal, one to Suez and the other to Pelusium. The concession was to last for 99 years from the date of the opening of the canal between the Red Sea and the Mediterranean, after which, in default of other arrangements, the canal passes into the hands of the Egyptian government. The confirmation of the sultan of Turkey being required, de Lesseps went to Constantinople to secure it, but found himself baffled by British diplomacy; and later in London he was informed by Lord Palmerston that in the opinion of the British government the canal was a physical impossibility, that if it were made it would injure British maritime supremacy, and that the proposal was merely a device for French interference in the East.

Although the sultan's confirmation of the concession was not actually granted till 1866, de Lesseps in 1858 opened the subscription lists for his company, the capital of which was 200 million francs in 400,000 shares of 500 francs each. In less than a month 314,494 shares were applied for; of these over 200,000 were subscribed in France and over 96,000 were taken by the Ottoman Empire. From other countries the subscriptions were trifling, and England, Austria and Russia, as well as the United States of America, held entirely aloof. The residue of 85,506 shares[1] was taken over by the viceroy. On the 25th of April 1859 the work of construction was formally begun, the first spadeful of sand being turned near the site of Port Said, but progress was not very rapid. By the beginning of 1862 the fresh-water canal had reached Lake Timsa, and towards the end of the same year a narrow channel had been formed between that lake and the Mediterranean. In 1863 the fresh-water canal was continued to Suez.

So far the work had been performed by native labour; the concession of 1856 contained a provision that at least four-fifths of the labourers should be Egyptians, and later in the same year Said Pasha undertook to supply labourers as required by the engineers of the canal company, which was to house and feed them and pay them at stipulated rates. Although the wages and the terms of service were better than the men obtained normally, this system of forced labour was strongly disapproved of in England, and the khedive Ismail who succeeded Said on the latter's death in 1863 also considered it as being contrary to the interests of his country. Hence in July the Egyptian foreign minister, Nubar Pasha, was sent to Constantinople with the proposal that the number of labourers furnished to the company should be reduced, and that it should be made to hand back to the Egyptian government the lands that had been granted it by Said in 1856. These propositions were approved by the sultan, and the company was informed that if they were not accepted the works would be stopped by force. Naturally the company objected, and in the end the various matters in dispute were referred to the arbitration of the emperor Napoleon III. By his award, made in July 1864, the company was allowed 38 million francs as an indemnity for the abolition of the *corvée*, 16 million francs in respect of its retrocessions of that portion of the fresh-water canal that lay between Wadi, Lake Timsa and Suez (the remainder had already been handed back by agreement), and 30 million francs in respect of the lands which had been granted it by Said. The company was allowed to retain a certain amount of land along the canals, which was necessary for purposes of construction, erection of workshops, &c., and it was put under the obligation of finishing the fresh-water canal between Wadi and

[1] These formed part of the 176,602 shares which were bought for the sum of £3,976,582 from the khedive by England in 1875 at the instance of Lord Beaconsfield (*q.v.*).

Suez to such dimensions that the depth of water in it would be $2\frac{1}{2}$ metres at high Nile and at least 1 metre at low Nile. The supply of Port Said with water it was allowed to manage by any means it chose; in the first instance it laid a double line of iron piping from Timsa, and it was not till 1885 that the original plan of supplying the town by a branch of the fresh-water canal was carried out. The indemnity, amounting to a total of 84 million francs, was to be paid in instalments spread over 15 years.

The abolition of forced labour was probably the salvation of the enterprise, for it meant the introduction of mechanical appliances and of modern engineering methods. The work was divided into four contracts. The first was for the supply of 250,000 cubic metres of concrete blocks for the jetties of Port Said; the second, for the first 60 kilometres of the channel from Port Said, involved the removal of 22 million cubic metres of sand or mud; the third was for the next length of 13 kilometres, which included the cutting through the high ground at El Gisr; and the fourth and largest was for the portion between Lake Timsa and the Red Sea. The contractors for this last section were Paul Borel and Alexandre Levalley, who ultimately became responsible also for the second or 60 kilometres contract. For the most part the material was soft and therefore readily removed. At some points, however, as at Shaluf and Serapeum, rock was encountered. Much of the channel was formed by means of dredgers. Through Lake Menzala, for instance, native workmen made a shallow channel by scooping out the soil with their hands and throwing it out on each side to form the banks; dredgers were then floated in and completed the excavation to the required depth, the soil being delivered on the other side of the banks through long spouts. At Serapeum, a preliminary shallow channel having been dug out, water was admitted from the fresh-water canal, the level of which is higher than that of the ship canal, and the work was completed by dredgers from a level of about 20 ft. above the sea. At El Gisr, where the soil, composed largely of loose sand, rises 60 ft. above the sea, the contractor, Alphonse Couvreux, employed an excavator of his own design, which was practically a bucket-dredger working in the dry. A long arm projecting downwards at an angle from an engine on the bank carried a number of buckets, mounted on a continuous chain, which scooped up the stuff at the bottom and discharged it into wagons at the top.

In 1865 de Lesseps, to show the progress that had been made, entertained over 100 delegates from chambers of commerce in different parts of the world, and conducted them over the works. In the following year the company, being in need of money, realized 10 million francs by selling to the Egyptian government the estate of El Wadi, which it had purchased from Said, and it also succeeded in arranging that the money due to it under the award of 1864 should be paid off by 1869 instead of 1879. Its financial resources still being insufficient, it obtained in 1867 permission to invite a loan of 100 million francs; but though the issue was offered at a heavy discount it was only fully taken up after the attractions of a lottery scheme had been added to it. Two years later the company got 30 million francs from the Egyptian government in consideration of abandoning certain special rights and privileges that still belonged to it and of handing over various hospitals, workshops, buildings, &c., which it had established on the isthmus. The government liquidated this debt, not by a money payment, but by agreeing to forego for 25 years the interest on the 176,602 shares it held in the company, which was thus enabled to raise a loan to the amount of the debt. Altogether, up to the end of the year (1869) in which the canal was sufficiently advanced to be opened for traffic, the accounts of the company showed a total expenditure of 432,807,882 francs, though the International Technical Commission in 1856 had estimated the cost at only 200 millions for a canal of larger dimensions.

The formal opening of the canal was celebrated in November 1869. On the 16th there was an inaugural ceremony at Port Said, and next day 68 vessels of various nationalities, headed by the "Aigle" with the empress Eugénie on board, began the passage, reaching Ismailia (Lake Timsa) the same day. On the 19th they continued their journey to the Bitter Lakes, and on the 20th they arrived at Suez. Immediately afterwards regular traffic began. In 1870 the canal was used by nearly 500 vessels, but the receipts for the first two years of working were considerably less than the expenses. The company attempted to issue a loan of 20 million francs in 1871, but the response was small, and it was only saved from bankruptcy by a rapid increase in its revenues.

The total length of the navigation from Port Said to Suez is 100 m. The canal was originally constructed to have a depth of 8 metres with a bottom width of 22 metres, but it soon became evident that its dimensions must be enlarged. Certain improvements in the channel were started in 1876, but a more extensive plan was adopted in 1885 as the result of the inquiries of an international commission which recommended that the depth should be increased first to $8\frac{1}{2}$ metres and finally to 9 metres, and that the width should be made on the straight parts a minimum of 65 metres between Port Said and the Bitter Lakes, and of 75 metres between the Bitter Lakes and Suez, increasing on curves to 80 metres. To pay for these works a loan of 100 million francs was issued. These widenings greatly improved the facilities for ships travelling in opposite directions to pass each other. In the early days of the canal, except in the Bitter Lakes, vessels could pass each other only at a few crossing places or gares, which had a collective length of less than a mile; but owing to the widenings that have been carried out, passing is now possible at any point over the greater part of the canal, one vessel stopping while the other proceeds on her way. From March 1887 navigation by night was permitted to ships which were provided with electric search-lights, and now the great majority avail themselves of this facility. By these measures the average time of transit, which was about 36 hours in 1886, has been reduced by half. The maximum speed permitted in the canal itself is 10 kilomètres an hour.

The dues which the canal company was authorized to charge by its concession of 1856 were 10 francs a ton. In the first instance they were levied on the tonnage as shown by the papers on board each vessel, but from March 1872 they were charged on the gross register tonnage, computed according to the method of the British Merchant Shipping Act 1854. The result was that the shipowners had to pay more, and, objections being raised, the whole question of the method of charge was submitted to an international conference which met at Constantinople in 1873. It fixed the dues at 10 francs per net register ton (English reckoning) with a surtax of 4 francs per ton, which, however, was to be reduced to 3 francs in the case of ships having on board papers showing their net tonnage calculated in the required manner. It also decided that the surtax should be gradually diminished as the traffic increased, until in the year after the net tonnage passing through the canal reached 2,600,000 tons it should be abolished. De Lesseps protested against this arrangement, but on the sultan threatening to enforce it, if necessary by armed intervention, he gave in and brought the new tariff into operation in April 1874. By an arrangement with the canal company, signed in 1876, the British government, which in 1875 by the purchase of the khedive's shares, had become a large shareholder, undertook negotiations to secure that the successive reductions of the tariff should take effect on fixed dates, the sixth and last instalment of 50 centimes being removed in January 1884, after which the maximum rate was to be 10 francs per official net ton. But before this happened British shipowners had started a vigorous agitation against the rates, which they alleged to be excessive, and had even threatened to construct a second canal. In consequence a meeting was arranged between them and representatives of the canal company in London in November 1883, and it was agreed that in January 1885 the dues should be reduced to $9\frac{1}{2}$ francs a ton, that subsequently they should be lowered on a sliding scale as the dividend increased, and that after the dividend reached 25% all the surplus profits should be applied in reducing the rates until they were lowered to 5 francs a ton. Under this arrangement they were fixed at $7\frac{3}{4}$ francs per ton at the beginning of 1906. For ships in ballast reduced rates are in force. For passengers the dues remain at 10 francs a head, the figure at which they were originally fixed.

By the concessions of 1854 and 1856 the dues were to be the same for all nations, preferential treatment of any kind being forbidden, and the canal and its ports were to be open "comme passages neutres" to every merchant ship without distinction of nationality. The question of its formal neutralization by international agreement was raised in an acute form during the Egyptian crisis of 1881-82, and in August of the latter year a few weeks before the battle of Tel-el-Kebir, navigation upon it was suspended for four days at the instance of Sir Garnet Wolseley, who was in command of the British forces. At the international conference which was then sitting at Constantinople various proposals were put forward to ensure the use of the canal to all nations, and ultimately at Constantinople on the 29th of October 1888 Great Britain, Germany, Austria, Spain, France, Italy, the Netherlands, Russia and Turkey signed the Suez Canal Convention, the purpose of which was to ensure that the canal should "always be free and open, in time of war as in time of peace, to every vessel of commerce or of war, without distinction of flag." Great Britain, however, in signing, formulated a reservation that the provisions of the convention should only apply so far as they were compatible with the actual situation, namely the "present transitory and exceptional condition of Egypt," and so far as they would not fetter the liberty of action of the British government during its occupation of that country. But by the Anglo-French agreement of the 8th of April 1904 Great Britain declared her adherence to the stipulations of the convention, and agreed to their being put in force, except as regards a provision by which the agents in Egypt of the signatory Powers of the convention were to meet once a year to take note of the due execution of the treaty. It was by virtue of this new agreement that the Russian warships proceeding to the East in 1904–1905 were enabled to use the canal, although passage was prohibited to Spanish warships in 1898 during the war between Spain and the United States.

L'Isthme et le Canal de Suez, historique, état actuel, by J. Charles-Roux (2 vols., Paris 1901), contains reprints of various official documents relating to the canal, with plates, maps and a bibliography extending to 1499 entries.

SUFFOLK, EARLS AND DUKES OF. These English titles were borne in turn by the families of Ufford, Pole, Brandon, Grey and Howard. A certain holder of land in Suffolk, named John de Peyton, had a younger son Robert, who acquired the lordship of Ufford in that county and was known as Robert de Ufford. He held an important place in the government of Ireland under Edward I. and died in 1298; his son Robert (1279–1316) was created Baron Ufford by a writ of summons to parliament in 1309, and increased his possessions by marriage with Cicely, daughter and heiress of Robert de Valoines. This Robert had several sons, one of whom was Sir Ralph de Ufford (d. 1346), justiciar of Ireland, who married Maud, widow of William de Burgh, earl of Ulster, and daughter of Henry Plantagenet, earl of Lancaster. Robert's eldest surviving son, another Robert (*c.* 1298–1369), was an associate of the young king Edward III., and was one of the nobles who arrested Roger Mortimer in 1330. In 1337 he was created earl of Suffolk. The earl was employed by Edward III. on high military and diplomatic duties and was present at the battles of Creçy and Poitiers. His son William, the 2nd earl (*c.* 1339–1382), held important appointments under Edward III. and Richard II. He played a leading part in the suppression of the Peasants' Revolt in 1381, but in the same year he supported the popular party in parliament in the attack on the misgovernment of Richard II. Although twice married he left no sons, and his earldom became extinct, his extensive estates reverting to the Crown.

In 1385 the earldom of Suffolk and the lands of the Uffords were granted by Richard II. to his friend Michael Pole (*c.* 1330–1389), a son of Sir William atte Pole, a baron of the exchequer and a merchant (see POLE FAMILY). After an active public life as the trusted adviser of Richard II. Pole was dismissed from his office of chancellor, was impeached and sentenced to death, but escaped to France, where he died. His titles and estates were forfeited, but in 1399 the earldom of Suffolk and most of the estates were restored to his son Michael (*c.* 1361–1415). Michael, the 3rd earl (1394–1415), was killed at the battle of Agincourt, and the earldom passed to his brother William (1396–1450), who was created earl of Pembroke in 1443, marquess of Suffolk in 1444, and duke of Suffolk in 1448 (see SUFFOLK, WILLIAM DE LA POLE, DUKE OF). The duke's son, John, 2nd duke of Suffolk (1442–1491), married Elizabeth, daughter of Richard, duke of York, and sister of King Edward IV., by whom he had six sons. The eldest, John (*c.* 1464–1487), was created earl of Lincoln, and was named heir to the throne by Richard III. He was killed fighting against Henry VII. at the battle of Stoke, and was attainted. His brother Edmund (*c.* 1472–1513) should have succeeded his father in the dukedom in 1491, but he surrendered this to Henry VII. in return for some of the estates forfeited by the earl of Lincoln, and was known simply as earl of Suffolk. Having incurred the displeasure of the king, he left his own country in 1501 and sought help for an invasion of England. Consequently he was attainted in 1504 and was handed over in 1506 to Henry. He was kept in prison until 1513, when he was beheaded by Henry VIII. His brother Richard now called himself duke of Suffolk, and put forward a claim to the English crown. Known as the "white rose," he lived abroad until 1525, when he was killed at the battle of Pavia.

In 1514 the title of duke of Suffolk was granted by Henry VIII. to his friend, Charles Brandon (see SUFFOLK, CHARLES BRANDON, DUKE OF) and it was borne successively by his two sons, Henry and Charles, becoming extinct when Charles died in July 1551. In the same year it was revived in favour of Henry Grey, marquess of Dorset, who had married Frances, a daughter of the first Brandon duke. Grey, who became marquess of Dorset in 1530, was a prominent member of the reforming party during the reign of Edward VI. He took part in the attempt to make his daughter, Jane, queen of England in 1553, but as he quickly made his peace with Mary he was not seriously punished. In 1554, however, he took part in the rising headed by Sir Thomas Wyat; he was captured, tried for treason and beheaded in February 1554, when the dukedom again became extinct. In 1603 Thomas Howard, Lord Howard de Walden, son of Thomas Howard, 4th duke of Norfolk, was created earl of Suffolk, and the earldom has been held by his descendants to the present day (see SUFFOLK, THOMAS HOWARD, 1st earl of).

SUFFOLK, CHARLES BRANDON, 1ST DUKE OF (*c.* 1484–1545), was the son of William Brandon, standard-bearer of Henry VII., who was slain by Richard III. in person on Bosworth Field. Charles Brandon was brought up at the court of Henry VII. He is described by Dugdale as "a person comely of stature, high of courage and conformity of disposition to King Henry VIII.," with whom he became a great favourite. He held a succession of offices in the royal household, becoming master of the horse in 1513, and received many valuable grants of land. On the 15th of May 1513 he was created Viscount Lisle, having entered into a marriage contract with his ward, Elizabeth Grey, Viscountess Lisle in her own right, who, however, refused to marry him when she came of age. He distinguished himself at the sieges of Terouenne and Tournai in the French campaign of 1513. One of the agents of Margaret of Savoy, governor of the Netherlands, writing from before Terouenne, reminds her that Lord Lisle is a second king and advises her to write him a kind letter. At this time Henry VIII. was secretly urging Margaret to marry Brandon, whom he created duke of Suffolk, though he was careful to disclaim (March 4, 1514) any complicity in the project to her father, the emperor Maximilian I. The regent herself left a curious account of the proceedings (*Letters and Papers of Henry VIII.* vol. i. 4850-4851). Brandon took part in the jousts which celebrated the marriage of Mary Tudor, Henry's sister, with Louis XII.

of France. He was accredited to negotiate various matters with Louis, and on his death was sent to congratulate the new king Francis I. An affection between Suffolk and the dowager queen Mary had subsisted before her marriage, and Francis roundly charged him with an intention to marry her. Francis, perhaps in the hope of Queen Claude's death, had himself been one of her suitors in the first week of her widowhood, and Mary asserted that she had given him her confidence to avoid his importunities. Francis and Henry both professed a friendly attitude towards the marriage of the lovers, but Suffolk had many political enemies, and Mary feared that she might again be sacrificed to political considerations. The truth was that Henry was anxious to obtain from Francis the gold plate and jewels which had been given or promised to the queen by Louis in addition to the reimbursement of the expenses of her marriage with the king; and he practically made his acquiescence in Suffolk's suit dependent on his obtaining them. The pair cut short the difficulties by a private marriage, which Suffolk announced to Wolsey, who had been their fast friend, on the 5th of March. Suffolk was only saved from Henry's anger by Wolsey, and the pair eventually agreed to pay to Henry £24,000 in yearly instalments of £1000, and the whole of Mary's dowry from Louis of £200,000, together with her plate and jewels. They were openly married at Greenwich on the 13th of May. The duke had been twice married already, to Margaret Mortimer and to Anne Browne, to whom he had been betrothed before his marriage with Margaret Mortimer. Anne Browne died in 1511, but Margaret Mortimer, from whom he had obtained a divorce on the ground of consanguinity, was still living. He secured in 1528 a bull from Pope Clement II. assuring the legitimacy of his marriage with Mary Tudor, and of the daughters of Anne Browne, one of whom, Anne, was sent to the court of Margaret of Savoy. After his marriage with Mary, Suffolk lived for some years in retirement, but he was present at the Field of the Cloth of Gold in 1520, and in 1523 he was sent to Calais to command the English troops there. He invaded France in company with Count de Buren, who was at the head of the Flemish troops, and laid waste the north of France, but disbanded his troops at the approach of winter. Suffolk was entirely in favour of Henry's divorce from Catherine of Aragon, and in spite of his obligations to Wolsey he did not scruple to attack him when his fall was imminent. The cardinal, who was acquainted with Suffolk's private history, reminded him of his ingratitude: "If I, simple cardinal, had not been, you should have had at this present no head upon your shoulders wherein you should have had a tongue to make any such report in despite of us." After Wolsey's disgrace Suffolk's influence increased daily. He was sent with the duke of Norfolk to demand the great seal from Wolsey; the same noblemen conveyed the news of Anne Boleyn's marriage to Queen Catherine, and Suffolk acted as high steward at the new queen's coronation. He was one of the commissioners appointed by Henry to dismiss Catherine's household, a task which he found distasteful. He supported Henry's ecclesiastical policy, receiving a large share of the plunder after the suppression of the monasteries. In 1544 he was for the second time in command of an English army for the invasion of France. He died at Guildford on the 24th of August in the following year.

After the death of Mary Tudor on the 24th of June 1533 he had married in 1534 his ward Catherine (1520-1580), Baroness Willoughby de Eresby in her own right, then a girl of fifteen. His daughters by his marriage with Anne Browne were Anne, who married firstly Edward Grey, Lord Powys, and, after the dissolution of this union, Randal Harworth; and Mary (b. 1510), who married Thomas Stanley, Lord Monteagle. By Mary Tudor he had Henry earl of Lincoln (1516–1634); Frances, who married Henry Grey, marquess of Dorset, and became the mother of Lady Jane Grey; and Eleanor, who married Henry Clifford, second earl of Cumberland. By Katherine Willoughby he had two sons who showed great promise, Henry (1535–1551) and Charles (*c.* 1537–1551), dukes of Suffolk. They died of the sweating sickness within an hour of one another. Their tutor, Sir Thomas Wilson, compiled a memoir of them, *Vita et obitus duorum fratrum Suffolcensium* (1551).

There is abundant material for the history of Suffolk's career in the *Letters and Papers of Henry VIII.* (ed. Brewer in the Rolls Series). See also Dugdale, *Baronage of England* (vol. ii. 1676); and G. E. C., *Complete Peerage.* An account of his matrimonial adventures is in the historical appendix to a novel by E. S. Holt entitled *The Harvest of Yesterday.*

SUFFOLK, THOMAS HOWARD, 1ST EARL OF (1561–1626), second son of Thomas Howard, 4th duke of Norfolk, was born on the 24th of August 1561. He behaved very gallantly during the attack on the Spanish armada and afterwards took part in other naval expeditions, becoming an admiral in 1599. Created Baron Howard de Walden in 1597 and earl of Suffolk in July 1603, he was lord chamberlain of the royal household from 1603 to 1614 and lord high treasurer from 1614 to 1618, when he was deprived of his office on a charge of misappropriating money. He was tried in the Star-chamber and was sentenced to pay a heavy fine. Suffolk's second wife was Catherine (d. 1633), widow of the Hon. Richard Rich, a woman whose avarice was partly responsible for her husband's downfall. She shared his trial and was certainly guilty of taking bribes from Spain. One of his three daughters was the notorious Frances Howard, who, after obtaining a divorce from her first husband, Robert Devereux, earl of Essex, married Robert Carr, earl of Somerset, and instigated the poisoning of Sir Thomas Overbury. The earl died on the 28th of May 1626. He built a magnificent residence at Audley End, Essex, which is said to have cost £200,000. One of Suffolk's seven sons was Sir Robert Howard (1585–1653), who inherited Clun Castle, Shropshire, on the death of his brother, Sir Charles Howard, in 1622. He was twice imprisoned on account of his illicit relations with Frances; Viscountess Purbeck (d. 1645), a daughter of Sir Edward Coke, and after sitting in six parliaments was expelled from the House of Commons for executing the king's commission of array in 1642. He died on the 22nd of April 1653. Another of Suffolk's sons, Edward (d. 1675), was created baron Howard of Escrick in 1628. He was one of the twelve peers who signed the petition on grievances, which he presented to Charles I. at York in 1640, and after the abolition of the House of Lords in 1649 he sat in the House of Commons as member for Carlisle, being also a member of the council of state. In 1651 he was expelled from parliament for taking bribes and he died on the 24th of April 1675. His second son, William, 3rd lord Howard of Escrick (*c.* 1626–1694), was a member of the republican party during the Commonwealth; later he associated himself with the opponents of the arbitrary rule of Charles II., but turning informer he was partly responsible for the conviction of Lord William Russell and of Algernon Sydney in 1683. On the death of William's son, Charles, the 4th lord, in 1715 the barony of Howard of Escrick became extinct.

Suffolk's eldest son, THEOPHILUS, 2nd earl of Suffolk (1584–1640), was captain of the band of gentlemen pensioners under James I. and Charles I., and succeeded to the earldom in May 1626, obtaining about the same time some of the numerous offices which had been held by his father, including the lord-lieutenancy of the counties of Suffolk, Cambridge and Dorset. He died on the 3rd of June 1640, when his eldest son James (1619–1689) became 3rd earl. This nobleman, who acted as earl marshal of England at the coronation of Charles II., died in January 1689 when his barony of Howard de Walden fell into abeyance between his two daughters.[1] His earldom, however, passed to his brother George (*c.* 1625–1691), who

[1] Having thus fallen into abeyance in 1689 the barony of Howard de Walden was revived in 1784 in favour of John Griffin Griffin, afterwards Lord Braybrooke, on whose death in May 1797 it fell again into abeyance. In 1799 the bishop of Derry, Frederick Augustus Hervey, 4th earl of Bristol, a descendant of the 3rd earl of Suffolk, became the sole heir to the barony. On Bristol's death in July 1803 it passed to Charles Augustus Ellis (1799–1868), a grandson of the bishop's elder son, John Augustus, Lord Hervey (1757–1796), who had predeceased his father. It was thus separated from the marquessate of Bristol, which passed to the bishop's only surviving son, and it has since been held by the family of Ellis.

became 4th earl of Suffolk. George's nephew, Henry, the 6th earl (*c.* 1670–1718), who was president of the board of trade from 1715 to 1718, left an only son, Charles William (1693–1722), who was succeeded in turn by his two uncles, the younger of them, Charles (1675–1733) becoming 9th earl on the death of his brother Edward in June 1731. This earl was the husband of Henrietta countess of Suffolk (*c.* 1681–1767), the mistress of George II., who was a daughter of Sir Henry Hobart, bart., of Blickling, Norfolk. When still the Hon. Charles Howard, he and his wife made the acquaintance of the future king in Hanover; after the accession of George I. to the English throne in 1714 both husband and wife obtained posts in the household of the prince of Wales, who, when he became king as George II., publicly acknowledged Mrs Howard as his mistress. She was formally separated from her husband before 1731 when she became countess of Suffolk. The earl died on the 28th of September 1733, but the countess, having retired from court and married the Hon. George Berkeley (d. 1746), lived until the 26th of July 1767. Among Lady Suffolk's friends were the poets Pope and Gay and Charles Mordaunt (earl of Peterborough).

A collection of *Letters to and from Henrietta Countess of Suffolk, and her Second Husband, the Hon. George Berkeley*, was edited by J. W. Croker (1824).

The 9th earl's only son Henry, the 10th earl (1706–1745), died without sons in April 1745, when his estate at Audley End passed to the descendants of the 3rd earl, being inherited in 1762 by John Griffin Griffin (1719–1797), afterwards Lord Howard de Walden and Lord Braybrooke. As owners of this estate the earls of Suffolk of the Howard line had hitherto been hereditary visitors of Magdalene College, Cambridge, but this office now passed away from them. The earldom of Suffolk was inherited by Henry Bowes Howard, 4th earl of Berkshire (1696–1757), who was the great-grandson of Thomas Howard (*c.* 1590–1669), the second son of the 1st earl of Suffolk, Thomas having been created earl of Berkshire in 1626. Since 1745 the two earldoms have been united, Henry Molyneux Paget Howard (b. 1877) succeeding his father, Henry Charles (1833–1898), as 19th earl of Suffolk and 12th earl of Berkshire in 1898.

SUFFOLK, WILLIAM DE LA POLE, Duke of (1396–1450), second son of Michael de la Pole, second earl of Suffolk, was born on the 16th of October 1396. His father died at the siege of Harfleur, and his elder brother was killed at Agincourt on the 25th of October 1415. Suffolk served in all the later French campaigns of the reign of Henry V., and in spite of his youth held high command on the marches of Normandy in 1421–22. In 1423 he joined the earl of Salisbury in Champagne, and shared his victory at Crévant. He fought under John, duke of Bedford, at Verneuil on the 17th of August 1424, and throughout the next four years was Salisbury's chief lieutenant in the direction of the war. When Salisbury was killed before Orleans on the 3rd of November 1428, Suffolk succeeded to the command. After the siege was raised, Suffolk was defeated and taken prisoner by Jeanne d'Arc at Jargeau on the 12th of June 1429. He was soon ransomed, and during the next two years was again in command on the Norman frontier. He returned to England in November 1431, after over fourteen years' continuous service in the field.

Suffolk had already been employed on diplomatic missions by John of Bedford, and from this time forward he had an important share in the work of administration. He attached himself naturally to Cardinal Beaufort, and even thus early seems to have been striving for a general peace. But public opinion in England was not yet ripe, and the unsuccessful conference at Arras, with the consequent defection of Burgundy, strengthened the war party. Nevertheless the cardinal's authority remained supreme in the council, and Suffolk, as his chief supporter, gained increasing influence. The question of Henry VI.'s marriage brought him to the front. Humphrey of Gloucester favoured an Armagnac alliance. Suffolk brought about the match with Margaret of Anjou. Report already represented Suffolk as too friendly with French leaders like Charles of Orleans, and it was with reluctance that he undertook the responsibility of an embassy to France. However, when he returned to England in June 1444, after negotiating the marriage and a two years' truce, he received a triumphant reception. He was made a marquess, and in the autumn sent again to France to bring Margaret home. The French contrived to find occasion for extorting a promise to surrender all the English possessions in Anjou and Maine, a concession that was to prove fatal to Suffolk and his policy. Still for the time his success was complete, and his position as the personal friend of the young king and queen seemed secure. Humphrey of Gloucester died in February 1447, within a few days of his arrest, and six weeks later Cardinal Beaufort died also. Suffolk was left without an obvious rival, but his difficulties were great. Rumour, though without sufficient reason, made him responsible for Humphrey's death, while the peace and its consequent concessions rendered him unpopular. So also did the supersession of Richard of York by Edmund Beaufort, duke of Somerset, in the French command. Suffolk's promotion to a dukedom in July 1448, marked the height of his power. The difficulties of his position may have led him to give some countenance to a treacherous attack on Fougéres during the time of truce (March 1449). The renewal of the war and the loss of all Normandy were its direct consequences. When parliament met in November 1449, the opposition showed its strength by forcing the treasurer, Adam Molyneux, to resign. Molyneux was murdered by the sailors at Portsmouth on the 9th of January 1450. Suffolk, realizing that an attack on himself was inevitable, boldly challenged his enemies in parliament, appealing to the long and honourable record of his public services. On the 7th of February and again on the 9th of March the Commons presented articles of accusation dealing chiefly with alleged maladministration and the ill success of the French policy; there was a charge of aiming at the throne by the betrothal of his son to the little Margaret Beaufort, but no suggestion of guilt concerning the death of Gloucester. The articles were in great part baseless, if not absurd. Suffolk, in his defence on the 13th of March, denied them as false, untrue and too horrible to speak more of. Ultimately, as a sort of compromise, the king sentenced him to banishment for five years. Suffolk left England on the 1st of May. He was intercepted in the Channel by the ship "Nicholas of the Tower," and next morning was beheaded in a little boat alongside. The "Nicholas" was a royal ship, and Suffolk's murder was probably instigated by his political opponents.

Popular opinion at the time judged Suffolk as a traitor. This view was accepted by Yorkist chroniclers and Tudor historians, who had no reason to speak well of a Pole. Later legend made him the paramour of Margaret of Anjou. Though utterly baseless, the story gained currency in the *Mirrour for Magistrates*, and was adopted in Shakespeare's *2 Henry VI.* (act III. sc. ii.). Suffolk's best defence is contained in the touching letter of farewell to his son, written on the eve of his departure (*Paston Letters*, i. 142), and in his noble speeches before parliament (*Rolls of Parliament*, v. 176, 182). Of the former Lingard said well that it is "difficult to believe that the writer could have been either a false subject or a bad man." The policy of peace which Suffolk pursued was just and wise; he foresaw from the first the personal risk to which its advocacy exposed him. This alone should acquit him of any base motive; his conduct was "throughout open and straightforward" (Stubbs). Whatever his defects as a statesman, he was a gallant soldier, a man of culture and a loyal servant.

Suffolk's wife, Alice, was widow of Thomas, earl of Salisbury, and granddaughter of Geoffrey Chaucer. By her he had an only son John, second duke of Suffolk.

Bibliography.—Suffolk is necessarily prominent in all contemporary authorities. The most important are J. Stevenson's *Wars of the English in France*, Thomas Beckington's *Correspondence*, T. Wright's *Political Poems and Songs*, ii. 222–234 (for the popular view)—these three are in the Rolls Series; and the *Paston Letters*. Of French writers E. de Monstrelet and Jehan de Waurin are most useful for his military career, T. Basin and Matthieu d'Escouchy for his fall (all these are published by the Société de l'Histoire de

France). For modern accounts see especially W. Stubbs, *Constitutional History* (favourable), *The Political History of England* (1906), vol. iv., by C. Oman (unfavourable), and G. du Fresne de Beaucourt's *Histoire de Charles VII*. See also H. A. Napier's *Historical Notices of Swincombe and Ewelme* (1858). (C. L. K.)

SUFFOLK, an eastern county of England, bounded N. by Norfolk, E. by the North Sea, S. by Essex and W. by Cambridgeshire. The area is 1488·6 sq. m. The surface is as a whole but slightly undulating. In the extreme north-west near Mildenhall, a small area of the Fen district is included. This is bordered by a low range of chalk hills extending from Haverhill northwards along the western boundary, and thence by Bury St Edmunds to Thetford. The coast-line has a length of about 62 m., and is comparatively regular, the bays being generally shallow and the headlands rounded and only slightly prominent. The estuaries of the Deben, Orwell and Stour, however, are between 10 and 12 m. in length. The shore is generally low and marshy, with occasional clay and sand cliffs. It includes, in the declivity on which Old Lowestoft stands, the most easterly point of English land. Like the Norfolk coast, this shore has suffered greatly from incursions of the sea, the demolition of the ancient port of Dunwich (*q.v.*) forming the most noteworthy example. The principal seaside resorts are Lowestoft, Southwold, Aldeburgh and Felixstowe. The rivers flowing northward are the Lark, in the north-west corner, which passes in a north-westerly direction to the Great Ouse in Norfolk; the Little Ouse or Brandon, also a tributary of the Great Ouse, flowing by Thetford and Brandon and forming part of the northern boundary of the county; and the Waveney, which rises in Norfolk and forms the northern boundary of Suffolk from Palgrave till it falls into the mouth of the Yare at Yarmouth. The Waveney is navigable from Bungay, and by means of Oulton Broad also communicates with the sea at Lowestoft. The rivers flowing in a south-easterly direction to the North Sea are the Blyth; the Alde or Ore, which has a course for nearly 10 m. parallel to the seashore; the Deben, from Debenham, flowing past Woodbridge, up to which it is navigable; the Orwell or Gipping, which becomes navigable at Stowmarket, whence it flows past Needham Market and Ipswich; and the Stour, which forms nearly the whole southern boundary of the county, receiving the Brett, which flows past Lavenham and Hadleigh; it is navigable from Sudbury. At the union of its estuary with that of the Orwell is the important port of Harwich (in Essex). The county has no valuable minerals. Flints are worked, as they have been from pre-historic times; a considerable quantity of clay is raised and lime and whiting are obtained in various districts.

Geology.—The principal geological formations are the Chalk and the Tertiary deposits. The former occupies the surface, except where covered by superficial drift, in the central and north-west portions of the county, and it extends beneath the Tertiaries in the south-east and east. In the extreme north-west round Mildenhall the Chalk borders a tract of fen land in a range of low hills from Haverhill by Newmarket and Bury St Edmunds to Thetford. The Chalk is quarried near Ipswich, Bury St Edmunds, Mildenhall and elsewhere; at Brandon the chalk flints for gun-locks and building have been exploited from early times. The Tertiary formations include Thanet sand, seen near Sudbury; and Reading Beds and London Clay which extend from Sudbury through Hadleigh, Ipswich, Woodbridge and thence beneath younger deposits to the extreme north-east of the county. Above the Eocene formations lie the Pliocene "Crags," which in the north overlap the Eocene boundary on to the chalk. The oldest of the crag deposits is the Coralline Crag, pale sandy and marly beds with many fossils; this is best exposed west and north of Aldeburgh and about Sudbourne and Orford. Resting upon the Coralline beds, or upon other formations in their absence, is the Red Crag, a familiar feature above the London Clay in the cliffs at Felixstowe and Baudsey, where many fossils used to be found; inland it appears at Bentley, Stutton and Chillesford, where the "Scrobicularia Clay" and Chillesford beds of Prestwich appear above it. The last-named beds probably correspond with the Norwich Crag, the name given to the upper, paler portion of the Red Crag, together with certain higher beds in the north part of east Suffolk. The Norwich Crag is visible at Dunwich, Bavent, Easton and Wangford. In the north the Cromer Forest beds, gravels with fresh-water fossils and mammalian remains, may be seen on the coast at Corton and Pakefield. Between the top of the London Clay and the base of the Crags is the "Suffolk Bone Bed" with abundant mammalian bones and phosphatic nodules. Glacial gravel, sand and chalky boulder clay are scattered over much of the county, generally forming stiffer soils in the west and lighter sandy soils in the east. Pebble gravels occur at Westleton and Halesworth, and later gravels, with palaeolithic implements, at Hoxne; while old river-gravels of still later date border the present river valleys. The chalk and gault have been penetrated by a boring at Stutton, revealing a hard palaeozoic slaty rock at the depth of about 1000 ft.

Agriculture.—Suffolk is one of the most fertile counties in England. In the 18th century it was famed for its dairy products. The high prices of grain during the wars of the French Revolution led to the extensive breaking up of its pastures, and it is now one of the principal grain-growing counties in England. There is considerable variety of soils, and consequently in modes of farming in different parts of the county. Along the sea-coast a sandy loam or thin sandy soil prevails, covered in some places with the heath on which large quantities of sheep are fed, interspersed with tracts, more or less marshy, on which cattle are grazed. The best land adjoins the rivers, and consists of a rich sandy loam, with patches of lighter and easier soil. In the south-west and the centre is much finer grain-land having mostly a clay subsoil, but not so tenacious as the clay in Essex. In climate Suffolk is one of the driest of the English counties; thus, the mean annual rainfall at Bury St Edmunds is rather less than 24 in. Towards the north-west the soil is generally poor, consisting partly of sand on chalk, and partly of peat and open heath. Some four-fifths of the total area of the county is under cultivation. Barley, oats and wheat are the most important of the grain crops. The breed of horses known as Suffolk punches is one of the most valued for agricultural purposes in England. The breed of cattle native to the county is a polled variety, on the improvement of which great pains have been bestowed. The old Suffolk cows, famous for their great milking qualities, were of various colours, yellow predominating. The improved are all red. Much milk is sent to London, Yarmouth, &c. Many cattle, mostly imported from Ireland, are grazed in the winter. The sheep are nearly all of the blackfaced improved Suffolk breed, a cross between the old Norfolk horned sheep and Southdowns. The breed of pigs most common is small and black.

Manufactures and Trade.—The county is essentially agricultural, and the most important manufactures relate to this branch of industry. They include that of agricultural implements, especially at Ipswich, Bury St Edmunds and Stowmarket, and that of artificial manures at Ipswich and Stowmarket, for which coprolites are dug. Malting is extensively carried on throughout the county. There are chemical and gun-cotton manufactories at Stowmarket and gun flints are still made at Brandon. At other towns small miscellaneous manufactures are carried on, including silk, cotton, linen, woollen, and horsehair and coco-nut matting. The principal ports are Lowestoft, Southwold, Aldeburgh, Woodbridge and Ipswich. Lowestoft is the chief fishing town. Herrings and mackerel are the fish most abundant on the coasts.

Communications.—The main line of the Great Eastern railway, entering the county from the south, serves Ipswich and Stowmarket, continuing north into Norfolk. The east Suffolk branch from Ipswich serves Woodbridge, Saxmundham, Halesworth, and Beccles, with branches to Felixstowe, to Framlingham, to Aldeburgh, and to Lowestoft; while the Southwold Light railway connects with that town from Halesworth. The other principal branches are those from Stowmarket to Bury St Edmunds and westward into Cambridgeshire, from Essex into Norfolk by Long Melford, Bury St Edmunds and Thetford, and from Long Melford to Haverhill, which is the northern terminus of the Colne Valley railway.

Population and Administration.—The area of the ancient county is 952,710 acres, with a population in 1891 of 371,235 and in 1901 of 384,293. Suffolk comprises 21 hundreds, and for administrative purposes is divided into the counties of East Suffolk (557,854 acres) and West Suffolk (390,914 acres). The following are municipal boroughs and urban districts.

(1) EAST SUFFOLK. Municipal boroughs—Aldeburgh (pop. 2405), Beccles (6898), Eye (2004), Ipswich, a county borough and the county town (66,630), Lowestoft (29,850), Southwold (2800). Urban districts—Bungay (3314), Felixstowe and Walton (5815), Halesworth (2246), Leiston-cum-Sizewell (3259), Oulton Broad (4044), Saxmundham (1452), Stowmarket (4162), Woodbridge (4640).

(2) WEST SUFFOLK. Municipal boroughs—Bury St Edmunds (16,255), Sudbury (7109). Urban districts—Glemsford (1975), Hadleigh (3245), Haverhill (4862), Newmarket (10,688), which is mainly in the ancient county of Cambridge.

Small market and other towns are numerous, such are Brandon, Clare, Debenham, Framlingham, Lavenham, Mildenhall, Needham Market and Orford. For parliamentary purposes the county constitutes five divisions, each returning one member, viz. north or Lowestoft division, north-east or Eye, north-west or Stowmarket, south or Sudbury, and south-east or Woodbridge. Bury St Edmunds returns one member and Ipswich two; part of the borough of Great Yarmouth falls within the county. There is one court of quarter sessions for the two administrative counties, which is usually held at Ipswich for east Suffolk, and then by adjournment at Bury St Edmunds for west Suffolk. East Suffolk is divided into 11 and west Suffolk into 8 petty sessional divisions. The boroughs of Bury St Edmunds, Ipswich, Sudbury, Eye, Lowestoft and Southwold have separate commissions of the peace, and the three first-named have also separate courts of quarter sessions. The total number of civil parishes is 519. The ancient county contains 465 ecclesiastical parishes and districts, wholly or in part; it is situated partly in the diocese of Ely and partly in that of Norwich.

History.—The county of Suffolk (Sudfole, Suthfolc) was formed from the south part of the kingdom of East Anglia which had been settled by the Angles in the latter half of the 5th century. The most important Anglo-Saxon settlements appear to have been made at Sudbury and Ipswich. Before the end of the Norman dynasty strongholds had arisen at Eye, Clare, Walton and Framlingham. Probably the establishment of Suffolk as a separate shire was scarcely completed before the Conquest, and although it was reckoned as distinct from Norfolk in the Domesday Survey of 1086, the fiscal administration of Norfolk and Suffolk remained under one sheriff until 1575. The boundary of the county has undergone very little change, though its area has been considerably affected by coast erosion. Parts of Gorleston and Thetford, which formerly belonged to the ancient county of Suffolk, are now within the administrative county of Norfolk, and other slight alterations of the administrative boundary have been made. Under the Local Government Act of 1888 Suffolk was divided into the two administrative counties of east and west Suffolk.

At first the whole shire lay within the diocese of Dunwich which was founded *c.* 631. In 673 a new bishopric was established at Elmham to comprise the whole of Norfolk which had formerly been included in the see of Dunwich. The latter came to an end with the incursion of the Danes, and on the revival of Christianity in this district Suffolk was included in the diocese of Elmham, subsequently removed from South Elmham to Thetford and thence to Norwich. In 1835–1836 the archdeaconry of Sudbury was transferred by the ecclesiastical commissioners to the diocese of Ely. This archdeaconry had been separated from the original archdeaconry of Suffolk in 1127. In 1256 the latter included thirteen deaneries which have since been subdivided, so that at present it contains eighteen deaneries; Sudbury archdeaconry which comprised eight deaneries in 1256 now includes eleven. There were also three districts under peculiar jurisdiction of Canterbury and one under that of Rochester.

The shire-court was held at Ipswich. In 1831 the whole county contained twenty-one hundreds and three municipal boroughs. Most of these hundreds were identical with those of the Domesday Survey, but in 1086 Babergh was rated as two hundreds, Cosford, Ipswich and Parham as half hundreds and Samford as a hundred and a half. Hoxne hundred was formerly known as Bishop's hundred and the vills which were included later in Thredling hundred were within Claydon hundred in 1086. Two large ecclesiastical liberties extended over more than half of the county; that of St Edmund included the hundreds of Risbridge, Thedwastry, Thingoe, Cosford, Lackford and Blackbourn in which the king's writ did not run, and St Aethelreda of Ely claimed a similar privilege in the hundreds of Carleford, Colneis, Plumesgate, Loes, Wilford and Thredling. Among others who had large lands in the county with co-extensive jurisdiction were the lords of the honor of Clare, earls of Gloucester and Hereford and the lords of the honor of Eye, held successively by the Bigods, the Uffords and the De la Poles, earls of Suffolk. The Wingfields, Bacons and Herveys have been closely connected with the county.

Suffolk suffered severely from Danish incursions, and after the Treaty of Wedmore became a part of the Danelagh. In 1173 the earl of Leicester landed at Walton with an army of Flemings and was joined by Hugh Bigod against Henry II. In 1317 and the succeeding years a great part of the county was in arms for Thomas of Lancaster. Queen Isabella and Mortimer having landed at Walton found all the district in their favour. In 1330 the county was raised to suppress the supporters of the earl of Kent; and again in 1381 there was a serious rising of the peasantry chiefly in the neighbourhood of Bury St Edmunds. Although the county was for the most part Yorkist it took little part in the Wars of the Roses. In 1525 the artisans of the south strongly resisted Henry VIII.'s forced loan. It was from Suffolk that Mary drew the army which supported her claim to the throne. In the Civil Wars the county was for the most part parliamentarian, and joined the Association of the Eastern Counties for defence against the Papists.

The county was constantly represented in parliament by two knights from 1290, until the Reform Bill of 1832 gave four members to Suffolk, at the same time disfranchising the boroughs of Dunwich, Orford and Aldeburgh. Suffolk was early among the most populous of English counties, doubtless owing to its proximity to the continent. Fishing fleets have left its ports to bring back cod and ling from Iceland and herring and mackerel from the North Sea. From the 14th to the 17th century it was among the chief manufacturing counties of England owing to its cloth-weaving industry, which was at the height of its prosperity during the 15th century. In the 17th and 18th centuries its agricultural resources were utilized to provide the rapidly-growing metropolis with food. In the following century various textile industries, such as the manufacture of sail-cloth, cocoa-nut fibre, horse-hair and clothing were established; silk-weavers migrated to Suffolk from Spitalfields, and early in the 19th century an important china factory flourished at Lowestoft.

Antiquities.—Of monastic remains the most important are those of the great Benedictine abbey of Bury St Edmunds, noticed under that town; the college of Clare, originally a cell to the abbey of Bec in Normandy and afterwards to St Peter's Westminster, converted into a college of secular canons in the reign of Henry VI., still retaining much of its ancient architecture, and now used as a boarding-school; the Decorated gateway of the Augustinian priory of Butley; and the remains of the Grey Friars monastery at Dunwich. A peculiarity of the church architecture is the use of flint for purposes of ornamentation, often of a very elaborate kind, especially on the porches and parapets of the towers. Another characteristic is the round towers, which are confined to East Anglia, but are considerably more numerous in Norfolk than in Suffolk, the principal being those of Little Saxham and Herringfleet, both good examples of Norman. It is questionable whether there are any remains of pre-Norman architecture in the county. The Decorated is well represented, but by far the greater proportion of the churches are Perpendicular, fine examples of which are so numerous that it is hard to select examples. But the church of Blythburgh in the east and the exquisite ornate building at Lavenham in the west may be noted as typical, while the church of Long Melford, another fine example, should be mentioned on account of its remarkable lady chapel. Special features are the open roofs and woodwork (as at St Mary's, Bury St Edmunds, Earl Stonham and Stonham Aspall, Ufford and Blythburgh), and the fine fonts.

The remains of old castles are comparatively unimportant, the principal being the entrenchments and part of the walls of Bungay, the ancient stronghold of the Bigods; the picturesque ruins of Mettingham, built by John de Norwich in the reign of Edward III.; Wingfield, surrounded by a deep moat, with the turret walls and the drawbridge still existing; the splendid ruin of Framlingham, with high and massive walls, originally founded in the 6th century, but restored in the 12th; the outlines of the extensive fortress of Clare Castle, anciently the baronial residence of the earls of Clare; and the fine Norman keep of Orford Castle, on an eminence overlooking the sea. Among the many fine residences within the county there are several interesting examples of domestic architecture of the reigns of Henry VIII. and Elizabeth. Hengrave Hall (*c.* 1530), 4 m. north-west from Bury St Edmunds, is a noteworthy example—an exceedingly picturesque building of brick and stone, enclosing a court-yard. Another is Helmingham Hall, a Tudor mansion of brick, surrounded by a moat crossed by a drawbridge. West Stow Manor is also Tudor; its gatehouse is fine, but the mansion has been adapted into a farmhouse.

See A. Suckling, *The History and Antiquities of Suffolk* (1846–1848); William White, *History, gazetteer and directory of Suffolk* (1855); John Kirby, *The Suffolk Traveller* (1735); A. Page, *Supplement to the Suffolk Traveller* (1843); *Victoria County History; Suffolk.*

SUFFRAGAN (Med. Lat. *suffraganeus suffragator*, one who assists, from *suffragari*, to vote in favour of, to support) in the Christian Church, (1) a diocesan bishop in his relation to the metropolitan; (2) an assistant bishop. (See the article Bishop.)

SUFFRAGE (Lat. *suffragium*), the right or the exercise of the right of voting in political affairs; in a more general sense, an expression of opinion, assent or approval; in ecclesiastical use, the short intercessory prayers in litanies spoken or sung by the people as distinguished from those of the priest or minister. (See REPRESENTATION; VOTE AND VOTING, and REGISTRATION: and, for the Women's Suffrage Movement, WOMEN: § *Political Rights.*) The etymology of the Latin word *suffragium* has been much discussed. It is usually referred to *sub-* and the root of *frangere*, to break, and its original meaning must thus have been a piece of broken tile or a potsherd on which the names or initials of the candidates were inscribed and used as a voting tablet or *tabella*. There is, however, no direct evidence that this was ever the practice in the case of voting upon legislation in the assembly (see W. Corssen, *Ueber Aussprache*, &c., *der Lateinischen Sprache*, i. 397, and Mommsen, *Römische Geschichte*, iii. 412 n. i.).

SUFFREN SAINT TROPEZ, PIERRE ANDRÉ DE (1729–1788), French admiral, was the third son of the marquis de Saint Tropez, head of a family of nobles of Provence which claimed to have emigrated from Lucca in the 14th century. He was born in the Château de Saint Canat in the present department of Aix on the 17th of July 1729. The French navy and the Order of Malta offered the usual careers for the younger sons of noble families of the south of France who did not elect to go into the Church. The connexion between the Order and the old French royal navy was close. Pierre André de Suffren was destined by his parents to belong to both. He entered the close and aristocratic corps of French naval officers as a "garde de la marine"—cadet or midshipman, in October 1743, in the "Solide," one of the line of battleships which took part in the confused engagement off Toulon in 1744. He was then in the "Pauline" in the squadron of M. Macnémara on a cruise in the West Indies. In 1746 he went through the duc D'Anville's disastrous expedition to retake Cape Breton, which was ruined by shipwreck and plague. Next year (1747) he was taken prisoner by Hawke in the action with the French convoy in the Bay of Biscay. His biographer Cunat assures us that he found British arrogance offensive. When peace was made in 1748 he went to Malta to perform the cruises with the galleys of the Order technically called "caravans," a reminiscence of the days when the knights protected the pilgrims going from Saint John d'Acre to Jerusalem. In Suffren's time this service rarely went beyond a peaceful tour among the Greek islands. During the Seven Years' War he had the unwonted good fortune to be present as lieutenant in the "Orphée" in the action with Admiral Byng (*q.v.*), which, if not properly speaking a victory, was at least not a defeat for the French, and was followed by the surrender of the English garrison of Minorca. But in 1757 he was again taken prisoner, when his ship the "Océan" was captured by Boscawen off Lagos. On the return of peace in 1763 he intended again to do the service in the caravans which was required to qualify him to hold the high and lucrative posts of the Order. He was, however, named to the command of the "Caméléon," a zebec—a vessel of mixed square and lateen rig peculiar to the Mediterranean—in which he cruised against the pirates of the Barbary coast. Between 1767 and 1771 he performed his caravans, and was promoted from knight to commander of the Order. From that time till the beginning of the War of American Independence he commanded vessels in the squadron of evolution which the French government had established for the purpose of giving practice to its officers. His nerve and skill in handling his ship were highly commended by his chiefs. In 1778 and 1779 he formed part of the squadron of D'Estaing (*q.v.*) throughout its operations on the coast of North America and in the West Indies. He led the line in the action with Admiral John Byron off Grenada, and his ship, the "Fantasque" (64), lost 62 men. His letters to his admiral show that he strongly disapproved of D'Estaing's half-hearted methods. In 1780 he was captain of the "Zèle" (74), in the combined French and Spanish fleets which captured a great English convoy in the Atlantic. His candour towards his chief had done him no harm in the opinion of D'Estaing. It is said to have been largely by the advice of this admiral that Suffren was chosen to command a squadron of five ships of the line sent out to help the Dutch who had joined France and Spain to defend the Cape against an expected English attack, and then to go on to the East Indies. He sailed from Brest on the 22nd of March on the cruise which has given him a unique place among French admirals, and puts him in the front rank of sea commanders. He was by nature even more vehement than able. The disasters which had befallen the navy of his country during the last two wars, and which, as he knew, were due to bad administration and timid leadership, had filled him with a burning desire to retrieve its honour. He was by experience as well as by temperament impatient with the formal manœuvring of his colleagues, which aimed at preserving their own ships rather than at taking the English, and though he did not dream of restoring the French power in India, he did hope to gain some such success as would enable his country to make an honourable peace. On the 16th of April 1781 he found the English expedition on its way to the Cape under the command of Commodore, commonly called Governor, George Johnstone (1730–1787), at anchor in Porto Praya, Cape de Verd Islands. Remembering how little respect Boscawen had shown for the neutrality of Portugal at Lagos, he attacked at once. Though he was indifferently supported, he inflicted as much injury as he suffered, and proved to the English that in him they had to deal with an admiral of quite a different type from the Frenchmen they had been accustomed to as yet. He pushed on to the Cape, which he saved from capture by Johnstone, and then made his way to the Isle de France (Mauritius), then held by the French. M. D'Orves, his superior officer, died as the united squadrons, now eleven sail of the line, were on their way to the Bay of Bengal. The campaign, which Suffren now conducted against the English admiral Sir Edward Hughes (1720?–1794), is famous for the number and severity of the encounters between them. Four actions took place in 1782: on the 17th of February 1782, south of Madras; on the 12th of April near Trincomalee; on the 6th of July off Cuddalore, after which Suffren seized upon the anchorage of Trincomalee compelling the small British garrison to surrender; and again near that port on the 3rd of September. No ship was lost by Sir Edward Hughes in any of these actions, but none were taken by him. Suffren attacked with unprecedented vigour on every occasion, and if he had not been ill-supported by some of his captains he would undoubtedly have gained a distinct victory; as it was, he maintained his squadron without the help of a port to refit, and provided himself with an anchorage at Trincomalee. His activity encouraged Hyder Ali, who was then at war with the Company. He refused to return to the islands for the purpose of escorting the troops coming out under command of Bussy, maintaining that his proper purpose was to cripple the squadron of Sir Edward Hughes. During the north-east monsoon he would not go to the islands but refitted in the Malay ports in Sumatra, and returned with the south-west monsoon in 1783. Hyder Ali was dead, but Tippoo Sultan, his son, was still at war with the Company. Bussy arrived and landed. The operations on shore were slackly conducted by him, and Suffren was much hampered, but when he fought his last battle against Hughes (April 20, 1783), with fourteen ships to eighteen he forced the English admiral to retire to Madras, leaving the army then besieging Cuddalore in a very dangerous position. The arrival of the news that peace had been made in Europe put a stop to hostilities, and Suffren returned to France. While refitting at the Cape on his way home, several of the vessels also returning put in, and the captains waited on him. Suffren said in one of his letters that their praise gave him more pleasure than any other compliment paid him. In France he was received with enthusiasm, and an additional office of vice-admiral of France was created for him. He had been promoted bailli in the Order of Malta during his absence. His death occurred very suddenly on the 8th of December 1788, when he was about to take command of a fleet collected in Brest. The official version of the cause of death was apoplexy, and as he was a very corpulent man it appeared plausible. But many years afterwards his body servant told M. Jal, the historiographer of the French navy, that he had been killed in a duel by the prince de Mirepoix. The cause of the encounter, according to the servant, was that Suffren had refused in very strong language to use his influence to secure the restoration to the navy of two of the prince's relations who had been dismissed for misconduct.

Suffren was crippled to a large extent by the want of loyal and capable co-operation on the part of his captains, and the vehemence of his own temperament sometimes led him to disregard prudence, yet he had an indefatigable energy, a wealth of resource, and a thorough understanding of the fact—so habitually disregarded by French naval officers—that success at sea is won by defeating an enemy and not by merely outmanœuvring him; and this made him a most formidable enemy. The portraits of Suffren usually reproduced are worthless, but there is a good engraving by Mme de Cernel after an original by Gérard.

The standard authority for the life of Suffren is the *Histoire du Bailli de Suffren* by Ch. Cunat (1852). The *Journal de Bord du Bailli de Suffren dans l'Inde*, edited by M. Mores, was published in 1888. There is an appreciative study in Captain Mahan's *Sea Power in History*. (D. H.)

ṢŪFIISM (*taṣawwuf*), a term used by Moslems to denote any variety of mysticism, is formed from the Arabic word *Ṣūfī*, which was applied, in the 2nd century of Islam, to men or women who adopted an ascetic or quietistic way of life. There can be no doubt that *Ṣūfī* is derived from *ṣūf* (wool) in reference to the woollen garments often, though not invariably, worn by such persons: the phrase *labisa's-ṣūf* ("he clad himself in wool") is commonly used in this sense, and the Persian word *pashmīna-pūsh*, which means literally "clothed in a woollen garment," is synonymous with *Ṣūfī*. Other etymologies, such as *Ṣafā* (purity)—a derivation widely accepted in the East—and σοφός, are open to objection on linguistic grounds.

In order to trace the origin and history of mysticism in Islam we must go back to Mahomet. On one side of his nature the Prophet was an ascetic and in some degree a mystic. Notwithstanding his condemnation of Christian monkery (*rahbānīya*), *i.e.* of celibacy and the solitary life, the example of the Ḥanīfs, with some of whom he was acquainted, and the Christian hermits made a deep impression on his mind and led him to preach the efficacy of ascetic exercises, such as prayer, vigils and fasting. Again, while Allah is described in the Koran as the One God working his arbitrary will in unapproachable supremacy, other passages lay stress on his all-pervading presence and intimate relation to his creatures, *e.g.* "Wherever ye turn, there is the face of Allah" (ii. 109), "We (God) are nearer to him (Man) than his neck-vein" (l. 15). The germs of mysticism latent in Islam from the first were rapidly developed by the political, social and intellectual conditions which prevailed in the two centuries following the Prophet's death. Devastating civil wars, a ruthless military despotism caring only for the things of this world, Messianic hopes and presages, the luxury of the upper classes, the hard mechanical piety of the orthodox creed, the spread of rationalism and freethought, all this induced a revolt towards asceticism, quietism, spiritual feeling and emotional faith. Thousands, wearied and disgusted with worldly vanities, devoted themselves to God. The terrors of hell, so vividly depicted in the Koran, awakened in them an intense consciousness of sin, which drove them to seek salvation in ascetic practices. Ṣūfiism was originally a practical religion, not a speculative system; it arose, as Junayd of Bagdad says, "from hunger and taking leave of the world and breaking familiar ties and renouncing what men deem good, not from disputation." The early Ṣūfīs were closely attached to the Mahommedan church. It is said that Abū Hāshim of Kūfa (d. before A.D. 800) founded a monastery for Ṣūfīs at Ramleh in Palestine, but such fraternities seem to have been exceptional. Many ascetics of this period used to wander from place to place, either alone or in small parties, sometimes living by alms and sometimes by their own labour. They took up and emphasized certain Koranic terms. Thus *dhikr* (praise of God) consisting of recitation of the Koran, repetition of the Divine names, &c., was regarded as superior to the five canonical prayers incumbent on every Moslem, and *tawakkul* (trust in God) was defined as renunciation of all personal initiative and volition, leaving one's self entirely in God's hands, so that some fanatics deemed it a breach of "trust" to seek any means of livelihood, engage in trade, or even take medicine. Quietism soon passed into mysticism. The attainment of salvation ceased to be the first object, and every aspiration was centred in the inward life of dying to self and living in God. "O God!" said Ibrāhīm ibn Adham, "Thou knowest that the eight Paradises are little beside the honour which Thou hast done unto me, and beside Thy love, and Thy giving me intimacy with the praise of Thy name, and beside the peace of mind which Thou hast given me when I meditate on Thy majesty." Towards the end of the 2nd century we find the doctrine of mystical love set forth in the sayings of a female ascetic, Rābi'a of Basra, the first of a long line of saintly women who have played an important rôle in the history of Ṣūfiism. Henceforward the use of symbolical expressions, borrowed from the vocabulary of love and wine, becomes increasingly frequent as a means of indicating holy mysteries which must not be divulged. This was not an unnecessary precaution, for in the course of the 3rd century, Ṣūfiism assumed a new character. Side by side with the quietistic and devotional mysticism of the early period there now sprang up a speculative and pantheistic movement which was essentially anti-Islamic and rapidly came into conflict with the orthodox *ulemā*. It is significant that the oldest representative of this tendency—Ma'rūf of Bagdad—was the son of Christian parents and a Persian by race. He defined Ṣūfiism as a theosophy; his aim was "to apprehend the Divine realities." A little later Abū Sulaimān al-Dārānī in Syria and Dhu'l-Nūn in Egypt developed the doctrine of gnosis (ma'rifat) through illumination and ecstasy. The step to pantheism was first decisively taken by the great Persian Ṣūfī, Abū Yazīd (Bāyezīd) of Bisṭām (d. A.D. 874), who introduced the doctrine of annihilation (*fanā*), *i.e.* the passing away of individual consciousness in the will of God.

It is, no doubt, conceivable that the evolution of Ṣūfiism up to this point might not have been very different even although it had remained wholly unaffected by influences outside of Islam. But, as a matter of fact, such influences made themselves powerfully felt. Of these, Christianity, Buddhism and Neoplatonism are the chief. Christian influence had its source, not in the Church, but in the hermits and unorthodox sects, especially perhaps in the Syrian Euchites, who magnified the duty of constant prayer, abandoned their all and wandered as poor brethren. Ṣūfiism owed much to the ideal of unworldliness which they presented. Conversations between Moslem devotees and Christian ascetics are often related in the ancient Ṣūfī biographies, and many Biblical texts appear in the form of sayings attributed to eminent Ṣūfīs of early times, while sayings ascribed to Jesus as well as Christian and Jewish legends occur in abundance. More than one Ṣūfī doctrine—that of *tawakkul* may be mentioned in particular—show traces of Christian teaching. The monastic strain which insinuated itself into Ṣūfiism in spite of Mahomet's prohibition was derived, partially at any rate, from Christianity. Here, however, Buddhistic influence may also have been at work. Buddhism flourished in Balkh, Transoxiana and Turkestan before the Mahommedan conquest, and in later times Buddhist monks carried their religious practices and philosophy among the Moslems who had settled in these countries. It looks as though the legend of Ibrāhīm ibn Adham, a prince of Balkh who one day suddenly cast off his royal robes and became a wandering Ṣūfī, were based on the story of Buddha. The use of rosaries, the doctrine of *fanā*, which is probably a form of Nirvana, and the system of "stations" (*maqāmāt*) on the road thereto, would seem to be Buddhistic in their origin. The third great foreign influence on Ṣūfiism is the Neoplatonic philosophy. Between A.D. 800 and 860 the tide of Greek learning, then at its height, streamed into Islam from the Christian monasteries of Syria, from the Persian Academy of Jundēshāpūr in Khūzistan, and from the Ṣābians of Ḥarrān in Mesopotamia. The so-called "Theology of Aristotle," which was translated into Arabic about A. D. 840, is full of Neoplatonic theories, and the mystical writings of the pseudo-Dionysius were widely known throughout western Asia. It is not mere coincidence that the doctrine of Gnosis was first worked out in detail by the Egyptian Ṣūfī, Dhu 'l-Nūn (d. A.D. 859), who is described as an alchemist and theurgist. Ṣūfiism on its theosophical side was largely a product of Alexandrian speculation.

By the end of the 3rd century the main lines of the Ṣūfī mysticism were already fixed. It was now fast becoming an organized system, a school for saints, with rules of discipline and devotion which the novice was bound to learn from his spiritual director, to whose guidance he submitted himself absolutely. These directors regarded themselves as being in the most intimate communion with God, who bestowed on them miraculous gifts (*karāmāt*). At their head stood a mysterious personage called the *Quṭb* (Axis): on the hierarchy of saints over which he presided the whole order of the universe was believed to depend. During the next two hundred years (A.D. 900–1100), various manuals of theory and practice were compiled: the *Kitāb al Luma'* by Abū Naṣr al-Sarrāj, the *Qūt al-Qulūb* by Abū Ṭālib al-Makkī, the *Risāla* of Qushairī, the Persian *Kashf al-Maḥjūb* by 'Alī ibn 'Uthmān al-Hujwīrī, and the famous *Iḥyā* by Ghazālī. Inasmuch as all these works are founded on the same materials, viz., the Koran, the Traditions of the Prophet and the sayings of well-known Ṣūfī teachers, they necessarily have much in common, although the subject is treated by each writer from his own standpoint. They all expatiate on the discipline of the soul and describe the process of purgation which it must undergo before entering on the contemplative life. The traveller journeying towards God passes through a series of ascending "stations" (*maqāmāt*): in the oldest extant treatise these are (1) repentance, (2) abstinence, (3) renunciation, (4) poverty, (5) patience, (6) trust in God, (7) acquiescence in the will of God. After the "stations" comes a parallel scale of "states" of spiritual feeling (*aḥwāl*), such as fear, hope, love, &c., leading up to contemplation (*mushāhadat*) and intuition (*yaqīn*). It only remained to provide Ṣūfiism with a metaphysical basis, and to reconcile it with orthodox Islam. The double task was finally accomplished by Ghazālī (*q.v.*). He made Islamic theology mystical, and since his time the revelation (*kashf*) of the mystic has taken its place beside tradition (*naql*) and reason (*'aql*) as a source and fundamental principle of the faith. Protests have been and are still raised by theologians, but Moslem sentiment will usually tolerate whatever is written in sufficiently abstruse philosophical language or spoken in manifest ecstasy.

The Ṣūfīs do not form a sect with definite dogmas. Like the monastic orders of Christendom, they comprise many shades of opinion, many schools of thought, many divergent tendencies—from asceticism and quietism to the wildest extravagances of pantheism. European students of Ṣūfiism are apt to identify it with the pantheistic type which prevails in Persia. This, although more interesting and attractive than any other, throws the transcendental and visionary aspects of Ṣūfiism into undue relief. Nevertheless some account must be given here of the Persian theosophy which has fascinated the noblest minds of that subtle race and has inspired the most beautiful religious poetry in the world. Some of its characteristic features occur in the sayings attributed to Bāyezīd (d. A.D. 874), whom Buddhistic ideas unquestionably influenced. He said, for example, "I am the winedrinker and the wine and the cup-bearer," and again, "I went from God to God, until they cried from me in me, 'O Thou I.'" The peculiar imagery which distinguishes the poetry of the Persian Ṣūfīs was more fully developed by a native of Khorasan, Abū Sa'īd ibn Abi'l-Khair (d. A.D. 1049) in his mystical quatrains which express the relation between God and the soul by glowing and fantastic allegories of earthly love, beauty and intoxication. Henceforward, the great poets of Persia, with few exceptions, adopt this symbolic language either seriously or as a convenient mask. The majority are Ṣūfīs by profession or conviction. "The real basis of their poetry," says A. von Kremer, "is a loftily inculcated ethical system, which recognizes in purity of heart, charity, self-renunciation and bridling of the passions the necessary conditions of eternal happiness. Attached to this we find a pantheistic theory of the emanation of all things from God and their ultimate reunion with him. Although on the surface Islam is not directly assailed, it sustains many indirect attacks, and frequently the thought flashes out, that all religions and revelations are only the rays of a single eternal sun; that all prophets have only delivered and proclaimed in different tongues the same principles of eternal goodness and eternal truth which flow from the divine soul of the world." The whole doctrine of Persian Ṣūfiism is expounded in the celebrated *Mathnawī* of Jalāluddīn Rūmī (*q.v.*), but in such a discursive and unscientific manner that its leading principles are not easily grasped. They may be stated briefly as follows:—

God is the sole reality (al-Ḥaqq) and is above all names and definitions. He is not only absolute Being, but also absolute Good, and therefore absolute Beauty. It is the nature of beauty to desire manifestation; the phenomenal universe is the result of this desire, according to the famous Tradition in which God says, "I was a hidden treasure, and I desired to be known, so I created the creatures in order that I might be known." Hence the Ṣūfīs, influenced by Neoplatonic theories of emanation, postulate a number of intermediate worlds or descending planes of existence, from the primal Intelligence and the primal Soul, through which "the Truth" (*al-Ḥaqq*) diffuses itself. As things can be known only through their opposites, Being can only be known through Not-being, wherein as in a mirror Being is reflected; and this reflection is the phenomenal universe, which accordingly has no more reality than a shadow cast by the sun. Its central point is Man, the microcosm, who reflects in himself all the Divine attributes. Blackened on one side with the darkness of Not-being, he bears within him a spark of pure Being. The human soul belongs to the spiritual world and is ever seeking to be re-united to its source. Such union is hindered by the bodily senses, but though not permanently attainable until death, it can be enjoyed at times in the state called ecstasy (*ḥāl*), when the veil of sensual perception is rent asunder and the soul is merged in God. This cannot be achieved without destroying the illusion of self, and self-annihilation is wrought by means of that divine love, to which human love is merely a stepping-stone. The true lover feels himself one with God, the only real being and agent in the universe; he is above all law, since whatever he does proceeds directly from God, just as a flute produces harmonies or discords at the will of the musician; he is indifferent to outward forms and rites, preferring a sincere idolater to an orthodox hypocrite and deeming the ways to God as many in number as the souls of men. Such in outline is the Ṣūfī theosophy as it appears in Persian and Turkish poetry. Its perilous consequences are plain. It tends to abolish the distinction between good and evil—the latter is nothing but an aspect of Not-being and has no real existence—and it leads to the deification of the hierophant who can say, like Ḥusain b. Manṣur al-Ḥallāj, "I am the Truth." Ṣūfī fraternities, living in a convent under the direction of a sheikh, became widely spread before A.D. 1100 and gave rise to Dervish orders, most of which indulge in the practice of exciting ecstasy by music, dancing, drugs and various kinds of hypnotic suggestion (see DERVISH).

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SUGAR, in chemistry, the generic name for a certain series of carbohydrates, *i.e.* substances of the general formula $C_n(H_2O)_m$. Formerly the name was given to compounds having a sweet taste, *e.g.* sugar of lead, but it is now restricted to certain oxy-aldehydes and oxy-ketones, which occur in the vegetable and animal kingdoms either free or in combination as glucosides (*q.v.*) and to artificial preparations of similar chemical structure. Cane sugar has been known for many centuries; milk sugar was obtained by Fabrizio Bartoletti in 1615; and in the middle of the 18th century Marggraf found that the sugars yielded by the beet, carrot and other roots were identical with cane sugar. The sugars obtained from honey were investigated by Lowitz and Proust, and the latter decided on three species: (1) cane sugar, (2) grape sugar, and (3) fruit sugar; the first has the formula $C_{12}H_{22}O_{11}$, the others $C_6H_{12}O_6$. This list has been considerably developed by the discovery of natural as well as of synthetic sugars.

It is convenient to divide the sugars into two main groups: monosaccharoses (formerly glucoses) and disaccharoses (formerly saccharoses). The first term includes simple sugars containing two to nine atoms of carbon, which are known severally as bioses, trioses, tetroses, pentoses, hexoses, &c.; whilst those of the second group have the formula $C_{12}H_{22}O_{11}$ and are characterized by yielding two monosaccharose molecules on hydrolysis. In addition trisaccharoses are known of the formula $C_{18}H_{32}O_{16}$; these on hydrolysis yield one molecule of a monosaccharose and one of a disaccharose, or three of a monosaccharose. It is found also that some monosaccharoses behave as aldehydes whilst others contain a keto group; those having the first character are called *aldoses*, and the others *ketoses*. All sugars are colourless solids or syrups, which char on strong heating; they are soluble in water, forming sweet solutions but difficultly soluble in alcohol. Their solutions are optically active, *i.e.* they rotate the plane of polarized light; the amount of the rotation being dependent upon the concentration, temperature, and, in some cases, on the age of the solution (cf. GLUCOSE). The rotation serves for the estimation of sugar solutions (saccharimetry). They are neutral to litmus and do not combine with dilute acids or bases; strong bases, such as lime and baryta, yield saccharates, whilst, under certain conditions, acids and acid anhydrides may yield esters. Sugars are also liable to fermentation.[1] Our knowledge of the chemical structure of the monosaccharoses may be regarded as dating from 1880, when Zincke suspected some to be ketone alcohols, for it was known that glucose and fructose, for example, yielded penta-acetates, and on reduction gave hexahydric alcohols, which, when reduced by hydriodic acid, gave normal and secondary hexyliodide. The facts suggested that the six carbon atoms formed a chain, and that a hydroxy group was attached to five of them, for it is very rare for two hydroxy groups to be attached to the same carbon atom. The remaining oxygen atom is aldehydic or ketonic, for the sugars combine with hydrocyanic acid, hydroxylamine and phenylhydrazine. The correctness of this view was settled by Kiliani in 1885. He prepared the cyanhydrins of glucose and fructose, hydrolysed them to the corresponding oxy-acids, from which the hydroxy groups were split out by reduction; it was found that glucose yielded normal heptylic acid and fructose methylbutylacetic acid; hence glucose is an aldehyde alcohol, $CH_2OH\cdot(CH\cdot OH)_4\cdot CHO$, whilst fructose is a ketone alcohol $CH_2OH\cdot(CH\cdot OH)_3\cdot CO\cdot CH_2OH$.[2] Kiliani also showed that arabinose, $C_5H_{10}O_5$, a sugar found in cherry gum, was an aldopentose, and thus indicated an extension of the idea of a "sugar."

Before proceeding to the actual synthesis of the sugars, it is advisable to discuss their decompositions and transformations.

1. *Cyanhydrins.*—The cyanhydrins on hydrolysis give monocarboxylic acids, which yield lactones; these compounds when reduced by sodium amalgam in sulphuric acid solution yield a sugar containing one more carbon atom. This permits the formation of a higher from a lower sugar (E. Fischer)

$$\begin{array}{lclclcl}
CH_2OH & & CH_2OH & & CH_2OH & & CH_2OH \\
\dot{C}H\cdot OH & & \dot{C}H\cdot OH & & \dot{C}H & & \dot{C}H\cdot OH \\
(\dot{C}H\cdot OH)_2 & \rightarrow & (\dot{C}H\cdot OH)_2 & \rightarrow O & (\dot{C}H\cdot OH)_2 & \rightarrow & (\dot{C}H\cdot OH)_2 \\
\dot{C}HO & & \dot{C}H\cdot OH & & \dot{C}H\cdot OH & & \dot{C}H\cdot OH \\
 & & \dot{C}N & & \dot{C}O & & \dot{C}HO \\
\text{Pentose} & \rightarrow & \text{Cyanhydrin} & \rightarrow & \text{Lactone} & \rightarrow & \text{Hexose.}
\end{array}$$

2. *Oximes.*—The oximes permit the reverse change, *i.e.* the passage from a higher to a lower sugar. Wohl forms the oxime and converts it into an acetylated nitrile by means of acetic anhydride and sodium acetate; ammoniacal silver nitrate solution removes hydrocyanic acid and the resulting acetate is hydrolysed by acting with ammonia to form an amide, which is finally decomposed with sulphuric acid.

$$\begin{array}{lclclcl}
CH_2OH & & CH_2OH & & CH_2OH & & CH_2OH \\
(\dot{C}H\cdot OH)_3 & \rightarrow & (\dot{C}H\cdot OH)_3 & \rightarrow & (\dot{C}H\cdot OH)_2 & \rightarrow & (\dot{C}H\cdot OH)_3 \\
\dot{C}H\cdot OH & & \dot{C}H\cdot OH & & \dot{C}H\cdot OH & & \dot{C}HO \\
\dot{C}HO & & \dot{C}H{:}NOH & & \dot{C}N & & \\
\text{Hexose} & \rightarrow & \text{Oxime} & \rightarrow & \text{Nitrile} & \rightarrow & \text{Pentose.}
\end{array}$$

Ruff effects the same change by oxidizing the sugar to the oxy-acid, and then further oxidizing this with Fenton's reagent, *i.e.* hydrogen peroxide and a trace of a ferrous salt:

$$\begin{array}{ccccc}
C_4H_9O_4(CH\cdot OH)\cdot CHO & \rightarrow & C_4H_9O_4(CH\cdot OH)\cdot CO_2H & \rightarrow & C_4H_9O_4\cdot CHO \\
\text{Hexose} & \rightarrow & \text{Acid} & \rightarrow & \text{Pentose.}
\end{array}$$

3. *Phenylhydrazine Derivatives.*—Fischer found that if one molecule of phenylhydrazine acted upon one molecule of an aldose or ketose a hydrazone resulted which in most cases was very soluble in water, but if three molecules of the hydrazine reacted (one of which is reduced to ammonia and aniline) insoluble crystalline substances resulted, termed *osazones*, which readily characterized the sugar from which it was obtained.

$$\begin{array}{lclcl}
R & & R & & R \\
\dot{C}H\cdot OH & \rightarrow & \dot{C}H\cdot OH & \rightarrow & \dot{C}{:}N\cdot NHPh \\
\dot{C}HO & & \dot{C}H{:}N\cdot NHPh. & & \dot{C}H{:}N\cdot NHPh. \\
\text{Aldose} & \rightarrow & \text{Hydrazone} & \rightarrow & \text{Osazone;} \\
R & & R & & R \\
\dot{C}O & \rightarrow & \dot{C}{:}N\cdot NHPh. & \rightarrow & \dot{C}{:}N\cdot NHPh \\
\dot{C}H_2OH & & \dot{C}H_2OH & & \dot{C}H{:}N\cdot NHPh. \\
\text{Ketose} & \rightarrow & \text{Hydrazone} & \rightarrow & \text{Osazone.}
\end{array}$$

On warming the osazone with hydrochloric acid the phenylhydrazine residues are removed and an *osone* results, which on reduction with zinc and acetic acid gives a ketose.

$$\begin{array}{lclcl}
R & & R & & R \\
\dot{C}{:}N\cdot NHPh. & \rightarrow & \dot{C}O & \rightarrow & \dot{C}O \\
\dot{C}H{:}N\cdot NHPh. & & \dot{C}HO & & \dot{C}H_2OH \\
\text{Osazone} & \rightarrow & \text{Osone} & \rightarrow & \text{Ketose.}
\end{array}$$

A ketose may also be obtained by reducing the osazone with zinc and acetic to an *osamine*, which with nitrous acid gives the ketose:

$$\begin{array}{lclcl}
R & & R & & R \\
\dot{C}{:}N\cdot NHPh. & \rightarrow & \dot{C}O & \rightarrow & \dot{C}O \\
\dot{C}H{:}N\cdot NHPh. & & \dot{C}H_2NH_2 & & \dot{C}H_2OH. \\
\text{Osazone} & \rightarrow & \text{Osamine} & \rightarrow & \text{Ketose.}
\end{array}$$

These reactions permit the transformation of an aldose into a ketose; the reverse change can only be brought about by reducing the ketose to an alcohol, and oxidizing this compound to an aldehyde. It is seen that aldoses and ketoses which differ stereochemically in only the two final carbon atoms must yield the same osazone; and since *d*-mannose, *d*-glucose, and *d*-fructose do form the same osazone (*d*-glucosazone) differences either structural or stereochemical must be placed in the two final carbon atoms.[3]

It may here be noticed that in the sugars there are asymmetric carbon atoms, and consequently optical isomers are to be expected. Thus glucose, containing four such atoms, can exist in 16 forms; and the realization of many of these isomers by E. Fischer may be regarded as one of the most brilliant achievements in modern chemistry. The general principles of stereochemistry being discussed in Stereoisomerism (*q.v.*), we proceed to the synthesis of glucose and fructose and then to the derivation of their configurations.

In 1861 Butlerow obtained a sugar-like substance, methylenitan, by digesting trioxymethylene, the solid polymer of formaldehyde, with lime. The work was repeated by O. Loew, who prepared in 1885 a sweet, unfermentable syrup, which he named formose, $C_6H_{12}O_6$ and, later, by using magnesia instead of lime, he obtained the fermentable methose. Fischer showed that methose was identical with the α-acrose obtained by himself and Tafel in 1887 by decomposing acrolein dibromide with baryta, and subsequently prepared by oxidizing glycerin with bromine in alkaline solution, and treating the product with dilute alkali at 0°. Glycerin appears to yield, on mild oxidation, an aldehyde, $CH_2OH\cdot CH(OH)\cdot CHO$, and a ketone, $CH_2OH\cdot CO\cdot CH_2OH$, and these condense as shown in the equation:

$$CH_2OH\cdot CH(OH)\cdot CHO + CH_2OH\cdot CO\cdot CH_2OH = CH_2OH\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CO.CH_2OH + H_2O.$$

The osazone prepared from α-acrose resembled most closely the glucosazone yielded by glucose, mannose, and fructose, but it was optically inactive; also the ketose which it gave after treatment with hydrochloric acid and reduction of the osone was like ordinary fructose except that it was inactive. It was surmised that α-acrose was a mixture of dextro and laevo fructose, a supposition which was proved correct by an indirect method. The starting point was ordinary (*d*) mannite (mannitol), $C_6H_{14}O_6$, a naturally occurring hexahydric alcohol, which only differed from α-acritol, the alcohol obtained by reducing α-acrose, with regard to optical activity. Mannite on oxidation yields an aldose, mannose, $C_6H_{12}O_6$, which

[1] See FERMENTATION; and for the relation of this property to structure see STEREOISOMERISM.

[2] These formulae, however, require modification in accordance with the views of Lowry and E. F. Armstrong, which postulate a γ oxidic structure (see GLUCOSE). This, however, does not disturb the tenor of the following arguments.

[3] To distinguish the isomerides of opposite optical activity, it is usual to prefix the letters *d-* and *l-*, but these are used only to indicate the genetic relationship, and not the character of the optical activity; ordinary fructose, for example, being represented as *d*-fructose—although it exercises a laevorotatory power—because it is derived from *d*-glucose.

on further oxidation gives a mannonic acid, $C_5H_6(OH)_5\cdot CO_2H$; this acid readily yields a lactone. Also Kiliani found that the lactone derived from the cyanhydrin of natural arabinose (laevo) was identical with the previous lactone except that its rotation was equal and opposite. On mixing the eslactones and reducing $(d+l)$-mnanitol was obtained, identical with α-acritol. A separation of α-acrose was made by acting with beer yeast, which destroyed the ordinary fructose and left *l*-fructose which was isolated as its osazone. Also $(d+l)$ mannonic acid can be split into the *d* and *l* acids by fractional crystallization of the strychnine or brucine salts. The acid yields, on appropriate treatment, *d*-mannose and *d*-mannite. Similarly the *l* acid yields the laevo derivatives.

The next step was to prepare glucose. This was effected indirectly. The identity of the formulae and osazones of *d*-mannose and *d*-glucose showed that the stereochemical differences were situated at the carbon atom adjacent to the aldehyde group. Fischer applied a method indicated by Pasteur in converting dextro into laevo-tartaric acid; he found that both *d*-mannonic and *d*-gluconic acids (the latter is yielded by glucose on oxidation) were mutually convertible by heating with quinoline under pressure at 140°. It was then found that on reducing the lactone of the acid obtained from *d*-mannonic acid, ordinary glucose resulted.

Fischer's α-acrose therefore led to the synthesis of the dextro and laevo forms of mannose, glucose and fructose; and these substances have been connected synthetically with many other sugars by means of his cyanhydrin process, leading to higher sugars, and Wohl and Ruff's processes, leading to lower sugars. Certain of these relations are here summarized (the starting substance is in italics):—

l-Glucose ⟵ l-*arabinose* ⟶ *l*-mannose ⟶ *l*-mannoheptose;
glucononose ⟵ α-gluco-octose ⟵ α-glucoheptose ⟵ d-*glucose* ⟶ β-glucoheptose ⟶ β-gluco-octose;
d-*mannose*⟶*d*-mannoheptose⟶manno-octose⟶mannononose;
d-*glucose* ⟶ *d*-arabinose ⟶ *d*-erythrose.
l-*glucose*⟶ *b*-arabinose ⟶ *l*-erythrose.

Their number is further increased by spatial inversion of the dicarboxylic acids formed on oxidation, followed by reduction; for example: *d*- and *l*-glucose yield *d*-and *l*-gulose; and also by Lobry de Bruyn and Van Ekenstein's discovery that hexoses are transformed into mixtures of their isomers when treated with alkalis, alkaline earths, lead oxide, &c.

Monosaccharoses.

Biose.—The only possible biose is glycollic aldehyde, $CHO\cdot CH_2OH$, obtained impure by Fischer from bromacetaldehyde and baryta water, and crystalline by Fenton by heating dihydroxymaleic acid with water to 60°. It polymerizes to a tetrose under the action of sodium hydroxide.

Trioses.—The trioses are the aldehyde and ketone mentioned above as oxidation products of glycerin. Glyceric aldehyde, $CH_2OH\cdot CH(OH)\cdot CHO$, was obtained pure by Wohlon oxidizing acrolein acetal, $CH_2\cdot CH(OC_2H_5)_2$, and hydrolysing. Although containing an asymmetric carbon atom it has not been resolved. The ketone, dihydroxyacetone, $CH_2OH\cdot CO\cdot CH_2OH$, was obtained by Piloty by condensing formaldehyde with nitromethane, reducing to a hydroxylamino compound, which is oxidized to the oxime of dihydroxyacetone; the ketone is liberated by oxidation with bromine water:

$$3H\cdot CHO + CH_3NO_2 \rightarrow (CH_2OH)_3C\cdot NO_2 \rightarrow (CH_2OH)_3C\cdot NH\ OH \rightarrow (CH_2OH)_2C:NOH \rightarrow (CH_2OH)_2CO.$$

The ketone is also obtained when Bertrand's *sorbose bacterium* acts on glycerol; this medium also acts on other alcohols to yield ketoses; for example: erythrite gives erythrulose, arabite arabinulose, mannitol fructose, &c.

Tetroses.—Four active tetroses are possible, and three have been obtained by Ruff and Wohl from the pentoses. Thus Wohl prepared *l*-threose from *l*-xylose and *l*-erythrose from *l*-arabinose, and Ruff obtained *d*- and *l*-erythrose from *d*- and *l*-arabonic acids, the oxidation products of *d*- and *l*-arabinoses. Impure inactive forms result on the polymerization of glycollic aldehyde and also on the oxidation of erythrite, a tetrahydric alcohol found in some lichens. *d*-Erythrulose is a ketose of this series.

Pentoses.—Eight stereoisomeric pentaldoses are possible, and six are known: *d*- and *l*-arabinose, *d*- and *l*-xylose, *l*-ribose, and *d*-lyxose. Scheibler discovered *l*-arabinose in 1869, and regarded it as a glucose; in 1887 Kiliani proved it to be a pentose. *d*-Arabinose is obtained from *d*-glucose by Wohl's method. *l*-Xylose was discovered by Koch in 1886; its enantiomorph is prepared from *d*-gulose by Wohl's method. *l*-Ribose and *d*-lyxose are prepared by inversion from *l*-arabinose and *l*-xylose; the latter has also been obtained from *d*-galactose. We may notice that the pentoses differ from other sugars by yielding furfurol when boiled with hydrochloric acid. Rhamnose or isodulcite, a component of certain glucosides, fucose, found combined in seaweeds and chinovose, present as its ethyl ester, chinovite, in varieties of quina-bark, are methyl pentoses. *l*-Arabinulose obtained from arabite and Bertrand's *sorbium bacterium* is a ketose.

Hexoses.—The hexoses may be regarded as the most important sub-division of the monosaccharoses. The reader is referred to Glucose and Fructose for an account of these substances. The next important aldose is mannose. *d*-Mannose, first prepared by oxidizing *d*-mannite, found in plants and manna-ash (*Fraxinus ornus*), was obtained by Tollens and Gans on hydrolysing cellulose and by Reis from seminine (reserve cellulose), found in certain plant seeds, *e.g.* vegetable ivory. *l*-Mannose is obtained from *l*-mannonic acid. Other forms are: *d*- and *l*-gulose, prepared from the lactones of the corresponding gulonic acids, which are obtained from *d*- and *l*-glucose by oxidation and inversion; *d*- and *l*-idose, obtained by inverting with pyridine *d*- and *l*-gulonic acids, and reducing the resulting idionic acids; *d*- and *l*-galactose, the first being obtained by hydrolysing milk sugar with dilute sulphuric acid, and the second by fermenting inactive galactose (from the reduction of the lactone of *d*, *l*-galactonic acid) with yeast; and *d*- and *l*-talose obtained by inverting the galactonic acids by pyridine into *d*- and *l*-talonic acids and reduction. Of the ketoses, we notice *d*-sorbose, found in the berries of mountain-ash, and *d*-tagatose, obtained by Lobry de Bruyn and van Ekenstein on treating galactose with dilute alkalis, talose and *l*-sorbose being formed at the same time. The higher sugars call for no special notice.

Configuration of the Hexaldoses.[1]—The plane projection of molecular structures which differ stereochemically is discussed under Stereoisomerism; in this place it suffices to say that, since the terminal groups of the hexaldose molecule are different and four asymmetric carbon atoms are present, sixteen hexaldoses are possible; and for the hexahydric alcohols which they yield on reduction, and the tetrahydric dicarboxylic acids which they give on oxidation, only ten forms are possible. Employing the notation in which the molecule is represented vertically with the aldehyde group at the bottom, and calling a carbon atom + or − according as the hydrogen atom is to the left or right, the possible configurations are shown in the diagram. The grouping of the forms 5 to 10 with 11 to 16 is designed to show that the pairs 5, 11 for example become identical when the terminal groups are the same.

				11	12	13	14	15	16
				+	+	+	+	+	−
				+	+	+	−	−	+
				+	−	−	+	−	−
				−	+	−	−	−	−
+	+	−	−	−	+	−	−	−	−
+	−	+	−	+	−	−	+	−	−
+	−	+	−	+	+	+	−	−	+
+	+	−	−	+	+	+	+	+	−
1	2	3	4	5	6	7	8	9	10

We can now proceed to the derivation of the structure of glucose. Since both *d*-glucose and *d*-gulose yield the same active (*d*) saccharic acid on oxidation, the configuration of this and the corresponding *l*-acid must be sought from among those numbered 5–10 in the above table. Nos. 7 and 8 can be at once ruled out, however, as acids so constituted would be optically inactive and the saccharic acids are active. If the configuration of *d*-saccharic acid were given by either 6 or 10, bearing in mind the relation of mannose to glucose, it would then be necessary to represent *d*-mannosaccharic acid by either 7 or 8—as the forms 6 and 10 pass into 7 and 8 on changing the sign of a terminal group; but this cannot be done as mannosaccharic acid is optically active. Nos. 6 and 10 must, in consequence, also be ruled out. No. 5, therefore, represents the configuration of one of the saccharic acids, and No. 9 that of the isomeride of equal opposite rotatory power. As there is no means of distinguishing between the configuration of a dextro- and laevo-modification, an arbitrary assumption must be made. No. 5 may therefore be assigned to the *d*- and No. 9 to the *l*-acid. It then follows that *d*-mannose is represented by No. 1, and *l*-mannose by No. 4, as mannose is produced by reversing the sign of the asymmetric system adjoining the terminal COH group.

It remains to distinguish between 5 and 11, 9 and 15 as representing glucose and gulose. To settle this point it is necessary to consider the configuration of the isomeric pentoses—arabinose and xylose—from which they may be prepared. Arabinose being convertible into *l*-glucose and xylose into *l*-gulose, the alternative formulae to be considered are—

$$CH_2(OH)---+COH$$
$$CH_2(OH)+++-COH.$$

[1] The following account is mainly from H. E. Armstrong's article Chemistry in the 10th edition of this Encyclopaedia; the representation differs from the projection of Meyer and Jacobsen.

If the asymmetric system adjoining the COH group, which is that introduced in synthesizing the hexose from the pentose, be eliminated, the formulae at disposal for the two pentoses are

$$CH_2(OH)---COH$$
$$CH_2(OH)+--COH.$$

When such compounds are converted into corresponding dibasic acids, $CO_2H.[CH(OH)]_3.CO_2H$, the number of asymmetric carbon atoms becomes reduced from three to two, as the central carbon atom is then no longer associated with four, but with only three different radicles. Hence it follows that the "optical" formulae of the acids derived from two pentoses having the configuration given above will be

$$CO_2H-0-CO_2H$$
$$CO_2H+0-CO_2H,$$

and that consequently only one of the acids will be optically active. As a matter of fact, only arabinose gives an active product on oxidation; it is therefore to be supposed that arabinose is the $---$ compound, and consequently

$$CH_2(OH)---+COH = l\text{-glucose}$$
$$CH_2(OH)+---COH = l\text{-gulose}.$$

When xylose is combined with hydrocyanic acid and the cyanide is hydrolysed, together with *l*-gulonic acid, a second isomeric acid, *l*-idonic acid, is produced, which on reduction yields the hexaldose *l*-idose. When *l*-gulonic acid is heated with pyridine, it is converted into *l*-idonic acid, and vice versa; and *d*-gulonic acid may in a similar manner be converted into *d*-idonic acid, from which it is possible to prepare *d*-idose. It follows from the manner in which *l*-idose is produced that its configuration is $CH_2(OH)+---+COH$.

The remaining aldohexoses discovered by Fischer are derived from *d*-galactose from milk-sugar. When oxidized this aldohexose is first converted into the monobasic galactonic acid, and then into dibasic mucic acid; the latter is optically inactive, so that its configuration must be one of those given in the sixth and seventh columns of the table. On reduction it yields an inactive mixture of galactonic acids, some molecules being attacked at one end, as it were, and an equal number of others at the other. On reducing the lactone prepared from the inactive acid an inactive galactose is obtained from which *l*-galactose may be separated by fermentation. Lastly, when *d*-galactonic acid is heated with pyridine, it is converted into talonic acid, which is reducible to talose, an isomeride bearing to galactose the same relation that mannose bears to glucose. It can be shown that *d*-galactose is $CH_2(OH)+-+-COH$, and hence *d*-talose is $CH_2(OH)+-++COH$.

The configurations of the penta-and tetra-aldoses have been determined by similar arguments; and those of the ketoses can be deduced from the aldoses.

Disaccharoses.

The disaccharoses have the formula $C_{12}H_{22}O_{11}$ and are characterized by yielding under suitable conditions two molecules of a hexose: $C_{12}H_{22}O_{11}+H_2O=C_6H_{12}O_6+C_6H_{12}O_6$. The hexoses so obtained are not necessarily identical: thus cane sugar yields *d*-glucose and *d*-fructose (invert sugar); milk sugar and melibiose give *d*-glucose and *d*-galactose, whilst maltose yields only glucose. Chemically they appear to be ether anhydrides of the hexoses, the union being effected by the aldehyde or alcohol groups, and in consequence they are related to the ethers of glucose and other hexoses, *i.e.* to the alkyl glucosides. Cane sugar has no reducing power and does not form an hydrazone or osazone; the other varieties, however, reduce Fehling's solution and form hydrazones and osazones, behaving as aldoses, *i.e.* as containing the group $\cdot CH(OH)\cdot CHO$. The relation of the disaccharoses to the α- and β-glucosides was established by E. F. Armstrong (*Journ. Chem. Soc.*, 1903, 85, 1305), who showed that cane sugar and maltose were α-glucosides, and raffinose an α-glucoside of melibiose. These and other considerations have led to the proposal of an alkylen oxide formula for glucose, first proposed by Tollens; this view, which has been mainly developed by Armstrong and Fischer, has attained general acceptance (see Glucose and Glucoside). Fischer has proposed formulae for the important disaccharoses, and in conjunction with Armstrong devised a method for determining how the molecule was built up, by forming the osone of the sugar and hydrolysing, whereupon the hexosone obtained indicates the aldose part of the molecule. Lactose is thus found to be glucosido-galactose and melibiose a galactosido-glucose.

Several disaccharoses have been synthesized. By acting with hydrochloric acid on glucose Fischer obtained isomaltose, a disaccharose very similar to maltose but differing in being amorphous and unfermentable by yeast. Also Marchlewski (in 1899) synthesized cane sugar from potassium fructosate and acetochloroglucose; and after Fischer discovered that acetochlorohexoses readily resulted from the interaction of the hexose penta-acetates and liquid hydrogen chloride, several others have been obtained.

Cane sugar, saccharose or saccharobiose, is the most important sugar; its manufacture is treated below. When slowly crystallized it forms large monoclinic prisms which are readily soluble in water but difficultly soluble in alcohol. It melts at 160°, and on cooling solidifies to a glassy mass, which on standing gradually becomes opaque and crystalline. When heated to about 200° it yields a brown amorphous substance, named caramel, used in colouring liquors, &c. Concentrated sulphuric acid gives a black carbonaceous mass; boiling nitric acid oxidizes it to *d*-saccharic, tartaric and oxalic acids; and when heated to 160° with acetic anhydride an octa-acetyl ester is produced. Like glucose it gives saccharates with lime, baryta and strontia.

Milk sugar, lactose, lactobiose, $C_{12}H_{22}O_{11}$, found in the milk of mammals, in the amniotic liquid of cows, and as a pathological secretion, is prepared by evaporating whey and purifying the sugar which separates by crystallization. It forms hard white rhombic prisms (with $1H_2O$), which become anhydrous at 140° and melt with decomposition at 205°. It reduces ammoniacal silver solutions in the cold, and alkaline copper solutions on boiling. Its aqueous solution has a faint sweet taste, and is dextro-rotatory, the rotation of a fresh solution being about twice that of an old one. It is difficultly fermented by yeast, but readily by the lactic acid bacillus. It is oxidized by nitric acid to *d*-saccharic and mucic acids; and acetic anhydride gives an octa-acetate.

Maltose, malt-sugar, maltobiose, $C_{12}H_{22}O_{11}$, is formed, together with dextrine, by the action of malt diastase on starch, and as an intermediate product in the decomposition of starch by sulphuric acid, and of glycogen by ferments. It forms hard crystalline crusts (with $1H_2O$) made up of hard white needles.

Less important disaccharoses are: Trehalose or mycose, $C_{12}H_{22}O_{11}\cdot 2H_2O$, found in various fungi, *e.g. Boletus edulis*, in the Oriental *Trehala* and in ergot of rye; melibiose, $C_{12}H_{22}O_{11}$, formed, with fructose, on hydrolysing the trisaccharose melitose (or raffinose), $C_{18}H_{32}O_{16}\cdot 5H_2O$, which occurs in Australian manna and in the molasses of sugar manufacture; touranose, $C_{12}H_{22}O_{11}$, formed with *d*-glucose and galactose on hydrolysing another trisaccharose, melizitose, $C_{18}H_{32}O_{16}\cdot 2H_2O$, which occurs in *Pinus larix* and in Persian manna; and agavose, $C_{12}H_{22}O_{11}$, found in the stalks of *Agave americana*. (X.)

Sugar Manufacture

Sugar-cane is a member of the grass family, known botanically as *Saccharum officinarum*, the succulent stems of which are the source of cane sugar. It is a tall perennial grass-like plant, giving off numerous erect stems 6 to 12 ft. or more in height from a thick solid jointed root-stock. The stems are solid and marked with numerous shining, polished, yellow, purple or striped joints, 3 in. or less in length, and about 1½ in. thick. They are unbranched and bear in the upper portion numerous long narrow grass-like leaves arranged in two rows; the leaf springs from a large sheath and has a more or less spreading blade 3 ft. in length or longer, and 3 in. or more wide. The small flowers or spikelets are borne in pairs on the ultimate branches of a much branched feathery plume-like terminal grey inflorescence, 2 ft. or more long. Production of flowers is uncertain under cultivation and seed is formed very rarely. The plant is readily propagated by cuttings, a piece of the stem bearing buds at its nodes will root rapidly when placed in sufficiently moist ground. The sugar-cane is widely cultivated in the tropics and some sub-tropical countries, but is not known as a wild plant. Its native country is unknown, but it probably originated in India or some parts of eastern tropical Asia where it has been cultivated from great antiquity and whence its cultivation spread westwards and eastwards. Alphonse de Candolle (*Origin of Cultivated Plants*, p. 158) points out that the epoch of its introduction into different countries agrees with the idea that its origin was in India, Cochin-China or the Malay Archipelago, and regards it as most probable that its primitive range extended from Bengal to Cochin-China. The sugar-cane was introduced by the Arabs in the middle ages into Egypt, Sicily and the south of Spain where it flourished until the abundance of sugar in the colonies caused its cultivation to be abandoned. Dom Enrique, Infante of Portugal, surnamed the Navigator (1394–1460) transported it about 1420, from Cyprus and Sicily to Madeira, whence it was taken to the Canaries in 1503, and thence to Brazil and Hayti early in the 16th century, whence it spread to Mexico, Cuba, Guadeloupe and Martinique, and later to Bourbon. It was introduced into Barbadoes from Brazil in 1641, and was distributed from there to other West Indian islands. Though cultivated in sub-tropical countries such as Natal and the Southern states of the Union, it is essentially tropical in its requirements and succeeds best in warm damp climates such as

Cuba, British Guiana and Hawaii, and in India and Java in the Old World. The numerous cultivated varieties are distinguished mainly by the colour of the internodes, whether yellow, red or purple, or striped, and by the height of the culm. Apart from the sugar-cane and the beet, which are dealt with in detail below, a brief reference need only be made here to maple sugar, palm sugar and sorghum sugar.

Maple Sugar.—This is derived from the sap of the rock or sugar maple (*Acer saccharinum*), a large tree growing in Canada and the United States.

The sap is collected in spring, just before the foliage develops, and is procured by making a notch or boring a hole in the stem of the tree about 3 ft. from the ground. A tree may yield 3 gallons of juice a day and continue flowing for six weeks; but on an average only about 4 ℔ of sugar are obtained from each tree, 4 to 6 gallons of sap giving 1 ℔ of sugar. The sap is purified and concentrated in a simple manner, the whole work being carried on by farmers, who themselves use much of the product for domestic and culinary purposes.

Palm Sugar.—That which comes into the European market as *jaggery* or *khaur* is obtained from the sap of several palms, the wild date (*Phoenix sylvestris*), the palmyra (*Borassus flabellifer*), the coco-nut (*Cocos nucifera*), the gomuti (*Arenga saccharifera*) and others. The principal source is *Phoenix sylvestris*, which is cultivated in a portion of the Ganges valley to the north of Calcutta. The trees are ready to yield sap when five years old; at eight years they are mature, and continue to give an annual supply till they reach thirty years. The collection of the sap (toddy) begins about the end of October and continues, during the cool season, till the middle of February. The sap is drawn off from the upper growing portion of the stem, and altogether an average tree will run in a season 350 ℔ of toddy, from which about 35 ℔ of raw sugar—jaggery—is made by simple and rude processes. Jaggery production is entirely in native hands, and the greater part of the amount made is consumed locally; it only occasionally reaches the European market.

Sorghum Sugar.—The stem of the Guinea corn or sorghum (*Sorghum saccharatum*) has long been known in China as a source of sugar. The sorghum is hardier than the sugar-cane; it comes to maturity in a season; and it retains its maximum sugar content a considerable time, giving opportunity for leisurely harvesting. The sugar is obtained by the same method as cane sugar.

Cane Sugar Manufacture.—The value of sugar-canes at a given plantation or central factory would at first sight appear to vary directly as the amount of saccharine contained in the juice expressed from them varies, and if canes with juice indicating 9° Beaumé be made a basis of value or worth, say at 10s. per ton, then canes with juice indicating

Commercial Values of Sugar-canes.

in degrees Beaumé	10°	9°	8°	7°	6°
and containing in sugar	18·05 %	16·23 %	14·42 %	12·61 %	10·80 %
would be worth per ton	11/1½	10/–	8/10½	7/9½	6/8

But this is not an accurate statement of the commercial value of sugar-canes—that is, of their value for the production of sugar to the planter or manufacturer—because a properly equipped and balanced factory, capable of making 100 tons of sugar per day, for 100 days' crop, from canes giving juice of 9° B., or say 10,000 tons of sugar, at an aggregate expenditure for manufacture (*i.e.* the annual cost of running the factory) of £3 per ton, or £30,000 per annum, will not be able to make as much sugar per day with canes giving juice of 8° B., and will make still less if they yield juice of only 6° B. In practice, the expenses of upkeep for the year and of manufacturing the crop remain the same whether the canes are rich or poor and whether the crop is good or bad, the power of the factory being limited by its power of evaporation. For example, a factory able to evaporate 622 tons of water in 24 hours could treat 1000 tons of canes yielding juice of 9° B., and make therefrom 100 tons of sugar in that time; but this same factory, if supplied with canes giving juice of 6° B., could not treat more than 935 tons of canes in 24 hours, and would only make therefrom 62·2 tons of sugar.

The following table may be useful to planters and central factory owners. It shows the comparative results of working with juice of the degrees of density mentioned above, under the conditions described, for one day of 24 hours, and the real value, as raw material for manufacture, of cane giving juice of 6° B. to 10° B., with their apparent value based solely on the percentage of sugar in the juice. The canes in each case are assumed to contain 88 % of juice and 12 % of fibre, and the extraction by milling to be 75 % of the weight of canes—the evaporative power of the factory being equal to 622 tons per 24 hours. The factory expenses are taken at £30,000 per annum, or £3 per ton on a crop of 10,000 tons (the sugar to cost £8 per ton all told at the factory)—equivalent to £300 per day for the 100 working days of crop time.

Degrees Beaumé.	6°	7°	8°	9°	10°
Tons of canes crushed per day	935·6	956·2	977·4	1000	1023·8
Tons of juice expressed . . .	701·7	717·2	733·1	750	767·9
Tons of water evaporated . .	622	622	622	622	622
Tons of 1st Massecuite . . .	79·7	95·2	111·1	128	145·9
Tons sugar of all classes recovered	62·2	74·3	86·7	100	114·0
Total output of sugar in 100 days. Tons .	6220	7430	8670	10,000	11,400
Total value of all sugars per day at £8 per ton .	£497, 6/–	£594, 4/–	£693, 6/–	£800	£912
Less factory expenses per day .	£300	£300	£300	£300	£300
Leaves for canes crushed . . .	£197, 6/–	£294, 4/–	£393, 6/–	£500	£612
Real value of canes per ton .	4/2⅝	6/2	8/–	10/–	11/11½
Apparent value (see preceding Table) . . .	6/8	7/9½	8/10½	10/–	11/1½

But it is obvious that it would not pay a planter to sell canes at 4s. 2⅝d. a ton instead of at 10s. a ton, any more than it would pay a factory to make only 62·2 tons of sugar in 24 hours, or 6220 tons in the crop of 100 days, instead of 10,000 tons. Hence arises the imperative necessity of good cultivation by the planter, and of circumspection in the purchase and acceptance of canes on the part of the manufacturer.

The details of manufacture of sugar from canes and of sugar from beetroots differ, but there are five operations in the production of the sugar of commerce from either material which are common to both processes. These are:—

1. The extraction of the juice.
2. The purification or defecation of the juice.
3. The evaporation of the juice to syrup point.
4. The concentration and crystallization of the syrup.
5. The curing or preparation of the crystals for the market by separating the molasses from them.

Extraction by Pressure.

Extraction of Juice.—The juice is extracted from canes by squeezing them between rollers. In India at the present day there are thousands of small mills worked by hand, through which the peasant cultivators pass their canes two or three at a time, squeezing them a little, and extracting perhaps a fourth of their weight in juice, from which they make a substance resembling a dirty sweetmeat rather than sugar. In Barbadoes there are still many estates making good Mascabado sugar; but as the juice is extracted from the canes by windmills, and then concentrated in open kettles heated by direct fire, the financial results are disastrous, since nearly half the yield obtainable from the canes is lost. In the best organized modern cane sugar estates as much as 12½ % of the weight of the canes treated is obtained in crystal sugar of high polarizing power, although in Louisiana, where cultivation and manufacture are alike most carefully and admirably carried out, the yield in sugar is only about 7 % of the weight of the canes, and sometimes, but seldom, as much as 9 %. This is due to conditions of climate, which are much less favourable for the formation of saccharine in the canes than in Cuba. The protection afforded to the planters by their government, however, enables them to pursue the industry with considerable profit, notwithstanding the poor return for their labour in saleable produce. As an instance of the influence of climatic conditions combined with high cultivation the cane lands of the Sandwich Islands may be cited. Here the tropical heat is tempered by constant trade winds, there is perfect immunity from hurricanes, the soil is peculiarly suited for cane-growing, and by the use of specially-prepared fertilizers and an ample supply of water at command for irrigation the land yields from 50 to 90 tons of canes per acre, from which from 12 to 14 % of sugar is produced. To secure this marvellous return, with an annual rainfall of 26 in., as much as 52,000,000 gallons of water are pumped per 24 hours from artesian wells on one estate alone. With an inexhaustible supply of irrigation water obtainable, there is no reason why the lands in Upper Egypt, if scientifically cultivated and managed, should not yield as abundantly as those in the Sandwich Islands.

In the Paris Exhibition of 1900 a cane-crushing mill was shown with three rollers 32 in. in diameter by 60 in. long. It is driven by a powerful engine through triple gearing of 42 to 1, and speeded to have a surface velocity of rollers of 15 ft. 9 in. per minute. This mill is guaranteed to crush thoroughly and efficiently from 250 to 300 tons of canes in 24 hours. In Louisiana two mills, set one behind the other, each with three rollers 32 in. in diameter by 78 in. long, and driven by one engine through gearing of 15 to 1, are speeded to have a surface velocity of rollers of 25 ft. 6 in. per minute (or 60% more than that of the French mill described above), and they are efficiently crushing 900 to 1200 tons of canes in 24 hours. In Australia, Demerara, Cuba, Java and Peru *double crushing and maceration* (first used on a commercial scale in Demerara by the late Hon. William Russell) have been generally adopted; and in many places, especially in the Hawaiian Islands, *triple crushing* (*i.e.* passing the canes through three consecutive sets of rollers, in order to extract everything possible of extraction by pressure) is employed. In the south of Spain, in some favoured spots where sugar-canes can be grown, they are submitted even to four successive crushings.

It has been found in practice advantageous to prepare the canes for crushing in the mills, as above described, by passing them through a pair of preparing rolls which are grooved or indented in such manner as to draw in and flatten down the canes, no matter in which way they are thrown or heaped upon the cane-carrier, and thus prepare them for feeding the first mill of the series; thus the work of crushing is carried on uninterruptedly and without constant stoppages from the mills choking, as is often the case when the feed is heavy and the canes are not prepared.

Although it cannot be said that any one system of extraction is the best for all places, yet the following considerations are of general application:—

Yield from Crushing.

a. Whatever pressure be brought to bear upon it, the vegetable or woody fibre of crushed sugar-canes will hold and retain *for the moment* a quantity of moisture equal to its own weight, and in practice 10% more than its own weight; or in other words, 100 lb of the best crushed megass will consist of 47·62 lb of fibre and 52·38 lb of moisture—that is, water with sugar in solution, or juice.

b. Canes vary very much in respect of the quality and also as to the quantity of the juice they contain. The quantity of the juice is the test to which recourse must be had in judging the efficiency of the extraction, while the quality is the main factor to be taken into account with regard to the results of subsequent manufacture.

For the application of the foregoing considerations to practice, the subjoined table has been prepared. It shows the greatest quantity of juice that may be expressed from canes, according to the different proportions of fibre they contain, but without employing maceration or imbibition, to which processes reference is made hereafter. The percentages are percentages of the original weight of the uncrushed canes.

	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Percentage of fibre in canes . . .	10	11	12	13	14	15
Percentage of juice in canes . . .	90	89	88	87	86	85
Percentage of juice retained in megass	10	11	12	13	14	15
Percentage of maximum expression.	80	78	76	74	72	70
Percentage of best average expression, in practice.	79	76·9	74·9	72·9	70·6	68·5
Percentage of juice left in megass, in practice . . .	11	12·1	13·2	14·3	15·4	16·5

The British Guiana Planters' Association appointed a sub-committee to report to the West India Commission on the manufacture of sugar, who stated the following:—

With canes containing 12% fibre the following percentages of sugar are extracted from the canes in the form of juice:—

Single crushing	76%
Double crushing	85%
Double crushing with 12% dilution	88%
Triple crushing with 10% dilution	90%
Diffusion with 25% dilution	94%

These results are equivalent to

66·88% extraction for single crushing.
74·80% ,, ,, double crushing.
77·44% ,, ,, double crushing with 12% dilution.
79·20% ,, ,, triple ,, ,, 10% ,,
82·72% ,, ,, diffusion with 25% ,,

Maceration or Imbibition.

To prevent the serious loss of juice left in the megass by even the best double and triple crushing, maceration or imbibition was introduced. The megass coming from the first mill was saturated with steam and water, in weight equal to between 20% and 30% and up to 40% of the original weight of the uncrushed canes. Consequently, after the last crushing the mixture retained by the residual megass was not juice, as was the case when crushing was employed without maceration, but juice mixed with water; and it was found that the loss in juice was reduced by one-half. A further saving of juice was sometimes possible if the market prices of sugar were such as to compensate for the cost of evaporating an increased quantity of added water, but a limit was imposed by the fact that water might be used in excess. Hence in the latest designs for large factories it has been proposed that as much normal juice as can be extracted by double crushing only shall be treated by itself, and that the megass shall then be soused with twice as much water as there is juice remaining in it; after which, on being subjected to a third crushing, it will yield a degraded juice, which would also be treated by itself. It is found that in reducing the juice of these two qualities to syrup, fit to pass to the vacuum pans for cooking to crystals, the total amount of evaporation from the degraded juice is about half that required from the normal juice produced by double crushing.

Mechanical Improvements.

Great improvements have been made in the means of feeding the mills with canes by doing away with hand labour and substituting mechanical feeders or rakes, which by means of a simple steam-driven mechanism will rake the canes from the cane waggons on to the cane-carriers. By the adoption of this system in one large plantation in the West Indies, crushing upwards of 1200 tons of canes per day, the labour of sixty-four hands was dispensed with, and was thus made available for employment in the fields. In Louisiana the use of mechanical feeders is almost universal.

With a view of safeguarding themselves from breakdowns caused by the inequality of feeding, or by the action of malicious persons introducing foreign substances, such as crowbars, bolts, &c., among the canes, and so into the mills, many planters have adopted so-called hydraulic attachments, applied either to the megass roll or the top roll bearings. These attachments, first invented by Jeremiah Howard, and described in the *United States Patent Journal* in 1858, are simply hydraulic rams fitted into the side or top caps of the mill, and pressing against the side or top brasses in such a manner as to allow the side or top roll to move away from the other rolls, while an accumulator, weighted to any desired extent, keeps a constant pressure on each of the rams. An objection to the top cap arrangement is, that if the volume or feed is large enough to lift the top roll from the cane roll, it will simultaneously lift it from the megass roll, so that the megass will not be as well pressed as it ought to be; and an objection to the side cap arrangement on the megass roll as well as to the top cap arrangement is, that in case more canes are fed in at one end of the rolls than at the other, the roll will be pushed out farther at one end than at the other; and though it may thus avoid a breakdown of the rolls, it is apt, in so doing, to break the ends off the teeth of the crown wheels by putting them out of line with one another. The toggle-joint attachment, which is an extremely ingenious way of attaining the same end as the hydraulic attachments, is open to the same objections.

Extraction by Diffusion.

Extraction of cane juice by diffusion (a process more fully described under the head of beetroot sugar manufacture) is adopted in a few plantations in Java and Cuba, in Louisiana and the Hawaiian Islands, and in one or two factories in Egypt; but hitherto, except under exceptional conditions (as at Aska, in the Madras Presidency, where the local price for sugar is three or four times the London price), it would not seem to offer any substantial advantage over double or triple crushing. With the latter system practically as much sugar is obtained from the canes as by diffusion, and the resulting megass furnishes, in a well-appointed factory, sufficient fuel for the crop. With diffusion, however, in addition to the strict scientific control necessary to secure the benefits of the process, fuel—that is, coal or wood—has to be provided for the working off of the crop, since the spent chips or slices from the diffusers are useless for this purpose; although it is true that in some plantations the spent chips have to a certain extent been utilized as fuel by mixing them with a portion of the molasses, which otherwise would have been sold or converted into rum. The best results from extraction by diffusion have been obtained in Java, where there is an abundance of clear, good water; but in the Hawaiian Islands, and in Cuba and Demerara, diffusion has been abandoned on several well mounted estates and replaced by double and triple crushing; and it is not likely to be resorted to again, as the extra cost of working is not compensated by the slight increase of sugar produced. In Louisiana diffusion is successfully worked on two or three large estates; but the general body of planters are shy of using it, although there is no lack of water, the Mississippi being near at hand.

Purification.—The second operation is the coagulation of the albumen, and the separation of it with other impurities from the juice which holds them in suspension or solution. The moment the juice is expelled from the cells of the canes chemical inversion commences, and the sooner it is stopped the better. This is effected by the addition of lime to neutralize the free acid. As cold juice has a greater affinity for lime than hot juice, it is best to treat the juice with lime when cold. This is easily done in liming or measuring tanks of known capacity, into which the juice is run from the mill. The requisite amount of milk of lime set up at 10° Beaumé is then added. Cream of lime of 17° Beaumé is sometimes used, but the weaker solution is preferable, since the proper proportion is more easily adjusted. In Demerara and other places the juice is then heated under pressure up to 220° F. to 250° F. for a few moments, on its way to a steam and juice separator, where the steam due to the superheated juice flashes off, and is either utilized for aiding the steam supplied to the multiple effect evaporators, or for heating cold juice on its way to the main heater, or it is allowed to escape into the atmosphere. The boiling juice is run down into subsiding tanks, where it cools, and at the same time the albumen, which has been suddenly coagulated by momentary exposure to high temperature, falls to the bottom of the tank, carrying with it the vegetable and other matters which were in suspension in the juice. After reposing some time, the clear juice is carefully decanted by means of a pipe fixed by a swivel joint to an outlet in the bottom of the tank, the upper end of the pipe being always kept at the surface of the liquor by a float attached to it. Thus clear liquor alone is run off, and the mud and cloudy liquor at the bottom of the tank are left undisturbed, and discharged separately as required.

Subsiding Tanks.

Continuous Juice Separator.

In Australia a continuous juice separator is generally used, and preferred to ordinary subsiding or filtering tanks. It is a cylindrical vessel about 6 ft. deep, fitted with a conical bottom of about the same depth. Such a vessel is conveniently made of a diameter which will give the cylindrical portion sufficient capacity to hold the juice expressed from the cane-mill in one hour. The hot liquor is conducted downwards in a continuous steady stream by a central pipe to eight horizontal branches, from which it issues into the separator at the level of the junction of the cylindrical and conical portions of the vessel. Since the specific gravity of hot liquor is less than that of cold liquor, and since the specific gravity of the scum and particles of solid matter in suspension varies so slightly with the temperature that practically it remains constant, the hot liquor rises to the top of the vessel, and the scums and particles of solid matter in suspension separate themselves from it and fall to the bottom. By the mode of admission the hot liquor at its entry is distributed over a large area relatively to its volume, and while this is necessarily effected with but little disturbance to the contents of the vessel, a very slow velocity is ensured for the current of ascending juice. In a continuous separator of which the cylindrical portion measures 13 ft. in diameter and 6 ft. deep (a suitable size for treating a juice supply of 4000 to 4500 gallons per hour), the upward current will have a velocity of about 1 inch per minute, and it is found that all the impurities have thus ample time to separate themselves. The clear juice when it arrives at the top of the separator flows slowly over the level edges of a cross canal and passes in a continuous stream to the service tanks of the evaporators or vacuum pan. The sloping sides of the conical bottom can be freed from the coating of scum which forms upon them every two or three hours by two rotatory scrapers, formed of L-irons, which can be slowly turned by an attendant by means of a central shaft provided with a suitable handle. The scums then settle down to the bottom of the cone, whence they are run off to the scum tank. Every twenty-four hours or so the flow of juice may be conveniently stopped, and, after all the impurities have subsided, the superincumbent clear liquor may be decanted by a cock placed at the side of the cone for the purpose, and the vessel may be washed out. These separators are carefully protected by non-conducting cement and wood lagging, and are closed at the top to prevent loss of heat; and they will run for many hours without requiring to be changed, the duration of the run depending on the quality of the liquor treated and amount of impurities therein. Smaller separators of the same construction are used for the treatment of syrup.

Double-bottomed Defecators.

In Cuba, Martinique, Peru and elsewhere the old-fashioned double-bottomed defecator is used, into which the juice is run direct, and there limed and heated. This defecator is made with a hemispherical copper bottom, placed in an outer cast-iron casing, which forms a steam jacket, and is fitted with a cylindrical curb or breast above the bottom. If double-bottomed defecators are used in sufficient number to allow an hour and a half to two hours for making each defecation, and if they are of a size which permits any one of them to be filled up by the cane-mill with juice in ten to twelve minutes, they will make as perfect a defecation as is obtainable by any known system; but their employment involves the expenditure of much high-pressure steam (as exhaust steam will not heat the juice quickly enough through the small surface of the hemispherical inner bottom), and also the use of filter presses for treating the scums. A great deal of skilled superintendence is also required, and first cost is comparatively large. When a sufficient number are not available for a two hours' defecation, it is the practice in some factories to skim off the scums that rise to the top, and then boil up the juice for a few minutes and skim again, and, after repeating the operation once or twice, to run off the juice to separators or subsiders of any of the kinds previously described. In Java and Mauritius, where very clean canes are grown, double-bottomed defecators are generally used, and to them, perhaps as much as to the quality of the canes, may be attributed the very strong, fine sugars made in those islands. They are also employed in Egypt, being remnants of the plant used in the days when the juice passed through bone-black before going to the evaporators.

Continuous Defecation.

A modification of the system of double-bottom defecators has lately been introduced with considerable success in San Domingo and in Cuba, by which a continuous and steady discharge of clear defecated juice is obtained on the one hand, and on the other a comparatively hard dry cake of scum or cachaza, and without the use of filter presses. These results are brought about by adding to the cold juice as it comes from the mill the proper proportion of milk of lime set up at 8° B., and then delivering the limed juice in a constant steady stream as near the bottom of the defecator as possible; it is thus brought into immediate contact with the heating surface and heated once for all before it ascends, with the result of avoiding the disturbance caused in the ordinary defecator by pouring cold juice from above on to the surface of the heated juice, and so establishing down-currents of cold juice and up-currents of hot juice. In the centre of the defecator an open-topped cylindrical vessel is placed, with its bottom about 6 in. above the bottom of the defecator and its top about 12 in. below the top of the defecator. In this vessel is placed the short leg of a draw-off siphon, reaching to nearly the bottom. The action of the moderate heat, 210° F., on the limed juice causes the albumen in it to coagulate; this rising to the surface collects the cachazas, which form and float thereon. The clear juice in the meantime flows over the edge of the cylindrical vessel without disturbance and finds its way out by the short leg of the siphon, and so passes to the canal for collecting the defecated juice. The admission of steam must be regulated with the greatest nicety, so as to maintain an equable temperature, 208° to 210° F., hot enough to act upon the albumen and yet not enough to cause ebullition or disturbance in the juice, and so prevent a proper separation of the cachazas. This is attained by the aid of a copper pipe, 4 in. in diameter, which follows the curve of the hemispherical bottom, and is fitted from one side to the other of the defecator; one end is entirely closed, and the other is connected by a small pipe to a shallow circular vessel outside the defecator, covered with an india-rubber diaphragm, to the centre of which is attached a light rod actuating a steam throttle-valve, and capable of being adjusted as to length, &c. The copper pipe and circular vessel are filled with cold water, which on becoming heated by the surrounding juice expands, and so forces up the india-rubber diaphragm and shuts off the steam. By adjusting the length of the connecting rod and the amount of water in the vessel, the amount of steam admitted can be regulated to a nicety. To make this apparatus more perfectly automatic, an arrangement for continually adding to and mixing with the juice the proper proportion of milk of lime has been adapted to it; and although it may be objected that once the proportion has been determined no allowance is made for the variation in the quality of the juice coming from the mill owing to the variations that may occur in the canes fed into the mills, it is obviously as easy to vary the proportion with the automatic arrangement from time to time as it is to vary in each separate direction, if the man in charge will take the trouble to do so, which he very seldom does with the ordinary defecators, satisfying himself with testing the juice once or twice in a watch. The scums forming on the top of the continuous defecator become so hard and dry that they have to be removed from time to time with a specially constructed instrument like a flat spade with three flat prongs in front. These scums are not worth passing through the filter presses, and are sent to the fields direct as manure.

Treatment of the Scums.

The scums separated from the juice by ordinary defecation entangle and carry away with them a certain amount of the juice with its contained saccharine. In some factories they are collected in suitable tanks, and steam is blown into them, which further coagulates the albuminous particles. These in their upward passage to the top, where they float, free themselves from the juice, which they leave below them comparatively clear. The juice is then drawn off and pumped up to one of the double-bottomed defecators and redefecated, or, where juice-heaters have been used instead of defecators, the scums from the separators or subsiders are heated and forced through filter presses, the juice expressed going to the evaporators and the scum cakes formed in the filter presses to the fields as manure.

In diffusion plants the milk of lime is added, in proper proportion, in the cells of the diffusion battery, and the chips or slices themselves act as a mechanical filter for the juice; while in the Sandwich Islands coral-sand filters have been employed for some years, in addition to the chips, to free the juice from impurities held in mechanical suspension. In Germany very similar filters have also been used, pearl-quartz gravel taking the place of coral sand, which it closely resembles. In Mexico filters filled with dry powdered megass have been found very efficient for removing the large quantity of impurities contained in the juice expressed from the very vigorous but rank canes grown in that wonderfully fertile country, but unless constant care is taken in managing them, and in changing them at the proper time, there is great risk of inversion taking place, with consequent loss of sugar.

After the juice has been defecated or purified by any of the means above mentioned it is sent to the evaporating apparatus, hereinafter described, where it is concentrated to 26° or 28° Beaumé, and is then conducted in a continuous stream either into the service tanks of the vacuum pan, if dark sugars are required, or, if a better colour is wanted, into clarifiers. The latter are circular or rectangular vessels, holding from 500 to 1500 gallons each, according to the capacity of the factory, and fitted with steam coils at the bottom and skimming troughs at the top. In them the syrup is quickly brought up to the boil and skimmed for about five minutes, when it is run off to the service tanks of the vacuum pans. The heat at which the syrup boils in the clarifiers, 220° F., has the property of separating a great deal of the gum still remaining in it, and thus cleansing the solution of sugar and water for crystallization in the vacuum pans; and if after skimming the syrup is run into separators or subsiders of any description, and allowed to settle down and cool before being drawn into the vacuum pan for crystallization, this cleansing process will be more thorough and the quality of the final product will be improved. Whether the improvement will be profitable or not to the planter or manufacturer depends on the market for the sugar, and on the conditions of foreign tariffs, which are not infrequently hostile.

Evaporation of the Juice to Syrup.—The third operation is the concentration of the approximately pure, but thin and watery, juice to syrup point, by driving off a portion of the water in vapour through some system of heating and evaporation. Since on an average 70% by measurement of the normal defecated cane juice has to be evaporated in order to reduce it to syrup ready for final concentration and crystallization in the vacuum pan, and since to attain the same end as much as 90 to 95% of the volume of mixed juices has to be evaporated when maceration or imbibition is employed, it is clear that some more economical mode of evaporation is necessary in large estates than the open-fire batteries still common in Barbados and some of the West Indian islands, and in small haciendas in Central America and Brazil, but seldom seen elsewhere. With open-fire batteries for making the syrup, which was afterwards finished in the vacuum pan, very good sugar was produced, but at a cost that would be ruinous in to-day's markets.

In the best days of the so-called Jamaica Trains in Demerara, three-quarters of a ton of coal in addition to the megass was burned per ton of sugar made, and with this for many years planters were content, because they pointed to the fact that in the central factories, then working in Martinique and Guadeloupe, with charcoal filters and triple-effect evaporation, 750 kilos of coal in addition to the megass were consumed to make 1000 kilos of sugar. All this has now been changed. It is unquestionably better and easier to evaporate *in vacuo* than in an open pan, and with a better system of firing, a more liberal provision of steam generators, and multiple-effect evaporators of improved construction, a far larger yield of sugar is obtained from the juice than was possible of attainment in those days, and the megass often suffices as fuel for the crop.

Multiple-Effect Evaporators.

The multiple-effect evaporator, originally invented and constructed by Norberto Rilleux in New Orleans in 1840, has undergone many changes in design and construction since that year. The growing demand for this system of evaporation for application in many other industries besides that of sugar has brought to the front a large number of inventors. Forgetful or ignorant of the great principle announced and established by Rilleux, they have mostly devoted their energies and ingenuity to contriving all sorts of complicated arrangements to give the juice the density required, by passing and repassing it over the heating surface of the apparatus, the saving of a few square feet of which would seem to have been their main object. In some instances the result has been an additional and unnecessary expenditure of high-pressure steam, and in all the well-known fact—of the highest importance in this connexion—appears to have been disregarded, that the shorter the time the juice is exposed to heat the less inversion will take place in it, and therefore the less will be the loss of sugar. But this competition among inventors, whatever the incentive, has not been without benefit, because to-day, by means of very simple improvements in details, such as the addition of circulators and increased area of connexions, what may be taken to be the standard type of multiple-effect evaporator (that is to say, vertical vacuum pans fitted with vertical heating tubes, through which passes the liquor to be treated, and outside of which the steam or vapour circulates) evaporates nearly double the quantity of water per square foot of heating surface per hour which was evaporated by apparatus in use so recently as 1885—and this without any increase in the steam pressure. That evaporation *in vacuo*, in a multiple-effect evaporator, is advantageous by reason of the increased amount of sugar obtained from a given quantity of juice, and by reason of economy of fuel, there is no doubt, but whether such an apparatus should be of double, triple, quadruple or quintuple effect will depend very much on the amount of juice to be treated per day, and the cost of fuel. Thus, supposing that 1000 lb of coal were required to work a single vacuum pan, evaporating, say, 6000 lb of water in a given time, then 500 lb of coal would be required for a double-effect apparatus to do the same work, 333 lb for a triple effect, 250 for a quadruple effect, and 200 lb for a quintuple effect. In some places where coal costs 60s. a ton, and where steam is raised by coal, as in a beetroot factory, it might pay to adopt a quintuple-effect apparatus, but on a cane-sugar estate, where the steam necessary for the evaporator is raised by burning the megass as fuel, and is first used in the engines working the mills, the exhaust alone passing to the evaporator, there would be very little, if any, advantage in employing a quadruple effect instead of a triple effect, and practically none at all in having a quintuple-effect apparatus, for the interest and sinking fund on the extra cost would more than counterbalance the saving in fuel.

With the juice of some canes considerable difficulty is encountered in keeping the heating surfaces of the evaporators clean and free from incrustations, and cleaning by the use of acid has to be resorted to. In places where work is carried on day and night throughout the week, the standard type of evaporator lends itself more readily to cleaning operations than any other. It is obviously easier to brush out and clean vertical tubes open at both ends, and about 6 ft. long, on which the scale has already been loosened by the aid of boiling with dilute muriatic acid or a weak solution of caustic soda in water, than it is to clean either the inside or the outside of horizontal tubes more than double the length. This consideration should be carefully remembered in the future by the planter who may require an evaporator and by the engineer who may be called upon to design or construct it, and more especially by a constructor without practical experience of the working of his constructions.

Concentration and Crystallization.—The defecated cane juice, having lost about 70% of its bulk by evaporation in the multiple-effect evaporator, is now syrup, and ready to enter the vacuum pan for further concentration and crystallization.

Howard's Vacuum Pan.

In a patent (No. 3607, 1812) granted to E. C. Howard it is stated, among other things, that "water dissolves the most uncrystallizable in preference to that which is most crystallizable sugar," and the patentee speaks of "a discovery I have made that no solution, unless highly concentrated, of sugar in water can without material injury to its colouring and crystallizing power, or to both, be exposed to its boiling temperature during the period required to evaporate such solution to the crystallizing point." He stated that "he had made a magma of sugar and water at atmospheric temperature, and heated the same to 190° or 200° F. in a water or steam bath, and then added more sugar or a thinner magma, and the whole being then in a state of imperfect fluidity, but so as to close readily behind the stirrer, was filled into moulds and purged" (drained). "I do further declare," he added, "that although in the application of heat to the refining of sugar in my said invention or process I have stated and mentioned the temperature of about 200° F. scale as the heat most proper to be used and applied in order to secure and preserve the colour and crystallizability of the sugars, and most easily to be obtained with precision and uniformity by means of the water bath and steam bath, yet when circumstances or choice may render the same desirable I do make use of higher temperatures, although less beneficial." Howard at any rate saw clearly what was one of the indispensable requisites for the economical manufacture of fine crystal sugar of good colour—the treatment of saccharine solutions at temperatures very considerably lower than 212° F., which is the temperature of water boiling at normal atmospheric pressure. Nor was he long in providing means for securing these lower temperatures. His patent (No. 3754 of 1813) describes the closed vacuum pan and the air pump with condenser for steam by injection, the use of a thermometer immersed in the solution in the pan, and a method of ascertaining the density of the solution with a proof stick, and by observations of the temperature at which, while fluid and not containing grain, it could be kept boiling under different pressures shown by a vacuum gauge. A table is also given of boiling points from 115° F. to 175° F., corresponding to decimal parts of an inch of mercury of the vacuum gauge. Since Howard published his invention the vacuum pan has been greatly improved and altered in shape and power, and especially of recent years, and the advantages of concentrating *in vacuo* having been acknowledged, the system has been adopted in many other industries, and crowds of inventors have turned their attention to the principle. In endeavouring to make a pan of less power do as much and as good work as one of greater power, they have imagined many ingenious mechanical contrivances, such as currents produced mechanically to promote evaporation and crystallization, feeding the pan from many points in order to spread the feed equally throughout the mass of sugar being cooked, and so on. All their endeavours have obtained at best but a doubtful success, for they have overlooked the fact that to evaporate a given weight of water from the syrup in a vacuum pan at least an equal weight (or in practice about 15% more) of steam must be condensed, and the first cost of mechanical agitators, together with the expenditure they involve for motive power and maintenance, must be put against the slight saving in the heating surface effected by their employment. On the other hand, the advocates of admitting the feed into a vacuum pan in many minute streams appeal rather to the ignorant and incompetent sugar-boiler than to a man who, knowing his business thoroughly, will boil 150 tons of hot raw sugar in a pan in a few hours, feeding it through a single pipe and valve 10 in. in diameter. Nevertheless, it has been found in practice, when syrups with low quotient of purity and high quotient of impurity are being treated, injecting the feed at a number of different points in the pan does reduce the time required to boil the pan, though of no practical advantage with syrups of high quotient of purity and free from the viscosity which impedes circulation and therefore quick boiling. Watt, when he invented the steam engine, laid down the principles on which it is based, and they hold good to the present day. So also the principles laid down by Howard with respect to the vacuum pan hold good to-day: larger pans have been made and their heating surface has been increased, but it has been found by practice now, as it was found then, that an ordinary worm or coil 4 in. in diameter and 50 ft. long will be far more efficient per square foot of surface than a similar coil 100 ft. long. Thus the most efficient vacuum pans of the present day are those which have their coils so arranged that no portion of them exceeds 50 or 60 ft. in length; with such coils, and a sufficient annular space in the pan free from obstruction, in order to allow a natural down-current of the cooking mass, while an up-current all round is also naturally produced by the action of the heated worms or coils, rapid evaporation and crystallization can be obtained, without any mechanical adjuncts to require attention or afford excuse for negligence.

The choice of the size of the crystals to be produced in a given pan depends upon the market for which they are intended. It is of course presupposed that the juice has been properly defecated, because without this no amount of skill and knowledge in cooking in the pan will avail; the sugar resulting must be bad, either in colour or grain, or both, and certainly in polarizing power. If a very large firm grain like sugar-candy is required the syrup when first brought into the pan must be of low density, say 20° to 21° Beaumé, but if a smaller grain be wanted it can easily be obtained from syrup of 27° to 28° Beaumé. On some plantations making sugar for particular markets and use in refineries it is the custom to make only one class of sugar, by boiling the molasses produced by the purging of one strike with the sugar in the next strike. On other estates the second sugars, or sugars produced from boiling molasses alone, are not purged to dryness, but when sufficiently separated from their mother-liquor are mixed with the defecated juice, thereby increasing its saccharine richness, and after being converted into syrup in the usual manner are treated in the vacuum pan as first sugars, which in fact they really are.

In certain districts, notably in the Straits Settlements, syrup is prepared as described above for crystallization in a vacuum pan, but instead of being cooked *in vacuo* it is slowly boiled up in open double-bottom pans. These pans are sometimes heated by boiling oil, with the idea that under such conditions the sugar which is kept stirred all the time as it thickens cannot be burnt or caramelized; but the same object can be attained more economically with steam of a given pressure by utilizing its latent heat. The sugar thus produced, by constant stirring and evaporation almost to dryness, forms a species of small-grained concrete. It is called "basket sugar," and meets with a brisk sale, at remunerative prices, among the Chinese coolies; and as the sugar as soon as cooled is packed ready for market, without losing any weight by draining, this branch of sugar-making is a most lucrative one wherever there is sufficient local demand. Very similar kinds of sugar are also produced for local consumption in Central America and in Mexico, under the names of "Panela" and "Chancaca," but in those countries the sugar is generally boiled in pans placed over special fire-places, and the factories making it are on a comparatively small scale, whereas in the Straits Settlements the "basket sugar" factories are of considerable importance, and are fitted with the most approved machinery.

Curing or Preparation of Crystals for the Market.—The crystallized sugar from the vacuum pan has now to be separated from the molasses or mother-liquor surrounding the crystals. In some parts of Mexico and Central America this separation is still effected by running the sugar into conical moulds, and placing on the top a layer of moist clay or earth which has been kneaded in a mill into a stiff paste. The moisture from the clay, percolating through the mass of sugar, washes away the adhering molasses and leaves the crystals comparatively free and clear. It may be noted that sugar that will not purge easily and freely with clay will not purge easily and freely in centrifugals. But for all practical purposes the system of claying sugar is a thing of the past, and the bulk of the sugar of commerce is now purged in centrifugals, as indeed it has been for many years. The reason is obvious. The claying system involved the expense of large curing houses and the employment of many hands, and forty days at least were required for completing the operation and making the sugar fit for the market, whereas with centrifugals sugar cooked to-day can go to market to-morrow, and the labour employed is reduced to a minimum.

When Cuba was the chief sugar-producing country making clayed sugars it was the custom (followed in refineries and found advantageous in general practice) to discharge the strike of crystallized sugar from the vacuum pan into a receiver heated below by steam, and to stir the mass for a certain time, and then distribute it into the moulds in which it was afterwards clayed. When centrifugals were adopted for purging the whole crop (they had long been used for curing the second or third sugars), the system then obtaining of running the sugar into wagons or coolers, which was necessary for the second and third sugars cooked only to string point, was continued, but latterly "crystallization in movement," a development of the system which forty years ago or more existed in refineries and in Cuba, has come into general use, and with great advantage, especially where proprietors have been able to erect appropriate buildings and machinery for carrying out the system efficiently. The vacuum pan is erected at a height which commands the crystallizers, each of which will, as in days gone by in Cuba, hold the contents of the pan, and these in their turn are set high enough to allow the charge to fall into the feeding-trough of the centrifugals, thus obviating the necessity of any labour to remove the raw sugar from the time it leaves the vacuum pan to the time it falls into the centrifugals. For this reason alone, and without taking into consideration any increase in the yield of sugar brought about by "crystallization in movement," the system is worthy of adoption in all sugar factories making crystal sugar.

Crystallizers. The crystallizers are long, horizontal, cylindrical or semi-cylindrical vessels, fitted with a strong horizontal shaft running from end to end, which is kept slowly revolving. The shaft carries arms and blades fixed in such a manner that the mass of sugar is quietly but thoroughly moved, while at the same time a gentle but sustained evaporation is produced by the continuous exposure of successive portions of the mass to the action of the atmosphere. Thus also the crystals already formed come in contact with fresh mother-liquor, and so go on adding to their size. Some crystallizers are made entirely cylindrical, and are connected to the condenser of the vacuum pan; in order to maintain a partial vacuum in them, some are fitted with cold-water pipes to cool them and with steam pipes to heat them, and some are left open to the atmosphere at the top. But the efficiency of all depends on the process of almost imperceptible yet continuous evaporation and the methodical addition of syrup, and not on the idiosyncrasies of the experts who manage them; and there is no doubt that in large commercial processes of manufacture the simpler the apparatus used for obtaining a desired result, and the more easily it is understood, the better it will be for the manufacturer. The sugar made from the first syrups does not require a crystallizer in movement to prepare it for purging in the centrifugals, but it is convenient to run the strike into the crystallizer and so empty the pan at once and leave it ready to commence another strike, while the second sugars will be better for twenty-four hours' stirring and the third sugars for forty-eight hours' stirring before going to the centrifugals. To drive these machines electricity has been applied, with indifferent success, but they have been very efficiently driven, each independently of the others in the set, by means of a modification of a Pelton wheel, supplied with water under pressure from a pumping engine. A comparatively small stream strikes the wheel with a pressure equivalent to a great head, say 300 ft., and as the quantity of water and number of jets striking the wheel can be regulated with the greatest ease and nicety, each machine can without danger be quickly brought up to its full speed when purging high-class sugars, or allowed to run slowly when purging low-class sugars, until the heavy, gummy molasses have been expelled; and it can then be brought up to its full speed for finally drying the sugar in the basket, a boon which all practical sugar-makers will appreciate. The water forced by the force-pump against the Pelton wheels returns by a waste-pipe to the tank, from which the force-pump takes it again.

Recent Progress.—The manufacture of cane sugar has largely increased in volume since the year 1901–1902. This, apart from the effect of the abolition of the sugar bounties, has been mainly the result of the increased employment of improved processes, carried on in improved apparatus, under skilled supervision, and with due regard to the importance of the chemical aspects of the work.

Central Factories. Numerous central factories have been erected in several countries with plant of large capacity, and many of them work day and night for six days in the week. There were 173 of these factories working in Cuba in 1908–1909, among which the "Chaparra," in the province of Oriente, turned out upwards of 69,000 tons of sugar in the crop of about 20 weeks, and the "Boston" had an output of about 61,000 tons in the same time. Of the 178 factories at work in Java in 1908–1909, nearly all had most efficient plant for treating the excellent canes grown in that favoured island. (See *Jaarboek voor suikerfabrikanten op Java, 13e Jaargang 1908–1909*, pp. 22–61, Amsterdam, J. H. de Bussy.) The severance of the agricultural work, *i.e.* cane-growing, from the manufacturing work, sugar-making, must obviously conduce to better and more profitable work of both kinds.

The use of multiple-effect evaporation made it possible to raise the steam for all the work required to be done in a well-equipped factory, making crystals, under skilful management, by means of the bagasse alone proceeding from the canes ground, without the aid of other fuel. The bagasse so used is now commonly taken straight from the cane mill to furnaces specially designed for burning it, in its moist state and without previous drying, and delivering the hot gases from it to suitable boilers, such as those of the multitubular type or of the water-tube type. The value of fresh bagasse, or as it is often called "green" bagasse, as fuel varies with the kind of canes from which it comes, with their treatment in the mill, and with the skill used in firing; but it may be stated broadly that 1 lb of fresh bagasse will produce from 1½ lb to 2¼ lb of steam, according to the conditions.

Green Bagasse as Fuel.

The use of preparing rolls with corrugations, to crush and equalize the feed of canes to the mill, or to the first of a series of mills, has become general. The Krajewski crusher has two such steel rolls, with V-shaped corrugations extending longitudinally across them. These rolls run at a speed about 30% greater than the speed of the first mill, to which they deliver the canes well crushed and flattened, forming a close mat of pieces of cane 5 to 6 in. long, so that the subsequent grinding can be carried on without the stoppages occasioned by the mill choking with a heavy and irregular feed. The crusher is preferably driven by an independent engine, but with suitable gearing it can be driven by the mill engine. The Krajewski crusher was invented some years ago by a Polish engineer resident in Cuba, who took out a patent for it and gave it his name. The patent has expired. The increase in the output for a given time obtained by the use of the Krajewski crusher has been estimated at 20 to 25% and varies with the quality of the canes; while the yield of juice or extraction is increased by 1 or 2%.

Extraction of Juice.

The process of continuous defecation which was introduced into Cuba from Santo Domingo about 1900 had by 1910 borne the test of some ten years' use with notable success. The Hatton defecator, which is employed for working it, has been already described, but it may be mentioned that the regulation of the admission of steam is now simplified and secured by a patent thermostat—a self-acting apparatus in which the unequal expansion of different metals by heat actuates, through compressed air, a diaphragm which controls the steam stop-valve—and by this means a constant temperature of 210° F. (98·8° C.) is maintained in the juice within the defecator during the whole time it is at work.

Purification.

Earthy matter and other matter precipitated and fallen on the copper double bottom may be dislodged by a slowly revolving scraper—say every twelve hours—and ejected through the bottom discharge cock; and thus the heating surface of the copper bottom will be kept in full efficiency. With ordinary care on the part of the men in charge Hatton defecators will work continuously for several days and nights, and the number required to deal with a given volume of juice is half the number of ordinary defecators of equal capacity which would do the same work; for it must be borne in mind that an ordinary double-bottomed defecator takes two hours to deliver its charge and be in readiness to receive a fresh charge, *i.e.* 20 minutes for filling and washing out after emptying; 60 minutes for heating up and subsiding; and 40 minutes for drawing off the defecated juice, without agitating it. Apart from increased yield in sugar of good quality, we may sum up the advantages procurable from the use of Hatton defecators as follows: cold liming; heating gently to the temperature required to coagulate the albumen and not beyond it, whereby disturbance would ensue; the continuous separation of the scums; the gradual drying of the scums so as to make them ready for the fields, without carrying away juice or requiring treatment in filter presses; and the continuous supply of hot defecated juice to the evaporators, without the use of subsiding tanks or eliminators; and, finally, the saving in expenditure on plant, such as filter presses, &c., and wages.

Beetroot Sugar Manufacture.—The sugar beet is a cultivated variety of *Beta maritima* (nat. ord. Chenopodiaceae), other varieties of which, under the name of mangold or mangel-wurzel, are grown as feeding roots for cattle.

About 1760 the Berlin apothecary Marggraff obtained in his laboratory, by means of alcohol, 6·2% of sugar from a white variety of beet and 4·5% from a red variety. At the present day, thanks to the careful study of many years, the improvements of cultivation, the careful selection of seed and suitable manuring, especially with nitrate of soda, the average beet worked up contains 7% of fibre and 93% of juice, and yields in Germany 12·79% and in France 11·6% of its weight in sugar. In Great Britain in 1910 the cultivation of beet for sugar was being seriously undertaken in Essex, as the result of careful consideration during several years. The pioneer experiments on Lord Denbigh's estates at Newnham Paddox, in Warwickshire, in 1900, had produced excellent results, both in respect of the weight of the beets per acre and of the saccharine value and purity of the juice. The average weight per acre was over 25½ tons, and the mean percentage of pure sugar in the juice exceeded 15½. The roots were grown under exactly the same cultivation and conditions as a crop of mangel-wurzel—that is to say, they had the ordinary cultivation and manuring of the usual root crops. The weight per acre, the saccharine contents of the juice, and the quotient of purity compared favourably with the best results obtained in Germany or France, and with those achieved by the Suffolk farmers, who between 1868 and 1872 supplied Mr Duncan's beetroot sugar factory at Lavenham; for the weight of their roots rarely reached 15 tons per acre, and the percentage of sugar in the juice appears to have varied between 10 and 12. On the best-equipped and most skilfully managed cane sugar estates, where the climate is favourable for maturing the cane, a similar return is obtained. Therefore, roughly speaking, one ton of beetroot may be considered to-day as of the same value as one ton of canes; the value of the refuse chips in one case, as food for cattle, being put against the value of the refuse bagasse, as fuel, in the other. Before beetroot had been brought to its present state of perfection, and while the factories for its manipulation were worked with hydraulic presses for squeezing the juice out of the pulp produced in the raperies, the cane sugar planter in the West Indies could easily hold his own, notwithstanding the artificial competition created and maintained by sugar bounties. But the degree of perfection attained in the cultivation of the roots and their subsequent manipulation entirely altered this situation and brought about the crisis in the sugar trade referred to in connexion with the bounties (see *History* below) and dealt with in the Brussels convention of 1902.

In beetroot sugar manufacture the operations are washing, slicing, diffusing, saturating, sulphuring, evaporation, concentration and curing.

Slicing.—The roots are brought from the fields by carts, canals and railways. They are weighed and then dumped into a washing machine, consisting of a large horizontal cage, submerged in water, in which revolves a horizontal shaft carrying arms. The arms are set in a spiral form, so that in revolving they not only stir the roots, causing them to rub against each other, but also force them forward from the receiving end of the cage to the other end. Here they are discharged (washed and freed from any adherent soil) into an elevator, which carries them up to the top of the building and delivers them into a hopper feeding the slicer. Slicers used to be constructed with iron disks about 33 to 40 in. diameter, which were fitted with knives and made 140 to 150 revolutions per minute, under the hopper which received the roots. This hopper was divided into two parts by vertical division plates, against the bottom edge of which the knives in the disk forced the roots and sliced and pulped them. Such machines were good enough when the juice was expelled from the small and, so to speak, chopped slices and pulp by means of hydraulic presses. But hydraulic presses have now been abandoned, for the juice is universally obtained by diffusion, and the small slicers have gone out of use, because the large amount of pulp they produced in proportion to slices is not suitable for the diffusion process, in which evenly cut slices are required, which present a much greater surface with far less resistance to the diffusion water. Instead of the small slicers, machines made on the same principle, but with disks 7 ft. and upwards in diameter, are used. Knives are arranged around their circumference in such a way that the hopper feeding them presents an annular opening to the disk, say 7 ft. outside diameter and 5 ft. inside, with the necessary division plates for the knives to cut against, and instead of making 140 to 150 revolutions the disks revolve only 60 to 70 times per minute. Such a slicer is capable of efficiently slicing 300,000 kilos of roots in twenty-four hours, the knives being changed four times in that period, or oftener if required, for it is necessary to change them the moment the slices show by their rough appearance that the knives are losing their cutting edges.

Diffusion.—The diffusion cells are closed, vertical, cylindrical vessels, holding generally 60 hectolitres, or 1320 gallons, and are arranged in batteries of 12 to 14. Sometimes the cells are erected in a circle, so that the spout below the slicing machine revolving above them with a corresponding radius can discharge the slices into the centre of any of the cells. In other factories the cells are arranged in lines and are charged from the slicer by suitable telescopic pipes or other convenient means. A circular disposition of the cells facilitates charging by the use of a pipe rotating above them, but it renders the disposal of the hot spent slices somewhat difficult and inconvenient. The erection of the cells in straight lines may cause some little complication in charging, but it allows the hot spent slices to be discharged upon a travelling band which takes them to an elevator, an arrangement simpler than any which is practicable when the cells are disposed in a circle. Recently, however, a well-known sugar maker in Germany has altered his battery in such manner that instead of having to open a large door below the cells in order to discharge them promptly, he opens a comparatively small valve and, applying compressed air at the top of the cell, blows the whole contents of spent slices up a pipe to the drying apparatus, thus saving not only a great deal of time but also a great deal of labour of a kind which is both arduous and painful, especially during cold weather. The slices so blown up, or elevated, are passed through a mill which expels the surplus water, and are then pressed into cakes and dried until they hold about 12% of water and 88% of beet fibre. These cakes, sold as food for cattle, fetch as much as £4 per ton in Rumania, where four or five beetroot factories are now at work. A cell when filled with fresh slices becomes the head of the battery, and where skilled scientific control can be relied upon to regulate the process, the best and most economical way of heating the slices, previous to admitting the hot liquor from the next cell, is by direct steam; but as the slightest inattention or carelessness in the admission of direct steam might have the effect of inverting sugar and thereby causing the loss of some portion of saccharine in the slices, water heaters are generally used, through which water is passed and heated up previous to admission to the freshly-filled cell. When once a cell is filled up and the slices are warmed through, the liquor from the adjoining cell, which hitherto has been running out of it to the saturators, is turned into the new cell, and beginning to displace the juice from the fresh slices, runs thence to the saturators. When the new cell comes into operation and becomes the head of the battery, the first or tail cell is thrown out, and number two becomes the tail cell, and so the rounds are repeated; one cell is always being emptied and one filled or charged with slices and heated up, the latter becoming the head of the battery as soon as it is ready.

Saturation.—The juice, previously treated with lime in the diffusion battery, flows thence into a saturator. This is a closed vessel, into which carbonic acid gas (produced as described hereafter) is forced, and combining with the lime in the juice forms carbonate of lime. The whole is then passed through filter presses, the clear juice being run off for further treatment, while the carbonate of lime is obtained in cakes which are taken to the fields as manure. The principal improvement made of recent years in this portion of the process has been the construction of pipes through which the carbonic acid gas is injected into the juice in such a manner that they can be easily withdrawn and a clean set substituted. The filter presses remain substantially unchanged, although many ingenious but slight alterations have been made in their details. The juice, which has now become comparatively clear, is again treated with lime, and again passed through a saturator and filter presses, and comes out still clearer than before. It is then treated with sulphurous acid gas, for the purpose of decolorization, again limed to neutralize the acid, and then passed through a third saturator wherein all traces of lime and sulphur are removed.

A process for purifying and decolorizing the juice expressed from beetroots by the addition of a small quantity of manganate of lime (20 to 50 grammes per hectolitre of juice), under the influence of an electric current, was worked with considerable success in a sugar factory in the department of Seine-et-Marne in the year 1900–1901. A saving of 40% is stated to be effected in lime. The use of sulphurous acid gas is entirely abandoned, and instead of three carbonatations with corresponding labour and plant only one is required. The coefficient of purity is increased and the viscosity of the juice diminished. The total saving effected is stated to be equivalent to 3 francs per ton of beetroot worked up. This system is also being tried on a small scale with sugar-cane juice in the West Indies. If by this process a more perfect defecation and purification of the juice is obtained, it will no doubt be highly beneficial to the cane planter, though no great economy in lime can be effected, because but very little is used in a cane factory in comparison with the amount used in a beet factory.

Evaporation and Crystallization.—The clear juice thus obtained is evaporated in a multiple-effect evaporator and crystallized in a vacuum pan, and the sugar is purged in centrifugals. From the centrifugal the sugar is either turned out without washing as raw sugar, only fit for the refinery, or else it is well washed with a spray of water and air until white and dry, and it is then offered in the market as refined sugar, although it has never passed through animal charcoal (bone-black). The processes of evaporation and concentration are carried on as they are in a cane sugar factory, but with this advantage, that the beet solutions are freer from gum and glucose than those obtained from sugar-canes, and are therefore easier to cook.

Curing.—There are various systems of purging refined, or so-called refined, sugar in centrifugals, all designed with a view of obtaining the sugar in lumps or tablets, so as to appear as if it had been turned out from moulds and not from centrifugals, and great ingenuity and large sums of money have been spent in perfecting these different systems, with more or less happy results. But the great achievement of recent manufacture is the production, without the use of animal charcoal, of a cheaper, but good and wholesome article, in appearance equal to refined sugar for all intents and purposes, except for making preserves of fruits in the old-fashioned way. The wholesale jam manufacturers of the present day use this sugar; they boil the jam *in vacuo* and secure a product that will last a long time without deteriorating, but it lacks the delicacy and distinctive flavour of fruit preserved by a careful housekeeper, who boils it in an open pan with cane sugar to a less density, though exposed for a short time to a greater heat.

Carbonatation.—The carbonic acid gas injected into the highly limed juice in the saturators is made by the calcination of limestone in a kiln provided with three cleaning doors, so arranged as to allow the lime to be removed simultaneously from them every six hours. The gas generated in the kiln is taken off at the top by a pipe to a gas-washer. In this it passes through four sheets of water, by which it is not only freed from any dust and dirt that may have come over with it from the kiln, but is also cooled to a temperature which permits an air-pump to withdraw the gas from the kiln, through the gas-washer, and force it into the saturators, without overheating. In some factories for refining sugar made from beet or canes this system of carbonatation is used, and enables the refiner to work with syrups distinctly alkaline and to economize a notable amount of animal charcoal.

Refining.—Briefly, sugar-refining consists of melting raw or unrefined sugar with water into a syrup of 27° to 28° Beaumé, or 1230 specific gravity, passing it through filtering cloth to remove the sand and other matters in mechanical suspension, and then through animal charcoal to remove all traces of colouring matter and lime, thus producing a perfectly clear white syrup, which, cooked in the vacuum pan and crystallized, becomes the refined sugar of commerce.

Melting Pans.—The melting pans are generally circular vessels, fitted with a perforated false bottom, on which the sugar to be melted is dumped. The pans are provided with steam worms to keep the mass hot as required, and with mechanical stirrers to keep it in movement and thoroughly mixed with the water and sweet water which are added to the sugar to obtain a solution of the specific gravity desired. Any sand or heavy matter in suspension is allowed to fall to the bottom of the pan into the "sandbox" before the melted sugar is run off to the cloth filters. In a process employed with great success in some refineries the raw sugars are washed before being melted, and thus a purer article is obtained for subsequent treatment. In this process the raw sugar is mixed with a small amount of syrup so as to form a suitable magma, and is then run into a continuous centrifugal, where it is sufficiently washed, and from which it runs out, comparatively clean, into the melting pans described above.

Filters.—Taylor bag filters are generally used for clearing the melted liquor of its mechanical impurities. They were introduced years ago by the man whose name they still retain, but they are very different in construction to-day from what they were when first employed. They consist of tanks or cisterns fitted with "heads" from which a number of bags of specially woven cloth are suspended in a suitable manner, and into which the melted sugar or liquor to be filtered flows from the melting pans. The bags, though 60 in. or more in circumference, are folded up in such a way that a sheath about 15 in. in circumference can be passed over them. Thus a maximum of filtering surface with a minimum of liquor in each bag is obtained, and a far greater number of bags are got into a given area that would otherwise be possible, while the danger of bursting the bags by leaving them unsupported is avoided. As the liquor goes on filtering through the bags they gradually get filled up with slime and sludge, and the clear liquor ceases to run. Steam is then turned on to the outside of the bags and sheaths, and hot water is run through them to wash out all the sweets they contain. Large doors at the side of the cistern are then opened, and as soon as the bags are cool enough they are removed at the expense of very exacting labour and considerable time, and fresh bags and sheaths are fixed in their places ready for filtering fresh liquor. The dirty bags and sheaths are then washed, mangled and dried, and made ready for use again. In a refinery in Nova Scotia a system has been introduced by which a travelling crane above the bag filters lifts up any head bodily with all its bags attached, and runs it to the mud and washing tanks at the end of the battery, while another similar crane drops another head, fitted with fresh bags, into the place of the one just removed. The whole operation of thus changing a filter occupies about ten minutes, and there is no need for anyone to enter the hot cistern to detach the bags, which are removed in the open air above the mud tank. By this arrangement the work of a refinery can be carried on with about one-half the cisterns otherwise required, because, although it does not reduce the number of bags required per day for a given amount of work, it enables the refiner to use one cistern twice a day with fresh bags, instead of only once as heretofore. In some refineries the travelling cranes are now run by electricity, which still further facilitates the work. Another method of enabling more work to be done in a given time in a given cistern is the use of a bag twice the ordinary length, open at both ends. This, being folded and placed in its sheath, is attached by both ends to the head, so that the melted liquor runs into both openings at the same time. The mud collects at the bottom of the U, and allows the upper part of the bag to filter for a longer time than would be the case if the bottom end were closed and if the bag hung straight like the letter I.

The clear, bright syrup coming from the bag filters passes to the charcoal cisterns or filters. These are large cylindrical vessels from 20 to 50 ft. high, and of such diameter as to hold a given quantity of animal charcoal (also called "bone-black" and "char") in proportion to the contemplated output of the refinery. A very usual size of cistern forming a convenient unit is one that will hold 20 tons of char. Each cistern is fitted with a perforated false bottom, on which a blanket or specially woven cloth is placed, to receive the char which is poured in from the top, and packed as evenly as possible until the cistern is filled. The char is then "settled" by water being slowly run on to it, in order to prevent the syrup making channels for itself and not permeating the whole mass evenly. The cistern being thus packed and settled is closed, and the syrup from the bag filters, heated up to nearly boiling point, is admitted at the top until the cistern is quite full. A small pipe entering below the false bottom allows the air in the cistern to escape as it is displaced by the water or syrup. In some refineries this pipe, which is carried up to a higher level than the top of the cistern, is fitted with a whistle which sounds as long as the air escapes. When the sound ceases the cistern is known to be full, and the entrance of further water or syrup is stopped. The syrup in the cistern is allowed to remain for about twelve hours, by which time the char will have absorbed all the colouring matter in it, as well as the lime. A cistern well packed with 20 tons of char will hold, in addition, about 10 tons of syrup, and after settling, this can be pressed out by allowing second quality syrup, also heated to nearly boiling point, to enter the cistern slowly from the top, or it may be pressed out by boiling water. By carefully watching the flow from the discharge cock of the cistern the change from the first liquor to the next is easily detected, and the discharge is diverted from the canal for the first liquor to the canal for the second liquor, and, when required, to the canals for the third and fourth liquors. Finally, boiling water is admitted and forces out all the last liquor, and then continues to run and wash out the sweets until only a trace remains. This weak solution, called "sweet water," is sometimes used for melting the raw sugar, or it is evaporated in a multiple-effect apparatus to 27° Beaumé density, passed through the char filter, and cooked in the vacuum pan like the other liquors. After the sweets have come away, cold water is passed through the char until no trace of lime or sulphate of lime is found in it; then a large manhole at the bottom of the cistern is opened, and the washed and spent char is removed. In most modern refineries the cisterns are so arranged that the spent char falls on to a travelling band and is conducted to an elevator which carries it up to the drying floor of the charcoal kiln.

Retorts for Reburning Char.—The kilns are made with either fixed or revolving retorts. The former perhaps produce a little better char, but the latter, working almost automatically, require less labour and attention for an equal amount of work, and on the whole have proved very satisfactory. From the drying floor on which the spent char is heaped up it falls by gravitation into the retorts. These are set in a kiln or oven, and are kept at as even a temperature as possible, corresponding to a dull cherry-red. Below each retort, and attached to it, is a cooler formed of thin sheet-iron, which receives the hot char as it passes from the retort, and at the bottom of the cooler is an arrangement of valves which permits a certain amount of char to drop out and no more. With the fixed retorts these valves are worked from time to time by the attendant, but with revolving retorts they are worked continuously and automatically and allow from sixteen to twenty-four ounces of char to escape per minute from each cooler, and so make room in the retort above for a corresponding quantity to enter from the drying floor. The reburnt and cooled char is collected and sent back to the char cisterns. In the best-appointed refineries the whole of the work in connexion with the char is performed mechanically, with the exception of packing the filter cisterns with fresh char and emptying the spent and washed char on to the carrying bands. In former days, when refining sugar or "sugar baking" was supposed to be a mystery only understood by a few of the initiated, there was a place in the refinery called the "secret room," and this name is still used in some refineries, where, however, it applies not to any room, but to a small copper cistern, constructed with five or six or more divisions or small canals, into which all the charcoal cisterns discharge their liquors by pipes led up from them to the top of the cistern. Each pipe is fitted with a cock and swivel, in such a manner that the liquor from the cistern can be turned into the proper division according to its quality.

Vacuum Pans and Receivers.—The filtered liquors, being collected in the various service tanks according to their qualities, are drawn up into the vacuum pans and boiled to crystals. These are then discharged into large receivers, which are generally fitted with stirrers, and from the receivers the cooked mass passes to the centrifugal machines. As in the beetroot factories, these machines work on different systems, but nearly all are arranged to turn out sugar in lumps or tablets presenting an appearance similar to that of loaf sugar made in moulds, as this kind of sugar meets with the greatest demand. Granulated sugar, so called, is made by passing the crystals, after leaving the centrifugals, through a large and slightly inclined revolving cylinder with a smaller one inside heated by steam. The sugar fed into the upper end of the cylinder gradually works its way down to the lower, showering itself upon the heated central cylinder. A fan blast enters the lower end, and, passing out at the upper end, carries off the vapour produced by the drying of the sugar, and at the same time assists the evaporation. The dry sugar then passes into a rotating screen fitted with two meshes, so that three grades of sugar are obtained, the coarsest being that which falls out at the lower end of the revolving screen.

Recent Improvements.—Systematic feeding for the vacuum pan and systematic washing of the massecuite have been recently introduced not only into refineries, but also into sugar houses or factories on plantations of both cane and beetroot, and great advantages have resulted from their employment. The first-mentioned process consists of charging and feeding the vacuum pan with the richest syrup, and then as the crystals form and this syrup becomes thereby less rich the pan is fed with syrup of lower richness, but still of a richness equal to that of the mother-liquor to which it is added, and so on until but little mother-liquor is left, and that of the poorest quality. The systematic washing of the massecuite is the reverse of this process. When the massecuite, well pugged and prepared for purging, is in the centrifugals, it is first washed with syrup of low density, to assist the separation of mother-liquor of similar quality, this washing being supplemented by the injection of pure syrup of high density, or "clairce," when very white sugar is required. The manufacturers who have adopted this system assert that, as compared with other methods, not only do they obtain an increased yield of sugar of better quality, but that they do so at a less cost for running their machines and with a reduced expenditure in sugar and "clairce." "Clairce" is the French term for syrup of 27° to 30° Beaumé specially prepared from the purest sugar.

Apart from modifications in the details of sugar refining which have come into use in late years, it should be mentioned that loaf sugar made in conical moulds, and sugars made otherwise, to resemble loaf sugar, have practically disappeared from the trade, having been replaced by cube sugar, which is found to be more economical as subject to less waste by grocers and housekeepers, and also less troublesome to buy and sell. Its manufacture was introduced into England many years ago by Messrs Henry Tate & Sons, and they subsequently adopted and use now the improved process and apparatus patented in March 1890 by M Gustave Adant, a foreman sugar refiner of Brussels.

The following is a brief description of the process and apparatus, as communicated by the courtesy of Messrs Henry Tate & Sons, Ltd.: Groups of cells or moulds are built within and against a cylindrical iron casing, by means of vertical plates inserted in grooves and set radially to the axis of the casing. Each cell is of suitable dimensions to turn out a slab of sugar about 14 in. long—this being about the height of the cell—and about 8 in. wide and about ½ in. to ⅝ in. thick. By means of a travelling crane the casing is placed within an iron drum, to which it is secured, and is then brought under an overhead vacuum pan, from which the cells are filled with massecuite. After cooling, the casing is lifted out of the drum by a crane, assisted by compressed air, and is then conveyed by a travelling crane to a vertical centrifugal, inside of which it is made fast. Suitable provision is made for the egress of syrup from the massecuite in the cells when undergoing purging in the centrifugal; and the washing of the crystals can be aided by the injection of refined syrup and completed by that of "clairce." When this is done, the casing is hoisted out of the centrifugal and the vertical plates and the slabs of sugar are extracted. The slabs are sent by a conveyor to a drying stove, whence they issue to pass through a cutting machine, provided with knives so arranged that the cutting takes place both downwards and upwards, and here the slabs are cut into cubes. The cubes fall from the cutting machine on to a riddling machine, which separates those which are defective in size from the rest. These latter pass to automatic weighing machines, which drop them, in quantities of 1 cwt., into wooden boxes of uniform measurement, made to contain that weight; and the boxes are then conveyed to the storehouse, ready for sale.

History and Statistics.—Strabo xv. i. 20, has an inaccurate notice from Nearchus of the Indian honey-bearing reed, and various classical writers of the first century of our era notice the sweet sap of the Indian reed or even the granulated salt-like product which was imported from India, or from Arabia and Opone (these being entrepôts of Indian trade),[1] under the name of saccharum or σάκχαρι (from Skr. *sarkara*, gravel, sugar), and used in medicine. The art of boiling sugar was known in Gangetic India, from which it was carried to China in the first half of the 7th century; but sugar refining cannot have then been known, for the Chinese learned the use of ashes for this purpose only in the Mongol period, from Egyptian visitors.[2] The cultivation of the cane in the West spread from Khūzistān in Persia. At Gundē-Shāpūr in this region "sugar was prepared with art" about the time of the Arab conquest,[3] and manufacture on a large scale was carried on at Shuster, Sūs and Askar-Mokram throughout the middle ages.[4] It has been plausibly conjectured that the art of sugar refining, which the farther East learned from the Arabs, was developed by the famous physicians of this region, in whose pharmacopoeia sugar had an important place. Under the Arabs the growth and manufacture of the cane spread far and wide, from India to Sūs in Morocco (Edrīsī, ed. Dozy, p. 62), and were also introduced into Sicily and Andalusia.

In the age of discovery the Portuguese and Spaniards became the great disseminators of the cultivation of sugar; the cane was planted in Madeira in 1420; it was carried to San Domingo in 1494; and it spread over the occupied portions of the West Indies and South America early in the 16th century. Within the first twenty years of the 16th century the sugar trade of San Domingo expanded with great rapidity, and it was from the dues levied on the imports brought thence to Spain that Charles V. obtained funds for his palace-building at Madrid and Toledo. In the middle ages Venice was the great European centre of the sugar trade, and towards the end of the 15th century a Venetian citizen received a reward of 100,000 crowns for the invention of the art of making loaf sugar. One of the earliest references to sugar in Great Britain is that of 100,000 ℔ of sugar being shipped to London in 1319 by Tomasso Loredano, merchant of Venice, to be exchanged for wool. In the same year there appears in the accounts of the chamberlain of Scotland a payment at the rate of 1s. 9½d. per ℔ for sugar. Throughout Europe it continued to be a costly luxury and article of medicine only, till the increasing use of tea and coffee in the 18th century brought it into the list of principal food staples. The increase in the consumption is exemplified by the fact that, while in 1700 the amount used in Great Britain was 10,000 tons, in 1800 it had risen to 150,000 tons, and in 1885 the total quantity used was almost 1,100,000 tons.

In 1747 Andreas Sigismund Marggraf, director of the physical classes in the Academy of Sciences, Berlin, discovered the existence of common sugar in beetroot and in numerous other fleshy roots which grow in temperate regions. But no practical use was made of the discovery during his lifetime. The first to establish a beet-sugar factory was his pupil and successor, Franz Carl Achard, at Cunern (near Breslau) in Silesia in 1801. The processes used were at first very imperfect, but the extraordinary increase in the price of sugar on the Continent caused by the Napoleonic policy gave an impetus to the industry, and beetroot factories were established at many centres both in Germany and in France. In Germany the enterprise came to an end almost entirely with the downfall of Napoleon I.; but in France, where at first more scientific and economical methods of working were introduced, the manufacturers were able to keep the industry alive. It was not, however, till after 1830 that it secured a firm footing; but from 1840 onwards it advanced with giant strides.

Under the bounty system, by which the protectionist countries of Europe stimulated the beet sugar industry by bounties on exports, the production of sugar in bounty-paying countries was encouraged and pushed far beyond the limits it could have reached without state aid. At the same time the consumption of sugar was greatly restricted owing to the heavy excise duties imposed mainly to provide for the payment of the bounties. The very large quantity of output made available for export under these exceptional conditions brought about the flooding of the British and other markets with sugars at depressed prices, not unfrequently below the prime cost of production, to the harassment of important industries carried on by British refiners and sugar-growing colonies. In these circumstances, the British government sent out invitations on the 2nd of July 1887 for an international conference to meet in London. The conference met, and on the 30th of August 1888 a convention was signed by all the powers represented except France—namely, by Austria, Belgium, Germany, Great Britain, Italy, the Netherlands, Russia and Spain. France withdrew because the United States was not a party to it. The first article declared that "The high contracting parties engage to take such measures as shall constitute an absolute and complete guarantee that no open or disguised bounty shall be granted on the manufacture or exportation of sugar." The seventh article provided that bountied sugars (*sucres primés*) must be excluded from import into the territories of the signatory powers, by absolute prohibition of entry or by levying thereon a special duty in excess of the amount of the bounties, from which duty sugars coming from the contracting countries, and not bounty-fed, must be free. The convention was to be ratified on the 1st of August 1890, and was to be put in force on the 1st of September 1891.

The convention of 1888 was never ratified, and it is doubtful whether its ratification was urged, for a bill introduced by the British government in 1889 to give it effect was not pressed, and it was manifest that there was hesitation—which presently became refusal—to uphold the policy of the penalties on the importation of bountied sugar imposed by the seventh article, without which the convention would be so much waste paper.

Eight years later, on the 1st of August 1896, the bounties offered by the governments of Germany and Austria-Hungary were approximately doubled, and France had a bill in preparation to increase hers correspondingly, although it was computed that they were even then equivalent to a grant of £3, 5s. per ton. So wrote Mr Chamberlain, the colonial secretary, on the 9th of November following, to the treasury. The minute plainly stated that it had become a question whether the continued enjoyment of advantages resulting from the importation of cheap bounty-fed sugar to some British industries did not involve the ruin of the British sugar-producing colonies; and that he was not prepared, as secretary of state for the colonies, to accept the responsibility of allowing matters to take their course and to acquiesce in the policy of non-intervention hitherto pursued in regard to the bounties without having satisfied himself as to what such a policy might entail as regarded both the colonies and the exchequer. Mr Chamberlain concluded by asking whether the treasury would consent to sending a royal commission to the West Indies to inquire into the effect of the foreign sugar bounties on their principal industry.

The treasury accepted the proposal, and a royal commission proceeded to the West Indies in December 1896, and reported a few months later in 1897. Only one commissioner, however, denounced the bounties as the real cause of the utter breakdown of trade and of the grievous distress which all three had witnessed

[1] Lucan iii. 237; Seneca, *Epist.* 84; Pliny, *H.N.* xii. 8 (who supposes that sugar was produced in Arabia as well as in India); *Peripl. mar. Eryth.* § 14; Dioscorides ii. 104. The view, often repeated, that the saccharum of the ancients is the hydrate of silica, sometimes found in bamboos and known in Arabian medicine as *tabāshīr*, is refuted by Yule, *Anglo-Indian Glossary*, p. 654; see also *Not. et extr. des MSS. de la bibl. nat.* xxv. 267 seq.

[2] Marco Polo, ed. Yule, ii. 208, 212. In the middle ages the best sugar came from Egypt (Kazwīnī i. 262), and in India coarse sugar is still called Chinese and fine sugar Cairene or Egyptian.

[3] So the Armenian *Geography* ascribed to Moses of Chorene (*q.v.* for the date of the work); St Martin, *Mém. sur l'Arménie*, ii. 372.

[4] Iṣṭakhrī p. 91; Yākūt ii. 497. Tha'ālibī, a writer of the 11th century, says that Askar-Mokram had no equal for the quality and quantity of its sugar, "notwithstanding the great production of 'Irāk, Jorjān and India." It used to pay 50,000 ℔ of sugar to the sultan in annual tribute (*Laṭāif*, p. 107). The names of sugar in modern European languages are derived through the Arabic from the Persian *shakar*.

and fully acknowledged. But the minute and commission were not barren of result. A fresh conference of the powers assembled at Brussels, on the invitation of the Belgian government, on the 7th of June 1898; and although the British delegates were not empowered to consent to a penal clause imposing countervailing duties on bountied sugar, the Belgian premier, who presided, was able to assure them that if Great Britain would agree to such a clause, he could guarantee the accession of the governments of Germany, Austria, Holland and his own. Of all the countries represented—Germany, Austria-Hungary, Belgium, Spain, France, Great Britain, the Netherlands, Russia and Sweden—only one, namely France, was opposed to the complete suppression of all export bounties, direct or indirect; and Russia declined to discuss the question of her internal legislation, contending that her system did not amount to a bounty on exportation.

Apart from the proceedings at the sittings, much of the actual work of the conference was done by informal discussion, undertaken to discover some means of arriving at a common understanding. Was a compromise possible which would bring about a satisfactory settlement? The British delegates wrote that it appeared that there were at that time but two methods of securing the suppression of the bounty system—an arrangement for limitation of the French and Russian bounties acceptable to the other sugar-producing states, in return for the total abolition of their bounties; or, a convention between a certain number of these states, providing for the total suppression of their bounties, and for the prohibition of entry into their territory of bounty-fed sugars, or countervailing duties prohibiting importation.

The Belgian government thought a compromise might be possible. A proposal was annexed to the *procès-verbal* of the final sitting, and the president closed the first session of the conference on the 25th of June 1898 with the expression of a hope that the delegates would soon reassemble.

The annual aggregate output of cane and date sugar in India was short of 4,000,000 tons. Exportation had long ceased, partly owing to the bountied competition of beet sugar, and partly because the people had become able to afford the consumption of a greater quantity than they produced; and German and Austrian sugars were pouring into the country to supply the deficiency. But the importation of foreign sugar, cheapened by foreign state aid to a price which materially reduced the fair and reasonable profit of native cultivators, was a state of things the Indian government could not accept. On the 20th of March 1899 an act, authorizing the imposition of countervailing duties on bounty-fed articles at the port of importation, was passed by the Council of India, and received the assent of the governor-general.

This decisive step was not long in making itself felt in the chanceries of Europe. In October 1900 a conditional agreement for the reduction of the bounties was made in Paris between France, Germany and Austria-Hungary; in February 1901 the Belgian government proposed a new session of the Conference of 1898, and on the 16th of December following Brussels welcomed once more the delegates of all the powers, with the exception of Russia, to the eighth European Sugar Bounty Conference since that of Paris in 1862. The discussion lasted over eight sittings, but the conference, to which the British delegates had come with powers to assent to a penal clause, arrived at an understanding, and a convention was signed in March 1902. This was ratified on the 1st of February 1903, subject to a declaration by Great Britain that she did not consent to penalize bounty-fed sugar from the British colonies.

It was agreed "to suppress the direct and indirect bounties which might benefit the production or export of sugar, and not to establish bounties of this kind during the whole duration of the convention," which was to come into force on the 1st of September 1903, and to remain in force five years, and thenceforward from year to year, in case no state denounced it twelve months before the 1st of September in any year. A permanent commission was established to watch its execution.

The full text in French, with an English translation, of the Sugar Convention, signed at Brussels on the 5th of March 1902 by the plenipotentiaries of the governments of Germany, Austria-Hungary, Belgium, Spain, France, Great Britain, Italy, the Netherlands and Sweden, will be found in a return presented to parliament in April 1902 (Miscellaneous, No. 5, 1902, Cd. 1013).

TABLE I.—Amounts (reduced to English money per cwt. avoirdupois) of the total net sugar bounties granted by European powers, according to the computation issued by the secretary of the United States treasury on the 12th of December 1898.

Sugars polarizing										
From . .	75°	88°	65°	90°	88°	93°	98°	98°	99°	99½°
To . . .	88°	93°	98°	98°	99°	99½°	99½°	100°	100°	100°
Bounties (per cwt.)										
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Countries—										
Russia .	2 3·3				2 11·1				3 4·65	
Austria-Hungary		1 2				1 3				1 9·3
France .			4 4¾							
Crystals								4 6½		
Refined								4 10½		
Germany				1 3			1 6			1 9·3

Sugars classed as (per cwt.)		
	Raw Sugar.	Refined Sugar.
Countries—	s. d.	s. d.
Belgium	1 10	2 2¼
Denmark	—	0 7·6

Sugars analysing in pure sugar (per cwt.)			
			Hard Dry Refined.
Less than . .	98 %	98 % and over.	(Additional)
Country—	s. d.	s. d.	s. d.
Holland . .	1 10·8	1 6	0 3

Sir H. Bergne reported on the 27th of July 1907 to Sir Edward Grey that—

"The permanent session had met in special session on the 25th of July, to consider the suggestion of His Britannic Majesty's government to the effect that, if Great Britain could be relieved from the obligation to enforce the penal provisions of the convention, they would be prepared not to give notice on the 1st of September next of their intention to withdraw on the 1st of September 1908 a notice which they would otherwise feel bound to give at the appointed time"; and he added that "At this meeting, a very general desire was expressed that, in these circumstances, arrangements should, if possible, be made which would permit Great Britain to remain a party to the Sugar Convention."

On the 1st of August 1907 the Belgian minister in London transmitted to Sir Edward Grey a draft additional act prepared by the commission for carrying out the proposal of His Britannic Majesty's government, and on the 28th of August following an additional act was signed at Brussels by the plenipotentiaries of the contracting parties, by which they undertook to maintain the convention of the 5th of March 1902 in force for a fresh period of five years.

On the 2nd of December 1907 Sir H. Bergne wrote to the foreign office from Brussels, reporting that a special session of the permanent commission, established under the sugar bounties convention, had opened on the 18th of November, and the principal matter for its consideration had been the application of Russia to become a party to the convention on special terms. A protocol admitting Russia to the sugar convention was signed at Brussels on the 19th of December 1907.

Sir A. H. Hardinge on behalf of Great Britain made the following declaration:—

"The assent of His Majesty's government to the present protocol is limited to the provisions enabling Russia to adhere to the convention, and does not imply assent to the stipulation tending to restrict the importation of Russian sugar."

When, in April 1908, Mr Asquith became premier, and Mr Lloyd George chancellor of the exchequer, the sugar convention

TABLE II.

The world's trade in cane and beet sugar in tons avoirdupois at decennial periods from 1840 to 1870, inclusive, and yearly from 1871 to 1901 inclusive, with the percentage of beet sugar and the average price per cwt. in shillings and pence. Tons avoirdupois of 2240 ℔ = 1016 kilogrammes.

Year.	Cane.	Beet.	Total.	Per cent. Beet.	Average price per cwt.	Year.	Cane.	Beet.	Total.	Per cent. Beet.	Average price per cwt.
					s. d.						s. d.
1840	1,100,000	50,000	1,150,000	4·35	48 0	1884–1885	2,351,000	2,545,000	4,896,000	51·98	12 4
1850	1,200,000	200,000	1,400,000	14·29	40 0	1885–1886	2,339,000	2,223,000	4,562,000	48·72	13 1
1860	1,510,000	389,000	1,899,000	20·43	35 0	1886–1887	2,345,000	2,733,000	5,078,000	53·82	11 9
1870	1,585,000	831,000	2,416,000	34·40	32 0	1887–1888	2,465,000	2,451,000	4,916,000	49·85	12 9
1871–1872	1,599,000	1,020,000	2,619,000	38·95	24 9	1888–1889	2,263,000	2,725,000	4,988,000	54·63	14 10
1872–1873	1,793,000	1,210,000	3,003,000	40·29	24 8	1889–1890	2,069,000	3,633,000	5,702,000	63·71	15 1
1873–1874	1,840,000	1,288,000	3,128,000	41·17	22 10	1890–1891	2,555,000	3,710,000	6,265,000	59·21	14 0
1874–1875	1,712,000	1,219,000	2,931,000	41·59	20 1	1891–1892	2,852,000	3,501,000	6,353,000	55·10	13 6
1875–1876	1,590,000	1,343,000	2,933,000	45·78	18 1	1892–1893	3,045,000	3,428,000	6,473,000	52·95	14 3
1876–1877	1,673,000	1,045,000	2,718,000	38·44	22 8	1893–1894	3,490,000	3,890,000	7,380,000	52·71	13 5
1877–1878	1,825,000	1,419,000	3,244,000	43·74	23 0	1894–1895	3,530,000	4,792,000	8,322,000	57·75	9 11
1878–1879	2,010,000	1,571,000	3,581,000	43·89	19 2	1895–1896	2,830,000	4,315,000	7,145,000	50·30	10 7
1879–1880	1,852,000	1,402,000	3,254,000	43·08	19 3	1896–1897	2,864,000	4,954,000	7,818,000	56·18	9 3
1880–1881	1,911,000	1,748,000	3,659,000	46·13	20 4	1897–1898	2,898,000	4,872,000	7,770,000	62·70	11 9
1881–1882	2,060,000	1,782,000	3,842,000	46·38	20 4	1898–1899	2,995,000	4,977,000	7,972,000	62·70	11 9
1882–1883	2,107,000	2,147,000	4,254,000	50·47	20 2	1899–1900	2,904,000	5,510,000	8,414,000	65·48	11 6
1883–1884	2,323,000	2,361,000	4,684,000	50·40	16 8	1900–1901	2,850,000	5,950,000	8,800,000	67·61	11 6

The quantities of cane sugar are based on the trade circulars of Messrs Willett & Gray of New York; those of beet sugar on the trade circulars of Messrs F. O. Licht of Magdeburg; and the prices are obtained from statements supplied by importers into the United States of the cost in foreign countries of the sugars which they import. The table has been adapted from the Monthly Summary of Commerce and Finance of the United States, January 1902, prepared in the Bureau of Statistics, Treasury Department, Washington Government Printing Office, 1902.

TABLE III.

Quantities of raw and refined cane and beet sugar in tons avoirdupois imported into the United Kingdom in 1870 and in 1875, and yearly from 1880 to 1901 inclusive, with the consumption per head of the population in ℔ and the price per cwt. of raw and refined sugar.

Year.	Raw Cane.	Raw Beet.	Refined Cane.	Refined Beet.	Total.	Consumption per head.		Total.	Price per cwt.	
						Raw.	Refined.		Raw.	Refined.
	Tons.	Tons.	Tons.	Tons.	Tons.	℔	℔	℔	s. d.	s. d.
1870	556,000	84,000	3,000	82,000	725,000	—	—	—	—	—
1875	705,000	107,000	16,000	128,000	956,000	50·64	8·88	59·52	21 2	30 4
1880	590,000	260,000	11,000	140,000	1,001,000	51·09	9·46	60·55	21 9	29 5
1881	623,000	310,000	5,000	135,000	1,071,000	56·01	8·44	64·45	21 9	28 11
1882	726,000	265,000	6,000	133,000	1,130,000	58·78	8·38	67·16	21 1	28 8
1883	597,000	420,000	7,000	157,000	1,183,000	58·73	9·87	68·10	20 1	27 2
1884	582,000	399,000	53,000	160,000	1,194,000	55·57	12·58	68·15	15 6	28 11
1885	561,000	410,000	114,000	152,000	1,237,000	55·46	15·75	71·21	13 10	18 2
1886	468,000	339,000	71,000	247,000	1,125,000	44·61	18·75	63·36	13 0	16 8
1887	439,000	461,000	39,000	311,000	1,250,000	50·80	20·25	71·05	12 1	15 8
1888	574,000	319,000	2,000	342,000	1,237,000	47·97	19·99	67·96	13 5	17 8
1889	470,000	407,000	1,000	448,000	1,326,000	48·38	26·54	74·92	15 5	19 8
1890	283,000	503,000	15,000	484,000	1,285,000	42·87	28·22	71·09	12 6	16 4
1891	349,000	461,000	27,000	540,000	1,377,000	45·08	32·94	78·02	12 10	16 6
1892	386,000	429,000	2,000	529,000	1,346,000	44·58	30·63	75·21	13 0	17 1
1893	368,000	434,000	2,000	575,000	1,379,000	42·41	33·17	75·58	14 2	18 4
1894	324,000	391,000	1,000	696,000	1,412,000	37·18	39·90	77·08	11 5	15 6
1895	388,000	463,000	1,000	706,000	1,558,000	45·28	40·10	85·38	9 7	13 4
1896	381,000	406,000	1,000	738,000	1,526,000	40·94	41·53	82·47	10 5	13 7
1897	242,000	434,000	1,000	793,000	1,469,000	34·52	43·92	78·44	9 0	12 3
1898	286,000	478,000	1,000	825,000	1,560,000	39·89	45·29	85·18	9 8	12 5
1899	186,000	469,000	1,000	889,000	1,545,000	35·63	48·68	84·31	10 6	12 7
1900	150,000	512,000	1,000	961,000	1,624,000	35·48	52·23	87·71	10 5	12 10
1901	178,472	526,451	1,000	1,079,553	1,785,476	36·80	56·40	93·20	10 6	12 0

of 1902 had thus been renewed in a modified form. Great Britain, instead of agreeing to prohibit the importation of bounty-fed sugar, was allowed to permit it under certain limits. Russia, which gave bounties, was to be allowed to send into European markets not more than 1,000,000 tons within the next five years, and Great Britain undertook to give certificates guaranteeing that sugar refined in the United Kingdom and exported had not been bounty-fed. The renewal of the convention was disapproved by certain Liberal politicians, who insisted that the price of sugar had been raised by the convention; and Sir Edward Grey said that the government had intended to denounce the convention, but other countries had urged that Great Britain had induced them to enter into it, and to alter their fiscal system for that purpose, and it would be unfair to upset the arrangement. Besides, denunciation would not have meant a return to prior conditions; for other countries would have continued the convention, and probably with success, and would have proposed prohibitive or retaliatory duties in respect of British sugar, with bad results politically. Still the British government had been prepared to denounce the convention in view of the penal clause which had ensured the exclusion of bounty-fed sugar, either directly or through the imposition of an extra duty. But this had been removed, and it was now unreasonable to insist on denunciation. Russia would have made the same arrangement she had obtained had we seceded from the convention. She had formerly sent to England about 40,000 tons of sugar yearly; she might now send 200,000 tons. Was this limitation a reason for sacrificing the advantages we had gained? Under the original terms of the convention Great Britain might have been asked to close her ports to sugar proceeding from one country or another. This was now impossible.

TABLE IV.

The cane and beet sugar crops of the world for 1909–1910, with the average of the crops for the seven preceding years from 1902–1903, in tons of 2240 lb.

A.—Cane sugar (compiled from the *Weekly Statistical Sugar Trade Journal* of Messrs Willett & Gray of New York, and books and reports published under the authority of the government of India).

Country.	Crop. 1909–1910	Average crop for 7 years ending 1908–1909.
	Tons avoirdupois.	Tons avoirdupois.
Africa—		
Egypt	55,000	67,592
Mauritius	220,000	183,688
Réunion	45,000	33,299
Natal	45,000	27,857
Total in Africa	365,000	312,436
America—		
Argentina	120,000	132,410
Brazil	276,000	218,214
British Colonies—		
Trinidad	45,000	45,232
Barbadoes	40,000	37,492
Jamaica	12,000	13,253
Antigua and St Kitts	25,000	21,857
Demerara	115,000	114,922
Lesser Antilles	6,000	10,715
Total in British Colonies	243,000	243,471
Costa Rica	2,500	2,657
Cuba	1,700,000	1,180,203
Danish Colony, St Croix	15,000	12,857
Dutch Colony, Surinam	15,000	13,149
French Colonies—		
Martinique	40,000	34,279
Guadeloupe	40,000	37,500
Total in French Colonies	80,000	71,779
Ecuador	7,000	6,143
Guatemala	7,500	8,016
Haiti and Santo Domingo	90,000	56,043
Mexico	130,000	114,790
Nicaragua	4,500	4,260
Peru	150,000	143,619
Salvador	6,500	5,646
United States—		
Louisiana	325,000	300,714
Texas	10,000	9,571
Porto Rico	280,000	176,286
Hawaiian Islands	490,000	404,424
Total in United States	1,105,000	890,995

Country.	Crop. 1909–1910	Average crop for 7 years ending 1908–1909.
	Tons avoirdupois.	Tons avoirdupois.
Venezuela	3,000	3,000
Total in America	3,955,000	3,107,252
Asia—		
British India and Dependencies	3,750,000	3,600,000
China	1,000,000	1,000,000
Dutch Colony—		
Java and Madoera	1,200,000	1,019,739
Japan and Formosa	130,000	94,225
United States possession—		
Philippine Islands	145,000	125,468
Siam	7,000	6,000
Total in Asia	6,232,000	5,845,432
Australia and Polynesia—		
British Colonies—		
Fiji Islands	69,000	49,928
Queensland	136,000	144,000
New South Wales	14,500	20,706
Total in Australia and Polynesia	219,500	214,634
Europe—		
Spain	16,000	19,473
Total in Europe	16,000	19,473
Summary—		
Africa	365,000	312,436
America	3,955,000	3,107,252
Asia	6,232,000	5,845,432
Australia and Polynesia	219,500	214,634
Europe	16,000	19,473
Total production of cane sugar in the world	10,787,500	9,499,227

B.—Beet sugar (compiled from data furnished by the Statistisches Bureau für die Rübenzucker Industrie des Deutschen Reiches, of Mr F. O. Licht, Magdeburg).

Country.	Crop, 1902–1903.	Crop, 1903–1904.	Crop, 1904–1905.	Crop, 1905–1906.	Crop, 1906–1907.	Crop, 1907–1908.	Crop, 1908–1909.	Estimated crop, 1909–1910.	Average of 7 years 1902–1903 to 1908–1909.
	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.	Tons avoirdupois.
Austria-Hungary	1,040,987	1,149,516	875,383	1,485,944	1,322,716	1,402,157	1,376,501	1,240,102	1,236,172
Belgium	220,550	200,233	173,679	323,577	278,338	228,682	254,258	246,051	239,902
Denmark	36,004	46,258	44,161	64,958	65,942	53,147	64,367	63,973	53,548
France	820,050	791,605	612,592	1,072,473	744,153	716,218	794,312	811,970	793,058
Germany	1,734,624	1,897,234	1,572,923	2,379,959	2,203,810	2,095,959	2,049,951	2,007,780	1,990,637
Holland	100,793	121,600	134,394	203,912	178,551	172,417	210,958	196,841	160,375
Italy	82,433	128,794	77,143	92,433	104,702	133,818	162,701	114,168	111,718
Russia	1,236,469	1,187,848	938,565	953,204	1,417,386	1,387,732	1,237,530	1,131,840	1,194,105
United States	192,376	204,847	206,410	279,236	426,171	433,248	377,945	418,288	302,890
Other countries	201,510	249,254	205,548	246,384	289,220	268,498	289,935	274,594	250,050
Total crop of the world	5,665,796	5,977,189	4,840,798	7,102,080	7,030,989	6,891,876	6,818,458	6,505,607	6,332,455

The matter temporarily dropped, but certain Liberal members of parliament continued to press for the withdrawal of Great Britain from the convention, it being stated that a promise had been privately given by Sir Henry Campbell-Bannerman that the government would withdraw as soon as practicable. On the 15th of July 1908, Mr Asquith said that Sir Edward Grey had announced in the House of Commons on the 6th of June 1907 that the British government intended to negotiate with the powers for the renewal of the convention, on condition that they would relinquish the penal clause, and that none of the obligations in the convention as renewed were penal or required statutory authority.

Tables II., III. (p. 773) and IV. (p. 774) give statistics of cane and beet sugar production.

The quantities for India have been computed from information furnished by the India office, and publications made under authority of the secretary of state and the commercial intelligence department of the Indian government.

The whole of the sugar produced in India is consumed in the country and sugar is imported, the bulk of it being cane sugar coming from Mauritius and Java, and about 85% of the import is of high quality resembling refined sugar.

It would appear that the purchasing power of the inhabitants of India has increased of late years, and there is a growing demand for refined sugar, fostered by the circumstance that modern processes of manufacture can make a quality of sugar, broadly speaking, equal to sugar refined by animal charcoal, without using charcoal, and so the religious objections to the refined sugars of old days have been overcome. (A. Ch.; V. W. Ch.)

SUGAR-BIRD, the English name commonly given in the West India Islands to the various members of the genus *Certhiola* (belonging to the Passerine family Coerebidae[1]) for their habit of frequenting the curing-houses where sugar is kept, apparently attracted thither by the swarms of flies. They often come into dwelling-houses, hopping from one piece of furniture to another and carefully exploring the surrounding objects with intent to find a spider or insect. In their figure and motions they remind a northern naturalist of a nuthatch, while their coloration—black, yellow, olive, grey and white—recalls to him a titmouse. They generally keep in pairs and build a domed but untidy nest, laying therein three eggs, white, blotched with rusty-red. Many species are recognized, some of them with a very limited range; three are continental, with a joint range extending from southern Mexico to Peru, Bolivia and south-eastern Brazil, while others are peculiar to certain of the Antilles, and several of them to one island only. Thus *C. caboti* is limited, so far as is known, to Cozumel (off Yucatan), *C. tricolor* to Old Providence, *C. flaveola* (the type of the genus) to Jamaica, and so on, while islands that are in sight of one another are often inhabited by different "species." The genus furnishes an excellent example of the effects of isolation in breaking up an original form, while there is comparatively little differentiation among the individuals which inhabit a large and continuous area. The non-appearance of this genus in Cuba is very remarkable. (A. N.)

SUGER (*c.* 1081–1151), French ecclesiastic, statesman and historian, was born of poor parents either in Flanders, at St Denis near Paris or at Toury in Beauce. About 1091 he entered the abbey of St Denis. Until about 1104 he was educated at the priory of St Denis de l'Estrée, and there first met his pupil King Louis VI. From 1104 to 1106 Suger attended another school, perhaps that attached to the abbey of St Benoît-sur-Loire. In 1106 he became secretary to the abbot of St Denis. In the following year he was made provost of Berneval in Normandy, and in 1109 of Toury. In 1118 he was sent by Louis VI. to the court of Pope Gelasius II. at Maguelonne, and lived from 1121 to 1122 at the court of his successor, Calixtus II. On his return from Italy Suger was appointed abbot of St Denis. Until 1127 he occupied himself at court mainly with the temporal affairs of the kingdom, while during the following decade he devoted himself to the reorganization and reform of St Denis. In 1137 he accompanied the future king, Louis VII., into Aquitaine on the occasion of that prince's marriage to Eleanor of Aquitaine, and during the second crusade was one of the regents of the kingdom (1147–1149). He was bitterly opposed to the king's divorce, having himself advised the marriage. Although he disapproved of the second crusade, he himself, at the time of his death, on the 31st of January 1151, was preaching a new crusade.

Suger was the friend and counsellor both of Louis VI. and Louis VII. He urged the king to destroy the feudal bandits, was responsible for the royal tactics in dealing with the communal movements, and endeavoured to regularize the administration of justice. He left his abbey, which possessed considerable property, enriched and embellished by the construction of a new church built in the nascent Gothic style.

Suger was the foremost historian of his time. He was the author of a panegyric on Louis VI. (*Vita Ludovici regis*), and part-author of the perhaps more impartial history of Louis VII. (*Historia gloriosi regis Ludovici*). In his *Liber de rebus in administratione sua gestis*, and its supplement *Libellus de consecratione ecclesiae S. Dionysii*, he treats of the improvements he had made to St Denis, describes the treasure of the church, and gives an account of the rebuilding. Suger's works served to imbue the monks of St Denis with a taste for history, and called forth a long series of quasi-official chronicles.

See O. Cartellieri, *Abt Suger von Saint-Denis* (Berlin, 1898); A. Luchaire, *Louis le Gros* (Paris, 1890); F. A. Gervaise, *Histoire de Suger* (Paris, 1721).

SUGGESTION. By the older British writers on psychology the words "suggest" and "suggestion" were used in senses very close to those which they have in common speech; one idea was said to suggest another when it recalled that other to mind or (in the modern phrase) reproduced it. Modern studies in mental pathology and hypnotism (*q.v.*) have led to the use of these words by psychologists in a special and technical sense. The hypnotists of the Nancy school rediscovered and gave general currency to the doctrine that the most essential feature of the hypnotic state is the unquestioning obedience and docility with which the hypnotized subject accepts, believes, and acts in accordance with every command or proposition of the hypnotizer. Commands or propositions made to the subject (they may be merely implied by a gesture, a glance, or a chance remark to a third person) and accepted with this peculiarly uncritical and intense belief were called "suggestions"; and the subject that accepted them in this fashion was said to be "suggestible." It has also been made abundantly clear, chiefly by the labours of French physicians, that a high degree of "suggestibility" is a leading feature of hysteria, and that this fact is the key to the understanding of very many of its protean manifestations.

It is also becoming widely recognized that the suggestibility of hypnosis and of hysteria is conditioned by a peculiar state of the brain, namely a cerebral or mental dissociation, which in hypnosis is temporarily induced by the operations of the hypnotist, and in hysteria arises from some deficiency of energy in the whole psycho-physical system. In respect to these points there is now a wide consensus of opinion among the leading authorities; but as to the range and scope of suggestion in our mental life great differences of opinion still obtain. We may distinguish three principal views. Firstly, it is maintained by a number of physicians (notably by Professor Pierre Janet, whose profound studies of hysterical patients are justly celebrated) that all hypnotizable persons are hysterical and that suggestibility is a condition peculiar to hysterical subjects. In view of the assertions in recent years of several physicians of high repute to the effect that they find more than 90% of all subjects hypnotizable, it would seem that this view cannot be maintained, and that this restriction of suggestion to hysterical subjects only, and the stigmatization of suggestibility as in every case a morbid symptom, are errors arising from too exclusive occupation with its manifestations in this field. A second group consists of writers who admit that suggestion may operate in normal minds, but who, while recognizing that it is not an essentially pathological process, maintain that it is a process of very peculiar and exceptional nature that has little or no affinity with normal mental operations. They hold that suggestion, whether it occurs in morbid or in healthy subjects, always implies the coming into operation of some obscurely conceived faculty or region of the mind which is present in all men, but which usually lies hidden or submerged beneath the flow of our more commonplace mental activities. This submerged faculty or system of faculties, which is held by these authors to be operative in all processes of suggestion, is variously designated by them the secondary or submerged stratum of consciousness, the subconscious or subliminal self (see Subliminal Self). The writers of this group insist upon the more startling of the effects producible by suggestion, the more profound changes of bodily and mental processes, such as paralysis,

[1] Known in French as *Guitguits*, a name used for them also by some English writers. The *Guitguit* of Hernandez (*Rer. medic. N. hisp. thesaurus*, p. 56), a name said by him to be of native origin, can hardly be determined, though thought by Montbeillard (*Hist. nat. oiseaux*, v. 529) to be what is now known as *Coereba caerulea*, but that of later writers is *C. cyanea*. The name is probably onomatopoetic, and very likely analogous to the "quit" applied in Jamaica to several small birds.

contracture, hyperaesthesia, increased power of recollection, hallucinations (*q.v.*), &c.; and they regard dissociation as the process by which the submerged and supernormal faculty (or faculties) that they postulate is liberated from the dominance of the normal waking self.

A third view has been rapidly gaining ground and is now predominant. It connects itself with, and bases itself upon, the view of Professor Bernheim and his colleagues of the Nancy school of hypnotism. According to this view all men are normally suggestible under favourable conditions, and the hypnotic subject and the hysteric patient differ from the normal human being chiefly in that their normal suggestibility is more or less (sometimes very greatly) increased, owing to the prevalence of the state of cerebral dissociation.

According to this third view, suggestion may be defined as the communication of any proposition from one person (or persons) to another in such a way as to secure its acceptance with conviction, in the absence of adequate logical grounds for its acceptance. The idea or belief so introduced to the mind of the recipient is held to operate powerfully upon his bodily and mental processes in proportion to the degree of its dominance over all other ideas or mental processes; and the extraordinary character of the effects, both bodily and mental, of suggestion in hypnotic and hysterical subjects is held to be due to the fact that, in these conditions of mental dissociation, the dominance of the suggested idea is complete and absolute; whereas in the absence of such dissociation the operation of the suggested idea is always subject to some weakening or inhibition through the influence of many opposed or incompatible tendencies and ideas, even if these do not rise into explicit consciousness.

This third view seems justified by the facts that no sharp line can be drawn between the suggestibility of normal men and that of hypnotized or hysterical subjects, and that under favourable conditions many of the most striking results of suggestion (*e.g.* hallucinations, contractures, inability to move, insensibility of various sense-organs, and so forth) may be produced in subjects who present at the time no other symptom of the hypnotic or hysterical condition.

If, then, we recognize, as we must, that the alogical production of conviction is the essence of suggestion, and that this frequently occurs in normal minds as well as in those suffering from various degrees of dissociation, it becomes necessary to define the conditions that favour the operation of suggestion in normal minds.

These conditions are resident, on the one hand, in the recipient of the suggestion, and, on the other hand, in the source from which the suggestion comes. Of the conditions of the former class three seem to be of principal importance.

(*a*) Defect of knowledge: the defect may be quantitative or qualitative, *i.e.* it may consist in the lack of knowledge or of firmly established beliefs about the subject of the proposition, or it may consist in the lack of systematic organization of such knowledge as the mind possesses. The well-trained mind is relatively insuggestible, firstly because it possesses large stores of knowledge and belief; secondly, because this mass of knowledge and belief is systematically organized in such a way that all its parts hang together and mutually support one another. On the other hand, the young child, the uncultured adult, and especially the savage, are apt to be suggestible in regard to very many topics, first, because they have relatively little knowledge; secondly, because what little they have is of a low degree of organization; *i.e.* it does not form a logically coherent system whose parts reciprocally support one another. Suggestion in such cases may be said to be conditioned by primitive credulity or the suggestibility of ignorance. (*b*) But the same person will not be found to be equally suggestible at all times under similar external conditions. There are changes of mental state which, without overstepping the limits of the normal, condition varying degrees of increased suggestibility. A man is least suggestible when his mind works most efficiently, when he is most vigorous and most wide awake; every departure from this state, due to fatigue, bodily ill-health, emotional perturbation, drugs or any other cause, favours suggestibility. (c) Persons of equal degrees of knowledge or ignorance will be found, even at their times of greatest mental efficiency, to be unequally suggestible owing to differences of native disposition; one person is by nature more open than another to personal influence, more easily swayed by others, more ready to accept their dicta and adopt their opinions for his own. Differences of this kind are probably the expression of differences in the native strength of one of the fundamental instinctive dispositions of the human mind, an instinct which is called into play by the presence of persons of superior powers and the excitement of which throws the subject into an attitude of submission or subjection towards the impressive personality.

Considered from the side of the agent, suggestion is favoured by whatever tends to render him impressive to the subject or patient—great bodily strength or stature, fine clothes, a confident manner, superior abilities of any kind, age and experience, any reputation for special capacities, high social position or the occupation of any position of acknowledged authority; in short, all that is summed up by the term "personality," all that contributes to make a personality "magnetic" or to give it prestige renders it capable of evoking on the part of others the submissive suggestible attitude. A group of persons in agreement is capable of evoking the suggestible attitude far more effectively than any single member of the group, and the larger the group the more strongly does it exert this influence. Hence the suggestive force of the popularly accepted maxims and well-established social conventions; such propositions are collective suggestions which carry with them all the immense collective prestige of organized society, both of the present and the past; they embody the wisdom of the ages. It is in the main through the suggestive power of moral maxims, endowed with all the prestige of great moral teachers and of the collective voice of society, that the child is led to accept with but little questioning the code of morals of his age and country; and the propagation of all religious and other dogma rests on the same basis. The normal suggestibility of the child is thus a principal condition of its docility, and it is in the main by the operation of normal suggestion that society moulds the characters, sentiments, and beliefs of its members, and renders the mass of its elements harmonious and homogeneous to the degree that is a necessary condition of its collective mental life. Normal suggestion produces its most striking effects in the form of mass-suggestion, *i.e.* when it operates in large assemblies or crowds, especially if the members have but little positive knowledge and culture. For, when a belief is propagated by collective suggestion through the large mass of men, each falls under the suggestive sway of the whole mass; and under these conditions the operation of suggestion is further aided by the universal tendency of mankind to imitation and sympathy, the tendency to imitate the actions of, and to experience the emotions expressed by, those about one.

Conditions very favourable to mass-suggestion prevailed during the middle ages of European history; for these "dark ages" were characterized by the existence of dense populations, among whom there was free intercourse but very little positive knowledge of nature, and who were dominated by a church wielding immense prestige. Hence the frequent and powerful operations of suggestion on a large scale. From time to time fantastic beliefs, giving rise to most extravagant behaviour, swept over large areas of Europe like virulent epidemics—epidemics of dancing, of flagellation, of hallucination, of belief in the miraculous powers of relics or of individuals, and so forth. In these epidemics all the conditions favourable to normal suggestion were generally present in the highest degree, with the result that in great numbers of persons there were produced the more extreme effects of suggestion, such as are usually associated with the hysterical or hypnotic state. At the present time similar manifestations occur in a modified form, as *e.g.* the popular pilgrimages to Lourdes, Holywell and other places that from time to time acquire reputations for miraculous curative powers.

Auto-suggestion.—Although auto-suggestion does not strictly fall under the definition of suggestion given above, its usage to denote a mental process which produces effects very similar to those producible by suggestion is now so well established that it must be accepted. In auto-suggestion a proposition is formulated in the mind of the subject rather than communicated from another mind, and is accepted with conviction in the absence of adequate logical grounds. Generally the belief is initiated by some external event or some bodily change, or through some interpretation of the behaviour of other persons; *e.g.* a man falls on the road and a wagon very nearly passes over his legs, perhaps grazing them merely; when he is picked up, his legs are found to be paralysed. The event has induced the conviction that his legs are seriously injured, and this conviction operates so effectively as to realize itself. Or a savage, suffering some slight indisposition, interprets the behaviour of some person in a way which leads him to the conviction that this person is compassing his death by means of magical practices; accordingly he lies down in deep despondency and, in the course of some days or weeks, dies, unless his friends succeed in buying off, or in some way counteracting, the malign influence. Or, as a more familiar and trivial instance of auto-suggestion, we may cite the case of a man who, having taken a bread pill in the belief that it contains a strong purgative or emetic, realizes the results that he expects.

LITERATURE.—H. Bernheim, *De la Suggestion, et de ses applications à la thérapeutique* (2nd ed., Paris, 1887); Pierre Janet, *The Major Symptoms of Hysteria* (London, 1907); Otto Stoll, *Suggestion und Hypnotismus in der Völkerpsychologie* (2nd ed., Leipzig, 1904); Boris Sidis, *The Psychology of Suggestion* (New York, 1898); W. M. Keatinge, *Suggestion in Education* (London, 1907); F. W. H. Myers, *Human Personality and its Survival of Bodily Death* (London, 1903; 2nd ed., abridged, 1907); A. Binet, *La Suggestibilité* (Paris, 1900). See also literature under HYPNOTISM. (W. McD.)

SUHL, a town of Germany, in the province of Prussian Saxony, picturesquely situated on the Lauter, on the southern slope of the Thuringian Forest, 6½ m. N.E. of Meiningen and 29 m. S.W. of Erfurt by rail. Pop. (1905), 13,814. The armourers of Suhl are mentioned as early as the 9th century, but they enjoyed their highest vogue from 1550 to 1634. The knights of south Germany especially prized the swords and armour of this town, and many of the weapons used in campaigns against the Turks and in the Seven Years' War are said to have been manufactured at Suhl. It has suffered considerably in modern times from the competition of other towns in this industry, especially since the introduction of the breech-loading rifle. It still contains, however, large factories for firearms military and sporting, and side arms, besides ironworks, machine-works, potteries and tanneries. The once considerable manufacture of fustian has declined. A brine spring (Soolquelle) at the foot of the neighbouring Domberg is said to have given name to the town.

Suhl, which obtained civic rights in 1527, belonged to the principality of Henneberg, and formed part of the possessions of the kingdom of Saxony assigned to Prussia by the Congress of Vienna in 1815.

See Werther, *Chronik der Stadt Suhl* (2 vols., Suhl, 1846–1847).

SUICIDE (from Lat. *sui*, of oneself, and *cidium*, from *caedere*, to kill), the act of intentionally destroying one's own life. The phenomenon of suicide has at all times attracted a large amount of attention from moralists and social investigators. Its existence is looked upon, in Western civilization, as a sign of the presence of maladies in the body politic which, whether remediable or not, deserve careful examination. It is, of course, impossible to compare Western civilization in this respect with, say, Japan, where suicide in certain circumstances is part of a distinct moral creed. In Christian ethics and Christian law it is wrong, indeed illegal, as a *felo de se*, self-murder. It is within comparatively recent years that the study of suicide by means of the vital statistics of various European countries has demonstrated that while the act may be regarded as a purely voluntary one, yet that suicide as a whole conforms there to certain general laws, and is influenced by conditions other than mere individual circumstances or surroundings. Thus it can be shown that each country has a different suicide-rate, and that while the rate for each country may fluctuate from year to year, yet it maintains practically the same relative proportions to the rates of other countries. The following table shows the suicide-rate for various European countries (Bertillon):—

TABLE I.

Country.	Period of Observation.	Annual Number of Suicides per Million Inhabitants.
Saxony	1878–1882	392
Denmark	1880–1882	251
Switzerland	1878–1882	239
Baden	"	198
Württemberg	1877–1881	189
France	1878–1882	180
Prussia	"	166
Belgium	"	100
Sweden	"	92
England and Wales	"	75
Norway	"	69
Scotland	1877–1881	49
Ireland	1878–1882	17

In addition to furnishing materials for an approximately accurate estimate of the number of suicides which will occur in any country in a year, statistics have demonstrated that the proportion of male to female suicides is practically the same from year to year, viz. 3 or 4 males to 1 female; that it is possible to predict the month of greatest prevalence, the modes of death adopted by men on the one hand and women on the other, and even the relative frequency of suicide amongst persons following different professions and employments; and that in most of the countries of Europe the suicide-rate is increasing. In England and Wales the annual death-rate per million from suicide has steadily advanced, as is shown by the following figures for quinquennial periods:—

1861–1865	65 per million living.
1866–1870	66 " "
1871–1875	66 " "
1876–1880	74 " "
1881–1885	75 " "
1886–1890	79 " "
1891–1895	88 " "
1896–1900	89 " "
1901–1905	100 " "

The next table illustrates the continued increase in recent years, and at the same time shows the total number and the number of male and female suicides each year from 1886 to 1905.

TABLE II.

Total Suicides—Male and Female—in England and Wales, 1886–1905, together with the annual rate per million living (Registrar-General's Reports).

Year.	Male.	Female.	Total.	Suicide-rate per Million Living.
1886	1694	560	2254	82
1890	1635	570	2205	77
1895	2071	726	2797	92
1896	1979	677	2656	86
1897	2090	702	2792	90
1898	2166	711	2877	91
1899	2121	723	2844	89
1900	2166	730	2896	90
1901	2318	803	3121	96
1902	2460	807	3267	99
1903	2640	871	3511	105
1904	2523	822	3345	99
1905	2683	862	3545	104
Total.	28,546	9564	38,110	—

The reason of the high suicide-rate in some countries as compared with others, and the causes of its progressive increase, are not easily determined. Various explanations have been offered, such as the influence of climate, the comparative prevalence of insanity, and the proportionate consumption of alcoholic drinks, but none satisfactorily accounts for the facts. It may, however, be remarked that suicide is much more common amongst

Protestant than amongst Roman Catholic communities, while Jews have a smaller suicide-rate than Roman Catholics. A point of considerable interest is the increase of suicide in relation to the advance of elementary education. Ogle states that suicide is more common among the educated than the illiterate classes. It is also more prevalent in urban than in rural districts. A curious feature in large towns is the sudden outbreak of self-destruction which sometimes occurs, and which has led to its being described as epidemic. In such cases force of example and imitation undoubtedly play a considerable part, as it is well recognized that both these forces exert an influence not only in causing suicide, but also in suggesting the method, time and place for the act. No age above five years is exempted from furnishing its quota of suicidal deaths, although self-destruction between five and ten years is very rare. Above this age the proportion of suicides increases at each period, the maximum being reached between fifty-five and sixty-five. Among females there is a greater relative prevalence at earlier age periods than among males. The modes of suicide are found to vary very slightly in different countries. Hanging is most common amongst males; then drowning, injuries from fire-arms, stabs and cuts, poison and precipitation from heights. Amongst females, drowning comes first, while poison and hanging are more frequent than other methods entailing effusion of blood and disfigurement of the person. The methods used in England and Wales by suicides during 1888–1897, and in Scotland during the years 1881–1897, are given in the following table:—

TABLE III.

Modes of Suicide in England and Wales, 1888–1897.

Order of Frequency.	Males.		Females.		Both Sexes.	
	Mode.	Number.	Mode.	Number.	Mode.	Number.
1	Hanging	5669	Drowning	2089	Hanging	7005
2	Stab-cut	3594	Poison	1652	Drowning	5532
3	Drowning	3443	Hanging	1336	Stab-cut	4365
4	Poison	2264	Stab-cut	771	Poison	3916
5	Fire-arms	2152	Fire-arms	52	Fire-arms	2204
6	Otherwise	1773	Otherwise	527	Otherwise	2300
	Total	18,895	Total	6427	Total	25,322

Modes of Suicide in Scotland, 1881–1897.

Order of Frequency.	Males.		Females.		Both Sexes.	
	Mode.	Number.	Mode.	Number.	Mode.	Number.
1	Hanging	741	Drowning	430	Drowning	1060
2	Drowning	630	Hanging	257	Hanging	998
3	Stab-cut	556	Poison	145	Stab-cut	700
4	Poison	257	Stab-cut	144	Poison	402
5	Fire-arms	245	Fire-arms	6	Fire-arms	251
6	Otherwise	207	Otherwise	100	Otherwise	307
	Total	2636	Total	1082	Total	3718

The season of the year influences suicide practically uniformly in all European countries, the number increasing from the commencement of the year to a maximum in May or June, and then declining again to a minimum in winter. Morselli attempts to account for this greater prevalence during what may well be called the most beautiful months of the year by attributing it to the influence of increased temperature upon the organism, while Durkheim suggests that the determining factor is more probably to be found in the length of the day and the effect of a longer period of daily activity. The suicide-rate is higher in certain male occupations and professions than in others (Ogle). Thus it is high amongst soldiers, doctors, innkeepers and chemists, and low for clergy, bargemen, railway drivers and stokers. The suicide-rate is twice as great for unoccupied males as for occupied males.

AUTHORITIES.—Morselli, *Il Suicidio* (Milan, 1879); Legoyt, *Le Suicide ancien et modern* (Paris, 1881); Westcott, *Suicide: its History, Literature, &c.* (London, 1885); Ogle, "Suicides in England and Wales, in relation to Age, Sex, Season, and Occupation," *Journal of the Statistical Society* (1886), vol. xlix.; Strahan, *Suicide and Insanity* (London, 1893); Mayr, "Selbstmord statistik," in *Handwörterbuch der Staatswissenschaften* (Jena, 1895); Durkheim, *Le Suicide* (Paris, 1897). (H. H. L.)

SŪÏDAS, Greek lexicographer. Nothing is known of him, except that he must have lived before Eustathius (12th–13th century), who frequently quotes him. Under the heading "Adam" the author of the lexicon (which a prefatory note states to be "by Sūïdas") gives a brief chronology of the world, ending with the death of the emperor John Zimisces (975), and under "Constantinople" his successors Basil and Constantine are mentioned. It would thus appear that Sūïdas lived in the latter part of the 10th century. The passages in which Michael Psellus (end of the 11th century) is referred to are considered later interpolations. The lexicon of Sūïdas is arranged alphabetically with some slight deviations, letters and combinations of letters having the same sound being placed together; thus, αι and ε follow δ, and ει, η, ι follow ζ. It partakes of the nature of a dictionary and encyclopaedia. It includes numerous quotations from ancient writers; the scholiasts on Aristophanes, Homer, Sophocles and Thucydides are also much used. The biographical notices, the author tells us, are condensed from the *Onomatologion* or *Pinax* of Hesychius of Miletus; other sources were the excerpts of Constantine Porphyrogenitus, the chronicle of Georgius Monachus, the biographies of Diogenes Laërtius and the works of Athenaeus and Philostratus. The work deals with scriptural as well as pagan subjects, from which it is inferred that the writer was a Christian. A prefatory note gives a list of dictionaries from which the lexical portion was compiled, together with the names of their authors. Although the work is uncritical and probably much interpolated, and the value of the articles is very unequal, it contains much information on ancient history and life.

Editio princeps, by Demetrius Chalcondyles (1499); later editions by L. Küster (1705), T. Gaisford (1834), G. Bernhardy (1834–1853) and I. Bekker (1854); see A. Daub, *De S. Biographicorum origine et fide* (1880) and *Studien zu den Biographika des S.* (1882); and J. E. Sandys, *Hist. of Cassical Scholarship* (1906), p. 407.

SUIDUN (Chinese, *Sui-din-chen*), a town of China, capital of the province of Kulja. It is the residence of the governor-general, and was founded in 1762 during the Mussulman rising, and rebuilt in 1883. It is a military town, with provision stores, an arsenal and an arms workshop. Its walls are armed with steel guns.

SUINA, a group of non-ruminating artiodactyle ungulate mammals typified by the swine (Suidae), but also including the hippopotamus (Hippopotamidae), and certain extinct forms. (See ARTIODACTYLA; HIPPOPOTAMUS; PECCARY; SWINE.)

SUITE (*Suite de pièces*; *Ordre*; *Partita*), in music, a group of dance tunes, mostly in binary form, of a type which may be described as "decorative" (see SONATA FORMS); constituting that classical form of early 18th-century instrumental music which most nearly foreshadows the later sonata. As understood by Bach, it consists essentially of four principal movements with the insertion of one or more lighter movements between the third and the last. The first movement is the *allemande*, of solid and intricate texture, in slow common time and rich flowing rhythm, beginning with one or three short notes before the first full bar. The second movement is the *courante*, of which there are two kinds. The French courante is again an intricate movement, also beginning with one or three notes before the main beat, and in a triple time ($\frac{3}{2}$) which, invariably at the cadences and sometimes elsewhere, drops into a crossing triple rhythm of twice the pace ($\frac{6}{4}$). The effect is restless and confused, and was supposed to form a contrast to the allemande; but it seldom did so effectively. Bach's study of Couperin led him to use the French courante frequently, but he was happier with the Italian type of *corrente*, which did not owe its name, like the French type, to the use of spasmodic runs, but was a brilliant continuously running piece in quick triple time ($\frac{3}{4}$ or $\frac{3}{8}$), forming a clear and lively contrast both to the allemande and to the third movement, which is generally a *sarabande*.

The *sarabande* is a slow movement in triple time beginning on the full bar, and with at least a tendency to the rhythm of which Handel's aria *Lascia ch'io pianga* is a familiar example.

Bach's sarabandes are among the most simply eloquent and characteristic of his smaller compositions. Then come the *galanteries*, from one to three in number. These are the only suite-movements which ever have an alternative section and a *da capo* (with the exception of Couperin's courantes and the courante in Bach's first English suite). The commonest galanteries are: (1) the *minuet*, often with a second minuet which is called "trio" only when it is in real three-part writing. It is a little faster than the stately minuet in Mozart's *Don Giovanni*, but it is never so quick as the lively minuets of Haydn's quartets and symphonies which led to the Beethoven scherzo; and it invariably begins, unlike many later minuets, on the full bar; (2) the *gavotte*, a lively dance in a not too rapid *alla breve* time (the textbooks say $\frac{4}{4}$ time, but there is no case in Bach which could possibly be played so slowly, whatever the time signature may be). The gavotte always begins on the half-bar. A second alternating gavotte is frequently founded on a pedal or drone-bass, and is then called *musette*; (3) the *bourrée*, which is not unlike the gavotte, but quicker, and beginning on the last quarter of the bar; (4) the *passepied*, a lively dance in quick triple time, beginning on the third beat. These dances are not always cast in binary form, and there are famous examples of gavottes and passepieds *en rondeau.* Other less common galanteries are (5) the *loure*,[1] a slow dance in $\frac{6}{4}$ time and dotted rhythm (dactylic in accent and amphimacer in quantity); (6) the *polonaise*, a leisurely triple-time piece, either a shade quicker or (as in the exquisite unattached examples of Friedemann Bach) much slower than the modern dance-rhythm of that name, with cadences on the second instead of the third beat of the bar; (7) the *air*, a short movement, quietly flowing, in a more florid style than its name would suggest. It sometimes precedes the sarabande. The suite concludes with a *gigue*, in the finest examples of which the decorative binary form is combined with a light fugue style of the utmost liveliness and brilliance. The gigue is generally in some triplet rhythm, *e.g.* $\frac{3}{8}$, $\frac{6}{8}$, $\frac{9}{8}$, $\frac{12}{8}$; but examples in a graver style may be found in slow square time with dotted rhythms, as in Bach's first French suite and the sixth Partita of the *Klavierübung*. In gigues in the typical fugato style Bach is fond of making the second part either invert the theme of the first, or else begin with a new subject to be combined with the first in double counterpoint. The device of inversion is also prominent in many of his allemandes and French courantes.

All suites on a large scale, with the exception of Bach's second and fourth solo violin sonatas, begin with a great prelude in some larger form. Bach's *French Suites* are small suites without prelude. His *English Suites* all have a great first movement which, except in the first suite, is in full *da capo* concerto form. His clavier *Partitas* show a greater variety of style in the dance movements and are preceded by preludes, in each case of a different type and title. Some large suites have finales after the gigue; the great chaconne for violin solo being the finale of a partita (see VARIATIONS).

Handel's suites are characteristically nondescript in form, but, in the probably earlier sets published after what is called his first set, there is a most interesting tendency to make several of the movements free variations of the first. Earlier composers had already shown the converse tendency to make variations take the forms of suite movements. In general Handel's suites are effective groups of movements of various lengths, with a tendency to use recognizable suite movements of a Franco-Italian type.

In modern times the term "suite" is used for almost any group of movements of which the last is in the same key as the first, and of which a fair proportion show traces of dance-rhythm, or at least use dance titles. It is often said that the suite-forms have shown more vitality under modern conditions than the classical sonata forms. But this only means that when composers do not feel inclined to write symphonies or sonatas they give their groups of movements the name of suite. Certainly there is no such thing as a definite modern suite-form distinguishable from the selection composers make, for use in concert rooms, of incidental music written for plays, such as Grieg's *Peer Gynt* suites. (D. F. T.)

[1] The *loure* of Bach's fifth French suite has in some editions been called the second *bourrée*, to the utter mystification of musicians.

SUKHUM-KALEH, a seaport of Russian Caucasia in the government of Kutais. Pop. (1900), about 16,000. It is situated 106 m. N. of Batum, and has the best roadstead on the east coast of the Black Sea, being sheltered by mountains on three sides and never freezing. In spite of the difficulties of communication with the interior, and the malarial marshes which surround the town, it has become important for the export of grain (chiefly maize). There is also a trade in tobacco. It stands on the site of the ancient Greek colony of Dioskurias. The annual mean temperature is 59° F. There are here a cathedral and a botanical garden. The town was captured by the Russians in 1809, but not formally relinquished by Turkey until 1829. In 1854 and again in 1877 it was occupied by the Turks.

SUKKUR, or SAKHAR, a town and district of British India, in Sind, Bombay. The town is situated on the right bank of the Indus, 24 m. N.W. of Skikarpur. Pop. (1901), 31,316. Sukkur has always commanded the trade of Sind, and the river is now crossed by a cantilever bridge carrying the North-Western railway to Kotri. The town was ceded to the Khairpur mirs between 1809 and 1824. In 1833 Shah Shuja defeated the Talpurs here with great loss. In 1842 it came under British rule.

The DISTRICT OF SUKKUR was created in 1901 out of part of Shikarpur district, the remainder of which was formed into the district of Larkana. Area, 5403 sq. m. It is chiefly alluvial plain, but there are slight hills at Sukkur and Rohri. In the higher-lying parts are salt lands (*Kalar*), or even desert in the area known as the Registan. The climate is hot, dry and enervating. The annual rainfall at Sukkur town averages only $4\frac{1}{2}$ in. The population in 1901 was 523,345, showing an increase of 10% in the decade. A considerable part of the district is irrigated, the principal crops being wheat, millets, rice, pulses and oil seeds. Earthen, leathern and metal ware, cotton cloth and tussore silk are manufactured, also pipe-bowls, snuff-boxes and scissors. Lines of the North-Western railway serve the district, and there is a branch from Sukkur towards Quetta.

SULA ISLANDS (Sulla, Xuila; Dutch *Soela*), a chain of islands forming a prolongation of the eastern peninsula of Celebes and the Banggai Islands, Dutch East Indies. The three main islands are long and narrow (Taliabu, 68 m. long, Mangoli or Mangala, 63 m. and Besi, 30 m.). The two first lie in line, separated by the narrow Chapalulu Strait; Besi extends at right angles to the south coast of Mangoli. The natives of Taliabu are allied to those of the Banggai Islands and the eastern peninsula of Celebes; but immigrant Malays are the principal inhabitants. Economically, Besi is the most important island. A Dutch commissioner resides at Sanana, at its northern extremity. It is fertile, and produces wax and honey, and coal has been found.

SULCI, an ancient town (mod. S. Antioco), situated on the east coast of an island on the south-west of Sardinia. The date of its foundation is not known, but it is certainly of Carthaginian origin. The assumption that it was originally an Egyptian colony is not justified. Its walls, of large rectangular blocks of stone, can be traced for a circuit of upwards of a mile: it extended to the low ground on the shore near the modern cemetery, where a dedicatory inscription set up by the people of Sulci in honour of Hadrian in A.D. 128 was found (F. Vivanet in *Notizie degli Scavi*, 1897, 407). Various discoveries have been made within the circuit, both of Phoenician and of Roman antiquities, including several statues[2] and inscriptions and many smaller objects, gems, &c., but at present few traces of ancient buildings are left, owing to their continued destruction in medieval and modern times. A cistern of fine masonry, perhaps dating from the Punic period,

[2] A statue of Drusus, the brother of Tiberius (?) was found in 1908.

in the low ground below the modern town, may be mentioned. Close to it, among the houses of the modern town, a solid base about 25 ft. square, belonging possibly to a lighthouse or a tomb, records the existence of a temple of Isis and Serapis during the imperial period. A bilingual inscription of the 1st century B.C. (?) in Latin and in neo-Punic records the erection of a statue to Himilkat, who had carried out a decree of the local *senatus* for the erection of a temple to a goddess (described in the Punic version as *domina dea*—possibly Tanit herself) by his son Himilkat (T. Mommsen in *Corp. inscr. lat.* x. 7513, 7514). The Phoenician tombs consist of a chamber cut in the rock, measuring about 14 ft. square and 8 ft. high, and approached by a staircase: some of these have been converted into dwellings in modern times. Many of the curious sculptured *stelae* found in these tombs are now in the museum of Cagliari. On many of them the goddess Tanit is represented, often in a form resembling Isis, which gave rise to the unfounded belief of the Egyptian origin of Sulci. The Roman tombs, on the other hand, are simply trenches excavated in the rock.

There are also several catacombs: a group still exists under the church, in which was discovered the body of the martyr St Antiochus, from whom the modern town takes its name. The church is cruciform, with heavy pillars between nave and aisles, and a dome over the crossing: it belongs to the Byzantine period, and contains an inscription of Torcotorius, protospatarius and Salusius, ἄρχων, dating from the 10th century A.D. (A. Taramelli in *Archivio storico sardo*, 1907, 83 sqq.). Others farther south-west were Jewish; they have inscriptions in red painted on the plaster with which they are lined, and the seven-branched candlestick occurs several times. The fort which occupies the highest point—no doubt the acropolis of the Punic period—is quite modern. The long, low isthmus which, with the help of bridges, connects the island with the mainland, is very likely in part or entirely of artificial origin; but neither it nor the bridges show any definite traces of Roman date. On either side of it ships could find shelter then as nowadays.

The origin of Sulci is attributed by Pausanias to the Carthaginians, and the Punic antiquities found there go to indicate the correctness of his account. It is mentioned in the account of the First Punic War as the place at which the Carthaginian admiral Hannibal took refuge after his defeat by C. Sulpicius, but was crucified. In 46 B.C. the city was severely punished by Caesar for the assistance given to Pompey's admiral Nasidius. Under the empire it was one of the most flourishing cities of Sardinia. It was attacked by the Vandals and Saracens, but ceased to exist before the 13th century. Previously to this it had been one of the four episcopal sees into which Sardinia was divided. A castle in the low ground, attributed to the index Torcotorius, to the south of the modern town, was destroyed in modern times.

See A. Tarawelli in *Notizie degli scavi* (1906), 135; (1908), 145, 192. (T. As.)

SULEIMAN I.[1] the "Magnificent" (1494–1566), sultan of Turkey, succeeded his father Selim I. in 1520. His birth coincided with the opening year of the 10th century of Mussulman chronology (A.H. 900), the most glorious period in the history of Islam. Eventful as the age was both in Europe, where the Renaissance was in full growth, and in India, where the splendour of the emperor Akbar's reign exceeded alike that of his predecessors and his successors, Suleiman's conquests overshadowed all these. It is noteworthy that though in Turkey he is distinguished only as the law-giver (*kanuni*), in European history he is known by such titles as the Magnificent. He was the most fortunate of the sultans. He had no rival worthy of the name. From his father he inherited a well-organized country, a disciplined army and a full treasury. He united in his person the best qualities of his predecessors, and possessed the gift of taking full advantage of the talents of the able generals, admirals and viziers who illustrated his reign. If his campaigns were not always so wisely and prudently planned as those of some of his predecessors, they were in the main eminently fortunate, and resulted in adding to his dominions Belgrade, Budapest, Temesvar, Rhodes, Tabriz, Bagdad, Nakshivan and Rivan, Aden and Algiers, and in his days Turkey attained the culminating point of her glory.

[1] Suleiman, eldest son of Bayazid I., who maintained himself as sultan at Adrianople from 1402 to 1410, is not reckoned as legitimate by the Ottoman historiographers, who reckon Suleiman the Magnificent as the first of the name. By others, however, the latter is sometimes styled Suleiman II.

The alliance concluded by him with France reveals him at once as rising superior to the narrow prejudices of his race and faith, which rejected with scorn any union with the unbeliever, and as gifted with sufficient political insight to appreciate the advantage of combining with Francis I. against Charles V. His Persian campaign was doubtless an error, but was due in part to a desire to find occupation, distant if possible, for his janissaries, who were always prone to turbulence while inactive at the capital. He was perhaps wanting in firmness of character, and the undue influence exercised over him by unscrupulous ministers, or by the seductions of fairer but no less ambitious votaries of statecraft, led him to make concessions which tarnished the glory of his reign, and were followed by baneful results for the welfare of his empire. It is from Suleiman's time that historians date the rise of that occult influence of the harem which has so often thwarted the best efforts of Turkey's most enlightened statesmen.

Suleiman's claims to renown as a legislator rest mainly on his organization of the Ulema, or clerical class, in its hierarchical order from the Sheikh-ul-Islam downwards. He reformed and improved the administration of the country both civil and military, inaugurated a new and improved system for the feudal tenures of limitary fiefs, and his amelioration of the lot of his Christian subjects is not his least title to fame. He was also not unknown to fame as a poet, under the pseudonym of "Muhibbr" (see Hammer-Purgstall, *Gesch. d. Osman. Reichs*, ii. 331; and further TURKEY: *History*).

Suleiman died on the 5th of September 1566, at the age of 72, while conducting the siege of Szigetvār.

SULEIMAN II. (1641–1691), sultan of Turkey, was a son of Sultan Ibrahim, and succeeded his brother Mahommed IV. in 1687. Forty-six years of enforced retirement had qualified him for the cloister rather than for the throne, and his first feeling when notified of his accession was one of terror for his brother's vengeance. Nor were the circumstances following on his elevation to the throne of a nature to reassure him, as one of the most violent of the revolts of the janissaries ended in the murder of the grand vizier and the brutal mutilation of his family, with general massacre and pillage throughout Constantinople. The war with Austria was for Turkey a succession of disasters. At this time, fortunately for the Ottoman Empire, a third great kuprili (Mustafa) arose and re-established order in the sorely-tried state (see KUPRILI). In the reforms which followed, whereby the situation of the Christian subjects of the Porte was greatly improved, Suleiman is at least to be given the credit of having allowed Mustafa Kuprili a free hand. With an improved administration Turkey's fortunes in the war began to revive, and the reconquest of Belgrade late in 1690 was the last important event of the reign, which ended in 1691 by Suleiman's death. (See also TURKEY: *History*.)

SULEIMANIEH, or SULEIMANIA, the chief town of a sanjak of the same name in Asiatic Turkey, in the vilayet of Mosul, situated on a treeless plain in the Kurdistan Mountains, in the region known as Shehrizor, some 40 or 50 m. from the Persian frontier, at an elevation of 2895 ft. It is a military station, and was founded towards the close of the 11th century. The estimated population is about 12,000, of whom 11,000 are Kurds, and the majority of the remaining 1000 Jews.

SULIMAN HILLS, a mountain system on the Dera Ismail Khan border of the north-west frontier of India. From the Gomal river southward commences the true Suliman system, presenting an impenetrable barrier between the plains of the Indus and Afghanistan. The Suliman Mountains finally merge into the hills of Baluchistan, which are inhabited by the Marri and Bugti tribes. The chief mass of the range is known as

Takht-i-Suliman or Solomon's throne. It may be seen on the western horizon from Dera Ismail Khan, a grey, flat-looking rampart rising from the lower line of mountains north and south of it, slightly saddle-backed in the middle, but culminating in a very well-defined peak at its northern extremity. The legend of the mountain is that Solomon visited Hindostan to marry Balkis, and that as they were returning through the air, on a throne supported by genii, the bride implored the bridegroom to let her look back for a few moments on her beloved land. Solomon directed the genii to scoop out a hollow for the throne on the summit of the mountain. The hollow is a cavity some 30 ft. square cut out of the solid rock, at the southern extremity of the mountain and is a place of pilgrimage for both Hindus and Mahommedans. The actual shrine is about two m. south of the highest peak. The whole mountain was traversed and surveyed by the Takht-i-Suliman Survey Expedition of 1883 (see SHERANI) and was found to consist of two parallel ridges running roughly north and south, the southern end of the eastern ridge culminating in a point 11,070 ft. high, which is the Takht proper on which the shrine is situated, and the western ridge culminating at its northern end in a point 11,300 ft. high known as Kaisargarh. Between these two ridges is a connecting tableland about 9000 ft. high. This plateau and the interior slopes of the ridges are covered with *chilghosa* (edible pine) forests. The mass of the mountain is composed of nummulitic limestone. No water is to be found on the summit.

SULINA, a town in Rumania, at the mouth of the Sulina branch of the Danube. Pop. (1900), 5611. Sulina is the only free port on the Danube, and is much used for the transhipment into sea-going vessels of grain which is brought down the river in large lighters from Rumania, Russia, Bulgaria, Servia and Austria-Hungary. No agricultural produce is grown in its neighbourhood, owing to the reed-covered swamps with which it is surrounded. Sulina is the headquarters of the technical department of the European Commission of the Danube (*q.v.*). Large steamers navigate up to Galatz and Braila. In 1901, 1411 steamers and sailing craft aggregating 1,830,000 tons register cleared from Sulina for European ports carrying, besides other merchandise, nearly 13,000,000 quarters of grain. Owing to the improvements effected by the European Commission, there is a depth of 24 ft. of water on the bar, and of 18 to 22 ft. in the fairway. A lighthouse overlooks the estuary. The town contains the only English church in Rumania.

SULITELMA, a mountain on the frontier between Norway and Sweden, forming a salient (6158 ft.) of the Kjöl or "keel" of the Scandinavian peninsula. The mass, composed of three peaks, is situated in 67° 10′ N., and covered with a snow-field from which many glaciers descend. In these rise feeders of the Swedish rivers Lilla Lule and Pite, flowing south-east. Westward, the foothills descend upon the Skjerstad Fjord, above which are two lakes, Nedre and Ovre Vand. From Sjönstaa steamers on the Langvand and a light railway give communication between the sea and Furulund, the headquarters of the Swedish Sulitelma Mining Company. A mountain track descends from Sulitelma to Kvickjock (or Kvikkjokk), a considerable village magnificently situated on the Tarrajock, a head-stream of the Lilla Lule. This is distant three days' journey on foot from Furulund.

SULLA, LUCIUS CORNELIUS (138–78 B.C.), surnamed *Felix*, Roman general, politician and dictator, belonged to a minor and impoverished branch of the famous patrician Cornelian gens. He received a careful education, and was a devoted student of literature and art. His political advancement was slow, and he did not obtain the quaestorship until 107, when he served in the Jugurthine war under Marius in Africa. In this he greatly distinguished himself, and claimed the credit of having terminated the war by capturing Jugurtha himself. In these African campaigns Sulla showed that he knew how to win the confidence of his soldiers, and throughout his career the secret of his success seems to have been the enthusiastic devotion of his troops, whom he continued to hold well in hand, while allowing them to indulge in plundering and all kinds of excess. From 104 to 101 he served again under Marius in the war with the Cimbri and Teutones and fought in the last great battle in the Raudian plains near Verona. It was at this time that Marius's jealousy of his legate laid the foundations of their future rivalry and mutual hatred. When the war was over, Sulla, on his return to Rome, lived quietly for some years and took no part in politics. In 93 he was elected praetor after a lavish squandering of money, and he delighted the populace with an exhibition of a hundred lions from Africa. Next year (92) he went as propraetor of Cilicia with special authority from the senate to make Mithradates VI. of Pontus restore Cappadocia to Ariobarzanes, one of Rome's dependants in Asia. Sulla with a small army soon won a victory over the general of Mithradates, and Rome's client-king was restored. An embassy from the Parthians now came to solicit alliance with Rome, and Sulla was the first Roman who held diplomatic intercourse with that remote people. In the year 91, which brought with it the imminent prospect of sweeping political change, with the enfranchisement of the Italian peoples, Sulla returned to Rome, and it was generally felt that he was the man to lead the conservative and aristocratic party.

Meanwhile Mithradates and the East were forgotten in the crisis of the Social or Italic War, which broke out in 91 and threatened Rome's very existence. The services of both Marius and Sulla were given; but Sulla was the more successful, or, at any rate, the more fortunate. Of the Italian peoples Rome's old foes the Samnites were the most formidable; these Sulla vanquished, and took their chief town, Bovianum. In recognition of this and other brilliant services, he was elected consul in 88, and brought the revolt to an end by the capture of Nola in Campania. The question of the command of the army against Mithradates again came to the front. The senate had already chosen Sulla; but the tribune Publius Sulpicius Rufus moved that Marius should have the command. Rioting took place at Rome at the prompting of the popular leaders, Sulla narrowly escaping to his legions in Campania, whence he marched on Rome, being the first Roman who entered the city at the head of a Roman army. Sulpicius was put to death, and Marius fled; and he and his party were crushed for the time.

Sulla, leaving things quiet at Rome, quitted Italy in 87, and for the next four years he was winning victory after victory against the armies of Mithradates and accumulating boundless plunder. Athens, the headquarters of the Mithradatic cause, was taken and sacked in 86; and in the same year, at Chaeroneia, the scene of Philip II. of Macedon's victory more than two and a half centuries before, and in the year following, at the neighbouring Orchomenus, he scattered immense hosts of the enemy with trifling loss to himself. Crossing the Hellespont in 84 into Asia, he was joined by the troops of C. Flavius Fimbria, who soon deserted their general, a man sent out by the Marian party, now again in the ascendant at Rome. The same year peace was concluded with Mithradates on condition that he should be put back to the position he held before the war; but, as he raised objections, he had in the end to content himself with being simply a vassal of Rome.

Sulla returned to Italy in 83, landing at Brundisium, having previously informed the senate of the result of his campaigns in Greece and Asia, and announced his presence on Italian ground. He further complained of the ill-treatment to which his friends and partisans had been subjected during his absence. Marius had died in 86, and the revolutionary party, specially represented by L. Cornelius Cinna, Cn. Papirius Carbo and the younger Marius, had massacred Sulla's supporters wholesale, confiscated his property, and declared him a public enemy. They felt they must resist him to the death, and with the troops scattered throughout Italy, and the newly enfranchised Italians, to whom it was understood that Sulla was bitterly hostile, they counted confidently on success. But on Sulla's advance at the head of his 40,000 veterans many of them lost heart and deserted their leaders, while the Italians themselves, whom he confirmed in their new privileges, were won over to his side. Only the Samnites, who were as yet without the Roman franchise, remained his enemies, and it seemed as if the old war between Rome and Samnium had to be fought once again. Several Roman nobles, among them Gnaeus Pompeius (Pompey the Great), Q. Caecilius Metellus Pius, Marcus Licinius Crassus, Marcus Licinius Lucullus, joined Sulla, and in the following year (82) he won a decisive victory over the younger Marius near Praeneste (mod. Palestrina) and then marched upon Rome, where again, just before his defeat of Marius, there had been a great massacre of his adherents, in which the learned jurist Q. Mucius Scaevola perished. Rome was at the same time in extreme peril from the advance of a Samnite army, and was barely saved by Sulla, who, after a hard-fought battle, routed the enemy under Pontius Telesinus at the Colline gate of Rome. With the death of the younger Marius, who killed himself after the surrender of Praeneste, the civil war was at an end, and Sulla was master of Rome and of the Roman world. Then came the memorable "proscription," when for the first time in Roman history a list of men declared to be outlaws and public enemies was exhibited in the forum, and a reign of terror began throughout Rome and Italy. The title of "dictator" was revived and Sulla was in fact emperor of Rome. After celebrating a splendid triumph for the Mithradatic War, and assuming the surname of "Felix" ("Epaphroditus," "Venus's favourite,"[1] he styled himself in addressing Greeks), he carried in 80 and 79 his great political reforms (see ROME: *History*, II. "*The Republic*"). The main object of these was to invest the senate, which he recruited with a number of his own party, with full control over the state, over every magistrate and every province; and the mainstay of his political system was to be the military colonies which he had established with grants of land throughout every part of Italy, to the ruin of the old Italian freeholders and farmers, who from this time dwindled away, leaving whole districts waste and desolate.

In 79 Sulla resigned his dictatorship and retired to Puteoli (mod. Pozzuoli), where he died in the following year, probably from the bursting of a blood-vessel. The story that he fell a victim to a disease similar to that which cut off one of the Herods (Acts xii. 23) is probably an invention of his enemies. The "half lion, half fox," as his enemies called him, the "Don Juan of politics" (Mommsen), the man who carried out a policy of "blood and iron" with a grim humour, amused himself in his last days with actors and actresses, with dabbling in poetry, and completing the *Memoirs* (*commentarii*, ὑπομνήματα) of his eventful life (see H. Peter, *Historicorum romanorum reliquiae*, 1870). Even then he did not give up his interest in state and local affairs, and his end is said to have been hastened by a fit of passion brought on by a remark of the quaestor Granius, who openly asserted that he would escape payment of a sum of money due to the Romans, since Sulla was on his death-bed. Sulla sent for him and had him strangled in his presence; in his excitement he broke a blood-vessel and died on the following day. He was accorded a magnificent public funeral, his body being removed to Rome and buried in the Campus Martius. His monument bore an inscription written by himself, to the effect that he had always fully repaid the kindnesses of his friends and the wrongs done him by his enemies. His military genius was displayed in the Social War and the campaigns against Mithradates; while his constitutional reforms, although doomed to failure from the lack of successors to carry them out, were a triumph of organization. But he massacred his enemies in cold blood, and exacted vengeance with pitiless and calculated cruelty; he sacrificed everything to his own ambition and the triumph of his party.

The ancient authorities for Sulla and his time are his *Life* by Plutarch (who made use of the *Memoirs*); Appian, *Bell. civ.*; for the references in Cicero see Orelli's *Onomasticon Tullianum*. Modern treatises by C. S. Zachariä, *L. Cornelius S. als Ordner des römischen Freystaates* (1834); T. Lau, *Lucius Cornelius Sulla* (1855); E. Linden, *De bello civili Sullano* (1896); P. Cantalupi, *La Guerra civile Sullana in Italia* (1892); C. W. Oman, *Seven Roman Statesmen* (1902); F. D. Gerlach, *Marius und Sulla* (1856); J. M. Sunden, "De tribunicia potestate a Lucio Sulla imminuta" in *Skrifter utgifna af k. humanistika Vetenskapssamfundet i Upsala*, v., 1897, in which it is argued against Mommsen that Sulla did not deprive the tribunes of the right of proposing rogations. See also Mommsen's *History of Rome*, vol. iii., bk. iv., ch., 8, 9; Drumann, *Geschichte Roms*, 2nd ed. by Groebe, ii. 364-432; Pauly-Wissowa, *Realencyclopädie*, iv. 1522-1566 (Fröhlich).

[1] A short epigram on Aphrodite in the *Greek Anthology* (Anth. Pal., *Appendix*, i. 153) is ascribed to him.

His nephew (as some say, though the degree of relationship cannot be clearly established), PUBLIUS CORNELIUS SULLA was consul in 66 B.C. with P. Autronius Paetus. Both were convicted of bribery, and Paetus subsequently joined Catiline in his first conspiracy. There is little doubt that Sulla also was implicated; Sallust does not mention it, but other authorities definitely assert his guilt. After the second conspiracy he was accused of having taken part in both conspiracies. Sulla was defended by Cicero and Hortensius, and acquitted. There is no doubt that, after his first conviction, Sulla remained very quiet, and, whatever his sympathies may have been, took no active part in the conspiracy. When the civil war broke out, Sulla took the side of Caesar, and commanded the right wing at the battle of Pharsalus. He died in 45.

See Cicero, *Pro Sulla, passim* (ed. J. S. Reid, 1882); *Ad Fam.* ix. 10, xv. 17; Dio Cassius xxxvi. 44, xxxvii. 25; Suetonius, *Caesar*, 9; Caesar, *Bell. civ.*, iii. 51, 89; Appian, *Bell. civ.* ii. 76.

SULLIVAN, SIR ARTHUR SEYMOUR (1842–1900), English musical composer, was born in London on the 13th of May 1842, being the younger of the two sons of Thomas Sullivan, a cultivated Irish musician who was bandmaster at the Royal Military College, Sandhurst, from 1845 to 1856, and taught at the Military School of Music at Kneller Hall from 1857 till his death in 1866. His mother, *née* Mary Coghlan (1811–1882), had Italian blood in her veins. Arthur Sullivan was brought up to music from boyhood, and he had learnt to play every wind instrument in his father's band by the age of eight. He was sent to school at Bayswater till he was twelve, and then, through Sir George Smart, he was, at his own persistent request, made a Chapel Royal chorister, and entered Mr Helmore's school for Chapel Royal boys in Cheyne Walk. He had a fine treble voice, and sang with exceptional taste. In 1856 the Mendelssohn Scholarship at the Royal Academy of Music was thrown open for the first time for competition, and was won by Sullivan, his nearest rival being Joseph Barnby. At the Academy he studied under Sterndale Bennett, Arthur O'Leary and John Goss, and did so well that he was given an extension of his scholarship for two years in succession. In 1858, his voice having broken, he was enabled by means of his scholarship to go to study at the conservatorium of Leipzig. There he had for teachers Moscheles and Plaidy for pianoforte, Hauptmann for counterpoint, Rietz and Reinecke for composition, and F. David for orchestral playing and conducting. Among his fellow-students were Grieg, Carl Rosa, Walter Bache, J. F. Barnett and Edward Dannreuther. Instead of the Mendelssohn *cultus* which represented orthodoxy in London, German musical interest at this period centred in Schumann, Schubert and the growing reputation of Wagner, whilst Liszt and Von Bülow were the celebrities of the day. Sullivan thus became acquainted for the first time with masterpieces which were then practically ignored in England. He entered enthusiastically into the spirit of the place, and after two years' hard study returned to London in April 1861. Before doing so, however, he had composed his incidental music for *The Tempest*, which he had begun as a sort of diploma work. Sullivan set himself to find converts in London to the enthusiasms he had imbibed at Leipzig. He became acquainted with George Grove, then secretary of the Crystal Palace, and August Manns, the conductor there; and at his instigation Schumann's First Symphony was introduced at one of the winter concerts. Early in 1862 Sullivan showed Grove and Manns his *Tempest* music, and on the 5th of April it was performed at the Crystal Palace. The production was an unmixed triumph, and Sullivan's exceptional gifts as a composer were generally recognized from that moment. He had hitherto been occupying himself with teaching, and he continued for some years to act as organist at St Michael's, Chester Square, but henceforth he devoted most of his time to composition. By 1864 he had produced his "Kenilworth" cantata (remembered chiefly for the lovely duet, "How sweet the Moonlight"), the "Sapphire Necklace" overture, and the five beautiful songs from Shakespeare, which include

" Orpheus with his Lute," "Oh Mistress Mine" and "The Willow Song." His attractive personality, combined with his undoubted genius and brilliant promise, brought him many friends. Costa, who was conductor at Covent Garden, gave him the post of organist, and in 1864 he produced there his *L'Île Enchantée* ballet. Some of his spare time was spent in Ireland, where in 1863 he began the composition of his (" Irish ") Symphony in E, which was produced at the Crystal Palace in 1866. The most important event, however, at this period, as bearing upon his later successes, was his co-operation with F. C. Burnand in the musical extravaganza *Cox and Box*, which first showed his capacity for musical drollery. This was acted privately in 1866, and was completed for public performance in 1867, in which year Sullivan again co-operated with Burnand in *Contrabandista*. Meanwhile he was in request as a conductor, and was made professor of composition at the Academy. His father's sudden death in 1866 inspired him to write the fine " In Memoriam " overture, which was produced at the Norwich Festival. In 1867, besides producing his " Marmion " overture, he and Grove did a great service to their art by bringing to light at Vienna a number of lost Schubert MSS., including the *Rosamunde* music. About this time Sullivan induced Tennyson to write his song-cycle " The Window," to be illustrated by Millais, with music by himself. But Millais abandoned the task, and Tennyson was not happy about his share; and the series, published in 1871, never became popular, in spite of Sullivan's dainty setting. In 1869 he brought out his oratorio *The Prodigal Son* at Worcester, and in 1870 his overture " Di Ballo " at Birmingham.

In 1871 Sullivan had become acquainted with W. S. Gilbert (*q.v.*), and in 1872 they collaborated in a piece for the Gaiety Theatre, called *Thespis; or, The Gods Grown Old*, which was a great success in spite of the limited vocal resources of the performers. In 1875 R. D'Oyly Carte, then acting as manager for Selina Dolaro at the Royalty, approached Gilbert with a view to his collaborating with Sullivan in a piece for that theatre. Gilbert had already suggested to Sullivan an operetta with its scene in a law court, and within three weeks of his completing the libretto of *Trial by Jury* the music was written. The piece succeeded beyond all expectation; and on the strength of its promise of further successes D'Oyly Carte formed his Comedy Opera Company and took the Opéra Comique Theatre. There in 1877 *The Sorcerer* was produced, George Grossmith and Rutland Barrington being in the cast. In 1878 *H.M.S. Pinafore* was brought out at the Opéra Comique. At first it did not attract large audiences, but eventually it became a popular success, and ran for 700 nights. In America it was enthusiastically received, and the two authors, with D'Oyly Carte, went over to the States in 1879, with a company of their own, in order to produce it in New York. To secure the American rights for their next opera, they brought out *The Pirates of Penzance* first at New York in 1879. In 1880, in London, it ran for nearly 400 nights. In 1881 *Patience* was produced at the Opéra Comique, and was transferred later in the year to the Savoy Theatre. There all the later operas came out: *Iolanthe* (1882), *Princess Ida* (1884), *The Mikado*—perhaps the most charming of all—(1885), *Ruddigore* (1887), *The Yeomen of the Guard* (1888), *The Gondoliers* (1889). This succession of pieces by Gilbert and Sullivan had made their united names stand for a new type of light opera. Its vogue owed something to such admirable performers as George Grossmith—famous for his " patter songs "—Rutland Barrington, Miss Jessie Bond, Miss Brandram, and later W. H. Denny and Walter Passmore; but these artistes only took advantage of the opportunities provided by the two authors. In place of the old adaptations of French *opéra bouffe* they had substituted a genuinely English product, humorous and delightful, without a tinge of vulgarity or the commonplace. But disagreements now arose between them which caused a dissolution of partnership. Sullivan's next Savoy opera, *Haddon Hall* (1892), had a libretto by Sydney Grundy; and the resumption of Gilbert's collaboration in 1893 in *Utopia, Limited*, and again in 1896 in *The Grand Duke*, was not as successful as before. Sullivan's music, however, still showed its characteristic qualities in *The Chieftain* (1894)—largely an adaptation of *Contrabandista*; *The Beauty Stone* (1898), with a libretto by A. W. Pinero and J. Comyns Carr; and particularly in *The Rose of Persia* (1900), with Captain Basil Hood.

In the public mind Sir Arthur Sullivan (who was knighted in 1883) had during these years become principally associated with the enormous success of the Savoy operas; but these by no means exhausted his musical energies. In 1872 his *Te Deum* for the recovery of the prince of Wales was performed at the Crystal Palace. In 1873 he produced at the Birmingham Musical Festival his oratorio *The Light of the World*, in 1877 he wrote his incidental music to *Henry VIII.*, in 1880 his sacred cantata *The Martyr of Antioch*, and in 1886 his masterpiece, *The Golden Legend*, was brought out at the Leeds Festival. *The Golden Legend* satisfied the most exacting critics that for originality of conception and grandeur of execution English music possessed in Sullivan a composer of the highest calibre. In 1891, for the opening of D'Oyly Carte's new English opera-house in Shaftesbury Avenue he wrote his " grand opera" *Ivanhoe* to a libretto by Julian Sturgis. The attempt to put an English opera on the stage for a long run was doomed to failure, but *Ivanhoe* was full of fine things. In 1892 he composed incidental music to Tennyson's *Foresters*. In 1897 he wrote a ballet for the Alhambra, called *Victoria and Merrie England*. Among his numerous songs, a conspicuous merit of which is their admirable vocal quality, the best known are " If Doughty Deeds " (1866), " The Sailor's Grave " (1872), " Thou'rt Passing Hence " (1875), " I would I were a King " (1878), " King Henry's Song " (1878) and " The Lost Chord " (1877). This last, hackneyed as it became, was probably the most successful English song of the 19th century. It was written in 1877, during the fatal illness of Sullivan's brother Frederic, who, originally an architect, had become an actor, and by means of his fine voice and powers as a comedian (best shown as the Judge in *Trial by Jury*) had won considerable success. Among Sullivan's many hymn tunes, the stirring " Onward, Christian Soldiers! " (1872) is a permanent addition to Church music. In 1876 he accepted the principalship of the National Training School of Music, which he held for six years; this was the germ of the subsequent Royal College. He received the honorary degree of Mus. Doc. from Cambridge (1876) and Oxford (1879). In 1878 he was a member of the royal commission for the Paris Exhibition. He was conductor of the Leeds Festivals from 1879 to 1898, besides being conductor of the Philharmonic Society in 1885. Apart from his broad sympathy and his practical knowledge of instruments, his work as a conductor must always be associated with his efforts to raise the standard of orchestral playing in England and his unwearying exertions on behalf of British music and British musicians. Sullivan liked to be associated in the public mind with patriotic objects, and his setting of Rudyard Kipling's " Absent-minded Beggar " song, at the opening of the Boer War in 1899, was, with the exception of *The Rose of Persia*, the last of his compositions brought out in his lifetime. He died somewhat suddenly of heart failure on the 22nd of November 1900, and his burial in St Paul's Cathedral was the occasion of a remarkable demonstration of public sorrow. He left unpublished a *Te Deum* written for performance at the end of the Boer War, and an unfinished Savoy opera for a libretto by Captain Hood, which, completed by Edward German, was produced in 1901 as *The Emerald Isle*.

Sullivan was the one really popular English composer of any artistic standing in his time; and his celebrity as a public man has somewhat interfered with a definite judgment as to his place in the history of English music. In his own time, English musical taste developed in a very remarkable degree; and musical criticism in serious quarters was a little disinclined to do justice to what was " popular." One of the most agreeable companions, broad-minded, and free from all affectation, he was intensely admired and loved in all circles of society; and though his health was not robust, for he suffered during many years at intervals from a painful ailment, he was a man of the world who enjoyed the life which his success opened out to him without being spoilt by it. He was always a devoted and an industrious musician, and from the day he left Leipzig his influence was powerfully exerted in favour of a wider and fuller recognition of musical culture. He was accused in some quarters of being unsympathetic towards Wagner and the post-Wagnerians, yet he had been one of the first to introduce Wagner's music to English audiences. He was keenly appreciative of new talent, but his tastes were too eclectic to satisfy the enthusiasts for any particular school; he certainly had no liking for what he considered uninspired academic writing. Serious critics deplored, with more justification, that he should have devoted so much of his great natural gift not merely to light comic opera, but to the production of a number of songs which, though always musicianly, were really of the nature of "pot-boiling." Sullivan was an extremely rapid worker, and his fertility in melody made it easy for him to produce what would please a large public. Moreover, it must be admitted that his great social success, so early achieved, was not calculated to nourish a rigidly artistic ideal. But when all is said, his genius remains undisputed; and it was a genius essentially English. His church music alone would entitle him to a high place among composers; and *The Golden Legend*, *Ivanhoe*, the *In Memoriam* overture, the "Irish" symphony and the charming "incidental music" to *The Tempest* and to *Henry VIII.* form a splendid legacy of creative effort, characterized by the highest scholarly qualities in addition to those beauties which appeal to every ear. Whether his memory will be chiefly associated with these works, or rather with the world-wide popularity of some of his songs and comic operas, time alone can tell. The Savoy operas did not aim at intellectual or emotional grandeur, but at providing innocent and wholesome pleasure; and in giving musical form to Gilbert's witty librettos Sullivan showed once for all what light opera may be when treated by the hand of a master. His scores are as humorous and fanciful *quâ* music as Gilbert's verses are *quâ* dramatic literature. Bubbling melody, consummate orchestration, lovely songs and concerted pieces (notably the famous vocal quintets) flowed from his pen in unexhausted and inimitable profusion. If he had written nothing else, his unique success in this field would have been a solid title to fame. As it was, it is Sir Arthur Sullivan's special distinction not only to have been prolific in music which went straight to the hearts of the people, but to have enriched the English *répertoire* with acknowledged masterpieces, which are no less remarkable for their technical accomplishment.

See also *Sir Arthur Sullivan: Life-story, Letters, and Reminiscences*, by Arthur Lawrence (London: Bowden, 1899). Besides being largely autobiographical, this volume contains a complete list of Sullivan's works, compiled by Mr Wilfrid Bendall, who for many years acted as Sir Arthur's private secretary. (H. Ch.)

SULLIVAN, JOHN (1740–1795), American soldier and political leader, was born in Somersworth, New Hampshire, on the 18th of February 1740. He studied law in Portsmouth, N.H., and practised at Berwick, Maine, and at Durham, N.H. He was a member of the New Hampshire Provincial Assembly in 1774, and in 1774–1775 was a delegate to the Continental Congress. In 1772 he had been commissioned a major of New Hampshire militia, and on the 15th of December 1774 he and John Langdon led an expedition which captured Fort William and Mary at New Castle. Sullivan was appointed a brigadier-general in the Continental army in June 1775 and a major-general in August 1776. He commanded a brigade in the siege of Boston. In June 1776 he took command of the American army in Canada and after an unsuccessful skirmish with the British at Three Rivers (June 8) retreated to Crown Point. Rejoining Washington's army, he served under General Israel Putnam in the battle of Long Island (August 27) and was taken prisoner. Released on parole, he bore a verbal message from Lord Howe to the Continental Congress, which led to the fruitless conference on Staten Island. In December he was exchanged, succeeded General Charles Lee in command of the right wing of Washington's army, in the battle of Trenton led an attack on the Hessians, and led a night attack against British and Loyalists on Staten Island, on the 22nd of August 1777. In the battle of Brandywine (Sept. 11, 1777) he again commanded the American right; he took part in the battle of Germantown (Oct. 4, 1777); in March 1778 he was placed in command in Rhode Island, and in the following summer plans were made for his co-operation with the French fleet under Count d'Estaing in an attack on Newport, which came to nothing. Sullivan after a brief engagement (Aug. 29) at Quaker Hill, at the N. end of the island of Rhode Island, was obliged to retreat. In 1779 Sullivan, with about 4000 men, defeated the Iroquois and their Loyalist allies at Newtown (now Elmira), New York, on the 29th of August, burned their villages, and destroyed their orchards and crops. Although severely criticised for his conduct of the expedition, he received, in October 1779, the thanks of Congress. In November he resigned from the army. Sullivan was again a delegate to the Continental Congress in 1780–1781 and, having accepted a loan from the French minister, Chevalier de la Luzerne, he was charged with being influenced by the French in voting not to make the right to the north-east fisheries a condition of peace. From 1782 to 1785 he was attorney-general of New Hampshire. He was president of the state in 1786–1787 and in 1789, and in 1786 suppressed an insurrection at Exeter immediately preceding the Shays Rebellion in Massachusetts. He presided over the New Hampshire convention which ratified the Federal constitution in June 1788. From 1789 until his death at Durham, on the 23rd of January 1795, he was United States District Judge for New Hampshire.

See O. W. B. Peabody, "Life of John Sullivan" in Jared Sparks's *Library of American Biography*, vol. iii. (Boston, 1844); T. C. Amory, *General John Sullivan, A Vindication of his Character as a Soldier and a Patriot* (Morrisania, N.Y., 1867); John Scales, "Master John Sullivan of Somersworth and Berwick and his Family," in the *Proceedings of the New Hampshire Historical Society*, vol. iv. (Concord, 1906); and *Journals of the Military Expedition of Major-General John Sullivan against the Six Nations of Indians* (Auburn, N. Y., 1887).

SULLIVAN, THOMAS BARRY (1824–1891), Irish actor, was born at Birmingham, and made his first stage appearance at Cork about 1840. His earliest successes were in romantic drama, for which his graceful figure and youthful enthusiasm fitted him. His first London appearance was in 1852 in *Hamlet*, and he was also successful as Angiolo in Miss Vandenhoff's *Woman's Heart*, Evelyn in *Money* and Hardman in Lord Lytton's *Not so Bad as we Seem*. Claude Melnotte—with Helen Faucit as Pauline—was also a notable performance. A tour of America in 1857 preceded his going to Australia (1861) for six years, as actor and manager. He completed a trip round the world in 1866. From 1868–1870 he managed the Holborn theatre, where Beverley in *The Gamester* was one of his most powerful impersonations. Afterwards he travelled over the United States, Canada, Australia and England. Among his later London performances were several Shakespearian parts, his best, perhaps, being Richard III. He was the Benedick of the cast of *Much Ado About Nothing* with which the Shakespeare Memorial was opened at Stratford-on-Avon. He died on the 3rd of May 1891.

SULLY, JAMES (1842–), English psychologist, was born on the 3rd of March 1842 at Bridgwater, and was educated at the Independent College, Taunton, the Regent's Park College, Göttingen and Berlin. He was originally destined for the Nonconformist ministry, but in 1871 adopted a literary and philosophic career. He was Grote professor of the philosophy of mind logic at University College, London, from 1892 to 1903, when he was succeeded by Carveth Read. An adherent of the associationist school of psychology, his views had great affinity with those of Alexander Bain. His monographs, as that on pessimism, are ably and readably written, and his textbooks, of which *The Human Mind* (1892) is the most important, are models of sound exposition.

Works.—*Sensation and Intuition* (1874), *Pessimism* (1877), *Illusions* (1881; 4th ed., 1895), *Outlines of Psychology* (1884; many editions), *Teacher's Handbook of Psychology* (1886), *Studies of Childhood* (1895), *Children's Ways* (1897), and *An Essay on Laughter* (1902).

SULLY, MAXIMILIEN DE BÉTHUNE, Duc de (1560–1641), French statesman, was born at the château of Rosny near Mantes, on the 13th of December 1560, of a noble family of Flemish descent. His father, François de Béthune, baron de Rosny, (1532–1575), was the son of Jean de Béthune, to whom in 1529 his wife Anne de Melun brought as part of her dowry a seigneurie at Rosny-sur-Seine, which later (1601) was made a marquisate. Brought up in the Reformed faith, Maximilien was presented to Henry of Navarre in 1571 and was thenceforth attached to the future king of France. The young baron de Rosny was taken to Paris by his patron and was studying at the college of Bourgogne at the time of the massacre of St Bartholomew's Day, from which he escaped by discreetly carrying a book of hours under his arm. He then studied mathematics and history at the court of Henry of Navarre, and on the outbreak of civil war in 1575 he enlisted in the Protestant army. In 1576 he accompanied the duke of Anjou on an expedition into the Netherlands in order to regain the former Rosny estates, but being unsuccessful he attached himself for a time to the prince of Orange. Later rejoining Henry of Navarre in Guienne, he displayed bravery in the field and particular ability as an engineer. In 1583 he was Henry's special agent in Paris. In 1584 he married Anne de Courtenay, a wealthy heiress, who died, however, in 1589. On the renewal of civil war Rosny again joined Henry of Navarre, and at the battle of Ivry (1590) was seriously wounded. He counselled Henry IV.'s conversion to Roman Catholicism, but steadfastly refused himself to become a Roman Catholic. As soon as Henry's power was established, the faithful and trusted Rosny received his reward in the shape of numerous estates and dignities. On the death of D'O, the superintendent of finances, in 1594, the king had appointed a finance commission of nine members, to which he added Rosny in 1596. The latter at once made a tour of inspection through the generalities, and introduced some order into the country's affairs. He was probably made sole superintendent of finances in 1598, although this title does not appear in official documents until the close of 1601. He authorized the free exportation of grain and wine, reduced legal interest from $8\frac{1}{3}$ to $6\frac{1}{4}$%, established a special court for the trial of cases of peculation, forbade provincial governors to raise money on their own authority, and otherwise removed many abuses of tax-collecting, abolished several offices, and by his honest, rigorous conduct of the country's finances was able to save between 1600 and 1610 an average of a million livres a year. His achievements were by no means solely financial. In 1599 he was appointed grand commissioner of highways and public works, superintendent of fortifications and grand master of artillery; in 1602 governor of Mantes and of Jargeau, captain-general of the queen's gens d'armes and governor of the Bastille; in 1604 governor of Poitou; and in 1606 duke and peer of Sully, ranking next to princes of the blood. He declined the office of constable because he would not become a Roman Catholic. Sully encouraged agriculture, urged the free circulation of produce, promoted stock-raising, forbade the destruction of the forests, drained swamps, built roads and bridges, planned a vast system of canals and actually began the canal of Briare. He strengthened the French military establishment; under his direction Évrard began the construction of a great line of defences on the frontiers. Sully opposed the king's colonial policy as inconsistent with the French genius, and likewise showed little favour to industrial pursuits, although on the urgent solicitation of the king he established a few silk factories. He fought in company with Henry IV. in Savoy (1600–1601) and negotiated the treaty of peace in 1602; in 1603 he represented Henry at the court of James I. of England; and throughout the reign he helped the king to put down insurrections of the nobles, whether Roman Catholic or Protestant. It was Sully, too, who arranged the marriage between Henry IV. and Marie de Médicis.

The political rôle of Sully practically ended with the assassination of Henry IV. on the 14th of May 1610. Although a member of the council of regency, his colleagues were not disposed to brook his domineering leadership, and after a stormy debate he resigned as superintendent of finances on the 26th of January 1611, and retired to private life. The queen-mother gave him 300,000 livres for his services and confirmed him in possession of his estates. He attended the estates-general in 1614, and on the whole was in sympathy with the policy and government of Richelieu. He disavowed the plots at La Rochelle, in 1621, but in the following year was arrested at Moulins, though soon released. The baton of marshal of France was conferred on him on the 18th of September 1634. The last years of his life were spent chiefly at Villebon, Rosny and Sully. He died at Villebon, on the 22nd of December 1641. By his first wife Sully had one son, Maximilien, marquis de Rosny (1587–1634), who led a life of dissipation and debauchery. By his second wife, Rachel de Cochefilet, widow of the lord of Châteaupers, whom he married in 1592 and who turned Protestant to please him, he had nine children, of whom six died young, and one daughter married in 1605 Henri de Rohan.

Sully was not popular. He was hated by most Roman Catholics because he was a Protestant, by most Protestants because he was faithful to the king, and by all because he was a favourite, and selfish, obstinate and rude. He amassed a large personal fortune, and his jealousy of all other ministers and favourites was extravagant. Nevertheless he was an excellent man of business, inexorable in punishing malversation and dishonesty on the part of others, and opposed to the ruinous court expenditure which was the bane of almost all European monarchies in his day. He was gifted with executive ability, with confidence and resolution, with fondness for work, and above all with deep devotion to his master. He was implicitly trusted by Henry IV. and proved himself the most able assistant of the king in dispelling the chaos into which the religious and civil wars had plunged France. To Sully, next to Henry IV., belongs the credit for the happy transformation in France between 1598 and 1610 by which agriculture and commerce were benefited and foreign peace and internal order were maintained.

Sully left a curious collection of memoirs written in the second person and bearing the quaint title, *Mémoires des sages et royales œconomies d'estat, domestiques, politiques, et militaires de Henry le Grand, l'exemplaire des roys, le prince des vertus, des armes, et des loix, et le père en effet de ses peuples françois; et des servitudes utiles, obissances convenables, et administrations loyales de Maxim. de Béthune, l'un des plus confidens, familiers, et utiles soldats et serviteurs du grand Mars des François: dédiées à la France, à tous les bons soldats, et tous peuples françois.* The memoirs are very valuable for the history of the time and as an autobiography of Sully, in spite of the fact that they contain many fictions, such as a mission undertaken by Sully to Queen Elizabeth in 1601, and the famous "Grand Design," a plan for a Christian republic, which some historians have taken seriously. Two folio volumes of the memoirs were splendidly printed, nominally at Amsterdam, but really under Sully's own eye, at his château in 1638; two other volumes appeared posthumously in Paris in 1662. The abbé de l'Écluse rewrote the memoirs in ordinary narrative form and edited them in 1745. The best edition of the original is that in J. F. Michaud and J. J. F. Poujoulat, *Nouvelle collection des mémoires relatifs à l'histoire de France* (1854), vols. xvi.–xvii. An English translation by Charlotte Lennox appeared in 1756 and was later revised and republished (4 vols., London, 1856).

See E. Lavisse, *Sully* (Paris, 1880); L. Dussieux, *Étude biographique sur Sully* (Paris, 1887); G. Fagniez, *Économie sociale de la France sous Henri IV.* (Paris, 1897); B. L. H. Martin, *Trois grands ministres, Sully, Richelieu et Colbert* (Paris, 1898); E. Lavisse, ed. *Histoire de France* (Paris, 1905), vol. vi.; P. Robiquet, *Histoire municipale de Paris*, vol. iii. *Histoire de Henri IV.* (Paris, 1904); E. Bonnal, *L'Économie politique au XVI^e siècle: Sully économiste* (Paris, 1872); J. Gourdault, *Sully et son temps* (Tours, 1873); T. Kükelhaus, *Der Ursprung des Planes vom ewigen Frieden in den Memoiren des Herzogs von Sully* (Berlin, 1892); C. Pfister, "Les 'Œconomies royales' de Sully et le grand dessein de Henri IV." in *Revue historique* (1894), vols. liv.–lvi.; Desclozeaux, "Gabrielle d'Estrées et Sully" in *Revue historique* (1887), vol. xxxiii. (C. H. Ha).

SULLY, THOMAS (1783–1872), American artist, was born at Horncastle, England, on the 8th of June 1783. His parents, who were actors, took him to America when he was nine years old, settling at Charleston, South Carolina, and he was first instructed in art by a French miniature painter. Afterwards he was a pupil of Gilbert Stuart in Boston, and in 1809 he went to London and entered the studio of Benjamin West. He returned in 1810, and made Philadelphia his home, but in 1837 again visited London, where he painted a full length portrait of Queen Victoria for the St George's Society of Philadelphia. Sully was one of the best of the early American painters. He died in Philadelphia on the 5th of November 1872. Among his portraits are those of Commodore Decatur (City Hall, New York); the actor George Frederick Cooke, as Richard III. (Pennsylvania Academy of the Fine Arts, Philadephia); Lafayette (Independence Hall); Thomas Jefferson (U.S. Military Academy, West Point, New York); Charles and Frances Anne Kemble, and Reverdy Johnson. His son ALFRED SULLY (1821–1879) an officer in the United States army, was a brigade-commander in the Army of the Potomac in 1862–63, and after 1863 commanded the department of Dakota and conducted several campaigns against hostile Indians in the north-west. In 1865 he was breveted brigadier-general in the regular army and major-general of volunteers.

SULLY-PRUDHOMME, RENE FRANÇOIS ARMAND PRUDHOMME (1839–1907), French poet, was born in Paris on the 16th of March 1839. He was educated at the Lycée Bonaparte, where after a time he took his degree as Bachelier ès Sciences. An attack of ophthalmia then interrupted his studies and necessitated an entire change in the course of his career. The scientific habit of mind, however, which he had derived from these years of technical study never left him; and it is in the combination of this scientific bent, with a soul aspiring towards what lies above and beyond science, and a conscience perpetually in agitation, that the striking originality of Sully-Prudhomme's character is to be found. He found employment for a time in the Schneider factory at Creuzot, but he soon abandoned an occupation to which he was eminently unsuited. He subsequently decided to read law, and entered a notary's office at Paris. It was during this period that he composed those early poems which were not long in acquiring celebrity among an ever-widening circle of friends. In 1865 he published his first volume of poems, which had for sub-title *Stances et poèmes*. This volume was favourably reviewed by Sainte-Beuve, to whose notice it had been brought by Gaston Paris. It was at this moment that the small circle of which Leconte de Lisle was the centre were preparing the *Parnasse*, to which Sully-Prudhomme contributed several pieces. In 1866 Lemerre published a new edition of the *Stances et poèmes* and a collection of sonnets entitled *Les Épreuves* (1866). From this time forward Sully-Prudhomme devoted his life entirely to poetry. It was in the volume of *Les Épreuves* that the note of melancholy which was to dominate through the whole work of his life was first clearly discernible. In 1869 he published a translation of the first book of Lucretius with a preface, and *Les Solitudes*. In 1870 a series of domestic bereavements and a serious paralytic illness resulting from the strain and fatigue of the winter of 1870, during which he served in the Garde Mobile, shattered his health. In 1872 he published *Les Écuries d'augias*, *Croquis italiens*, *Impressions de la guerre* (1866–72) and *Les Destins*, *La Révolte des heurs* in 1874, in 1875 *Les Vaines tendresses*, in 1878 *La Justice*, in 1886 *Le Prisme*, and in 1888 *Le Bonheur*. All these poems were collected and republished under the title of *Poésies*, occupying four volumes of his *Œuvres* (6 vols., 1883–1904). After the publication of *Le Bonheur* he practically ceased to produce verse, and devoted himself almost entirely to philosophy. He published two volumes of prose criticism *L'expression dans les beaux arts* (1884) and *Réflexions sur l'art des vers* (1892). Various monographs by him appeared from time to time in the philosophical reviews, and among them a remarkable series of essays (*Revue des deux mondes*, Oct. 15th, Nov. 15th, 1890) on Pascal, and a valuable study on the "Psychologie du libre arbitre" in the *Revue de métaphysique et de morale* (1906). He was elected to the Academy on the 8th of December 1881. On the 10th of December 1901 he was awarded the Nobel prize for literature, and devoted most of the money to the foundation of a prize for poetry to be awarded by the *Société de gens de lettres*. He was one of the earliest champions of Captain Dreyfus. In 1902 he wrote, in collaboration with Charles Richet, *Le Problème des causes finales*. During his later years he lived at Châtenay in great isolation, a victim of perpetual ill-health, and mainly occupied with his *Vraie religion selon Pascal* (1905). He had been partially paralysed for some time when he died suddenly on the 6th of September 1907. He left a volume of unpublished verse and a prose work, *Le Lien social*, which was a revision of an introduction which he had contributed to Michelet's *La Bible de l'humanité*.

What strikes the reader of Sully-Prudhomme's poetry first and foremost is the fact that he is a thinker; and moreover a poet who thinks, and not a thinker who turns to rhyme for recreation. The most strikingly original portion of his work is to be found in his philosophic and scientific poetry. If he has not the scientific genius of Pascal, he has at least the scientific habit of mind and a delight in mathematic certainties. In attempting to interpret the universe as science reveals it to us he has created a new form of poetry which is not lacking in a certain grandeur. One of his most beautiful poems, "L'Idéal" (*Stances et poèmes*), is inspired by the thought, which is due to scientific calculations, of stars so remote from our planet that their light has been on its way to us since thousands of centuries and will one day be visible to the eyes of a future generation. The second chief characteristic of Sully-Prudhomme's poetry is the extreme sensibility of soul, the profoundly melancholy note which we find in his love lyrics and his meditations. Sully-Prudhomme is above all things introspective; he penetrates into the hidden corners of his heart; he lays bare the subtle torments of his conscience, the shifting currents of his hopes and fears, belief and disbelief in face of the riddle of the universe to an extent so poignant as to be sometimes almost painful. And to render the fugitive phases and tremulous adventures of his spirit he finds incomparably delicate shades of expression, an exquisite and sensitive diction. We are struck in reading his poems by the nobility of his ideas, by a religious elevation like that of Pascal; for there is in his work something both of Lucretius and of Pascal. Yet he is far from being either an Epicurean or a Jansenist; he is rather a Stoic to whom the deceptions of life have brought pity instead of bitterness.

As an artist Sully-Prudhomme is remarkable for the entire absence of oratorical effect; for the extreme simplicity and fastidious precision of his diction. Other poets have been endowed with a more glowing imagination; his poetry is neither exuberant in colour nor rich in sonorous harmonies of rhyme. The grace of his verse is a grace of outline and not of colour, his melody one of subtle rhythm; his verse is as if carved in ivory, his music like that of a perfect unison of stringed instruments. His imagination is inseparable from his ideas, and this is the reason of the extraordinary perspicuity of his poetic style. He extends poetry to two extreme limits; on the one hand to the borderland of the unreal and the dreamlike, as in a poem such as "Le Rendezvous" (*Vaines tendresses*), in which he seems to express the inexpressible in precise language; on the other hand, in his scientific poems he encroaches on the province of prose. His poetry is plastic in the creation of forms which fittingly express his fugitive emotions and his elevated ideas. Both by the charm of his pure and perfect phrase, by his consummate art, and the dignity which informs all his work, Sully-Prudhomme deserves rank among the foremost of modern poets. (E. G.)

See C. Hémon, *La Philosophie de Sully-Prudhomme* (1907), *Sully-Prudhomme* by E. Zyromski (Paris 1907).

SULMONA, or SOLMONA (anc. *Sulmo*), a city and episcopal see of the Abruzzi, Italy, in the province of Aquila, 40 m. by rail S.E. by E. of that town, and 107 m. E. by N. of Rome (75 m. direct). Pop. (1901), 13,372 (town), 18,247 (commune). Sulmona is situated at a height of 1322 ft. above the sea on the Gizio, a tributary of the Pescara, which supplies water-power to its paper-mills, fulling-mills and copper-works. Its cathedral of San Panfilio has a 14th-century portal. The interior has been modernized, but in the crypt are some medieval sculptures.

Sulmona has also in S. Maria della Tomba a good example of pure Gothic. S. Francesco d'Assisi occupies the site of an older and larger church, the Romanesque portal of which still stands at the end of the Corso Ovidio, and forms the entrance to the meat market. Opposite is a picturesque aqueduct of 1266 with pointed arches. S. Agostino has a good Gothic portal. The Ospedale Civico, next to the church of the Annunziata, begun in the first half of the 15th century, shows an interesting mixture of Gothic and Renaissance styles. The window of the Palazzo Tabassi is similar, and both are due to Lombard masters. In the court of the grammar school is a fine 15th-century statue of Ovid, the most celebrated native of the town, whose memory is preserved among the peasants in songs and folk-lore. The Porta Napoli is an interesting gate of the early 14th century. Innocent VII. was a native of the town. In the vicinity of the town is Monte Morrone where Pietro di Morone lived (*c.* 1254) as a hermit and founded a monastery for his hermits, who after his elevation to the papacy as Celestine V. took the name of Celestines; the monastery (S. Spirito) remained till 1870, when it was transformed into a prison. There are some ruins of the imperial period, attributed, groundlessly, to the house of Ovid near it. The church contains a Gothic tomb of 1412 by a German master, in which Renaissance influence is, according to Burckhardt, traceable for the first time in south Italy in the realistic characterization of the portrait figures.

Sulmo, a city of the Paeligni, is first mentioned during the Second Punic War (211 B.C.). It was the second town of the Paeligni in importance, Corfinium coming first. It became a Roman colony probably in the reign of Augustus, and as a municipium it continued to flourish throughout the empire. It was situated 7 m. south-east of Corfinium on the road to Aesernia, and was famous for its ironsmiths. Hardly any remains of the ancient city exist above ground, owing to frequent earthquakes. A number of discoveries of tombs (both archaic and of the Roman period), &c., have however been made (cf. A. de Nino, in *Notizie degli Scavi*, passim). Charles V. erected it into a principality, which he bestowed on Charles Lannoy, who had captured Francis I. at the battle of Pavia. It ultimately passed to the Corno and Borghese families. The bishopric is known as that of Valva and Sulmona.

SULPHONAL, or acetone diethyl sulphone $(CH_3)_2C(SO_2C_2H_5)_2$, a valuable hypnotic prepared by condensing acetone with ethyl mercaptan in the presence of hydrochloric acid, the mercaptol $(CH_3)_2C(SC_2H_5)_2$ formed being subsequently oxidized by potassium permanganate (E. Baumann, *Ber.*, 1886, 19, p. 2808). It is also formed by the action of alcoholic potash and methyl iodide on ethylidene diethyl sulphine, $CH_3{\cdot}CH(SO_2C_2H_5)_2$ (which is formed by the oxidation of dithioacetal with potassium permanganate). It crystallizes in prisms melting at 125° C., which are practically insoluble in cold water, but dissolve in 15 parts of hot and also in alcohol and ether.

It is the *sulphonalum* of the B.P., and the *sulphomethanum* of the U.S.P. It produces lengthened sleep in functional nervous insomnia, and is also useful in insanity, being given with mucilage of acacia or in hot liquids, owing to its insolubility, or in large capsules. Its hypnotic power is not equal to that of chloral, but as it is not a depressant to the heart or respiration it can be used when morphine or chloral are contra-indicated. It is, however, very uncertain in its action, often failing to produce sleep when taken at bedtime, but producing drowsiness and sleep the following day. The drowsiness the next day following a medicinal dose can be avoided by a saline laxative the morning after its administration. It is unwise to use it continuously for more than a few days at a time, as it tends to produce the sulphonal habit, which is attended by marked toxic effects, disturbances of digestion, giddiness, staggering gait and even paralysis of the lower extremities. These effects are accompanied by skin eruptions, and the urine becomes of a dark red colour (haematoporphinuria). Sulphonal is cumulative in its effects. Many fatal cases of sulphonal poisoning are on record, both from chronic poisoning and from a single large dose. Trional $(CH_3)(C_2H_5)C(SO_2C_2H_5)_2$, and tetronal, $(C_2H_5)_2C(SO_2C_2H_5)_2$, are also hypnotics. They are faster in action than sulphonal, and trional does not disorder the digestion.

SULPHONIC ACIDS, in organic chemistry, a group of compounds of the type $R{\cdot}SO_3H$, where R is an alkyl or an aryl group.

Aliphatic Sulphonic Acids.—The members of this class may be prepared by the direct sulphonation of some paraffins (I. Worstall, *Amer. Chem. Journ.*, 1898, 20, p. 664); by the oxidation of mercaptans with concentrated nitric acid (H. Kopp, *Ann.*, 1840, 35, p. 346); in the form of their salts from the alkyl halides and alkaline sulphites, and as esters from the alkyl halides and silver sulphite. They are colourless oils or crystalline solids which are extremely hygroscopic, very soluble in water and have a strongly acid reaction. They are unaffected by heating with aqueous alkalis or acids and are stable towards concentrated nitric acid. Phosphorus pentachloride converts them into the corresponding acid chlorides, $R{\cdot}SO_2Cl$, which are decomposed slowly by water. These chlorides, on reduction by zinc and sulphuric acid, pass readily into the mercaptans, whilst if zinc dust and alcohol be used they are converted into the sulphinic acids, $R{\cdot}SO_2H$.

Methyl sulphonic acid, $CH_3{\cdot}SO_3H$, was obtained by H. Kolbe (*Ann.*, 1845, 54, p. 174) by reducing trichloromethyl sulphonic chloride (formed from chlorine and carbon bisulphide in the presence of water: $CS_2+5Cl_2+2H_2O=CCl_3{\cdot}SO_2Cl+4HCl+SCl_2$) with sodium amalgam. It is a colourless syrup which decomposes when heated above 130° C. The corresponding acid chloride is an extremely stable solid which melts at 135° C. It is formed by the action of carbon bisulphide on potassium bichromate in the presence of nitric and hydrochloric acids (Loew, *Zeit. f. Chem.*, 1869, p. 82). When heated under pressure it decomposes with the final production of carbonyl and thionyl chlorides: $CCl_3{\cdot}SO_2Cl=CCl_4+SO_2=COCl_2+SOCl_2$. *Ethyl sulphonic acid*, $C_2H_5{\cdot}SO_3H$, is a crystalline deliquescent solid formed by oxidizing ethyl mercaptan or by reducing vinyl sulphonic acid, $CH_2{:}CH{\cdot}SO_3H$ (Kohler, *Amer. Chem. Journ.*, 1898, 20, p. 687).

Thiosulphonic acids of the type $R{\cdot}SO_2{\cdot}SH$ are formed by the action of the sulphochlorides on a concentrated solution of potassium sulphide: $R{\cdot}SO_2Cl+K_2S=R{\cdot}SO_2K+S+KCl=KCl+R{\cdot}SO_2{\cdot}SK$; or by the action of the salt of a sulphinic acid on an alkaline sulphide in the presence of iodine (Otto, *Ber.*, 1891, 24, p. 144).

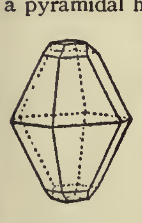
Aromatic Sulphonic Acids.—The acids of this group are very similar to the corresponding aliphatic sulphonic acids and are usually obtained by the direct heating of an aromatic hydrocarbon with concentrated sulphuric acid, fuming sulphuric acid or sulphur chlorhydrin. After the action is completed they may frequently be "salted out" by adding common salt to the acid solution until no more dissolves, when the sodium salt of the acid separates (L. Gattermann, *Ber.*, 1891, 24, p. 2121). They are also formed by oxidizing thiophenols or by decomposing diazonium salts with sulphurous acid. The free acids are usually hygroscopic, crystalline solids which are readily soluble in water. When heated under pressure with concentrated hydrochloric acid to about 150° C. they yield hydrocarbons and sulphuric acid. The salts usually crystallize well, and those of the alkali metals are employed in the preparation of phenols, into which they pass when fused with the caustic alkalis. When distilled with potassium cyanide they yield the aromatic nitriles. The sulphonic acids with phosphorus pentachloride are converted into sulphochlorides which are stable to cold water, but with ammonia they yield sulphonamides, $R{\cdot}SO_2NH_2$, and with alcohols esters of the sulphonic acids.

Benzene sulphonic acid, $C_6H_5{\cdot}SO_3H,1\frac{1}{2}H_2O$, crystallizes in small plates and is very deliquescent. *Benzene sulphochloride*, $C_6H_5{\cdot}SO_2Cl$, is a colourless fuming liquid which boils at 120° C. (10 mm.). The aminobenzene sulphonic acids, particularly the meta and para compounds, are of importance owing to their employment in the colour industry. The direct sulphonation of aniline yields the para acid, *sulphanilic acid*, $C_6H_4(NH_2)(SO_3H)$, which crystallizes in small plates and is sparingly soluble in cold water. When fused with caustic potash it yields aniline, whilst oxidation with chromic acid yields benzoquinone. In constitution it is probably to be regarded as a cyclic ammonium salt, $C_6H_4\left\langle\begin{array}{l}NH_3\\SO_3\end{array}\right\rangle$. When diazotized in acid solution and coupled with dimethyl aniline it yields helianthine, the sodium salt of which is used as an indicator (*q.v.*). *Metanilic acid* $C_6H_4(NH_2)(SO_3H)$ [1.3], which crystallizes in prisms, is formed by the reduction of meta-nitrobenzene sulphonic acid and is used in the preparation of various azo dyes.

Sulphinic acids, $R \cdot SO_2H$, are formed by reducing sulphochlorides with zinc dust; by the action of sulphur dioxide on the zinc aikyls (Hobson, *Ann*, 1857, 102, p. 72; 1858, 106, p. 287); by the action of sulphochlorides on mercaptans in alkaline solution; and by the action of the Grignard reagent on sulphur dioxide or thionyl chloride (Rosenheim, *Ber.*, 1904, 37, p. 2152; Oddo, *R. Accad. Lin.*, 1905 (5), 14 (i.), p. 169). The free acids are unstable. They are readily oxidized to sulphonic acids and reduced to mercaptans. Their alkali salts on treatment with the alkyl halides yield sulphones, R_2SO_2. Ethyl sulphinic acid, $C_2H_5 \cdot SO_2H$, is a colourless syrup. Benzene sulphinic acid, $C_6H_5 \cdot SO_2H$, crystallizes in large prisms and acts as a reducing agent. It decomposes when heated with water under pressure: $3C_6H_5 \cdot SO_2H = C_6H_5 \cdot SO_2H + C_6H_5 \cdot SO_2 \cdot S \cdot C_6H_5 + H_2O$. The potassium salt when fused with caustic potash yields benzene and potassium sulphite.

SULPHUR [symbol S, atomic weight 32·07 (O=16)], a non-metallic chemical element, known from very remote times and regarded by the alchemists, on account of its inflammable nature, as the principle of combustion; it is also known as brimstone (*q.v.*). The element occurs widely and abundantly distributed in nature both in the free state and in combination. Free or native sulphur, known also as "virgin sulphur," occurs in connexion with volcanoes and in certain stratified rocks in several modes, viz. as crystals, and as stalactitic, encrusting, reniform, massive, earthy and occasionally pulverulent forms as "sulphur meal." It seems rather doubtful whether the unstable monoclinic modification of sulphur (β–sulphur) is ever found in a native state.

The crystals belong to the orthorhombic system, and have usually a pyramidal habit (fig.), but may be sphenoidal or tabular. Twins are rare. The cleavage is imperfect, but there is a well-marked conchoidal fracture. The hardness ranges from about 1 to 2, and the sp.gr. from 1·9 to 2·1. Crystals of sulphur are transparent or translucent and highly refractive with strong birefringence; they have a resinous or slightly adamantine lustre, and present the characteristic sulphur-yellow colour. Impurities render the mineral grey, greenish or reddish, bituminous matter being often present in the massive varieties. Sulphur containing selenium, such as occurs in the isle of Vulcano in the Lipari Isles, may be orange-red; and a similar colour is seen in sulphur which contains arsenic sulphide, such as that from La Solfatara near Naples. The presence of tellurium in native sulphur is rare, but is known in certain specimens from Japan.



Volcanic sulphur usually occurs as a sublimate around or on the walls of the vents, and has probably been formed in many cases by the interaction of sulphur dioxide and hydrogen sulphide. Sublimed sulphur also results from the spontaneous combustion of coal seams containing pyrites. Deposits of sulphur are frequently formed by the decomposition of hydrogen sulphide, on exposure to the atmosphere: hence natural sulphureous waters, especially hot springs, readily deposit sulphur. The reduction of sulphates to sulphides by means of organic matter, probably through the agency of sulphur-bacteria, may also indirectly furnish sulphur, and hence it is frequently found in deposits of gypsum. Free sulphur may also result from the decomposition of pyrites, as in pyritic shales and lignites, or from the alteration of galena: thus crystals of sulphur occur, with anglesite, in cavities in galena at Monteponi near Iglesias in Sardinia; whilst the pyrites of Rio Tinto in Spain sometimes yield sulphur on weathering. It should be noted that the oxidation of sulphur itself by atmospheric influence may give rise to sulphuric acid, which in the presence of limestone will form gypsum: thus the sulphur-deposits of Sicily suffer alteration of this kind, and have their outcrop marked by a pale earthy gypseous rock called *briscale.*

Some of the most important deposits of sulphur in the world are worked in Sicily, chiefly in the provinces of Caltanisetta and Girgenti, as at Racalmuto and Cattolica; and to a less extent in the provinces of Catania, Palermo (Lercara) and Trapani (Gibellina). The sulphur occurs in Miocene marls and limestone, associated with gypsum, celestine, aragonite and calcite. It was formerly believed that the sulphur had a volcanic origin, but it is now generally held that it has either been reduced from gypsum by organic agencies, or more probably deposited from sulphur-bearing waters. Liquid occasionally enclosed in the sulphur and gypsum has been found by O. Silvestri and by C. A. H. Sjögren to contain salts like those of sulphur-springs. An important zone of sulphur-bearing Miocene rocks occurs on the east side of the Apennines, constituting a great part of the province of Forli and part of Pesaro, Cesena and Perticara are well-known localities in this district, the latter yielding crystals coated with asphalt. Sulphur is occasionally found crystallized in Carrara marble; and the mineral occurs also in Calabria. Fine crystals occur at Conil near Cadiz; whilst in the province of Teruel in Aragon, sulphur in a compact form replaces fresh-water shells and plant-remains, suggesting its origin from sulphur-springs. Nodular forms of sulphur occur in Miocene marls near Radoboj in Croatia, and near Swoszowic, south of Cracow. Russia possesses large deposits of sulphur in Daghestan in Transcaucasia, and in the Transcaspian steppes. Important deposits of sulphur are worked at several localities in Japan, especially at the Kosaka mine in the province of Rikuchiu, and at Yatsukoda-yama, in the province of Mutsu. Sulphur is worked in Chile and Peru. A complete list of localities for sulphur would include all the volcanic regions of the world. In the United States, sulphur occurs in the following states, in many of which the mineral has been worked: Louisiana (*q.v.*), Utah, Colorado, California, Nevada, Alaska, Idaho, Texas and Wyoming. The Rabbit Hole sulphur-mines are in Nevada, and a great deposit in Utah occurs at Cove Creek, Beaver county. In the British Islands native sulphur is only a mineralogical rarity, but it occurs in the Carboniferous Limestone of Oughterard in Co. Galway, Ireland.[1]

In combination the element chiefly occurs as metallic sulphides and sulphates. The former are of great commercial importance, being, in most cases, valuable ores, *e.g.* copper pyrites (copper), galena (lead), blende (zinc), cinnabar (mercury), &c. Of the sulphates we notice gypsum and anhydrite (calcium), barytes (barium) and kieserite (magnesium). Gaseous compounds, *e.g.* sulphur dioxide and sulphuretted hydrogen, are present in volcanic exhalations (see VOLCANO) and in many mineral waters. The element also occurs in the animal and vegetable kingdoms. It is present in hair and wool, and in albuminous bodies; and is also a constituent of certain vegetable oils, such as the oils of garlic and mustard. There is, in addition, a series of bacteria which decompose sulphureous compounds and utilize the element thus liberated in their protoplasm (see BACTERIOLOGY).

Extraction.—As quarried or mined free sulphur is always contaminated with limestone, gypsum, clay, &c.; the principle underlying its extraction from these impurities is one of simple liquation, *i.e.* the element is melted, either by the heat of its own combustion or other means, and runs off from the earthy residue.

In the simplest and crudest method, as practised in Sicily, a mass of the ore is placed in a hole in the ground and fired; after a time the heat melts a part of the sulphur which runs down to the bottom of the hole and is then ladled out. This exceptionally wasteful process, in which only one-third of the sulphur is recovered, has been improved by conducting the fusion in a sort of kiln. A semicircular or semi-elliptical pit (*calcarone*) about 33 ft. in diameter and 8 ft. deep is dug into the slope of a hill, and the sides are coated with a wall of stone. The sole consists of two halves slanting against each other, the line of intersection forming a descending gutter which runs to the outlet. This outlet having been closed by small stones and sulphate of lime cement, the pit is filled with sulphur ore, which is heaped up considerably beyond the edge of the pit and covered with a layer of burnt-out ore. In building up the heap a number of narrow vertical passages are left to afford a draught for the fire. The ore is kindled from above and the fire so regulated (by making or unmaking air-holes in the covering) that, by the heat produced

[1] *References.*—A very full article ("Zolfo") by G. Aichino, of the Geological Survey of Italy, will be found in the *Enciclopedia delle arte e industrie* (Turin, 1898). This includes a full bibliography. See also J. F. Kemp in Rothwell's *Mineral Industry* (1893), vol. ii.; Jules Brunfaut, *De l'Exploitation des soufres* (2nd ed., 1874); Georgio Spezia, *Sull' origine del solfo nei giacementi solfiferi della Sicilia* (Turin, 1892). For Japanese sulphur see T. Wada, *Minerals of Japan* (Tōkyō, 1904).

by the combustion of the least sufficient quantity of sulphur, the rest is liquefied. The molten sulphur accumulates on the sole, whence it is from time to time run out into a square stone receptacle, from which it is ladled into damp poplar-wood moulds and so brought into the shape of truncated cones weighing 110 to 130 lb each. These cakes are sent out into commerce. A calcarone with a capacity of 28,256 cub. ft. burns for about two months, and yields about 200 tons of sulphur. The yield is about 50%. The immense volumes of sulphurous acid evolved give rise to many complaints; all the minor pits suspend work during the summer to avoid destruction of the crops. A calcarone that is to be used all the year round must be at least 220 yds. from any inhabited place and 110 yds. from any field under cultivation.

More efficient is the Gill kiln which uses coke as a fuel. The kiln consists of two (or more) connected cells which are both charged with the ore. The first cell is heated and the products of combustion are led into the second cell where they give up part of their heat to the contained ore, so that by the time the first cell is exhausted the mass in the second cell is at a sufficiently high temperature to ignite spontaneously when air is admitted. Other methods have been employed, but with varying commercial success. For example, in the Gritti and Orlando processes the ore is charged into retorts and the fusion effected by superheated steam, the sulphur being run off as usual; or as was suggested by R. E. Bollman in 1867 the ore may be extracted by carbon bisulphide.

Crude sulphur, as obtained from kilns, contains about 3% of earthy impurities, and consequently needs refining. The following apparatus (invented originally by Michel of Marseilles and improved subsequently by others) enables the manufacturer to produce either of two forms of "refined" sulphur which commerce demands. It consists of a large stone chamber which communicates directly with two slightly slanting tubular retorts of iron. The retorts are charged with molten sulphur from an upper reservoir, which is kept at the requisite temperature by means of the lost heat of the retort fires. The chamber has a safety value at the top of its vault, which is so balanced that the least surplus pressure from within sends it up. The first puff of sulphur vapour which enters the chamber takes fire and converts the air of the chamber into a mixture of nitrogen and sulphur dioxide. The next following instalments of vapour, getting diffused throughout a large mass of relatively cold gas, condense into a kind of "snow," known in commerce and valued as "flowers of sulphur" (*flores sulphuris*). By conducting the distillation slowly, so that the temperature within the chamber remains at a sufficiently low degree, it is possible to obtain the whole of the product in the form of "flowers." If compact ("roll") sulphur is wanted the distillation is made to go on at the quickest admissible rate. The temperature of the interior of the chamber soon rises to more than the fusing-point of sulphur (113° C.), and the distillate accumulates at the bottom as a liquid, which is tapped off from time to time to be cast into the customary form of rods.

The Louisiana deposits are worked by a process devised by Herman Frasch in 1891. It consists in sinking a bore-hole, after the manner of a petroleum well, and letting in four pipes centrally arranged, the outer pipe being 10 in. in diameter, the next 6 in., the next 3 in. and the innermost 1 in. The operation consists in forcing down the 3-in. pipe superheated steam at 330° F. to melt the sulphur. Compressed air is now driven down the 1-in. pipe and bubbles into the melted sulphur and water; the specific gravity of which is greatly diminished, so that it rises to the surface through the outer pipes; it is then run off to settling tanks. The sulphur so obtained is 98% pure.

In some places sulphur is extracted from iron pyrites by one of two methods. The pyrites is subjected to dry distillation from out of iron or fire-clay tubular retorts at a bright red heat. One-third of the sulphur is volatilized—$3FeS_2 = Fe_3S_4 + 2S$—and obtained as a distillate. The second method is analogous to the calcarone method of liquation: the ore is placed in a limekiln-like furnace over a mass of kindled fuel to start a partial combustion of the mineral, and the process is so regulated that, by the heat generated, the unburnt part is decomposed with elimination of sulphur, which collects in the molten state on an inverted roof-shaped sole below the furnace and is thence conducted into a cistern. Such pyrites sulphur is usually contaminated with arsenic, and consequently is of less value than Sicilian sulphur, which is characteristically free from this impurity.

Large quantities are also recovered from alkali waste (see ALKALI MANUFACTURE); another source is the spent oxide of gas manufacture (see GAS).

The substance known as "milk of sulphur" (*lac sulphuris*) is very finely divided sulphur produced by the following, or some analogous, chemical process. One part of quicklime is slaked with 6 parts of water, and the paste produced diluted with 24 parts of water; 2·3 parts of flowers of sulphur are added; and the whole is boiled for about an hour or longer, when the sulphur dissolves. The mixed solution of polysulphides and thiosulphate of calcium thus produced is clarified, diluted largely, and then mixed with enough of pure dilute hydrochloric acid to produce a feebly alkaline mixture when sulphur is precipitated. The addition of more acid would produce an additional supply of sulphur (by the action of the $H_2S_2O_3$ on the dissolved H_2S); but this thiosulphate sulphur is yellow and compact, while the polysulphide part has the desired qualities, forming an extremely fine, almost white, powder. The precipitate is washed, collected, and dried at a very moderate heat.

Properties.—Sulphur exists in several allotropic modifications, but before considering these systematically we will deal with the properties of ordinary (or rhombic) sulphur. Commercial sulphur forms yellow crystals which melt at 113° and boil at 444·53° C. under ordinary pressure (H. L. Callendar, *Chem. News*, 1891, 63, p. 1); just above the boiling point the vapour is orange-yellow, but on continued heating it darkens, being deep red at 500°; at higher temperatures it lightens, becoming straw-yellow at 650°. These colour changes are connected with a dissociation of the molecules. At 524° Dumas deduced the structure S_6 from vapour-density determinations, whilst for the range 860° to 1040°, Sainte-Claire Deville and Troost deduced the formula S_2. Biltz (*Ber.*, 1888, 21, p. 2013; 1901, 34, p. 2490) showed that the vapour density decreased with the temperature, and also depended on the pressure. G. Preuner and W. Schupp (*Zeit. phys. Chem.*, 1909, 69, p. 157), in a study of the dissociation isotherms over 300°–850°, detected molecules of S_8, S_6 and S_2, whilst S_1 appears to exist below pressures of 30 mm. Boiling and freezing-point determinations of the molecular weight in solution indicate the formula S_8. The density of solid sulphur is 2·062 to 2·070, and the specific heat 0·1712; it is a bad conductor of electricity and becomes negatively electrified on friction. It ignites in air at 363° and in oxygen at 275–280° (H. Moissan, *Compt. rend.*, 1903, 137, p. 547), burning with a characteristic blue flame and forming much sulphur dioxide, recognized by its pungent odour. At the same time a little trioxide is formed, and, according to Hempel (*Ber.*, 1890, 23, p. 1455), half the sulphur is converted into this oxide if the combustion be carried out in oxygen at a pressure of 40 to 50 atmospheres. Sulphur also combines directly with most of the elements to form sulphides. The atomic weight was determined by Berzelius, Erdmann and Marchand, Dumas and Stas. Thomsen (*Zeit. phys. Chem.*, 1894, 13, p. 726) obtained the value 32·0606.

Allotropic Modifications.—Sulphur assumes crystalline, amorphous and (possibly) colloidal forms. Historically the most important are the rhombic (S_α) and monoclinic (S_β) forms, discussed by E. Mitscherlich in 1822 (see *Ann. chim. phys.*, 1823, 24, p. 264). The transformations of these two forms are discussed in CHEMISTRY: *Physical.* Rhombic sulphur may be obtained artificially by slowly crystallizing a solution of sulphur in carbon bisulphide, or, better, by exposing pyridine saturated with sulphuretted hydrogen to atmospheric oxidation (Ahrens, *Ber.*, 1890, 23, p. 2708). It is insoluble in water,[1] but readily soluble in carbon bisulphide, sulphur chloride and oil of turpentine. The common monoclinic variety is obtained by allowing a crust to form over molten sulphur by partially cooling it, and then breaking the crust and pouring off the still liquid portion, whereupon the interior of the vessel will be found coated with long needles of this variety. Like S_α it is soluble in carbon bisulphide. Three other monoclinic forms have been described. By acting upon a solution of sodium hyposulphite with potassium bisulphate, Gernez (*Compt. rend.*, 1884, 98, p. 144) obtained a form which he termed *nacré* (or pearly) sulphur; the same modification was obtained by Sabatier (ibid., 1885, 100, p. 1346) on shaking hydrogen persulphide with alcohol or ether. It is readily transformed into rhombic sulphur. Another form, mixed with the variety just described, is obtained by adding 3 to 4 volumes of alcohol to a solution of ammonium sulphide saturated with sulphur and exposing the mixture to air at about 5°. Engel's monoclinic form (*Compt. rend.*, 1891, 112, p. 866) is obtained by mixing a solution of sodium hyposulphite with double its volume of hydrochloric acid, filtering and extracting with chloroform; the extract yielding the variety on evaporation. A triclinic form is claimed to be obtained by Friedel (*Bull. soc. chim.*, 1879, 32, p. 14) on subliming ordinary sulphur.

[1] It is a common practice of keepers of dogs to place a piece of roll sulphur in the animal's water but this serves no useful purpose owing to this property.

Amorphous sulphur or S_γ exists in two forms, one soluble in carbon bisulphide, the other insoluble. Milk of sulphur (see above), obtained by decomposing a polysulphide with an acid, contains both forms. The insoluble variety may also be obtained by decomposing sulphur chloride with water and by other reactions. It gradually transforms itself into rhombic sulphur.

The colloidal sulphur, S_δ, described by Debus as a product of the interaction of sulphuretted hydrogen and sulphur dioxide in aqueous solution, is regarded by Spring (*Rec. trav. chim.*, 1906, 25, p. 253) as a hydrate of the formula $S_8 \cdot H_2O$. The "blue sulphur," described by Orloff, has been investigated by Paternò and Mazzucchelli (*Abs. Journ. Chem. Soc.*, 1907, ii. 451).

Molten Sulphur.—Several interesting phenomena are witnessed when sulphur is heated above its melting point. The solid melts to a pale yellow liquid which on continued heating gradually darkens and becomes more viscous, the maximum viscosity occurring at 180°, the product being dark red in colour. This change is associated with a change in the spectrum (N. Lockyer). On continuing the heating, the viscosity diminishes while the colour remains the same. If the viscous variety be rapidly cooled, or the more highly heated mass be poured into water, an elastic substance is obtained, termed plastic sulphur. This substance, however, on standing becomes brittle. The character of molten sulphur has been mainly elucidated by the researches of A. Smith and his collaborators. Smith (*Abs. Journ. Chem. Soc.*, 1907, ii. 20, 451, 757) regards molten sulphur as a mixture of two isomers S_λ and S_μ in dynamic equilibrium, S_λ being light in colour and mobile, and S_μ dark and viscous. At low temperatures S_λ predominates, but as the temperature is raised S_μ increases; the transformation, however, is retarded by some gases, *e.g.* sulphur dioxide and hydrochloric acid, and accelerated by others, *e.g.* ammonia. The solid derived from S_λ is crystalline and soluble in carbon bisulphide, that from S_μ is amorphous and insoluble. As to the formation of precipitated sulphur, Smith considers that the element first separates in the liquid S_μ condition, which is transformed into S_λ and finally into S_α; the insoluble (in carbon bisulphide) forms arise when little of the S_μ has been transformed; whilst the soluble consist mainly of S_α. Similar views are adopted by H. Erdmann (*Ann.*, 1908, 362, p. 133), but he regards S_μ as the polymer S_3, analogous to ozone O_3; Smith, however, regards S_μ as S_8.

Compounds.

Sulphuretted hydrogen, H_2S, a compound first examined by C. Scheele, may be obtained by heating sulphur in a current of hydrogen, combination taking place between 200° C. and 358° C., and being complete at the latter temperature, dissociation taking place above this temperature (M. Bodenstein, *Zeit. phys. Chem.*, 1899, 29, p. 315); by heating some metallic sulphides in a current of hydrogen; by the action of acids on various metallic sulphides (ferrous sulphide and dilute sulphuric acid being most generally employed); by the action of sulphur on heated paraffin wax or vaseline, or by heating a solution of magnesium sulphydrate. It is also produced during the putrefaction of organic substances containing sulphur and is found among the products obtained in the destructive distillation of coal. To obtain pure sulphuretted hydrogen the method generally adopted consists in decomposing precipitated antimony sulphide with concentrated hydrochloric acid. As an alternative, H. Moissan (*Comp. rend.*, 1903, 137, p. 363) condenses the gas by means of liquid air and fractionates the product.

Sulphuretted hydrogen is a colourless gas possessing an extremely offensive odour. It acts as a strong poison. It burns with a pale blue flame, forming sulphur dioxide and water. It is moderately soluble in water, the solution possessing a faintly acid reaction. This solution is not very stable, since on exposure to air it slowly oxidizes and becomes turbid owing to the gradual precipitation of sulphur. The gas is much more soluble in alcohol. It forms a hydrate of composition $H_2S \cdot 7H_2O$. (De Forcrand, *Compt. rend.*, 1888, 106, p. 1357.) The gas may be liquefied by a pressure of about 17 atmospheres, the liquid so obtained boiling at −61·8° C.; and by further cooling it yields a solid, the melting point of which is given by various observers as −82° to −86° C. (see Ladenburg, *Ber.*, 1900, 33, p. 637). It is decomposed by the halogens, with liberation of sulphur. Concentrated sulphuric acid also decomposes it: $H_2SO_4 + H_2S = 2H_2O + SO_2 + S$. It combines with many metals to form sulphides, and also decomposes many metallic salts with consequent production of sulphides, a property which renders it extremely useful in chemical analysis. It is frequently used as a reducing agent: in acid solutions it reduces ferric to ferrous salts, arsenates to arsenites, permanganates to manganous salts, &c., whilst in alkaline solution it converts many organic nitro compounds into the corresponding amino derivatives. Oxidizing agents rapidly attack sulphuretted hydrogen, the primary products of the reaction being water and sulphur.

By the action of dilute hydrochloric acid on metallic polysulphides, an oily product is obtained which C. L. Berthollet considered to be H_2S_5. L. Thénard, on the other hand, favoured the formula H_2S_2. It was also examined by W. Ramsay (*Journ. Chem. Soc.*, 1874, 12, p. 857). Hofmann, who obtained it by saturating an alcoholic solution of ammonium sulphide with sulphur and mixing the product with an alcoholic solution of strychnine, considered the resulting product to be H_2S_3; while P. Sabatier by fractionating the crude product in vacuo obtained an oil which boiled between 60° and 85° C. and possessed the composition H_4S_5.

Several halogen compounds of sulphur are known, the most stable of which is sulphur fluoride, SF_6, which was first prepared by H. Moissan and Lebeau (*Compt. rend.*, 1900, 130, p. 865) by fractionally distilling the product formed in the direct action of fluorine on sulphur. It is tasteless, colourless and odourless gas, which is exceedingly stable and inert. It may be condensed and yields a solid which melts at −55° C. Sulphuretted hydrogen decomposes it with formation of hydrofluoric acid and liberation of sulphur. Sulphur chloride, S_2Cl_2, is obtained as a by-product in the manufacture of carbon tetrachloride from carbon bisulphide and chlorine, and may also be prepared on the small scale by distilling sulphur in a chlorine gas, or by the action of sulphur on sulphuryl chloride in the presence of aluminium chloride (O. Ruff). It is an amber-coloured, fuming liquid possessing a very unpleasant irritating smell. It boils at 139° C. and is solid at −80° C. It is soluble in carbon bisulphide and in benzene. It is gradually decomposed by water: $2S_2Cl_2 + 3H_2O = 4HCl + 2S + H_2S_2O_3$, the thiosulphuric acid produced in the primary reaction gradually decomposing into water, sulphur and sulphur dioxide. Sulphur chloride dissolves sulphur with great readiness and is consequently used largely for vulcanizing rubber; it also dissolves chlorine. The chloride SCl_2 according to the investigations of O. Ruff and Fischer (*Ber.*, 1903, 36, p. 418) did not appear to exist, but E. Beckmann (*Zeit. phys. Chem.*, 1909, 42, p. 1839) obtained it by distilling the product of the interaction of chlorine and S_2Cl_2 at low pressures. The tetrachloride, SCl_4, is formed by saturating S_2Cl_2 with chlorine at −22° C. (Michaelis, *Ann.*, 1873, 170, p. 1). It is a yellowish-brown liquid which dissociates rapidly with rise of temperature. On cooling it solidifies to a crystalline mass which fuses at −80° C. (Ruff, ibid.). Water decomposes it violently with formation of hydrochloric and sulphurous acids. Sulphur bromide, S_2Br_2, is a dark red liquid which boils with decomposition at about 200° C. The products obtained by the action of iodine on sulphur are probably mixtures, although E. McIvor (*Chem. News*, 1902, 86, p. 5) obtained a substance of composition S_3I_2 (which in all probability is a chemical individual) as a reddish-coloured powder by the action of sulphuretted hydrogen on a solution of iodine trichloride.

Four oxides of sulphur are known, namely sulphur dioxide, SO_2, sulphur trioxide, SO_3, sulphur sesquioxide, S_2O_3, and persulphuric anhydride, S_2O_7. The dioxide has been known since the earliest times and is found as a naturally occurring product in the gaseous exhalations of volcanoes and in solution in some volcanic springs. It was first collected in the pure condition by J. Priestley in 1775 and its composition determined somewhat later by A. L. Lavoisier. It is formed when sulphur is burned in air or in oxygen, or when many metallic sulphides are roasted. It may also be obtained by heating carbon, sulphur and many metals with concentrated sulphuric acid: $C + 2H_2SO_4 = 2SO_2 + CO_2 + 2H_2O$; $S + 2H_2SO_4 = 3SO_2 + 2H_2O$; $Cu + 2H_2SO_4 = SO_2 + CuSO_4 + 2H_2O$; and by decomposing a sulphite, a thiosulphate or a thionic acid with a dilute mineral acid. It is a colourless gas which possesses a characteristic suffocating odour. It does not burn, neither does it support combustion. It is readily soluble in alcohol and in water, the solution in water possessing a strongly acid reaction. It is easily liquefied, the liquid boiling at −8° C., and it becomes crystalline at −72·7° C. (Walden, *Zeit. phys. Chem.*, 1902, 43, p. 432). Walden (ibid.) has shown that certain salts dissolve in liquid sulphur dioxide forming additive compounds, two of which have been prepared in the case of potassium iodide: a yellow crystalline solid of composition, $KI \cdot 14SO_2$, and a red solid of composition, $KI \cdot 4SO_2$. It is decomposed by the influence of strong light or when strongly heated. It combines directly with chlorine to form sulphuryl chloride and also with many metallic peroxides, converting them into sulphates. In the presence of water it frequently acts as a bleaching agent, the bleaching process in this case being one of reduction. It is frequently used as an "antichlor," since in presence of water it has the power of converting chlorine into hydrochloric acid: $SO_2 + Cl_2 + 2H_2O = 2HCl + H_2SO_4$. In many cases it acts as a reducing agent (when used in the presence of acids); thus, permanganates are reduced to manganous salts, iodates are reduced with liberation of iodine, &c., $2KMnO_4 + 5SO_2 + 2H_2O = K_2SO_4 + 2MnSO_4 + 2H_2SO_4$; $2KIO_3 + 5SO_2 + 4H_2O = I_2 + 2KHSO_4 + 3H_2SO_4$.

It is prepared on the industrial scale for the manufacture of sulphuric acid, for the preparation of sodium sulphate by the Hargreaves process, and for use as a bleaching-disinfecting agent and as a preservative. When compressed it is also used largely as a refrigerating agent, and in virtue of its property of neither burning nor supporting combustion it is also used as a fire extinctor. The solution of the gas in water is used under the name of sulphurous acid. The free acid has not been isolated, since on evaporation the solution gradually loses sulphur dioxide. This solution possesses reducing properties, and gradually oxidizes to sulphuric acid on exposure. When heated in a sealed tube to 180° C. it is transformed into sulphuric acid, with liberation of sulphur. Numerous salts, termed sulphites, are known. Since the free acid would be dibasic, two series of salts exist, namely, the neutral and acid salts. The neutral alkaline salts are soluble in water and show an alkaline reaction, the other neutral salts being either insoluble or difficultly soluble in water. The acid salts have a neutral or slightly acid reaction. The sulphites are prepared by the action of sulphur dioxide on the oxides, hydroxides or carbonates of the metals, or by processes of precipitation. Sulphurous acid may have either of the constitutions $O{:}S{<}^{OH}_{OH}$ or $^{O}_{O}{>}S{<}^{OH}_{H}$, or be an equilibrium mixture of these two substances. Although the correct formula for the acid is not known, sulphites are known of both types. Sodium sulphite is almost certainly of the second and unsymmetrical type. Two ethyl sulphites are known, the first or symmetrical form being derived from sulphuryl chloride and alcohol, and the second and unsymmetrical from sodium sulphite and ethyl iodide; the junction of one ethyl group with a sulphur atom in the second salt follows because it yields ethyl sulphonic acid, also obtainable from ethyl mercaptan, C_2H_5SH. Two isomeric sodium potassium sulphites are known, and may be obtained by neutralizing acid sodium sulphite with potassium carbonate, and acid potassium sulphite with sodium carbonate; their formulae are: $O_2SK(ONa)$ and $O_2SNa(OK)$.

There are various haloid derivatives of sulphurous acid. Thionyl fluoride, SOF_2, has been obtained as a fuming gas by decomposing arsenic fluoride with thionyl chloride (Moissan and Lebeau, *Compt. rend.*, 1900, 130, p. 1436). It is decomposed by water into hydrofluoric and sulphurous acids. Thionyl chloride, $SOCl_2$, may be obtained by the action of phosphorus pentachloride on sodium sulphite; by the action of sulphur trioxide on sulphur dichloride at 75–80° C. (*Journ. Chem. Soc.*, 1903, p. 420); and by the action of chlorine monoxide on sulphur at low temperature. It is a colourless, highly refracting liquid, boiling at 78°; it fumes on exposure to moist air. Water decomposes it into hydrochloric and sulphurous acids. On treatment with potassium bromide it yields thionyl bromide, $SOBr_2$, an orange-yellow liquid which boils at 68° C. (40 mm.) (Hartoz and Sims, *Chem. News*, 1893, 67, p. 82).

Sulphur trioxide, SO_3, mentioned by Basil Valentine in the 15th century, was obtained by N. Lemery in 1675 by distilling green vitriol. It may be prepared by distilling fuming sulphuric acid, or concentrated sulphuric acid over phosphorus pentoxide, or by the direct union of sulphur dioxide with oxygen in the presence of a catalyst, such as platinized asbestos (see SULPHURIC ACID). This oxide exists in two forms. The α- form is readily fusible and melts at 14·8° C. It corresponds to the simple molecular complex SO_3. The β- variety is infusible, but on heating to 50° C. is transformed into the α- form. It corresponds to the molecular complex $(SO_3)_2$. When perfectly dry this oxide has no caustic properties; it combines rapidly, however, with water to form sulphuric acid, with the development of much heat. It combines directly with concentrated sulphuric acid to form pyrosulphuric acid, $H_2S_2O_7$. It reacts most energetically with many organic compounds, removing the elements of water in many cases and leaving a carbonized mass. It combines directly with many elements and compounds and frequently acts as energetic oxidizing agent. It finds considerable application in the colour industry.

Sulphuryl fluoride, SO_2F_2, formed by the action of fluorine on sulphur dioxide (H. Moissan, *Compt. rend.* 132, p. 374), is an exceedingly stable colourless gas at ordinary temperatures, becoming solid at about −120° C. Sulphuryl chloride, SO_2Cl_2, first obtained in 1838 by Regnault (*Ann. chim. phys.*, 1838, (2), 69, p. 170), by the action of chlorine on a mixture of ethylene and sulphur dioxide, may also be obtained by the direct union of sulphur dioxide and chlorine (especially in the presence of a little camphor); and by heating chlorsulphonic acid in the presence of a catalyst, such as mercuric sulphate (Pawlewski, *Ber.*, 1897, 30, p. 765): $2SO_2Cl{\cdot}OH = SO_2Cl_2 + H_2SO_4$. It is a colourless fuming liquid which boils at 69° C. and which is readily decomposed by water into sulphuric and hydrochloric acids. Fluorsulphonic acid, $SO_2F{\cdot}OH$, is a mobile liquid obtained by the action of an excess of hydrofluoric acid on well-cooled sulphur trioxide. It boils at 162·6° and is decomposed violently by water. Chlorsulphonic acid, $SO_2Cl{\cdot}OH$, first prepared by A. Williamson (*Proc. Roy. Soc.*, 1856, 7, p. 11) by the direct union of sulphur trioxide with hydrochloric acid gas, may also be obtained by distilling concentrated sulphuric acid with phosphorus oxychloride: $2H_2SO_4 + POCl_3 = 2SO_2Cl{\cdot}OH + HCl + HPO_3$. It is a colourless fuming liquid which boils at 152–153° C. When heated under pressure it decomposes, forming sulphuric acid, sulphuryl chloride, &c. (Ruff, *Ber.*, 1901, 34, p. 3509). It is decomposed by water with explosive violence. Disulphuryl chloride, $S_2O_5Cl_2$, corresponding to pyrosulphuric acid, is obtained by the action of sulphur trioxide on sulphur dichloride, phosphorus oxychloride, sulphuryl chloride or dry sodium chloride: $6SO_3 + 2POCl_3 = P_2O_5 + 3S_2O_5Cl_2$; $S_2Cl_2 + 5SO_3 = S_2O_5Cl_2 + 5SO_2$; $SO_3 + SO_2Cl_2 = S_2O_5Cl_2$; $2NaCl + 3SO_3 = S_2O_5Cl_2 + Na_2SO_4$. It may also be obtained by distilling chlorsulphonic acid with phosphorus pentachloride: $2SO_2Cl{\cdot}OH + PCl_5 = S_2O_5Cl_2 + POCl_3 + 2HCl$. It is a colourless, oily, fuming liquid which is decomposed by water into sulphuric and hydrochloric acids. An oxychloride of composition $S_2O_3Cl_4$ has been described.

Sulphur sesquioxide, S_2O_3, is formed by adding well-dried flowers of sulphur to melted sulphur trioxide at about 12–15° C. The sulphur dissolves in the form of blue drops which sink in the liquid and finally solidify in blue-green crystalline crusts. It is unstable at ordinary temperatures and rapidly decomposes into its generators on warming. It is readily decomposed by water with formation of sulphurous, sulphuric and thiosulphuric acids, with simultaneous liberation of sulphur. Hyposulphurous acid, $H_2S_2O_4$, was first really obtained by Berthollet in 1789 when he showed that iron left in contact with an aqueous solution of sulphur dioxide dissolved without any evolution of gas, whilst C. F. Schönbein subsequently showed the solution possessed reducing properties. P. Schutzenberger (*Compt. rend.*, 1869, 69, p. 169) obtained the sodium salt by the action of zinc on a concentrated solution of sodium bisulphite: $Zn + 4NaHSO_3 = Na_2S_2O_4 + ZnSO_3 + Na_2SO_3 + 2H_2O$, the salt being separated from the sulphites formed by fractional precipitation. A solution of the free acid may be prepared by adding oxalic acid to the solution of the sodium salt. This solution is yellow in colour, and is very unstable decomposing at ordinary temperature into sulphur and sulphur dioxide. A pure zinc salt has been prepared by Nabl (*Monats.*, 1899, 20, p. 679) by acting with zinc on a solution of sulphur dioxide in absolute alcohol, whilst H. Moissan (*Compt. rend.*, 1902, 135, p. 647) has also obtained salts by the action of dry sulphur dioxide on various metallic hydrides. Considerable controversy arose as to the constitution of the salts of this acid, the formula of sodium salt, for example, being written as $NaHSO_2$ and $Na_2S_2O_4$; but the investigations of C. Bernthsen (*Ann.*, 1881, 208, p. 142; 1882, 211, p. 285; *Ber.*, 1900, 33, p. 126) seem to decide definitely in favour of the latter (see also T. S. Price, *Journ. Chem. Soc.*; also Bucherer and Schwalbe, *Zeit. angew. Chem.*, 1904, 17, p. 1447). Although this acid appears to be derived from an oxide S_2O_3, it is not certain that the known sesquioxide is its anhydride.

Persulphuric anhydride, S_2O_7, is a thick viscous liquid obtained by the action of the silent discharge upon a mixture of sulphur trioxide and oxygen. It solidifies at about 0° C. to a mass of long needles, and is very volatile. It is decomposed readily into sulphur trioxide and oxygen when heated. Water decomposes it with formation of sulphuric acid and oxygen: $2S_2O_7 + 4H_2O = 4H_2SO_4 + O_2$. Persulphuric acid, HSO_4, the acid corresponding to S_2O_7, has not been obtained in the free state, but its salts were first prepared in 1891 by H. Marshall (*Journ. Chem. Soc.*, 1891, p. 771) by electrolysing solutions of the alkaline bisulphates. The potassium salt, after recrystallization from warm water, separates in large tabular crystals. Its aqueous solution gradually decomposes with evolution of oxygen, behaves as a strong oxidant, and liberates iodine from potassium iodide. Solutions of persulphates in the cold give no precipitate with barium chloride, but when warmed barium sulphate is precipitated with simultaneous liberation of chlorine: $K_2S_2O_8 + BaCl_2 = BaSO_4 + K_2SO_4 + Cl_2$. The conductivity measurements of G. Bredig point to the salt possessing the double formula.

Thiosulphuric acid, formerly called hyposulphurous acid, $H_2S_2O_3$, cannot be preserved in the free state, since it gradually decomposes with evolution of sulphur dioxide and liberation of sulphur: $H_2S_2O_3 = S + SO_2 + H_2O$. The salts of the acid, however, are stable, the sodium salt in particular being largely used for photographic purposes under the name of "hypo." This salt may be prepared by digesting flowers of sulphur with sodium sulphite solution or by boiling sulphur with milk of lime. In this latter reaction the deep yellow solution obtained is exposed to air when the calcium polysulphide formed is gradually converted into thiosulphate by oxidation, and the calcium salt thus formed is converted into the sodium salt by sodium carbonate or sulphate. The thiosulphates are readily decomposed by mineral acids with liberation of sulphur dioxide and precipitation of sulphur: $Na_2S_2O_3 + 2HCl = 2NaCl + S + SO_2 + H_2O$. They form many double salts and give a dark violet coloration with ferric chloride solution, this colour, however, gradually disappearing on standing, sulphur being precipitated. The acid is considered to possess the structure $O_2S(SH)(OH)$, since sodium thiosulphate reacts with ethyl bromide to give sodium ethyl thiosulphate, which on treatment with barium chloride gives presumably barium ethyl thiosulphate. This salt, on standing, decomposes into barium dithionate, BaS_2O_6, and diethyl disulphide, $(C_2H_5)_2S_2$, which points to the presence of the SH group in the molecule.

The *thionic acids* are a group of sulphur-containing acids of general formula $H_2S_nO_6$, where $n = 2, 3, 4, 5$ and possibly 6. Dithionic acid, $H_2S_2O_6$, prepared by J. Gay-Lussac in 1819, is usually obtained in the form of its barium salt by suspending freshly precipitated hydrated manganese dioxide in water and passing sulphur dioxide into the mixture until all is dissolved; the barium salt is then precipitated by the careful addition of barium hydroxide. Much manganese sulphate is formed during the reaction, and H. C. Carpenter (*Journ. Chem. Soc.*, 1902, 81, p. 1) showed that this can be almost entirely avoided by replacing the manganese oxide by hydrated ferric oxide, the reaction proceeding according to the equation: $2Fe(OH)_3 + 3SO_2 = FeS_2O_6 + FeSO_3 + 3H_2O$. He points out that the available oxygen in the oxides may react either as $SO_2 + H_2O + O = H_2SO_4$ or as $2SO_2 + H_2O + O = H_2S_2O_6$; and that in the case of ferric oxide 96% of the theoretical yield of dithionate is obtained, whilst manganese oxide only gives about 75%. A solution of the free acid may be obtained by decomposing the barium salt with dilute sulphuric acid and concentrating the solution *in vacuo* until it attains a density of about 1·35 (approximately), further concentration leading to its decomposition into sulphur dioxide and sulphuric acid. The dithionates are all soluble in water and when boiled with hydrochloric acid decompose with evolution of sulphur dioxide and formation of a sulphate. Trithionic acid, $H_2S_3O_6$, is obtained in the form of its potassium salt by the action of sulphur dioxide on a solution of potassium thiosulphate: $2K_2S_2O_3 + 3SO_2 = 2K_2S_3O_6 + S$; or by warming a solution of silver potassium thiosulphate: $KAgS_2O_3 = Ag_2S + K_2S_3O_6$; whilst the sodium salt may be prepared by adding iodine to a mixture of sodium thiosulphate and sulphite: $Na_2SO_3 + Na_2S_2O_3 + I_2 = Na_2S_3O_6 + 2NaI$. The salts are unstable; and a solution of the free acid (obtained by the addition of hydrofluosilicic acid to the potassium salt) on concentration *in vacuo* decomposes rapidly: $H_2S_3O_6 = H_2SO_4 + S + SO_2$. Tetrathionic acid, $H_2S_4O_6$, is obtained in the form of its barium salt by digesting barium thiosulphate with iodine: $2Ba_2S_2O_3 + I_2 = BaS_4O_6 + 2BaI$, the barium iodide formed being removed by alcohol; or in the form of sodium salt by the action of iodine on sodium thiosulphate. The free acid is obtained (in dilute aqueous solution) by the addition of dilute sulphuric acid to an aqueous solution of the barium salt. It is only stable in dilute aqueous solution, for on concentration the acid decomposes with formation of sulphuric acid, sulphur dioxide and sulphur.

Wackenroder's solution (Debus, *Journ. Chem. Soc.*, 1888, 53, p. 278) is prepared by passing sulphuretted hydrogen gas into a nearly saturated aqueous solution of sulphur dioxide at about 0° C. The solution is then allowed to stand for 48 hours and the process repeated many times until the sulphur dioxide is all decomposed. The reactions taking place are complicated, and the solution contains ultimately small drops of sulphur in suspension, a colloidal sulphur (which Spring (*Rec. trav. chim.*, 1906, 25, p. 253) considers to be a hydrate of sulphur of composition $S_8{\cdot}H_2O$), sulphuric acid, traces of trithionic acid, tetra-and pentathionic acids and probably hexathionic acid. The solution obtained may be evaporated *in vacuo* until it attains a density of 1·46 when, if partially saturated with potassium hydroxide and filtered, it yields crystals of potassium pentathionate, $K_2S_5O_6{\cdot}3H_2O$. The formation of the pentathionic acid may be represented most simply as follows: $5SO_2 + 5H_2S = H_2S_5O_6 + 5S + 4H_2O$. The aqueous solution of the acid is fairly stable at ordinary temperatures. The pentathionates give a brown colour on the addition of ammoniacal solutions of silver nitrate and ultimately a black precipitate. Hexathionic acid, $H_2S_6O_6$, is probably present in the mother liquors from which potassium pentathionate is prepared. The solution on the addition of ammoniacal silver nitrate behaves similarly to that of potassium pentathionate, but differs from it in giving an immediate precipitate of sulphur with ammonia, whereas the solution of the pentathionate only gradually becomes turbid on standing.

The *per-acids* of sulphur were first obtained in 1898 by Caro (*Zeit. angew. Chem.*, 1898, p. 845) who prepared monopersulphuric acid by the action of sulphuric acid on a persulphate. This acid may also be prepared by the electrolysis of concentrated sulphuric acid, and it is distinguishable from persulphuric acid by the fact that it immediately liberates iodine from potassium iodide. It behaves as a strong oxidant and in aqueous solution is slowly hydrolysed. It most probably corresponds to the formula H_2SO_6.

See H. E. Armstrong and Lowry, *Chem. News* (1902), 85, p. 193; Lowry and West, *Journ. Chem. Soc.* (1900), 77, p. 950; H. E. Armstrong and Robertson, *Proc. Roy. Soc.*, 50, p. 105; T. S. Price, *Ber.*, 1902, 35, p. 291; *Journ. Chem. Soc.* (1906), p. 53; A. v. Baeyer and V. Villiger, *Ber.*, *passim.*

Pharmacology.—The sources of all sulphur preparations used in medicine (except calx sulphurata) are native virgin sulphur and the sulphides of metals. Those contained in the British Pharmacopoeia are the following: (1) *Sulphur sublimatum*, flowers of sulphur (U.S.P.), which is insoluble in water. From it are made (*a*) *confectio sulphuris*; (*b*) *unguentum sulphuris*; (*c*) *sulphur praecipitatum*, milk of sulphur (U.S.P.) which has a sub-preparation *trochiscus sulphuris* each lozenge containing 5 grs. of precipitated sulphur and 1 gr. of potassium acid tartrate; (*d*) *potassa sulphurata* (liver of sulphur), a mixture of salts of which the chief are sulphides of potassium; (*e*) *sulphuris iodidum* (U.S.P.), which has a preparation *unguentum sulphuris iodidi*, strength 1 in 25. From the heating of native calcium sulphate and carbon is obtained *calx sulphurata* (U.S. and B.P.), or sulphurated lime, a greyish-white powder.

Therapeutics.—Externally, sulphur is of use in skin affections. Powdered, it has little effect upon the skin, but in ointment or used by fumigation it has local therapeutic properties. In scabies (itch) it is the best remedy, killing the male parasite, which remains on the surface of the skin. To get at the female and the ova prolonged soaking in soap and water is necessary, the epiderm being rubbed away and the ointment then applied. Precipitated sulphur is also useful in the treatment of acne, but sulphurated lime is more powerful in acne pustulosa and in the appearance of crops of boils. Internally, sulphur is a mild laxative, being converted in the intestine into sulphides. Milk of sulphur, the confection and the lozenge, is used for this purpose. Sulphur and sulphur waters such as those of Harrogate, Aix-la-Chapelle and Aix-les-Bains, have a powerful effect in congested conditions of the liver and intestines, haemorrhoids, gout and gravel. Sulphur is of use in chronic bronchial affections, ridding the lungs of mucus and relieving cough. In chronic rheumatism sulphur waters taken internally and used as baths are effectual. Sulphur in some part escapes unchanged in the faeces.

When sulphur is burned in air or oxygen, sulphur dioxide is produced, which is a powerful disinfectant, used to fumigate rooms which have been occupied by persons suffering from some infectious disease.

SULPHURIC ACID, or Oil of Vitriol, H_2SO_4, perhaps the most important of all chemicals, both on account of the large quantities made in all industrial countries and of the multifarious uses to which it is put. It is not found in nature in the free state to any extent, and although enormous quantities of its salts, especially calcium and barium sulphate, are found in many localities, the free acid is never prepared from these salts, as it is more easily obtainable in another way, viz. by burning sulphur or a sulphide, and combining the sulphur dioxide thus formed with more oxygen (and water).

Originally prepared by heating alum, green vitriol and other sulphates, and condensing the products of distillation, sulphuric acid, or at least an impure substance containing more or less sulphur trioxide dissolved in water, received considerable attention at the hands of the alchemists. The acid so obtained from ferrous sulphate (green vitriol) fumes strongly in moist air, hence its name "fuming sulphuric acid"; another name for the same product is "Nordhausen sulphuric acid," on account of the long-continued practice of this process at Nordhausen.

Ordinary sulphuric acid, H_2SO_4, may be prepared by dissolving sulphur trioxide in water, a reaction accompanied by a great evolution of heat; by the gradual oxidation of an aqueous solution of sulphur dioxide, a fact which probably explains the frequent occurrence of sulphuric acid in the natural waters rising in volcanic districts; or by deflagrating a mixture of sulphur and nitre in large glass bells or jars, absorbing the vapours in water and concentrating the solution. The latter process, which was known to Basil Valentine, was commercially applied by the quack doctor, Joshua Ward (1685–1761), of Twickenham, England, to the manufacture of the acid, which was known as "oil of vitriol made by the bell" or *per campanum.* Dr John Roebuck (1718–1794), of Birmingham, replaced the glass vessels by leaden ones, thereby laying the foundation of the modern method of manufacture (see below).

Properties.—Pure sulphuric acid, H_2SO_4, is a colourless, odourless liquid of an oily consistency, and having a specific gravity of 1·8384 at 15°. It boils at 338°, and at about 400° the vapour dissociates into sulphur trioxide and water; at a red heat further decomposition ensues, the sulphur trioxide dissociating into the dioxide and water. It freezes to a colourless crystalline mass, melting at 10·5°. The acid is extremely hygroscopic, absorbing moisture from the atmosphere with great rapidity; hence it finds considerable application as a desiccating agent. The behaviour of aqueous solutions of sulphuric acid is very interesting. The pure acid (100% H_2SO_4) cannot be prepared by boiling down a weaker acid under any pressure (at least between 3 and 300 centimetres of mercury), an acid of the composition $H_2SO_4,\frac{1}{12}H_2O$ or $12SO_3,13H_2O$ being invariably obtained. Neither is there any advantage gained by mixing this hydrate with sulphur trioxide; for when such a mixture is concentrated by evaporation, sulphur trioxide is vaporized until the same hydrate is left. The pure acid, however, may be obtained by strongly cooling this hydrate.

when it separates in the form of white crystals, which melt at 10·5°, and on gentle heating evolve sulphur trioxide and again form the same hydrate. When strong sulphuric acid is mixed with water there is a great development of heat; the heat evolved when four parts of acid are mixed with one of water being sufficient to raise the temperature from 0° to 100° C. (Hence the laboratory precaution of always adding the acid to the water and not the water to the acid.) In addition to the heat evolution there is also a diminution in volume, the maximum occurring when the components are present in the ratio $H_2SO_4:2H_2O$, thus pointing to the existence of a hydrate $H_2SO_4,2H_2O$. A second hydrate, H_2SO_4,H_2O, may be obtained as rhombic crystals, which melt at 7° and boil at 205°, by diluting the strong acid until it has a specific gravity of 1·78, and cooling the mixture; this compound is sometimes known as *glacial sulphuric acid*. Both the mono- and di-hydrates form freeing mixtures with snow. Other hydrates have also been described.

Reactions.—Sulphuric acid has the widest commercial application of all chemical reagents. Here only reactions of commercial utility will be considered, and reference should be made to the article SULPHUR for reactions which are more of a purely scientific interest. In inorganic chemistry its principal applications are based on its solvent power for metals, and its power of expelling other acids from their salts. In the first group we have to notice the use of iron or zinc and dilute sulphuric acid for the manufacture of hydrogen, which may be used directly, as for inflating balloons or for purposes of combustion, or in the *nascent* condition, for reduction purposes, as generally is the case in organic chemistry (see ANILINE). It is worthy of notice that while many metals dissolve in cold dilute sulphuric acid, with the liberation of hydrogen, in accordance with the typical equation: $M + H_2SO_4 = MSO_4 + H_2$ (M denoting one atom of divalent or two atoms of a monovalent metal), there are several (copper, mercury, antimony, tin, lead and silver) which are insoluble in the cold dilute acid, but dissolve in the hot strong acid with evolution of sulphur dioxide, thus: $M + 2H_22SO_4 = MSO_4 + SO_2 + 2H_2O$. Carbon decomposes hot strong sulphuric acid on long continued boiling, with the formation of carbon dioxide and sulphur dioxide. The power which sulphuric acid exhibits for expelling other acids from their combinations, a power occasioned by its comparative involatility and high degree of avidity, forms the basis of a considerable number of commercial processes. Hydrochloric, hydrobromic, hydriodic, hydrofluoric, nitric, phosphoric and many other acids are manufactured by the action of sulphuric acid on their salts; the alkali and chlorine industries, and also the manufacture of bromine and iodine, employ immense quantities of this acid.

In organic chemistry sulphuric acid is extensively employed. Its powerful affinity for the elements of water makes it a valuable dehydrating and condensation agent. It extracts the elements of water from formic acid, giving carbon monoxide; from oxalic acid, giving a mixture of carbon monoxide and dioxide; from alcohol, to give ether or ethylene according to the conditions of the experiment; and from many oxygenated compounds (*e.g.* sugar, tartaric acid, &c.), with the production of charred masses. The formation of esters and ethers are generally facilitated by the presence of this acid. It also acts in an opposite manner in certain cases, *adding* the elements of water to compounds; thus, nitriles are converted into acid-amides, and various acetylene derivatives may be caused to yield ketonic derivatives. As an oxidizing agent its application is limited. The transformation of piperidine into pyridine by W. Königs, and the observation that anthraquinone yielded oxyanthraquinones when treated in the cold with strong sulphuric acid, and the recent introduction of fuming sulphuric acid for the oxidation of naphthalene to phthalic acid, a process of great value in the manufacture of artificial indigo, may be noted. But its chief technical application depends upon the formation of sulphonic acids when it reacts with aromatic hydrocarbon residues; these compounds being important either as a step towards the preparation of hydroxy-compounds, *e.g.* resorcin, the naphthols, alizarin, &c., or for preparing dye-stuffs in a more soluble form.

Sulphates.—Sulphuric acid, being a dibasic acid, forms two series of salts with monovalent metals: an acid sulphate, $MHSO_4$, and a normal sulphate, M_2SO_4. Acid sodium sulphate, $NaHSO_4$, has been employed in the manufacture of sulphur trioxide. When heated it loses water to form sodium pyrosulphate, $Na_2S_2O_7$, which on treatment with sulphuric acid yields normal sodium sulphate and sulphur trioxide. The normal sulphates are the more important, and occur widely and abundantly distributed in the mineral kingdom; anhydrite, gypsum, anglesite, barytes, celestite and kieserite are among the commonest species. As a general class, the sulphates are soluble in water, and exhibit well crystallized forms. Of the most insoluble we may notice the salts of the metals of the alkaline earths, barium, strontium and calcium, barium sulphate being practically insoluble, and calcium sulphate sparingly but quite appreciably soluble. Lead sulphate is very slightly soluble in water, soluble in strong sulphuric acid, and almost insoluble in alcohol.

Sulphates may be detected by heating the salt mixed with sodium carbonate on charcoal in the reducing flame of the blowpipe; sodium sulphide is thus formed, and may be identified by the black stain produced if the mass be transferred to a silver coin and then moistened. In solution, sulphates are always detected and estimated by the formation of a white precipitate of barium sulphate, insoluble in water and all the common reagents.

Manufacture.—The first step in its manufacture is the combustion of sulphur. Formerly this was employed exclusively in the free state as brimstone, and this is still the case to a considerable extent in some countries, notably in the United States, but the great bulk of sulphuric acid is now made from metallic sulphides, especially those of iron and zinc. Most of the brimstone of trade comes from Sicily, but in the United States Louisiana sulphur is playing an important part, and seems likely to oust the Sicilian sulphur. Free sulphur is also contained as "gas sulphur" in the "spent oxides" of gasworks, which are actually utilized for the manufacture of sulphuric acid. Sulphur is also recovered in a very pure state from the "alkali waste" of the Leblanc process, but this "recovered sulphur" is too expensive to be burned for the purpose in question. In the United Kingdom much gas sulphur is used for the manufacture of sulphuric acid, together with a limited quantity of Sicilian sulphur for the production of sulphuric acid free from arsenic.

A much larger percentage of the sulphuric acid is made from pyrites, *i.e.* more or less pure disulphide of iron which occurs in large quantities in many countries. Great Britain produces very little of it, Ireland a little more, but of poor quality. Most of the pyrites consumed in the United Kingdom come from Spain; this Spanish pyrites generally (not always) contains enough copper (say 3 or 4%) to make its extraction from the residues ("cinders") a paying process, and this of course cheapens the price of the sulphur to the acid manufacturer. Spain also supplies much pyrites to Germany, France and America, all of which countries are themselves producers of this ore. Sweden and Norway are exporters of it to all these countries. Good pyrites contains from 48 to 50%, exceptionally up to 52% of sulphur, of which all but from 1 to 4% is utilized when burning the ore. Another metallic sulphide, blende, ZnS, is of importance for Germany, Belgium and the United States, much less so for the United Kingdom, as a source of sulphur. Blende contains only about half as much sulphur as good pyrites, and this cannot be burned off as easily as from pyrites, but this "roasting" has to be done somehow in any case in order to prepare the ore for the extraction of the zinc.

Brimstone is easily burned without any extraneous help; indeed the only precaution required is to take care lest the heat produced by the burning sulphur should not volatilize part of it in the unburned state. This can never be entirely avoided, and sometimes causes trouble in the succeeding apparatus.

The roasting of pyrites always takes place without using any extraneous fuel, the heat given off by the oxidation of the sulphur and the iron being quite sufficient to carry on the process. If the ore is in pieces of the size of a walnut or upwards, it is roasted in plain "kilns" or "burners," provided with a grating of suitable construction for the removal of the cinders, with a side door in the upper part for charging in the fresh ore on the top of the partially burned ore, and with an arch-shaped roof, from which the burner-gas is carried away in a flue common to a whole set of kilns. The latter are always set in a row of twelve or more, and are one after another charged once or twice a day at appropriate intervals, so that a regular evolution of gas takes place all the day round. By employing suitable precautions, a gas of approximately uniform composition is obtained, containing from 6 to 8% sulphur dioxide, SO_2, with a little trioxide, SO_3, and about 12% of oxygen, which is more than sufficient for converting later all the SO_2 into SO_3 or H_2SO_4. The burning of "smalls" or "dust" was formerly considered much more difficult and incomplete than that of pieces, but this difficulty has been entirely overcome in various ways, principally by the "shelf-burner," originally constructed by E. Malétra, and mechanical burners, which were formerly almost entirely confined to America, where the saving of labour is a primary consideration. The first really successful mechanical pyrites-burner was constructed many years ago by MacDougall Bros. of Liverpool. The drawbacks still present in this burner caused it to be abandoned after a few years, but they have since been overcome by several recent inventors, principally American. The Hereshoff burner has been most widely introduced, both in America and in European countries. The roasting of blende is nothing like so easy as that of pyrites, since the heat developed by the oxidation of the zinc sulphide itself is not sufficient for carrying on the process, and external heat must be applied. It is now usually performed by a series of muffles, superposed one over another, so that the whole forms a kind of shelf-burner, with internally heated shelves (the "Rhenania" furnace). This operation is both more costly and more delicate than the roasting of pyrites, but it is now perfectly well understood, and gas is obtained from blende furnaces hardly inferior in quality to that yielded by pyrites kilns. In America, and quite exceptionally also in Europe, mechanical furnaces are used for the roasting of blende.

The gas produced in the burning of sulphur ores, when issuing from the burner, holds in mechanical suspension a considerable quantity of "flue-dust," which must be removed as far as is practicable before the gas is subjected to further treatment. Flue-dust contains principally ferric oxide, zinc oxide, arsenious and sulphuric acids, and small quantities of the various metals occurring in the raw ore. All the thallium and selenium on the market is obtained from this source. Sometimes the burner-gas is employed directly for the sake of the SO_2 which it contains, principally in the manufacture of "sulphite cellulose" from wood. When the gas is to be utilized for the manufacture of sulphuric acid the SO_2 must be combined with more oxygen, for which purpose an "oxygen carrier" must be employed. Until recently the only agent practically used for this purpose was furnished by the oxides of nitrogen; more recently other oxygen carriers, acting by "contact processes," have also come into use (see below).

The production of sulphuric acid by the assistance of the oxides of the nitrogen is carried out in the "vitriol chambers." These are immense receptacles, mostly from 100 to 200 ft. long, 20 to 30 ft. wide, and 15 to 25 ft. high, constructed of sheet-lead, the joints of the sheets being made by "burning" or autogenous soldering, *i.e.* fusing them together by a blow-pipe without the aid of solder (which would be quickly destroyed by the acid). The vitriol chambers must be supported on all sides by suitable wooden or iron framework, and they are always erected at a certain height over the ground, so that any leaks occurring can be easily detected. In nearly all cases several of these chambers are connected so as to form a set of a cubic capacity of from 100,000 to 200,000 cub. ft. The burner gas is introduced at one end, the waste gases issue from the other, the movement of the gases being impelled partly by their own chemical reactions, partly by the draught produced by a chimney (or tower), or by mechanical means. At the same time water is introduced in a number of places in the shape of steam or finely divided as a spray, to furnish the material for the reaction: $SO_2 + O + H_2O = H_2SO_4$. As this reaction of its own accord takes place only to a very small extent, an "oxygen carrier" is always introduced in the shape of the vapours of nitric acid or the lower oxides of nitrogen. By the play of reactions induced in this way practically the whole of the SO_2 is ultimately converted into sulphuric acid, and at the same time the nitrogen oxides are always recovered with comparatively very slight losses and made to serve over again.

The reactions taking place in the vitriol chambers are very complicated, and have been explained in many different ways. The view hitherto accepted by most chemists is that developed by G. Lunge, according to which there are two principal reactions succeeding each other, it may be in quite contiguous places, but under different conditions. Where the nitrous fumes prevail and there is less water present, sulphur dioxide combines with nitrous acid and oxygen to form nitroso-sulphuric acid, a crystalline substance of the formula $SO_2(OH)(ONO)$. The reaction is therefore: $SO_2 + O + HNO_2 = SO_5NH$. The solid substance is, however, only exceptionally met with, as it at once dissolves in the mist of sulphuric acid floating in the chamber and forms "nitrous vitriol." Wherever this nitrous vitriol comes into contact with liquid water (*not* steam), which is also present in the chamber in the shape of mist, and practically as dilute sulphuric acid, it is decomposed into sulphuric and nitrous acid, thus: $SO_2(OH)(ONO) + H_2O = H_2SO_4 + HNO_2$. The re-formed nitrous acid, although not stable, any more than is its anhydride, N_2O_3, is nevertheless the "oxygen carrier" in question, as the products of its spontaneous decomposition, when meeting with other compounds, always react like nitrous acid itself and thus may transfer an indefinite quantity of oxygen to the corresponding quantities of SO_2 and H_2O, with the corresponding formation of H_2SO_4. This theory at once explains, among other things, why the acid formed in the vitriol chambers always contains an excess of water (the second of the above-quoted reactions requiring the "mass action" of this excess), and why the external cooling produced by the contact of the chamber sides with the air is of great importance (*liquid* water in the shape of a mist of dilute sulphuric acid being necessary for the process).

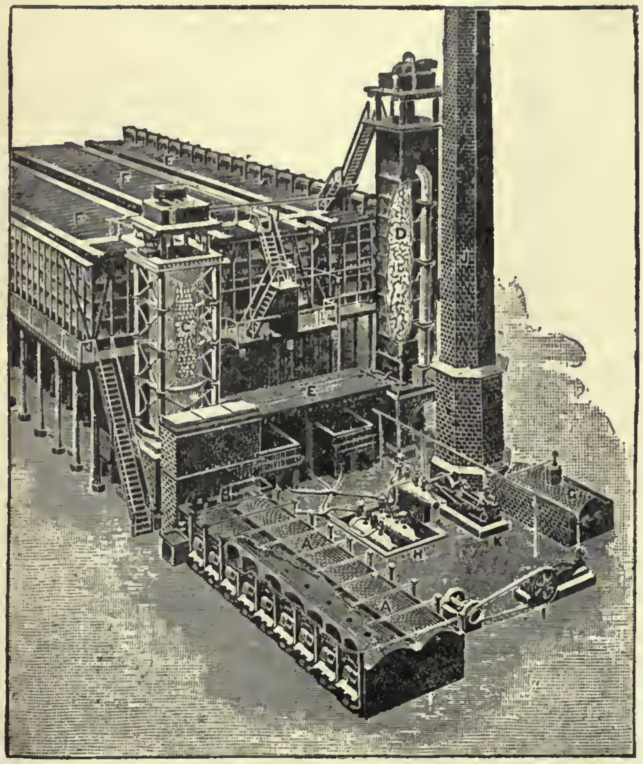
In 1906 Lunge (in a paper published with Bert) to some extent modified his views, by introducing an intermediate compound, sulphonitronic acid, SO_5NH_2, which had been noticed by various chemists for some time through its property of imparting a deep blue colour to sulphuric acid. It is evident that the "nitrous gases" present in the vitriol chamber consist essentially of a mixture of NO and NO_2, the latter being formed from NO by the excess of oxygen present. The NO_2 (or NO + O) reacts upon $SO_2 + H_2O$, forming SO_3NH_2, which, being extremely unstable, is at once oxidized to SO_5NH (nitroso-sulphuric acid). The latter is now either converted by hydrolysis into sulphuric acid and nitrogen oxides: $2SO_5NH + H_2O = 2H_2SO_4 + NO + NO_2$, the latter acting as before: or it reacts with more SO_2, forming again sulphonitronic acid: $2SO_5NH + SO_2 + 2H_2O = H_2SO_4 + 2SO_5NH_2$. The latter can also split up directly into NO and SO_4H_2.

Whatever be the true theory of the vitriol-chamber process, there is no doubt about the way in which the reactions have to be carried out in practice. Since the reactions occur among gases and liquids in the nebulous state, vast spaces have to be provided in which the process may be carried out as completely as possible before the waste gases are allowed to escape into the outer air. These spaces cannot be constructed in any other way than is actually done in the shape of the lead chambers; neither iron nor brickwork can be employed for this purpose, as they would be quickly destroyed by the acid liquids and gases.

When issuing from the chambers, the gases still contain the whole of the free nitrogen contained in the air which had entered into the burners, together with about a third, or at least a fourth, of the oxygen originally present therein, such excess of oxygen being required in order to carry out the conversion of the sulphur dioxide into sulphuric acid as completely as possible. For similar reasons it is necessary to employ much more water than is required to form H_2SO_4; and this is all the more necessary as strong sulphuric acid dissolves the nitrous compounds in the shape of nitroso-sulphuric acid, and thus withdraws these oxygen carriers from the gas-space of the chambers where the necessary reactions take place. It follows from this that the acid collecting at the bottom of the chambers must never exceed a certain concentration, say 70%, H_2SO_4 having a specific gravity of 1·615, but it is preferable to make it only 66 to 67%, having a specific gravity of 1·57 to 1·58. On the other hand, it should never go down below 60% H_2SO_4, equivalent to a specific gravity of 1·50.

The commercial production of sulphuric acid imperatively requires that the nitrogen oxides (which originally were always introduced in the shape of nitric acid) should be available as long as possible, before being lost mechanically or by reduction to the inactive forms of nitrous oxide or elementary nitrogen. The first step towards securing this requirement was taken as early as 1827 by Gay-Lussac, who discovered that the nitrous fumes, otherwise carried away from the lead chambers by the waste atmospheric nitrogen and oxygen, could be retained by bringing the gases into contact with moderately strong sulphuric acid, the result being the formation of nitroso-sulphuric acid: $2H_2SO_4 + N_2O_3 = 2SO_2(OH)(ONO) + H_2O$, and the latter remaining dissolved in sulphuric acid as "nitrous vitriol." But this important invention was of little use until John Glover, about 1866, found that the nitrous vitriol could be most easily reintroduced into the process by subjecting it to the action of burner-gas before this enters into the lead chambers, preferably after diluting it with chamber acid, that is, acid of from 65 to 70%, H_2SO_4, as formed in the lead chambers. The reaction is then: $2SO_2(OH)(ONO) + SO_2 + 2H_2O = 3H_2SO_4 + 2NO$; that is to say, all the "nitre" is returned to the chambers in the shape of NO; the sulphuric acid employed in the Gay-Lussac process is not merely recovered, but an additional quantity is formed from fresh SO_2; as the heat of the burner-gases also comes into play, much water is evaporated, which supplies part of the steam required for the working of the chambers; and the acid issues from the apparatus in a "denitrated" and sufficiently concentrated state (78 to 80% H_2SO_4) to be used over again for absorbing nitrous vapours or any other purpose desired. Since that time, in every properly appointed sulphuric acid manufactory, the following cycle of operations is carried out. To begin with, in the burners pyrites (or, as the case may be, brimstone or blende) is made to yield hot burner-gas containing about 7% (in the case of brimstone 10 or 11%) of SO_2. This, after having been deprived of most of the flue-dust, is passed through the "Glover tower," *i.e.* an upright cylindrical or square tower, consisting of a leaden shell lined with heat- and acid-proof stone or brick, and loosely filled or "packed" with the same material, over which a mixture of acid from the Gay-Lussac tower and from the chambers trickles down in such proportions that it arrives at the bottom as denitrated acid of from 78 to 80% H_2SO_4. The gases now pass on to the lead chambers, described above, where they meet with more nitrous vapours, and with steam, or with water, converted into a fine dust or spray. Here the reactions sketched above take place, so that "chamber-acid" as already described is formed, while a mixture of gases escapes containing all the atmospheric nitrogen, some oxygen in excess, about 0·5% of the total SO_2, and some oxides of nitrogen. This gas is now passed through the Gay-Lussac tower, which somewhat resembles the Glover tower, but is usually filled with coke, over which sulphuric acid of about 80% H_2SO_4 trickles down in sufficient quantity to retain the nitrous vapours. Ultimately the waste gas is drawn off by a chimney, or sometimes by mechanical means.

Of course a great many special improvements have been made in the plant and the working of chamber systems; of these we mention only some of the most important. By judiciously watching all stages of the process, by observing the draught, the strength of the acid produced, the temperature, and especially by frequent analyses of the gases, the yield of acid has been brought up to 98% of the theoretical maximum, with a loss of nitre sometimes as low as two parts to 100 of sulphur burned. The supply of the nitric acid required to make up this loss is obtained in England by "potting" that is, by decomposing solid nitrate of soda by sulphuric acid in a flue between the pyrites burners and the chambers. On the continent of Europe makers generally prefer to employ liquid nitric acid, which is run through the Glover tower together with the nitrous vitriol. Although this method appears more troublesome, it allows the amount of nitre to be more easily and more accurately regulated. The size of the Glover towers, and more especially that of the Gay-Lussac towers, has been progressively increased, and thereby the cube of the lead chambers themselves has been diminished to a much greater extent. By improved



(From Thorpe's *Inorganic Chemistry*.)

Sulphuric Acid Plant.

A, Pyrites burners.
B, Nitre oven.
C, Glover tower.
D, Gay-Lussac tower.
E, Cooling pipes for Glover-tower acid.
F, F, F, Vitriol chambers.
G, Steam boiler.
H, Acid eggs or reservoirs for pumping the acid to top of towers.
I, Steam engine and stone-breaker for breaking up pyrites.
J, Chimney.
K, Engine for compressing air.

" packing " the towers have been rendered more durable, and in the case of the Gay-Lussac tower the loss of nitre has been diminished by avoiding the use of a coke packing, which acts upon that substance as a reducing agent. Many attempts have been made to reduce the chamber space by apparatus intended to bring about a better mixture of the gases, and to facilitate the interaction of the misty particles of nitrous vitriol and dilute acid floating in the chamber with each other and with the chamber atmosphere. The earliest really successful, and still the most generally applied apparatus of this kind, is the Lunge-Rohrmann " plate columns " or " reaction towers " placed between the chambers, but though this and similar apparatus has proved to be very useful in the later stages of the process, it has not been found practicable to do away with the lead chambers entirely. The pumping of the acids up to the top of the towers is now always performed by means of compressed air, either in the old " acid eggs," or more economically in " pulsometers."

Most of the sulphuric acid manufactured is not required to be of higher strength than is furnished by the vitriol chambers, either directly (65 to 70 %), or after a passage through the Glover tower (78 to 80 %). This, for instance, holds good of the acid employed in the manufacture of sulphate of soda and hydrochloric acid from common salt, and in the manufacture of superphosphates. But for many purposes more highly concentrated acid is required. Formerly all such acid was made by boiling down the dilute acid, for which purpose a great variety of apparatus was invented. The first question is always that of material. Lead can be used for the purpose only when the boiling-point of the acid is reduced by means of a vacuum—a plan which has not met with much success. Formerly glass vessels were generally employed and they still survive in England, but elsewhere they are not much used. Porcelain, enamelled iron, for high concentrations even cast-iron without any protection, are also in use. On the continent of Europe platinum vessels have been for a long time almost universal, and they have been greatly improved by an internal lining of gold. The second consideration is the form of the vessels; these may be open pans or dishes, or closed retorts, or combinations of both. We also note the Faure and Kessler apparatus, which consists of a platinum pan, surmounted by a double-walled leaden hood, in such a manner that, while the hood is constantly cooled from the outside by water, the thin acid condensing on its inside is carried away without being allowed to flow back into the pan. The majority of acid makers, however, prefer retorts made entirely of platinum, preferably provided by the Heraeus process with a dense, closely adherent coating of gold, including the top or " dome." The new Kessler furnace is a very ingenious apparatus, in which the fire from a gas-producer travels over the sulphuric acid contained in a trough made of Volvic lava, and surmounted by a number of perforated plates, over which fresh acid is constantly running down; the temperature is kept down by the production of a partial vacuum, which greatly promotes the volatilization of the water, whilst retarding that of the acid. This furnace is also very well adapted for impure acids, unsuitable for platinum or platinum-gold stills on account of the crusts forming at the bottom of the retorts; and it is more and more coming into use both in Great Britain and on the Continent. A third consideration is the condensation of the vapours formed in the concentrating process; the further the concentration proceeds the more sulphuric acid they contain. Condensation is a comparatively easy task in the case of platinum apparatus, but with glass or porcelain beakers or retorts it presents great difficulties. In this respect the Kessler furnace has also proved to be very efficacious, so that it is at the present time considered the best apparatus for the concentration of sulphuric acid found in the trade.

The highest strength of sulphuric acid practically attainable by boiling down is 98 % H_2SO_4, and this is only exceptionally reached, since it involves much expenditure of fuel, loss of acid and wear and tear of apparatus. The usual strength of the O.V. of commerce, mostly designated by its specific gravity as 168° Twaddell, is from 93 to 95, or at most 96 % H_2SO_4. When attempts are made to push the process beyond 98 % it is found that the acid which distils over is as strong as that which remains behind. Real " monohydrate " or acid approaching 100 % can be made by Lunge's process of cooling strong O.V. down to −16° C. when H_2SO_4 crystallizes out, or by the addition of anhydrous SO_3 in the shape of fuming acid.

Since the development of the contact processes the fuming acid has become so cheap that it is now exclusively used for the preparation of the acids approaching the composition of " monohydrate."

Fuming or Nordhausen Oil of Vitriol, a mixture or chemical compound of H_2SO_4, with more or less SO_3, has been made for centuries by exposing pyritic schist to the influence of atmospheric agents, collecting the solution of ferrous and ferric sulphate thus formed, boiling it down into a hard mass (" vitriolstein ") and heating this to a low red heat in small earthenware retorts. Since about 1800 this industry had been confined to the north-west of Bohemia, and it survived just till 1900, when it was entirely abandoned—not because its product had become any less necessary, but, quite on the contrary, because the enormously increasing demand for fuming sulphuric acid, arising through the discovery of artificial alizarine and other coal-tar colours, could not possibly be supplied by the clumsy Bohemian process. Other sources of supply had accordingly to be sought, and they were found by going back to a reaction known since the first quarter of the 19th century, when J. W. Döbereiner discovered the combination of SO_2 and O into SO_3 by means of spongy platinum. This reaction, now known by the name of the catalytic or contact process, was made the subject of a patent by Peregrine Phillips, in 1831, and was tried later in many ways, but had been always considered as useless for practical purposes until 1875, when it was simultaneously and independently taken up by Clemens Winkler in Freiberg, and by W. S. Squire and R. Messel in London. Both these inventors began in the same way, viz. by decomposing ordinary sulphuric acid by a high temperature into SO_2, O, and H_2O (the last of course being in the shape of steam), absorbing the water by sulphuric acid, and causing the SO_2 and O to combine to SO_3 by means of moderately heated platinum in a fine state of division. Winkler showed that this division was best obtained by soaking asbestos with a solution of platinum chloride and reducing the platinum to the metallic state, and he described later a specially active kind of " contact substance," prepared from platinum chloride at a low temperature. This revival of the synthetical production of SO_3, at a period when this article had suddenly become of great importance, caused the greatest excitement among chemists and led to numerous attempts in the same direction, some of which were at once sufficiently successful to compete with the Bohemian process. It was soon found that the production of a mixture of SO_2 and O from sulphuric acid, as above described, was both too troublesome and costly, and after a number of experiments in other directions inventors went back to the use of ordinary burner-gas from pyrites and sulphur burners. For a good many years the further development of this industry was surrounded by great mystery, but it is now known that a satisfactory solution of the difficulties existing in the above respect was attained in several places, for instance, at Freiberg and in London, by the labours of the original inventors, Professor Winkler and Dr Messel. These difficulties were mostly caused by the solid impurities contained in the burner-gases in the shape of flue-dust, especially the arsenic, which after a short time rendered the contact substance inactive, in a manner not as yet entirely understood. Another difficulty arose from the fact that the reaction $SO_2+O=SO_3$ is reversible, the opposite reaction, $SO_3=SO_2+O$ setting in but little above the temperature required for the synthesis of SO_3. As far as is known (so much secrecy having been observed), the best results obtained in various places, save one, did not exceed 67% of the theoretical quantity, the remaining 33% of SO_2 having to be converted into sulphuric acid in the ordinary lead chambers. As is now known, the exception (undoubtedly the only one until 1899) was the process discovered as early as 1889 by Dr R. T. J. Knietsch, of the Badische Anilin-und Soda-Fabrik, at Ludwigshafen, but kept strictly secret until 1899, when the patents were published. The principal features of this invention are, first, a much more thorough purification of the burner-gas than had been practised up to that time, both in a chemical and a mechanical sense, and second, the prevention of superheating of the contact substance, which formerly always occurred by the heat generated in the process itself. As the Badische process effects this prevention by cooling the contact apparatus by means of the gaseous mixture to be later submitted to the catalytic action, the mixture is at the time heated up to the requisite temperature, and a considerable saving of fuel is the consequence. Altogether this process has been brought to such a pitch of simplicity and perfection, that it is cheap enough, not merely for the manufacture of fuming oil of vitriol of all strengths, but even for that of ordinary sulphuric acid of chamber-acid strength, while it is decidedly cheaper than the old process in the case of stronger acids, otherwise obtained by concentration by fire. It should be noted that these are not the results of a few years' working with an experimental plant, but of many years' work with large plant, now equal to a capacity of 120,000 tons of pyrites per annum. It is therefore not too much to say that, in all probability, the contact process will ultimately be employed generally for concentrated acids. Still, for the reasons given in the beginning of this article, the revolution thus impending will require a certain time for its accomplishment. Since the Badische process has become known several other new contact processes have come into the field, in some of which ferric oxide is employed as contact substance, but we must refrain from describing these in detail. (G. L.)

Medicine.—Sulphuric acid or oil of vitriol is a colourless oily-looking liquid incompatible with alkalis and their carbonates, lead and calcium. There are two medicinal preparations: (1) *Acidum sulphuricum dilutum*, containing 13·65% of hydrogen sulphate, (2) *acidum sulphuricum aromaticum* (elixir of vitriol), containing alcohol, spirit of cinnamon and ginger and 13·8% of hydrogen sulphate.

Therapeutics—For external use, sulphuric acid is a powerful irritant and caustic, acting by its powerful affinity for water and therefore dehydrating the tissues and causing them to turn black. It coagulates the albumen. Strong sulphuric acid is occasionally used as a caustic to venereal sores, warts and malignant growths. It is difficult, however, to limit its action, and glacial acetic and nitric acids are preferable for this purpose. Considerable burns on the face or body may result from the application of sulphuric acid in the practice known as "vitriol-throwing," a brownish black eschar serving to distinguish the burns produced by this acid from those of other corrosive fluids. Internally, dilute sulphuric acid is used in poisoning by alkalis as a neutralizing agent. Both it and the aromatic solution are powerful intestinal astringents, and are therefore useful in diarrhoea of a serious type, being strongly recommended both as a prophylactic and as a treatment during epidemics of Asiatic cholera. Small doses of the aromatic acid also serve as a prophylactic to those artisans who work in lead and as a treatment in lead poisoning in order to form an insoluble sulphate of lead. Sponging the body with very dilute solutions of sulphuric acid is useful to diminish the night-sweats of phthisis.

Toxicology.—Given in toxic doses or in strong solution, sulphuric acid is a severe gastro-intestinal irritant, causing intense burning pain, extending from the mouth to the stomach, and vomiting of mucous and coffee-coloured material. The effects of the ingestion of large quantities may be so rapid that death may take place in a couple of hours, owing to collapse, consequent on perforation of the walls of the oesophagus or stomach, or from asphyxia due to swelling of the glottis consequent on some of the acid having entered the larynx. Should the patient survive the first twenty-four hours death generally results later from stricture of the oesophagus or intestine, from destruction of the glands of the stomach or from exhaustion. Death has occurred in a child from the ingestion of half a teaspoonful of the strong acid, but recovery is recorded after half an ounce had been swallowed. The treatment consists in the prompt neutralization of the acid, by chalk, magnesia, whiting, plaster, soap or any alkaline substance at hand; emetics or the stomach pump should not be used. Morphine may be given hypodermically to mitigate the pain. Should the patient survive he will probably have to be fed by rectal enemata. The prognosis of sulphuric acid poisoning is bad, 60 to 70% of the cases proving fatal. The post-mortem appearances will be those of corrosive poisoning. The buccal mucous membrane will be greyish, brown or black in colour, due to the corrosive effects of the acid.

SULPICIA, the name of two Roman poets. The earlier lived in the reign of Augustus, and was a niece of Messalla, the patron of literature. Her verses, which were preserved with those of Tibullus and were for long attributed to him, are elegiac poems addressed to a lover called Cerinthus, possibly the Cornutus addressed by Tibullus in two of his *Elegies* (bk. ii., 2 and 3; see Schanz, *Gesch. d. röm. Litt.* § 284; F. Plessis, *La Poésie latine*, pp. 376–377 and references there given). The younger Sulpicia lived during the reign of Domitian. She is praised by Martial (x. 35, 38), who compares her to Sappho, as a model of wifely devotion, and wrote a volume of poems, describing with considerable freedom of language the methods adopted to retain her husband Calenus's affection. An extant poem (70 hexameters) also bears her name. It is in the form of a dialogue between Sulpicia and the muse Calliope, and is chiefly a protest against the banishment of the philosophers by the edict of Domitian (A.D. 94), as likely to throw Rome back into a state of barbarism. At the same time Sulpicia expresses the hope that no harm will befall Calenus. The muse reassures her, and prophesies the downfall of the tyrant. It is now generally agreed that the poem (the MS. of which was discovered in the monastery of Bobbio in 1493, but has long been lost) is not by Sulpicia, but is of much later date, probably the 5th century; according to some it is a 15th-century production, and not identical with the Bobbio poem.

Editions by O. Jahn (with Juvenal and Persius, revised by F. Bücheler, 1893) and in E. Bährens, *De Sulpiciae quae vocatur satira* (1873); see also monograph by J. C. Boot (1868); R. Ellis in *Academy*, (Dec. 11, 1869) and *Journal of Philology* (1874), vol. v.; O. Ribbeck, *Geschichte der römischen Dichtung* (1892), vol. iii.; H. E. Butler, *Post-Augustan Poetry* (1909), pp. 174–176; M. Schanz, *Geschichte der römischen Litteratur* (1900), iii. 2; Teuffel, *Hist. of Roman Literature* (Eng. trans., 1900), p. 233, 6. There are English translations by L. Evans in Bohn's *Classical Library* (prose, with Juvenal and Persius) and by J. Grainger (verse, 1759).

SULPICIUS RUFUS, PUBLIUS (*c.* 121–88 B.C.), Roman orator and statesman, legate in 89 to Cn. Pompeius Strabo in the Social War, and in 88 tribune of the plebs. Soon afterwards Sulpicius, hitherto an aristocrat, declared in favour of Marius and the popular party. He was deeply in debt, and it seems that Marius had promised him financial assistance in the event of his being appointed to the command in the Mithradatic War. To secure the appointment for Marius, Sulpicius brought in a franchise bill by which the newly enfranchised Italian allies and freedmen would have swamped the old electors (see further ROME, *History*, II. "The Republic"). The majority of the senate were strongly opposed to the proposals; a *justitium* (cessation of public business) was proclaimed by the consuls, but Marius and Sulpicius got up a riot, and the consuls, in fear of their lives, withdrew the *justitium*. The proposals of Sulpicius became law, and, with the assistance of the new voters, the command was bestowed upon Marius, then a mere *privatus*. Sulla, who was then at Nola, immediately marched upon Rome. Marius and Sulpicius, unable to resist him, fled from the city. Marius managed to escape to Africa, but Sulpicius was discovered in a villa at Laurentum and put to death; his head was sent to Sulla and exposed in the forum. Sulpicius appears to have been originally a moderate reformer, who by force of circumstances became one of the leaders of a democratic revolt. Although he had impeached the turbulent tribune C. Norbanus (*q.v.*), and resisted the proposal to repeal judicial sentences by popular decree, he did not hesitate to incur the displeasure of the Julian family by opposing the candidature for the consulship of C. Julius Caesar (Strabo Vopiscus), who had never been praetor and was consequently ineligible. His franchise proposals, as far as the Italians were concerned, were a necessary measure of justice; but they had been carried by violence. Of Sulpicius as an orator, Cicero says (*Brutus*, 55): "He was by far the most dignified of all the orators I have heard, and, so to speak, the most tragic; his voice was loud, but at the same time sweet and clear; his gestures were full of grace; his language was rapid and voluble, but not redundant or diffuse; he tried to imitate Crassus, but lacked his charm." Sulpicius left no written speeches, those that bore his name being written by a certain P. Canutius (or Cannutius). He is one of the interlocutors in Cicero's *De oratore*.

See Appian, *Bell. civ.* i. 55–60; Plutarch, *Sulla* and *Marius*; Vell. Pat. ii. 18; Livy, *Epit.* 77; E. A. Ahrens, *Die drei Volkstribunen* (Leipzig, 1836); Mommsen, *Hist. of Rome*, bk. iv. ch. 7; Long, *Decline of the Roman Republic*, vol. ii. ch. 17.

SULPICIUS RUFUS, SERVIUS (*c.* 106–43 B.C.), surnamed *Lemonia* from the tribe to which he belonged, Roman orator and jurist. He studied rhetoric with Cicero, and accompanied him to Rhodes in 78 B.C. Finding that he would never be able to rival his teacher he gave up rhetoric for law (Cic. *Brut.* 41). In 63 he was a candidate for the consulship, but was defeated by L. Licinius Murena (*q.v.*), whom he subsequently accused of bribery; in 51 he was successful. In the Civil War, after considerable hesitation, he threw in his lot with Caesar, who made him proconsul of Achaea in 46. He died in 43 while on a mission from the senate to Antony at Mutina. He was accorded a public funeral, and a statue was erected to his memory in front of the Rostra. Two excellent specimens of Sulpicius's style are preserved in Cicero (*Ad. Fam.* iv. 5 and 12). Quintilian (*Instit.* x. 1, 116) speaks of three orations by Sulpicius as still in existence; one of these was the speech against Murena, another *Pro* or *Contra Aufidium*, of whom nothing is known. He is also said to have been a writer of erotic poems. It is as a jurist, however, that Sulpicius was chiefly distinguished. He left behind him a large number of treatises, and he is often quoted in the Digest, although direct extracts are not found (for titles see Teuffel-Schwabe, *Hist. of Roman Lit.* 174, 4). His chief characteristics were lucidity, an intimate acquaintance with the principles of civil and natural law, and an unrivalled power of expression.

See R. Schneider, *De Servio Sulpicio Rufo* (Leipzig, 1834); O. Karlowa, *Römische Rechtsgeschichte*, vol. i. (Leipzig, 1885); the chief ancient authority is Cicero.

SULTAN (an Arabic word meaning "victorious" or "a ruler," *sultat*, dominion), a title of honour borne by a great variety of rulers of very varying powers and importance in Mahommedan Africa and the East. The word has thus no exact equivalent in English, and was early imported into the language in the Middle English form of *soudan* (from old Fr. *soudan*, *souldan*). This title is that conventionally applied by foreigners to the ruler of the Ottoman Empire, the sultan *par excellence*, whose proper styles are, however, *padishah* (emperor) and "commander of the faithful" (see AMIR). The feminine form "sultana" is derived from the Italian (fem. of *sultano*).

SULTANPUR, a town and district of British India, in the Fyzabad division of the United Provinces. The town is on the right bank of the river Gumti, midway between Benares and Lucknow, on the Oudh & Rohilkhand railway. Pop. (1901), 9550.

The DISTRICT OF SULTANPUR has an area of 1713 sq. m. The surface is generally level, being broken only by ravines in the neighbourhood of the rivers. The central portion is highly cultivated, while in the south are widespread arid plains and swampy *jhils* or marshes. The principal river is the Gumti, which passes through the centre of the district and affords a valuable highway for commerce. Minor streams are the Kandu, Pili, Tengha and Nandhia, the last two being of some importance, as their channels form the outlet for the superfluous water of the *jhils*, draining into the Sai. There are no forests in the district, only stunted *dhâk* jungles used for fuel. In 1901 the population was 1,083,904, showing an increase of less than 1% in the decade. Sultanpur is a purely agricultural district with a very dense population. The principal crops are rice, pulses, wheat, barley, sugar-cane and a little poppy. The main line of the Oudh & Rohilkhand railway from Lucknow to Rae Bareli and Mogul Serai serves the south-western portion.

The only incident worthy of note in the history of the district since the British annexation of Oudh is the revolt of the native troops stationed at Sultanpur during the Mutiny. The troops rose in rebellion on the 9th of June 1857, and, after murdering two of their officers, sacked the station. Upon the restoration of order Sultanpur cantonment was strengthened by a detachment of British troops; but in 1861 it was entirely abandoned as a military station.

See *Sultanpur District Gazetteer* (Allahabad, 1903).

SUMACH. The Sumach of commerce is the finely ground leaves of *Rhus coriaria*, a native of the North Mediterranean region from Portugal to Asia Minor; it is a shrub or low tree with hairy leaves composed of 11 to 15 elliptical leaflets with large blunt teeth, and large loose panicles of whitish-green flowers. Another species, *Rhus cotinus*, known as Venetian Sumach,

Sumach, *Rhus coriaria*. (½ nat. size.)
1. Flower (1½ nat. size). 2. Cluster of fruit. 3. One fruit. 4. A seed. (2, 3, 4, ½ nat. size.)

also a native of southern Europe and Asia Minor, yields the yellow dye-wood known as young fustic; it is also known as the Smoke-plant or Wig-tree, from the feathery or hairy appearance of the flower-stalks, which become elongated and hairy after the flowering. The genus *Rhus* is a member of the natural order Anacardiaceae and contains about 120 species of trees or shrubs mostly native in the temperature regions of both hemispheres. The leaves are alternate and simple or compound, with few to many entire-margined or serrated leaflets, and terminal or axillary panicles of small flowers with parts in fours or sixes. The species are mostly poisonous, some being especially noxious. Such are *Rhus toxicodendron*, the North American poison ivy, a shrub climbing on rocks and trees by means of rootlets, and poisonous to the touch. *R. venenata*, the North American poison elder sumach or dogwood, also contains an extremely irritant poison. *R. vermicifera* is the Japan lacquer or varnish-tree. Several species are cultivated in the British Isles as store, greenhouse or hardy trees.

SUMATRA, the westernmost and, next to Borneo, the largest of the Great Sunda Islands in the Malay Archipelago. It stretches N.W. to S.E. from Malacca Passage to Sunda Strait, between 5° 40′ N. and 5° 59′ S., and 95° 16′ and 106° 3′ 45″ E. Its length is about 1100 m., its extreme breadth 250 m., and its area, including the neighbouring islands, except Banka and Billiton, is 178,338 sq. m. The northern half runs roughly parallel to the Malay Peninsula, from which it is separated by the Strait of Malacca, and the southern end is separated by the narrow Sunda Strait from Java. Unlike Java, Sumatra has a series of considerable islands (Nias Islands, Mentawi Islands, &c.) arranged like outworks in front of the west coast, which faces the open Indian Ocean. The general physical features of the island are simple: a chain of lofty mountain ranges extends throughout its length, the western slopes descending rapidly towards the ocean and the eastern looking out over a vast alluvial tract of unusual uniformity.

Towards the north end of the island the spurs of the main chain sometimes extend towards the neighbourhood of the east coast and the eastern plain widens from north to south. Owing to this configuration of the island the watercourses of the western

Emery Walker sc.

side are comparatively short: only very few of them are large enough to be navigable. Those of the eastern slope, on the other hand, such as the Musi, Jambi, Indragiri, Kampar, Siak, Rokan, Panei, Bila and Asahan, are longer, and with many of their affluents are navigable in their middle and lower courses over considerable stretches for craft drawing 6 to 10 ft. The Musi and Jambi are navigable for 372 and 497 m. respectively. As waterways all the rivers labour under the drawbacks of rapids, mud-banks at their mouths, banks overgrown with forest, sparse population, and currents liable to serious variations due to irregularity of supply from the mountains and sudden rainfalls. In their lower courses some of them form enormous intercommunicating deltas. The mountainous regions contain numerous lakes, many evidently occupying the craters of extinct volcanoes. When, as sometimes happens, two or three of these craters have merged into one, the lake attains a great size. Among the larger lakes may be mentioned Toba; Maninyu, west of Fort de Kock; Singkara, south-east of Fort de Kock; Korinchi, inland from Indrapura; and Ranua, in the south-west.

Orography.—In order to appreciate the orography of the island the following sections of Sumatra should be discriminated one from another: (1) The valley of the Achin or Atjeh River. (2) The plains around the lake of Toba, which are of varied level and physical character. Those on the south and north lie at an elevation of 4000 ft., having the character of steppes, with scanty forest-cover, and, save in the narrow valleys and river-courses, are suitable for cattle-rearing. The plains on the east and west lie at a lower level and are eroded by larger rivers, clothed with forest, showing more sawahs and ladangs, or dry ricefields, and, near the rivers, planted with jagong (maize), coffee and fruits. Except on the south-east, where the Asahan flows away to the east coast, Toba Lake is surrounded by steep shores. According to R. D. M. Verbeek, P. van Dyk, B. Hagen and W. Volz, the lake had its origin in the collapse of a volcano. (3) The valley of the Batang Toru, with the plateau of Sipirok in the east and the mountain chain of Tapanuli in the west. On the south and south-east the valley is bounded by two volcanoes, Lubuk Raja and Si Buwal Buwali, whence were derived the volcanic tuffs of the valley and of the plateau of Sipirok, with their lakes, which are drained by the Batang Toru and its affluents. The valley varies in breadth from 5½ m. to half a mile and less. Flowing in a deep bed cut in the tuff strata, the river is not navigable. (4) The longitudinal valley of the Batang Gadis, with its affluent the Angkola, and in the south the valley of the Sumpur, the upper course of the Rokan, between Lubuk Raja in the north and Mt Merapi in the south. This valley is 64 m. long, with a mean breadth of 4 to 5 m. All the rivers of this valley, flowing in deep beds of eroded diluvial tuffs, with a fall as much sometimes as 330 to 660 ft. a mile, are unnavigable. The valley is bounded east and west by chains of slate and Palaeozoic rocks. The bottom is in many parts the diluvium of lakes drained by the rivers. (5) The section of middle Sumatra between the line of the three volcanoes, Singalang-Tandikat, Merapi and Sago on the north, and that of the three mountains Patah Sembilan, Korinchi and Tujuh on the south. This section is divided by the Middengebergte or middle chain into a northern half watered by the Ombilin or upper Indragiri with its affluents, and a southern half traversed by the Batang Hari or upper Jambi. To the north of the volcanoes, which rise to 9500 ft. or more, there is a high plateau of volcanic formation, whose elevation declines in a direction from west to east from 2950 to 1640 ft., with the lake of Maninyu (about 40 sq. m. in area) filling the hollow of an old volcano, and with rivers which have eroded their beds in the tuffs to a depth of 300 ft. and more. South of the volcanoes the northern affluents of the Ombilin—Sumpur, Sello and Sinamar—flow through valleys parallel to one another in a north-west to south-east direction. Here, too, are found fertile tuffs, and the valleys are densely populated. The rivers, like those already characterized, and for the same reason, are not available as waterways. Singkara Lake (44 sq. m.) is of origin similar to that of Maninyu. The Ombilin, issuing out of the lake on the east side and flowing through a plateau of Eocene sandstone, has on its banks the coalfields of Sungei Durian, &c., but is not serviceable as a waterway for that part of Sumatra. The coal has to be transported by railway via Solok to Padang (Emmahaven), a seaport on the west coast. Solok lies on the Sumami, which, flowing from the south to the lake of Singkara, prolongs the valley of the Sumpur to the Middengebergte. Unlike the northern, the southern affluents of the Ombilin do not follow longitudinal valleys hemmed in by the Barisan range and ranges of slate, limestone and sandstone. Here prevailing granite and diabase give rise to a complicated mountain system through which the rivers cleave their way in a curved and irregular course. South of the Middengebergte, however, the northern affluents of the Batang Hari, the Seliti, Gumanti, Si Potar, Mamun and Pangean, at least those in the west, again run in longitudinal valleys. These affluents and the Batang Hari itself (except the part at the mouth, Mamun-Simalidu) are navigable only by praus drawing not more than 12 in. (6) South Sumatra, so far as known, presents everywhere in its valleys the same character as that of the Batang Toru, Batang Gadis, Sumpur, &c. They also are closed in on the north and south by volcanoes which have here produced similar masses of tuff, with lakes and rivers of the same formation as in the north. Such are the valley of Korinchi, with the river of the same name, between the peak of Korinchi and Mt Raja; the valleys of Serampei and Sungei Tenang (as imperfectly known as that of the Korinchi), in which are to be sought the sources of the Tambesi and Asei, both affluents of the Jambi; the longitudinal valley of

Ketaun, in Lebong, flowing to the west coast, and of the upper Musi, flowing to the east coast; the valleys of Makakau and Selabung or the upper Komering, an affluent of the Musi, between Sebelat and Kaba. The Makakau and Selabung drain into Lake Ranau, which on the south side is dammed by the volcano Seminung. The southernmost longitudinal valley of Sumatra is that of the Semangka, which flows into the bay of the same name. Generally the lower valleys of the rivers lie at elevations of 600 to 1000 ft.; higher up they rise to 2500 or 3000 ft.; the mountain chains rise to 5500 ft.; the volcanoes tower up from 6500 to nearly 10,000 ft. (7) The section of south Sumatra between the eastern chain of old rocks and the east coast with its numerous river mouths is formed of the alluvium of sea and rivers. In the river-beds, however, and at some distance from the sea, older strata and eruptive rocks underlie the alluvium. The strata near the mountain chains and volcanoes consist of diluvial tuffs.

Geology.—The oldest rocks are gneiss, schist and quartzite, the schist often containing gold. They probably belong to several geological periods, but all were folded and denuded before the Carboniferous beds were deposited. They form the backbone of the island, and crop out on the surface at intervals along the mountain chain which runs parallel to the west coast. Here and there they are penetrated by granitic intrusions which are also Pre-Carboniferous. The next series of rocks consists of slates below and limestones above. It lies unconformably upon the older rocks; and the limestone contains *Fusulina*, *Phillipsia* and *Productus*, indicating that it belongs to the Upper Carboniferous. These beds are found only in northern Sumatra. They are accompanied by intrusions of diabase and gabbro, and they are sometimes folded, sometimes but little disturbed. No Permian beds are known, and for many years Mesozoic deposits were supposed to be entirely absent, but Triassic clays and sandstones with Daonella have been found in the upper part of the basin of the Kwalu (East Sumatra). They rest unconformably upon the Carboniferous beds, and have themselves been tilted to a steep angle. Cretaceous beds also have been recorded by Bücking. Tertiary deposits are very widely spread over the plains and low-lying country. They consist of breccias, conglomerates, sandstones, marls, and limestones, with seams of coal and lignite. The most valuable coal occurs in the Eocene beds. At the close of the Eocene period great eruptions of augite-andesite took place from two fissures which ran along the west coast. The Miocene consists chiefly of marls, with occasional beds of lignite and limestone. On the east coast it sometimes yields petroleum. The Pliocene occurs chiefly in the low-lying land and is generally covered by drift and alluvium. Sometimes it contains thick seams of lignite or brown coal.

The present volcanoes lie along a line (with offshoots) which runs parallel to the west coast, but some distance to the east of the fissures from which the early Tertiary lavas were poured. Lava streams are seldom emitted from these volcanoes, the material erupted consisting chiefly of ash and scoriae, which are spread over a very wide extent of country. Augite-andesite predominates, but basalt and rhyolite also occur.

Climate.—As throughout the whole of the Malayan Archipelago, so in Sumatra, which lies about equally balanced on both sides of the equator, the temperature stands at a high level subject to but slight variations. The monthly temperature mounts only from 77° F. in February to 80·6° in May, August and November. In the distribution of the rainfall, as dependent on the direction of the winds, the following parts of Sumatra must be distinguished: (1) south-east Sumatra, on which, as on Banka and Billiton, the heaviest rainfall occurs during the north-west monsoon, the annual volume of rainfall increasing from 98·4 in. in the east to 139 in. in the west. Of the 139 in. of yearly rainfall, 91·7 in. are brought by the north-west and 47·3 in. by the south-east monsoon. (2) The west coast. Here the rainfall for the year increases from the southern and northern extremities towards the middle. Benkulen, *e.g.* gets 126 in.; Singkel (2° 15′ N.), 172 in.; and Padang 184 in. in the year. Here, too, the prevailing rainfall is brought by the north-west monsoon, but in this belt its prevalence is not so pronounced, Padang getting 94 in. of rain during the north-west monsoon, against 90 in. during the south-east. The mountain chain immediately overhanging it, the high temperature of the sea washing it, the frequent thunderstorms to which it is subject, the moist atmosphere of its equatorial situation, and the shorter régime of the dry south-east wind are the principal causes of the heavier rainfall on the west coast. The higher stations of middle Sumatra, on the lee side of the western mountain chain, have a yearly rainfall of only 78·7 in. (3) The northern and north-eastern parts of Sumatra are swept by a variety of winds. The south-east wind, however, predominates. Blowing over land and in the direction of the longitudinal valleys, the south-east wind is comparatively dry, and thus favours the formation of steppes in the north such as the Toba plains. The north-east and south-west winds, on the other hand, being laden with the moisture of the sea, bring rain if they blow for any length of time.

Fauna.—Though Sumatra is separated from Java by so narrow a strait, both the zoologist and the botanist at once find that they have broken new ground on crossing to the northern island. The *Pachydermata* are strongly characteristic of the Sumatran fauna: not only are the rhinoceros (*Rh. sumatranus*), the *Sus vittatus*, and the tapir common, but the elephant, altogether absent from Java, is represented in Sumatra by a species considered by some to be peculiar. The Sumatran rhinoceros differs from the Javanese in having two horns, like the African variety. It is commonest in the marshy lowlands, but extends to some 6500 ft. above sea-level. The range of the elephant does not extend above 4900 ft. The wild *Bos sundaicus* does not appear to exist in the island. An antelope (*kambing-utan*) occurs in the loneliest parts of the uplands. The common Malay deer is widely distributed, *Cervus muntjac* less so. The orang-utang occurs, rarely, in the north-east. The siamang (*Siamanga syndactyla*) is a great ape peculiar to the island. The ungko (*Hylobates agilis*) is not so common. A fairly familiar form is the simpei (*Semnopithecus melalophus*). The chigah (*Cercocebus cynomolgus*) is the only ape found in central Sumatra in a tame state. The pigtail ape (*Macacus nemestrinus*)—as Raffles described it in his "Descriptive Catalogue of a Zoological Collection made in Sumatra," *Trans. Linn. Soc.* (1820), xiii. 243—is trained by the natives of Benkulen to ascend coco-nut trees to gather nuts. The *Galeopithecus volans* (*kubin*, flying cat or flying lemur) is fairly common. Bats of some twenty-five species have been registered; in central Sumatra they dwell in thousands in the limestone caves. The *Pteropus edulis* (*kalong*, flying fox) is to be met with almost everywhere, especially in the durian trees. The tiger frequently makes his presence felt, but is seldom seen; he prefers to prowl in what the Malays call tiger weather, that is, dark, starless, misty nights. The clouded tiger or *rimau bulu* (*Felis macroscelis*) is also known, as well as the Malay bear and wild dog. *Paradoxurus musanga* ("coffee-rat" of the Europeans) is only too abundant. The Sumatran hare (*Lepus netscheri*), discovered in 1880, adds a second species to the *Lepus nigricollis*, the only hare previously known in the Malay Archipelago. The *Manis javanicus* is the only representative of the Edentata. Some 350 species of birds are known, and the avifauna closely resembles that of the Malay Peninsula and Borneo, including few peculiar species.

Flora.—Rank grasses (*lalang*, *glaga*), which cover great areas in Java, have an even wider range in Sumatra, descending to within 700 or 800 ft. of sea-level; wherever a space in the forest is cleared these aggressive grasses begin to take possession of the soil, and if once they are fully rooted the woodland has great difficulty in re-establishing itself. Among the orders more strongly represented in Sumatra than in Java are the Dipterocarpaceae, Chrysobalanaceae, sclerocarp Myrtaceae, Melastomaceae, Begonias, Nepenthes, Oxalidaceae, Myristicaceae, Ternströmiaceae, Connaraceae, Amyridaceae, Cyrtandraceae, Epacridaceae and Eriocaulaceae. Many of the Sumatran forms which do not occur in Java are found in the Malay Peninsula. In the north the pine tree (*Pinus Merkusii*) has advanced almost to the equator, and in the south are a variety of species characteristic of the Australian region. The distribution of species does not depend on elevation to the same extent as in Java, where the horizontal zones are clearly marked; and there appears to be a tendency of all forms to grow at lower altitudes than in that island. A remarkable feature of the Sumatran flora is the great variety of trees that vie with each other in stature and beauty, and as a timber-producing country the island ranks high even among the richly wooded lands of the archipelago. Forest products—gums and resins of various sorts, such as gutta-percha—are valuable articles of export. The process of reckless deforestation is perceptible in certain districts, the natives often destroying a whole tree for a plank or rafter. The principal cultivated plants, apart from sugar-cane and coffee, are rice (in great variety of kinds), the coco-nut palm, the areng palm, the areca and the sago palms, maize, yams, and sweet potatoes; and among the fruit trees are the Indian tamarind, pomegranate, guava, papaw, orange and lemon. Even before the arrival of Europeans Sumatra was known for its pepper plantations; and these still form the most conspicuous feature of the south of the island. For the foreign market coffee is the most important of all the crops, the Padang districts being the chief seat of its cultivation. Benzoin was formerly obtained almost exclusively from Sumatra from the *Styrax benzoin*.

Population.—The following table gives the area and estimated population of the several political divisions of Sumatra and of the island as a whole (excluding the small part belonging to the Riouw-Lingga residency):—

Division.	Area in sq. m.	Population. 1900.
Sumatra, West Coast	31,649	1,527,297
Sumatra, East Coast	35,312	421,090
Benkulen	9,399	162,396
Lampong Districts	11,284	142,426
Palembang	53,497	804,299
Achin (Atjeh)	20,471	110,804
Total	161,612	3,168,312

Of the total population, about 5000 are Europeans, 93,000 Chinese, 2500 Arabs, 7000 foreigners of other nations, and the rest natives. In 1905 the total population was given as 4,029,505.

The natives of the mainland of Sumatra are all of Malay stock (those of the north being the most hybrid), but it is doubtful to what extent Malay has here absorbed pre-Malay blood. The different tribes vary in language, customs and civilization. No race of true Negrito type has been found. The Kubus (*q.v.*), a savage forest people of the highlands, were believed by some to be Negrito owing to the frizzled character of their hair, but it appears certain that they are Malayan. The north of Sumatra is occupied by the Achinese (see ACHIN). South of Achin and west of Lake Toba is the country of the Battas (*q.v.*) or Battaks. In the hill-country south of the lake are two forest tribes, Orang-ulu and Orang-lubu, pure savages of whom practically nothing is known, affiliated by most authorities to the Battas. The plains east of this territory are occupied by the Siaks, and farther south on the east coast are the Jambis, both Malays. Above Padang are the several tribes of the prosperous and comparatively civilized Menangkabos (*q.v.*). The Korinchis live among the mountains south of Padang, and farther south on the borders of Palembang and Benkulen are the Rejangers, a peculiar tribe who employ a distinctive written character which they cut with a kris on bamboo or lontar. The same character is employed by their immediate neighbours to the south, the Pasumas, who bear traces of Javanese influence. In the extreme south are the Lampong people, who claim descent from the Menangkabos, but have also an admixture of Javanese blood. The inhabitants of the islands west of Sumatra are of mixed origin. Simalu is peopled partly by Achinese and partly by Menangkabo settlers. They profess Mahommedanism but are practically savages. Nias (*q.v.*) has an interesting native population, apparently of pre-Malayan origin; and the Mentawi islands (*q.v.*) are inhabited by a race generally held to be a Polynesian settlement which has escaped fusion with Malayan stock. As regards education and the spread of Christianity among the natives, the west coast division is far in advance of the rest of the island. Here about 32,000 natives profess Christianity and there are about 300 schools; elsewhere schools are comparatively few and the adhesion to Christianity very slight.

Administrative Divisions and Towns.—In the west coast lands European influence, fertile soil, comparatively good roads, agriculture, timber, and coalfields have created populous settlements on the coast at Padang (the capital of the west coast, with 35,158 inhabitants in 1897, of whom 1640 were Europeans), Priaman, Natal, Ayer Bangis, Siboga, Singkel, and also on the plateaus at Fort de Kock, Payokombo, &c. In the east coast lands it is only at the mouths of rivers—Palembang at the mouth of the Musi, with 53,000 inhabitants, and Medan in Deli, the residence of the highest civil and military officials of the east coast, in which a fine government house has been erected—that considerable centres of population are to be found. Nine-tenths of the natives of Sumatra live by agriculture, the rest by cattle-rearing, fishing, navigation, and, last but not least, from the products of the forests; they are therefore little concentrated in towns.

The Dutch government of the west coast, extending along the shore of the Indian Ocean from 2° 53′ N. to 2° 25′ S., comprises the residencies of the Padang lowlands, Tapanuli and the Padang highlands. The governor has his residence at Padang, which is also the capital of the lowlands residency. Padang Sidempuan, the chief town of Tapanuli, lies inland, south of Mt Lubu Raja. The town of Siboga has considerable commercial importance, the bay on which it stands being one of the finest in all Sumatra. Bukit Tinggi, or, as it is commonly called, Fort de Kock, is the capital of the residency of the Padang highlands. To the government of the west Coast belong the following islands: Simalu; Banyak Islands, a small limestone group, well wooded and sparsely peopled; Nias; Batu Islands (Pulu Pini, Tana Masa, Tana Bala, &c.); Mentawi and Pegeh or Nassau Islands. The residency of Bankulen (*i.e. Bang Kulon*, " west coast ") lies along the west coast from the southern extremity of the west coast government to the south-western end of the island. The capital, Benkulen, is on the coast near Pulu Tiku, or Rat Island, in a low and swampy locality, and on an open roadstead. This was the chief establishment possessed by the British East India Company in Sumatra. Among other noteworthy places are Mokko-Mokko, with the old British fort Anna; Pasar Bintuhan, and Lais (Laye), the former seat of the British resident.

The residency of the Lampong districts is the southernmost in the island, being separated from Palembang by the Masuji River. It is partly mountainous, partly so flat as to be under water in the rainy season. The more important places are Telok Betong, chief town of the residency, Menggala (with a good trade), Gunung Sugi, Sukadana, Tanjong Karang, and Kota Agung.

The residency of Palembang consists of the former kingdom of this name and various districts more or less dependent on that monarchy. Between the mainland dependency of the Riouw-Lingga residency and the residency of Palembang lies Jambi, an extensive sultanate, of which a portion belongs to the residency of Palembang as a protectorate, the sultan having in his capital (also called Jambi) a Dutch " comptroller," who represents the resident of Palembang; another portion is claimed by a quasi-independent sultan who reigns in the interior. Of this interior very little was known until the scientific expedition despatched by the Dutch Royal Geographical Society towards the end of the 'seventies, but in 1901 an armed Dutch expedition, necessitated by frequent disturbances, penetrated right into the Jambi hinterland, the Gajo districts, where until then no European had ever trod. The town of Palembang is a large place on the river Musi, with 50,000 inhabitants (2500 Chinese), extensive barracks, hospitals, &c., a mosque (1740), considered the finest in the Dutch Indies, and a traditional tomb of Alexander the Great. The residency of Riouw, which embraces many hundreds of islands, great and small, also includes a portion of the Sumatra mainland, between the residencies of Palembang to the south and the east coast of Sumatra to the north. This is the old kingdom of Indragiri, and lies on either hand of the river of that name.

The residency of the east coast was formed in 1873 of the territory of Siak and its dependencies and the state of Kampar. In includes perhaps the richest and best-developed districts of northern Sumatra, namely, Deli (with an assistant-resident), Langkat, Serdang, &c.—districts little known in 1873, but by the beginning of the 20th century famous among the chief tobacco-producing countries in the world. Belawan is the harbour to Deli, but the capital is Medan, where the sultan and the Dutch resident reside. Belawan is connected with Medan by a railway, constructed before 1890 by a private company, almost entirely dependent for its earnings upon the numerous tobacco plantations, several of which belong to British corporations. The plantation labourers are almost entirely alien coolies, largely Chinese, and the Malays are comparatively few in number. The tobacco plantations of British North Borneo were nearly all started by planters from Deli.

The government of Achin (*q.v.*) occupies the northern part of the island. No little progress has been made by the Dutch even in this war-ridden territory. There is a railway in the lower valley of the Achin River, connecting the capital, Kotaraja, and neighbourhood with Olehleh, a good, free port, with an active trade, carried on by numerous steamers, both Dutch and foreign. Edi on the north-east coast, with another harbour, is capital of a sultanate which formerly owed allegiance to the sultan of Achin, but has formed a political division of the government of Achin since 1889, when an armed expedition restored order. Edi is a centre of the still extensive pepper trade, carried on mainly with the Chinese at Singapore and Penang, which island faces Edi.

Products and Industry.—Forests and natural vegetation cover a much larger part of Sumatra than of Java. Whereas in Java tall timber on the mountains keeps to altitudes of not less than 3000 ft., the tall timber on the mountains of Sumatra commonly descends below 1000 ft., and in many cases right down to the coast. In Sumatra, as in Java, the vegetation of the lowlands up to nearly 1000 ft. is distinct from the vegetation of the mountain slopes and plateaus from that elevation up to 4000 ft. and over. The principal exports from all the regencies alike are black and white pepper, bamboo (*rotan*), gums, caoutchouc, copra, nutmegs, mace and gambir. From the west coast and Palembang coffee is also exported, and from Deli, tobacco. The system of compulsory cultivation of coffee was abolished in Sumatra in 1908.

Sumatra possesses various kinds of mineral wealth. Gold occurs in the central region, where it is worked at a profit, and it has also been worked in the Menangkabo district and the interior of Padang. Tin is known, especially in Siak. Copper has been worked in the Padang highlands (most largely in the district of Lake Singkara) and at Muki in Achin. Iron is not infrequent. The most important mineral economically, however, is coal. Coal seams exist in the Malabuh valley (Achin), in the Sinamu valley, and on both sides of the Ombilin River; the Ombilin field was brought into especial notice by D. D. Veth of the 1877–79 expedition. The production of this field increased from 1730 tons in 1892 to 78,500 metric tons in 1899. The profit on the working, which is carried on by the state, is slight. Lignite of good quality is found in several localities. The production of petroleum began to be strongly developed towards the close of the 19th century; on the Lepan River in Langkat it mounted from 362,880 gallons in 1891 to 20,141,000 gallons in 1899. Muara Enim in Palembang also produces petroleum. Perlak, formerly a tributary state of Achin and now a political division of the Achin government, has become one of the chief centres of the petroleum industry. The crude oil is conveyed in pipes to Aru Bay, on the east coast, and refined in the island of Sembilan. Arsenic, saltpetre, alum, naphtha and sulphur may be collected in the volcanic districts. A systematic mineralogical survey has been undertaken in central Sumatra.

Roads and Railways.—In the west, with its long line of coast and numerous valleys, the transport of coffee has induced the construction of very good roads as far as the Lake of Toba, owing to the want of navigable rivers. There is a railway connecting not only the coalfields of the Ombilin valley with Padang, but also the Ombilin river and the Lake of Singkara with the most productive and densely populated plateaus and valleys, north and south of the line of the volcanoes Singalang, Merapi and Sago. A second railway in the district of Deli connects the inland plantations with the coast; and there is another, as already indicated, in the lower Achin valley. Good roads traverse the broad plains of Benkulen, Palembang and the Lampong districts.

History.—As far as is known, Sumatran civilization and culture are of Hindu origin; and it is not improbable that the island was the first of all the archipelago to receive the Indian immigrants who played so important a part in the history of the region. Certain inscriptions discovered in the Padang highlands seem to certify the existence in the 7th century of a powerful Hindu kingdom in Tanah Datar, not far from the site of the later capital of Menangkabo. In these inscriptions Sumatra is called the "first Java." The traces of Hindu influence still to be found in the island are extremely numerous, though far from being so important as those of Java. There are ruins of Hindu temples at Butar in Deli, near Pertibi, on the Panbi river at Jambi, in the interior of Palembang above Lahat, and in numerous other localities. One of the principal Hindu ruins is at Muara Takus on the Kampar river. The buildings (including a stupa 40 ft. high) may possibly date from the 11th century. At Pagar Rujung are several stones with inscriptions in Sanskrit and Menangkabo Malay. Sanskrit words occur in the various languages spoken in the island; and the *Ficus religiosa*, the sacred tree of the Hindu, is also the sacred tree of the Battas. At a later period the Hindu influence in Sumatra was strengthened by an influx of Hindus from Java, who settled in Palembang, Jambi and Indragiri, but their attachment to Sivaism prevented them from coalescing with their Buddhist brethren in the north. In the 13th century Mahommedanism began to make itself felt, and in course of time took a firm hold upon some of the most important states. In Menangkabo, for instance, the Arabic alphabet displaced the Kavi (ancient Javanese) character previously employed. Native chronicles derive the Menangkabo princes from Alexander the Great; and the Achinese dynasty boasts its origin from a missionary of Islam. The town of Samudera was at that period the seat of an important principality in the north of the island, whose current name is probably a corruption of this word. There is a village called Samudra near Pasei which possibly indicates the site.

Sumatra first became known to Europeans through the Portuguese, Diogo Lopes de Sequeira, in 1508. The Portuguese were the first to establish trading posts on the island, but at the end of the century they were driven out by the Dutch. At this time the most powerful native state in the island was Achin (*q.v.*). Elsewhere Dutch sovereignty was gradually extended—in 1664 over Indrapura; in 1666 over Padang, until by 1803 it was established over much of the southern part of the eastern lands, including Palembang. Meanwhile, in 1685 the British had acquired a footing in Benkulen, and between them and the Dutch there was always much jealousy and friction until in 1824 a treaty was made under which the British vacated Sumatra in favour of the Dutch, who reciprocated by giving up Malacca. In May 1825 Benkulen was taken over from the British. In the second half of the 19th century the Dutch found a succession of armed expeditions necessary to consolidate their power. Thus in 1851 a revolt was suppressed in Palembang, and an expedition was sent to the Lampong districts. In 1853 Raja Tiang Alam, ringleader of the revolt in Palembang, surrendeied. In 1858 an expedition was sent against Jambi; the sultan was dethroned and a treaty made with his successor. In 1860 Rejang was added to the Palembang residency. In 1863 there was an expedition against Nias, and in 1865 another against Asahan and Serdang (east coast). In 1873 war was declared against Achin. In 1876 there was an expedition against Kota Jutan (east coast) and the emancipation of slaves was carried out on the west coast. In 1878 Benkulen was made a residency, and the civil administration of Achin and dependencies was entrusted to a governor. From 1883 to 1894 the government, with the help of missionaries, extended its authority over the south-east and south-west of the island, and also over some of the lands to the east and north of Toba lake, including the districts of Toba, Silindong and Tanah Jawa, and in 1895 over the southern part of the peninsula of Samosir in Toba lake. Its jurisdiction was also extended over Tamiang, till then the northern frontier of the Dutch east coast of Sumatra. By military expeditions (1890–95) the Dutch influence on the Batang Hari, or Upper Jambi, was increased; as also in 1899 in the Lima Kotas[1] in central Sumatra, included within the territory of Siak. The war in Achin did not materially retard the development of Sumatra, and although the titular sultan of Achin continued a desultory guerrilla warfare against the Dutch in the mountainous woodlands of the interior, the almost inaccessible Pasei country, really active warfare has long ceased. All along the main coasts of the former sultanate of Achin military posts have been established and military roads constructed; even in Pedir, on the north coast, until 1899 the most actively turbulent centre of resistance of the sultan's party, and still later only pacified in parts, Dutch engineers were able to build a highway to connect the west with the east coast, and other works have been successfully carried out. Practically the whole of the island is now more or less explored and under control.

The literature dealing with Sumatra is very extensive. Of the older works the best known is W. Marsden, *History of Sumatra* (London, 1811). A full list of other older authorities will be found in P. J. Veth's *Aardrijkskundig Woordenboek van Nederl. Indië* (1869). Among later works one of great importance is *Midden-Sumatra; Reizen en Onderzoekingen der Sumatra Expeditie, 1877–1879* (Leiden, 1881, sqq.), edited by P. J. Veth. See also Brau de Saint-Pol Lias, *Île de Sumatra* (Paris, 1884); E. B. Kielstra, *Beschrijving van der Atjeh Oorlog* (1885–1886), and "Sumatras West-Kust van 1819–1825," in *Bijd. tot Land-, &c., Kunde* (1887); on the history of Palembang, west coast and the war in Achin, in *Indisch militair Tijdschrift* (1886–1889); *Tijdschr. bat. Gen.* (1887–1892). For topography and geology, see R. Fennema, "Topographische en geologische Beschrijving van het Noordelijk gedeelte . . . Westkust, &c.," *Jaarb. v. het Mijnwezen* (1887); R. D. M. Verbeek, *Topographische en geologische Beschrijving van een Deel van Sumatra's Westkust*, with atlas (Batavia, 1883); similar work dealing with south Sumatra, *Jaarb. v. het Mijnwezen* (1881), and *Supplement* (1887). W. Volz, "Beiträge zur geologischen Kenntniss von Nord-Sumatra," *Zeitschr. deutsch. geol. Gesell.* (1899), vol. li.; H. Bücking, "Zur Geologie von Nord- und Ost-Sumatra," *Samml. geol. Reichs-Mus.* 1st series, vol. viii., with map and five plates (Leiden, 1904); D. J. Erb, "Beiträge zur Geologie und Morphologie der südlichen West-Küste von Sumatra," *Z. Ges. E. Berlin* (1905); J. F. Hoekstra, *Die Oro- und Hydrographie Sumatras* (Groningen, 1893); J. W. Ijzerman, &c., *Dwars door Sumatra, Tocht van Padang naar Siak* (Haarlem, 1895); A. Maas, *Quer durch Sumatra* (Berlin, 1904); E. Otto, *Pflanzen- und Jägerleben auf Sumatra* (Berlin, 1903); B. Hagen, "Die Gajo-Länder," *Jahresb. Frankfurter V.G.*, lxvi., lxvii. (1901–1903); Climate: J. P. van der Stok, *Regenwaarnemingen* and *Atlas of Wind and Weather* (Batavia, 1897). Consult further *Tijd. Aardr. Gen.*, *Tijd. Batav. Gen.*, *Jaarb. van het Mijnwezen*, and *Koloniale Verslagen*, passim. (See also MALAY ARCHIPELAGO.)

SUMBA (TJENDANA, or SANDALWOOD), one of the Lesser Sunda Islands in the Dutch East Indies, lying south of Flores, from which it is separated by Sumba strait, about 10° S., 120° E. It has an area of about 4600 sq. m., consists of a plateau with an extreme elevation of about 3300 ft., and appears to be composed mainly of sedimentary rocks. It has a large Malay population (estimated at 200,000). Some trade is carried on in cotton, ponies, edible birds' nests, tortoiseshell, &c., mainly by Bugis and Arabs, the chief centre for which is Waingapu or Nangamessi on the north-east coast. Sumba is included in the Dutch residency of Timor, together with the lesser island of Savu, to the east. From this last island the sea is enclosed by Timor, Sumba and the islands between them, and Flores and the chain of islands east of it is called the Savu Sea.

[1] "Kota" means settlement or township, and a great many districts have been named from the number of kotas they contain; *e.g.* the VII. Kotas, the VIII. Kotas, &c.

SUMBAWA (Dutch *Soembawa*), one of the Little Sunda islands in the Dutch East Indies, east of Lombok, from which it is separated by the narrow Alas Strait. It has an area of 4300 sq. m., or, including the neighbouring islands, 5240 sq. m. The deep bay of Salé or Sumbawa on the north divides the island into two peninsulas, and the isthmus is further reduced by the narrower Bay of Chempi on the south. The eastern peninsula is deeply indented on the north by the Bay of Bima. Four mountain chains cross the island in a west to east direction. The northern, as in Bali and Lombok, is of volcanic origin. Tambora, forming a minor peninsula east of Sumbawa Bay, is said to have lost a third of its elevation in the eruption of 1815, but is still 9055 ft. high. In the southern chain is found a limestone formation analogous to that in Bali, Lombok and Java. Between these two chains are round hills consisting of lavas or sometimes of volcanic tuffs, covered with the long silvery grass which also clothes vast prairies in Java and Sumatra. There are no navigable streams. The climate and productions are not unlike those of Java, though the rains are heavier, the drought more severe, and the fertility less. Sulphur, arsenic, asphalt and petroleum exist. The natives live solely by agriculture. But out of a total population of about 75,000 there are 11,000 foreigners, living mostly by trade and navigation. The natives consist of Sumbawans proper, a people of Malayan stock; of Buginese and Macassar immigrants, and of wild tribes of the mountains of whom nothing is known. Mahommedanism prevails throughout the island, except among the mountain tribes.

Politically Sumbawa, with its four independent states, belongs to the confederated states of the government of Celebes and its dependencies, a situation to be explained by the fact of the old supremacy of the Macassaresi over Sumbawa, Flores and Sumba. The independent states are Sumbawa proper, Dompo, Sangar and Bima. Two other states on the northern extremity of the island were so far devastated by the Tambora eruption of 1815 that their territory, after lying for long uninhabited, was in 1866 divided between Dompo and Sangar. Sumbawa proper occupies the western peninsula. The residence of the sultan is Sumbawa on the north coast. It is surrounded with a palisade and ditches. The inhabitants of this state employ sometimes the Malay and sometimes the Macassar character in writing. A considerable trade is carried on in the export of horses, buffaloes, goats, dinding (dried flesh), skins, birds' nests, wax, rice, katyang, sappanwood, &c. Sumbawa entered into treaty relations with the Dutch East India Company in 1674. Dompo is the western half of the eastern peninsula. The capital of the state, Dompo, lies in the heart of the country, on a stream that falls into Chempi Bay. Bada, the sultan's residence, is farther west. Sangar occupies the north-western promontory of the island, and Bima the extreme east. Bima or Bodjo, the chief town of the latter state, lies on the east side of the Bay of Bima; it has a stone-walled palace and a mosque, as well as a Dutch fort.

See Zollinger, "Soembawa," in *Verhandelingen van het Batav. Genootschap*, xxiii.; Ligtvoet, "Anteekeningen betreffende den economischen Toestand en de Ethnographie van Soembawa," in *Tijdschr. Bat. Gen.* xxiii.

SUMBUL, or SUMBAL, also called Musk Root, a drug occasionally employed in European medical practice. It consists of the root of *Ferula sumbul*, Hook., a tall Umbelliferous plant found in the north of Bokhara, its range apparently extending beyond the Amur. It was first brought to Russia in 1835 as a substitute for musk; and in 1867 was introduced into the British pharmacopoeia. The root as found in commerce consists of transverse sections an inch or more in thickness and from 1 to 3 or more inches in diameter. It has a dark thin papery bark, a spongy texture, and the cut surface is marbled with white and blackish or pale brown; it has a musky odour and a bitter aromatic taste. The action and uses of the drug are the same as those of asafetida (*q.v.*) It owes its medicinal properties to a resin and an essential oil. Of the former it contains about 9% and of the latter ⅓ %. The resin is soluble in ether and has a musky smell, which is not fully developed until after contact with water.

Under the name of East Indian sumbul, the root of *Dorema ammoniacum*, Don., has occasionally been offered in English commerce. It is of a browner hue, has the taste of ammoniacum, and gives a much darker tincture than the genuine drug; it is thus easily detected. The name "sumbal" (a word of Arabic origin, signifying a spike or ear) is applied to several fragrant roots in the East, the principal being *Nardostachys jatamansi*, D.C. (see SPIKENARD). West African sumbul is the root of a species of *Cyperus*.

SUMER and **SUMERIAN.** The Babylonian name Shumer was used in the cuneiform inscriptions together with Akkad, viz. *mat Shumeri u Akkadi*, "land of S. and A.," to denote Babylonia in general (see AKKAD). In the non-Semitic ideographic documents the equivalent for Shumer is *Kĕngi*, which seems to be a combination of *kĕn*, "land" + *gi*, "reed," *i.e.* "land of reeds," and appropriate designation for Babylonia, which is essentially a district of reedy marshes formed by the Tigris and Euphrates. It was formerly thought that Shumer was employed especially to denote the south of Babylonia, while Akkad was used only of the north, but this view is no longer regarded as tenable. It is more probable that the expression Shumer designated the whole of Babylonia in much the same manner as did Akkad, and that the two words "Shumer and Akkad" were used together as a comprehensive term. That Shumer actually did mean all Babylonia appears evident from the biblical use of Shinar = Shumer to describe the district which contained the four chief Babylonian cities, viz. Babel, Erech, Accad and Calneh (Gen. x. 10), which, according to the Old Testament account, constituted the beginnings of Nimrod's kingdom. The identity of Shinar and Shumer is also demonstrated by the Septuagint rendering of Shinar in Isaiah xi. 11 by "Babylonia." In short, there can be no doubt that the biblical name Shinar was practically equivalent to the *mat Shumeri u Akkadi* = non-Semitic *Kêngi-Uri* of the Babylonian inscriptions. Furthermore, the fact that the Syriac *Sen'ar* = Shinar was later used to denote the region about Bagdad (northern Babylonia) does not necessarily prove that Shinar-Shumer meant only northern Babylonia, because, when the term *Sen'ar* was applied to the Bagdad district the great southern Babylonian civilization had long been forgotten and "Babylonia" really meant only what we now know as northern Babylonia.

The actual meaning of the word Shumer is uncertain. Dr T. G. Pinches has pointed out[1] that Shumer may be a dialectic form of an as yet unestablished non-Semitic form, Shenger, just as the non-Semitic word *dimmer*, "god," is equivalent to another form, *dingir*. Others have seen in the ancient Babylonian place-name *Gir-su* an inversion of *Su-gir* = *Su-n̂gir*, which has also been identified with Shumer. In this connexion Hommel's theory[2] should be mentioned, that the word Shumer was a later palatalization of *Ki-imgir*, "land of Imgir" = *Shi-imgir*, subsequently *Shingi* with palatalized *k* = *sh* and elision of the final *r*. The form *imgir* (*imgur*), however, as a place-name for Babylonia is uncertain. All that can be said at present about this difficult etymology is that in the non-Semitic Babylonian the medial *m* represented quite evidently an indeterminate nasal which could also be indicated by the combination *n̂g*. Hence we find Shumer, probably pronounced *Shuwer*, with a sound similar to that heard to-day in the Scottish Gaelic word *lamh*, "hand"; viz. a sort of nasalized *w*. This gave rise to the later inaccurate forms: Greek, *Senaar*; Syriac, *Sen'ar*; and biblical Hebrew, Shinar = *Shin̂gar*.

The so-called "Sumerian problem," which has perplexed Assyriologists for many years, may be briefly stated as follows. In a great number of Babylonian inscriptions an idiom has long been recognized which is clearly not ordinary Semitic in character. This non-Semitic system, which is found, in many instances, on alternate lines with a regular Semitic translation, in other cases in opposite columns to a Semitic rendering, and again without any Semitic equivalent at all, has been held by one school, founded and still vigorously defended by the distinguished French Assyriologist, Joseph Halévy, to be nothing more than a priestly system of cryptography based, of course, on the then current Semitic speech. This cryptography, according to some of the Halévyans, was read aloud in Semitic, but, according to other expositors, the system was read as an "ideophonic," secret, and purely artificial language.

The opposing school (the Sumerists) insists that these

[1] Hastings's *Dict. Bible*, iv. 503. [2] Ibid. i. 224b.

non-Semitic documents were evidently in an agglutinative language, naturally not uninfluenced by Semitic elements, but none the less essentially non-Semitic in origin and fundamental character. Scholars of this opinion believe that this language, which has been arbitrarily called "Akkadian" in England and "Sumerian" on the European continent and in America, was primitively the speech of the pre-Semitic inhabitants of the Euphratean region who were conquered by the invading Semites. These invaders, according to this latter view, adopted the religion and culture of the conquered Sumerians; and, consequently, the Sumerian idiom at a comparatively early date began to be used exclusively in the Semitic temples as the written vehicles of religious thought in much the same way as was the medieval Latin of the Roman Church. The solution of this problem is of vital importance in connexion with the early history of man's development in the Babylonian region.

The study of the Sumerian vocabulary falls logically into three divisions. These are (1) the origin of the cuneiform signs, (2) the etymology of the phonetic values, and (3) the elucidation of the many and varied primitive sign-meanings.

Previous to Professor Friedrich Delitzsch's masterly work on the origin of the most ancient Babylonian system of writing,[1] no one had correctly understood the facts regarding the beginnings of the cuneiform system, which is now generally recognized as having been originally a pure picture writing which later developed into a conventionalized ideographic and syllabic sign-list. In order to comprehend the mysteries of the Sumerian problem a thorough examination of the beginning of every one of these signs is, of course, imperative, but it is equally necessary that every phonetic Sumerian value and word-combination be also studied, both in connexion with the equivalent signs and with other allied phonetic values. This etymological study of Sumerian is attended with incalculable difficulties, because nearly all the Sumerian texts which we possess are written in an idiom which is quite evidently under the influence of Semitic. With the exception of some very ancient texts, the Sumerian literature, consisting largely of religious material such as hymns and incantations, shows a number of Semitic loanwords and grammatical Semitisms, and in many cases, although not always, is quite patently a translation of Semitic ideas by Semitic priests into the formal religious Sumerian language. Professor Paul Haupt may be termed the father of Sumerian etymology, as he was really the first to place this study on a scientific basis in his *Sumerian Family Laws* and *Akkadian and Sumerian Cuneiform Texts*.[2] It is significant that all phonetic and grammatical work in Sumerian tends to confirm nearly every one of Haupt's views. Professors Peter Jensen and Zimmern have also done excellent work in the same field and, together with Haupt, have established the correct method of investigating the Sumerian vocables, which should be studied only in relation to the Sumerian literature. Sumerian words should by no means be compared with words in the idioms of more recent peoples, such as Turkish, in spite of many tempting resemblances.[3] Until further light has been thrown on the nature of Sumerian, this language should be regarded as standing quite alone, a prehistoric philological remnant, and its etymology should be studied only with reference to the Sumerian inscriptions themselves. On the other hand, grammatical and constructional examples may be cited from other more modern agglutinative idioms, in order to establish the truly linguistic character of the Sumerian peculiarities and to disprove the Halévyan contentions that Sumerian is really not a language at all.[4]

It is not surprising that Halévy's view as to the cryptographic nature of Sumerian should have arisen. In fact, the first impression given by the bewildering labyrinth of the Sumerian word-list is the conclusion that such a vocabulary could never have arisen in a regularly developed language. For example, anyone studying Brünnow's *List*[5] will find the same sign denoting pages of meanings, many of which have apparently no connexion with any other meaning belonging to the sign in question. A great multiplicity of meanings is also attributed, apparently quite arbitrarily, to the same sign, sound-value or word. In these instances, however, we can explain the difficulty away by applying that great fundamental principle followed by the Semitic priests and scribes who played with and on the Sumerian idiom, and in the course of many centuries turned what was originally an agglutinative language into what has almost justified Halévy and his followers in calling Sumerian a cryptography. This principle is that of popular etymology, *i.e.* of sound-association and idea-association which has brought together in the word-lists many apparently quite distinct meanings, probably primarily for purposes of mnemonic aid. The present writer in his *Materials for a Sumerian Lexicon* has mentioned this ruling phenomenon again and again. A very few examples, however, will suffice here. Thus the word *ag*=the sign RAM=*râmu*, "love" (proper meaning) is associated with *ramâmu*, "to roar," for phonetic reasons only. The word *a*= the sign A= "water" (original meaning) can indicate anything whatever connected with the idea moisture. Thus, *a*="water, moisture, weep, tears, inundate, irrigate," &c. The word *a* can also mean "shining, glistening," an idea evidently developed from the shining rippling of water. Note that in Turkish *su* means both "water" and "the lustre of a jewel," while in English we speak of "gems of the first water." The combination *a-má-tu*, literally "water enter ship," means *abûbu*, "deluge," ordinarily, but in one passage *a-má-tu* is made the equivalent of *shabûbu*, "flame," a pure pun on *abûbu*, "deluge." Examples of this, the leading principle which was followed by the framers of the Sumerian system, might be cited almost *ad infinitum*.

Facts of this character taken by themselves would perhaps be sufficient to convince most philologists that in Sumerian we have an arbitrarily compounded cryptography just as Halévy believes, but these facts cannot be taken by themselves, as the evidences of the purely linguistic basis of Sumerian are stronger than these apparent proofs of its artificial character.

Briefly considered there are six most striking proofs that the Sumerian was based on a primitive agglutinative language. These may be tabulated concisely as follows:—

1. Sumerian presents a significant list of internal phonetic variations which would not have been possible in an arbitrarily invented language. Thus, taking the vowels alone; *e*=*a* by the principle of *umlaut*. Hence, we find the words *ga* and *ge*, *a* and *e* for the same idea respectively. The vowel *i* could become *e* as *de*=*di*, &c. Consonantal variation is most common. Thus, *b*=*m*, as *barun*=*marun*. Compare the modern Arabic pronunciation *Maalbek* for *Baalbek*. Perhaps the most interesting of these consonantal interchanges is that occurring between *n* and the sibilants *sh* and *z*; *ner*=*sher*; *na*=*za*, which by some scholars has been declared to be phonetically impossible, but its existence is well established between the modern Chinese colloquial idioms. For example, Pekingese *zhen*, Hakka *nyin*, Fuchow *nöng*, Ningpo *zhing* and *nying*, Wönchow *zang* and *nang* all ="man." This demonstrates beyond a doubt the possibility of a strongly palatalized *n* becoming a palatal sibilant or vice versa, between which utterances there is but a very slight tongue movement.

The discussion of these phenomena brings us to another point which precludes the possibility of Sumerian having been merely an artificial system, and that is the undoubted existence in this language of at least two dialects, which have been named, following the inscriptions, the *Eme-ku*, "the noble or male speech," and the *Eme-sal*, "the woman's language." The existence and general phonetic character of the "woman's language" were first pointed out by Professor Paul Haupt,

[1] *Die Entstehung des ältesten Schriftsystems oder der Ursprung der Keilschriftzeichen* (Leipzig, 1897).

[2] *Die sumerischen Familiengesetze* (1879). *Die akkadische Sprache* (Berlin, 1883). *Akkadische und sumerische Keilschrifttexte* (Leipzig, 1881). See especially his Sumerian grammar in this latter work, pp. 133–147.

[3] Cf. A. H. Sayce's interesting article in Philological Society (1877–1878), pp. 1–20.

[4] Prince, *Materials for a Sumerian Lexicon*, pp. 18, 21.

[5] R. E. Brünnow, *A Classified List of all Simple and Compound Ideographs* (1889).

who cited, for example, the following very common interdialectic variations: Eme-ku *gir* = Eme-sal *meri*, "foot"; Eme-ku *ner* = Eme-sal *sher*, "ruler"; Eme-ku *duga* = Eme-sal *zeba*, "knee," &c. Such phonetic and dialectic changes, so different from any of the Semitic linguistic phenomena, are all the more valuable because they are set before us only by means of Semitic equivalents. Certainly no cryptography based exclusively on Semitic could exhibit this sort of interchange.

It should be added here in passing that the geographical or tribal significance of these two Sumerian dialects has never been established. There can be no doubt that Eme-sal means "woman's language," and it was perhaps thus designated because it was a softer idiom phonetically than the other dialect. In it were written most of the penitential hymns, which were possibly thought to require a more euphonious idiom than, for example, hymns of praise. It is doubtful whether the Eme-sal was ever really a woman's language similar in character to that of the Carib women of the Antilles, or that of the Eskimo women of Greenland. It is much more likely that the two dialects were thus designated because of their respectively harsh and soft phonetics.[1]

2. Sumerian has a system of vowel harmony strikingly like that seen in all modern agglutinative languages, and it has also vocalic dissimilation similar to that found in modern Finnish and Esthonian. Vocalic harmony is the internal bringing together of vowels of the same class for the sake of greater euphony, while vocalic dissimilation is the deliberate insertion of another class of vowels, in order to prevent the disagreeable monotony arising from too prolonged a vowel harmony. Thus, in Sumerian we find such forms as *numunnib-bi*, "he speaks not to him," where the negative prefix *nu* and the verbal prefix *mun* are in harmony, but in dissimilation to the infix *nib*, "to him," and to the root *bi*, "speak," which are also in harmony. Compare also *an-sud-dam*, "like the heavens," where the ending *dam* stands for a usual *dim*, being changed to a hard *dam* under the influence of the hard vowels in *an-sud*.

3. Sumerian has only postpositions instead of prepositions, which occur exclusively in Semitic. In this point also Sumerian is in accord with all other agglutinative idioms. Note Sumerian *e-da*, "in the house" (*e*, "house," +*da*, "in," by dissimilation), and compare Turkish *ev*, "house," *de*, "in," and *evde*, "in the house."

4. The method of word formation in Sumerian is entirely non-Semitic in character. For example, an indeterminative vowel, *a*, *e*, *i* or *u*, may be prefixed to any root to form an abstract; thus, from *me*, "speak," we get *e-me*, "speech"; from *ra*, "to go," we get *a-ra*, "the act of going," &c. In connexion with the very complicated Sumerian verbal system[2] it will be sufficient to note here the practice of infixing the verbal object which is, of course, absolutely alien to Semitic. This phenomenon appears also in Basque and in many North American languages.

5. Sumerian is quite devoid of grammatical gender. Semitic, on the other hand, has grammatical gender as one of its basic principles.

6. Furthermore, in a real cryptography or secret language, of which English has several, we find only phenomena based on the language from which the artificial idiom is derived. Thus, in the English "Backslang," which is nothing more than ordinary English deliberately inverted, in the similar Arabic jargon used among school children in Syria and in the Spanish thieves' dialect, the principles of inversion and substitution play the chief part. Also in the curious tinker's "Thary" spoken still on the English roads and lanes, we find merely an often inaccurately inverted Irish Gaelic. But in none of these nor in any other artificial jargons can any grammatical development be found other than that of the language on which they are based.

7. All this is to the point with regard to Sumerian, because these very principles of inversion and substitution have been cited as being the basis of many of the Sumerian combinations. Deliberate inversion certainly occurs in the Sumerian documents, and it is highly probable that this was a priestly mode of writing, but never of speaking; at any rate, not when the language was in common use. It is not necessary to imagine, however, that these devices originated with the Semitic priesthood. It is quite conceivable that the still earlier Sumerian priesthood invented the method of orthographic inversion, which after all is the very first device which suggests itself to the primitive mind when endeavouring to express itself in a manner out of the ordinary. For example, evident Sumerian inversions are *Gibil*, "the fire god," for *Bil-gi*; *ushar* for Sem. *sharru*, "king," &c.

It is, moreover, highly probable that Sumerian had primitively a system of voice-tones similar to that now extant in Chinese. Thus, we find Sumerian *ab*, "dwelling," "sea"; *ab*, "road," and *-ab*, a grammatical suffix, which words, with many others of a similar character, were perhaps originally uttered with different voice-tones. In Sumerian, the number of conjectural voice-tones never exceeds the possible number eight.

It is also clear that Sumerian was actually read aloud, probably as a ritual language, until a very late period, because we have a number of pure Sumerian words reproduced in Greek transliteration; for example, *Delephat* = *Dilbat*, "the Venus-star"; *Illinos* = the god *Illil* = Bêl; *aidô* = *itu*, "month," &c.

In view of the many evidences of the linguistic character of Sumerian as opposed to the one fact that the language had engrafted upon it a great number of evident Semitisms, the opinion of the present writer is that the Sumerian, as we have it, is fundamentally an agglutinative, almost polysynthetic, language, upon which a more or less deliberately constructed *pot-pourri* of Semitic inventions was superimposed in the course of many centuries of accretion under Semitic influences. This view stands as a connecting link between the extreme idea of the Halévyan school and the extreme idea of the opposing Sumerist school.

LITERATURE.—Radau, *Early Babylonian History*; Lenormant, *Études accadiennes*, ii. 3, p. 70; Eberhardt Schrader, *Keilinschriften u. das Alte Testament*, ii. 118 sqq., *Keilinschriften u. Geschichtsforschung*, pp. 290, 533; Weissbach, *Zur Lösung der sumerischen Frage*; T. G. Pinches, "Language of the Early Inhabitants of Mesopotamia," in *Journ. Roy. Asiatic Soc.* (1884), pp. 301 sqq.; "Sumerian or Cryptography," ibid. (1900), pp. 75 sqq., 343, 344, 551, 552; article "Shinar" in Hastings's *Dict. Bible*, iv. 503–505; Halévy, *Journal asiatique* (1874), 3rd series, vol. iv. pp. 461 sqq.; *Comptes rendus*, 3rd series, vol. iv. p. 477; 3rd series, vol. iv. pp. 128, 130; *Journal asiatique*, 7th series, vol. viii. pp. 201 sqq.; *Recherches critiques sur l'origine de la civilisation babylonienne* (Paris, 1876); J. D. Prince, *Journal of the American Oriental Society*, xxv. 49–67; *American Journal of Semitic Languages*, xix. 203 sqq.; *Materials for a Sumerian Lexicon*, with grammatic introduction (Leipzig, 1905–1907). Compare also the material cited in the footnotes above, and note the correspondence between Brünnow and Halévy in the *Revue sémitique* (1906). (J. D. Pr.)

SUMMANUS, according to some, an old Sabine or Etruscan deity; the name, however, is Latin, formed by assimilation from *sub-mānus* (cf. *mane*, *Matuta*), signifying the god of the time "before the morning." His sphere of influence was the nocturnal heavens, thunderstorms at night being attributed to him, those by day to Jupiter. Summanus had a temple at Rome near the Circus Maximus, dedicated at the time of the invasion of Italy by Pyrrhus, king of Epirus (278), when a terracotta image of the god (or of Jupiter himself) on the pediment of the Capitoline temple was struck by lightning and hurled into the river Tiber. Here sacrifice was offered every year to Summanus on the 20th of June, together with cakes called *summanalia* baked in the form of a wheel, supposed to be symbolical of the car of the god of the thunderbolt. In Plautus (*Bacchides* iv. 8, 54) Summanus and the verb *summanare* are used for the god of thieves and the act of stealing, with obvious reference to Summanus as a god of night, a time favourable to thieves and their business. The later explanation that Summanus is a contraction from Summus Manium (the greatest of the Manes), and that he is to be identified with Dis Pater, is now generally rejected.

See Augustine, *De civitate dei*, iv. 23; Ovid, *Fasti*, vi. 729; Festus,

[1] Prince, *Materials for a Sumerian Lexicon*, p. 14.
[2] Ibid. pp. 20–34.

s.v. Provorsum fulgor; G. Wissowa, *Religion und Kultus der Römer* (1902); W. W. Fowler, *The Roman Festivals* (1899).

SUMMARY JURISDICTION. In the widest sense this phrase in English law includes the power asserted by courts of record to deal *brevi manu* with contempts of court without the intervention of a jury. Probably the power was originally exercisable only when the fact was notorious, *i.e.* done in presence of the court. But it has long been exercised as to extra curial contempts (see CONTEMPT OF COURT). The term is also applied to the special powers given by statute or rules to the High Court of Justice and to county courts for dealing with certain classes of causes or matters by methods more simple and expeditious than the ordinary procedure of an action (see SUMMONS). But the phrase in modern times is applied almost exclusively to certain forms of jurisdiction exercised by justices of the peace out of general or quarter sessions, and without the assistance of a jury.

Ever since the creation of the office of *justice of the peace* (*q.v.*) the tendency of English legislation has been to enable them to deal with minor offences without a jury. Legislation was necessary because, as Blackstone says, except in the case of contempts the common law is a stranger to trial without a jury, and because even when an offence is created by statute the procedure for trying must be by indictment and trial before a jury, unless by the statute creating the offence or some other statute another mode of trial is provided. In one remarkable instance power is given by an act of 1725 (12 Geo. I. c. 29, s. 4) to judges of the superior courts summarily to sentence to transportation (penal servitude) a solicitor practising after conviction of barratry, forgery or perjury (Stephen, *Dig. Crim. Law*, 6th ed., 113). In other words all the summary jurisdiction of justices of the peace is the creation of statute. The history of the gradual development of the summary jurisdiction of justices of the peace is stated in Stephen's *Hist. Crim. Law*, vol. i. ch. 4. The result of legislation is that summary jurisdiction has been conferred by statutes and by-laws as to innumerable petty offences of a criminal or quasi-criminal character (most of which in French law would be described as *contraventions*), ranging through every letter of the alphabet. The most important perhaps are those under the Army, Game, Highway, Licensing, Merchant Shipping, Post Office, Public Health, Revenue and Vagrancy Acts.

A court of summary jurisdiction is defined in the Interpretation Act 1889 as "any justice or justices of the peace or other magistrate, by whatever name called, to whom jurisdiction is given by, or who is authorized to act under, the Summary Jurisdiction Acts, whether in England, Wales or Ireland, and whether acting under the Summary Jurisdiction Acts or any of them or any other act or by virtue of his commission or under the common law" (52 & 53 Vict. c. 63, s. 13 [11]). This definition does not apply to justices of the peace sitting to hold a preliminary inquiry as to indictable offences, or in the discharge of their quasi-administrative functions as licensing authority. The expression "Summary Jurisdiction Acts" means as to England and Wales the Summary Jurisdiction Acts of 1848 (11 & 12 Vict. c. 42) and 1879 (42 & 43 Vict. c. 49) and any act amending these acts or either of them. These acts define the procedure to be followed by justices in those cases in which they are empowered *by statute* to hear and determine civil or criminal cases without the intervention of a jury or the forms of an action or indictment at law or a suit in equity. Besides these two acts the procedure as to the exercise of summary jurisdiction is also regulated by acts of 1857 (20 & 21 Vict. c. 1, c. 43), 1884 (47 & 48 Vict. c. 43) and 1899 (62 & 63 Vict. c. 22), and by the Summary Jurisdiction Process Act 1881 (44 & 45 Vict. c. 24).

The act of 1848 repealed and consolidated the provisions of a large number of earlier acts. The act of 1857 provided a mode of appeal to the High Court by case stated as to questions of law raised in summary proceedings. The act of 1879 amended the procedure in many details with the view of uniformity, and enlarged the powers of justices to deal summarily with certain classes of offences ordinarily punishable on indictment. The act gives power to make rules regulating details of procedure. The rules now in force were made in 1886, but have since been amended in certain details. The act of 1884 swept away special forms of procedure contained in a large number of statutes, and substituted the procedure of the Summary Jurisdiction Acts. The act of 1899 added the obtaining of property by false pretences to the list of indictable offences which could *sub modo* be summarily dealt with. The statutes above mentioned form a kind of code as to procedure and to some extent also as to jurisdiction.

As already stated, to enable a justice to deal summarily with an offence, whether created by statute or by-law, some statutory authority must be shown. A very large number of petty offences (contraventions) have been created (*e.g.* poaching, minor forms of theft, malicious damage and assault), and are annually being created (1) by legislation, or (2) by the by-laws of corporations made under statutory authority, or (3) by departments of state acting under such authority. The two latter classes differ from the first in the necessity of proving by evidence the existence of the by-law or statutory rule, and if need be that it is *intra vires.*

In the case of offences which are primarily made punishable only on summary conviction, the accused, if the maximum punishment is imprisonment for over three months, can elect to be tried by a jury (act of 1879, s. 17).

In the case of offences which are primarily punishable only on indictment, power to convict summarily is given in the following cases:—

1. All indictable offences (except homicide) committed by children over seven and under twelve, if the court thinks it expedient and the parent or guardian does not object (1879, s. 10).

2. All indictable offences (except homicide) committed by young persons of twelve and under sixteen, if the young person consents after being told of his right to be tried by a jury (1879, s. 11; 1899, s. 2).

3. The indictable offences specified in sched. 1, col. 2 of the act of 1879 and in the act of 1899, if committed by adults, if they consent to summary trial after being told of their right to be tried by a jury (1879, s. 12).

4. The indictable offences specified in sched. 1, col. 1 of the act of 1879 and the act of 1899, if committed by an adult who pleads guilty after due caution that if he does so he will be summarily convicted (1879, s. 13).

Adults cannot be summarily dealt with under 3 or 4 if the offence is punishable by law with penal servitude owing to previous conviction *or indictment* of the accused (1879, s. 14).

It will be observed that as to all the indictable offences falling under heads 1 to 4, the summary jurisdiction depends on the consent of the accused or a person having authority over him after receiving due information as to the right to go to a jury, and that the punishments on summary conviction in such cases are not those which could be imposed after conviction or indictment, but are limited as follows:—

Case 1. Imprisonment for not more than one month or fine not exceeding 40s. and (or) whipping of male children (not more than six strokes with a birch); sending to an industrial school or reformatory.

Case 2. Imprisonment with or without hard labour for not more than three months or fine not exceeding £10 and (or) whipping of males (not more than twelve strokes with a birch); sending to an industrial school or reformatory.

Case 3. Imprisonment for not more than three months with or without hard labour or fine not exceeding £20.

Case 4. Imprisonment with or without hard labour for not over six months.

These limitations of punishment have had a potent effect in inducing culprits to avoid the greater risks involved in a jury trial.

Where the offence is indictable the accused is brought before the justices either on arrest without warrant or on warrant or summons under the Indictable Offences Act 1848, and the summary jurisdiction procedure does not apply till the necessary option has been taken.

Where the offence is indictable only at the election of the accused the summary jurisdiction procedure applies until on being informed of his option the accused elects for jury trial (act of 1879, s. 17).

In the case of an offence punishable on summary conviction the procedure is ordinarily as follows:—

Information, usually oral, is laid before one or more justices of the peace alleging the commission of the offence. An information must not state more than a single offence, but great latitude is given as to amending at the hearing any defects in the mode of stating an offence. Upon receipt of the information the justice may issue his summons for the attendance of the accused at a time and place named to answer the charge. It is usual to summon to a petty sessional court (*i.e.* two justices or a stipendiary magistrate, or, in the city of London, an alderman). The summons is usually served by a constable. If the accused does not attend in obedience to the summons, after proof of service the court may either issue a warrant for his arrest or may deal with the charge in his absence.

Occasionally a warrant is issued in place of a summons in the first instance, in which case the information must be laid in writing and be verified by oath. The proceedings must be begun, *i.e.* by laying the information, not later than six months after the commission of the offence, unless by some particular statute another period is named or unless the offence is what is called a continuing offence.

In a certain number of summary cases the accused is arrested under statutory authority without application to a justice, *e.g.* in the case of rogues and vagabonds and certain classes of offences committed in the street in view of a constable or by night. Whether the accused is brought before the court on arrest with or without warrant or attends in obedience to summons, the procedure at the hearing is the same. The hearing is ordinarily before a petty sessional court, *i.e.* before two or more justices sitting at their regular place of meeting or some place temporarily appointed as the substitute for the regular court-house, or before a stipendiary magistrate, or in the city of London an alderman, sitting at a place where he may by law do alone what in other places may be done by two justices (1879, s. 20; 1889, s. 13). A single justice sitting alone in the ordinary court-house or two or more justices sitting together at an occasional court-house have certain jurisdiction to hear and determine the case, but cannot order a fine of more than 20s. or imprisonment for more than fourteen days (1879, s. 20 [7]). The hearing must be in open court, and parties may appear by counsel or solicitor. If both parties appear, the justices must hear and determine the case. If the defendant does not appear, the court may hear and determine in his absence, or may issue a warrant and adjourn the hearing until his apprehension. Where the defendant is represented by solicitor or counsel but is not himself present it is usual, except in serious cases, to proceed in his absence. If the defendant is present the substance of the information is stated to him and he is asked whether he is guilty or not guilty. If he pleads guilty the court may proceed to conviction. If he does not the court hears the case, and witnesses for the prosecution and defence are examined and cross-examined. If the complainant does not appear, the justices may dismiss the complaint or adjourn the hearing.

If necessary rebutting evidence may be called. The prosecutor is not allowed to reply in the case of the defendant. On the completion of the evidence the court proceeds to convict or acquit. Where the case is proved but is trifling the court may, without proceeding to conviction, make an order dismissing the information subject to payment of damages for injury or compensation for loss up to £10 or any higher limit fixed by statute as to the offence, and costs, or discharging the accused conditionally on his giving security for good behaviour and on paying damages and costs (1907, c. 17, s. 1). To this order probationary conditions may be attached (s. 2). Subject to this provision the punishment which may be enforced depends as a general rule on the statute or by-law defining the offence, and consists in imprisonment and (or) fine, except in cases where a minimum fine is stipulated for by a treaty, &c., with a foreign state, *e.g.* in sea fishery conventions. The court may mitigate the fine in the case of a first offence, even in a revenue case, or may reduce the period of imprisonment and impose it without hard labour, or substitute a fine not exceeding £25 for imprisonment. A scale is prescribed for imprisonment on failure to pay money, fines, or costs, adjudged to be paid on a conviction, or in default of a sufficient distress to satisfy the sum adjudged (1879, s. 5). Instead of sending the defendant to prison for not paying fine and costs the court may direct its levy by distress warrant, or may accept payment by instalments. In the case of distress the wearing apparel and bedding of the defendant and his family, and to the value of £5 the tools and implements of his trade, may not be taken (act of 1879, s. 21). If the defendant after going to prison can pay part of the money his imprisonment is reduced proportionally (Prison Act 1898, s. 9). The imprisonment is without hard labour unless hard labour is specially authorized by the act on which the conviction is founded. The maximum term of imprisonment without the option of a fine is in most cases six months, but depends on the particular statute. Imprisonment under order of a court of summary jurisdiction is in the common gaol (5 Hen. IV. c. 10), *i.e.* in a local prison declared by the home secretary to be the common gaol for the county, &c., for which the court acts. The place of imprisonment during remands or in the case of youthful offenders may in certain cases be elsewhere than in a prison.

The court has power to order costs to be paid by the prosecutor or the defendant. Where the order is made on a conviction it is enforceable by imprisonment in default of payment or sufficient distress.

The extent of the local jurisdiction of justices exercising summary jurisdiction is defined by s. 46 of the act of 1879 with reference to offences committed on the boundaries of two jurisdictions or during journeys or on the sea or rivers or in harbours.

Proceedings under the Bastardy Acts are regulated by special legislation, but as to proof of service and the enforcement of orders and appeals are assimilated to convictions under the Summary Jurisdiction Acts. The same rule applies (except as to appeals) to orders made under the Summary Jurisdiction (Married Women) Act 1895, as amended by the Licensing Act 1902.

A warrant of arrest is executed by the constable or person to whom it is directed within the local jurisdiction of the issuing court; or a fresh pursuit within seven miles of its boundaries, without endorsement, in the rest of England and Wales, and in Scotland, the Channel Islands and Isle of Man after endorsement by a competent magistrate of the place where the accused is, and in Ireland by a justice of the peace or an inspector of constabulary. An English summons to a defendant or witness, except in respect of civil debts, is served in Scotland after endorsement by a competent magistrate there (Summary Jurisdiction Process Act 1881, 44 and 45 Vict. c. 24). The attendance of a witness who is in prison is obtained by writ of habeas corpus or by a secretary of state's order under the Prison Act 1898. If a witness will not attend on summons he can be brought to the court by warrant, and if he will not answer questions lawfully put to him may be sent to prison for seven days or until he sooner consents to answer.

Civil Jurisdiction.—In cases where justices have a summary civil jurisdiction, *e.g.* as to certain civil debts recoverable summarily, or to make orders to do or to abstain from doing certain acts, *e.g.* with reference to nuisances and building, the procedure differs in certain details from that in criminal cases.

1. The summons is issued on a complaint which need not be in writing nor on oath, and not on an information, and warrants of arrest cannot be issued.

2. The rules as to the evidence of the defendant and his or her spouse are the same as in civil actions.

3. The court's decision is by order and not by conviction.

4. The order if for payment of a civil debt or costs in connexion therewith is enforceable by distress and sale of the defendant's effects or by imprisonment, but only on proof that the defendant has had since the order means of paying and has refused or neglected to pay (1879, s. 35).

Proceedings for the enforcement of local rates are not affected by the Summary Jurisdiction Acts except as to the power of submitting to the High Court questions of law arising on a summons to enforce rates (*re* Allen, 1894, 2 Q.B., 924). The functions of justices as to such rates are sometimes but not quite accurately described as ministerial, for their powers of inquiry though limited are judicial and of a quasi-criminal character.

Appeal.—The orders and convictions of a court of summary jurisdiction are in many cases appealable to quarter sessions. The right to appeal is always dependent on the specific provisions of a statute. The Summary Jurisdiction Act 1879 gives a general power of appeal against an adjudication on conviction (but not on plea of guilty) to imprisonment without the option of a fine, whether as punishment for an offence or for failure to do or abstaining from doing any act, other than compliance with an order to pay money or find security or enter into recognizances or to find sureties (1879, s. 19). The procedure on the appeals is regulated and made uniform by the acts of 1879, ss. 31, 32; and 1884. These provisions are supplementary of the particular provisions of many statutes authorizing an appeal.

The decisions of courts of summary jurisdiction on points of law are generally reviewed by a case stated for the opinion of the High Court under the acts of 1857 and 1879, but are occasionally corrected by the common law remedies of *mandamus*, prohibition or *certiorari*. The application of the last-named remedy is restricted by many statutes. The court of appeal has jurisdiction to review judgments and orders of the High Court dealing with appeals, &c., from the decisions of justices in the exercise of their civil jurisdiction; but not when the subject-matter is a criminal cause or matter.

In proceedings between husband and wife for separation orders there is a special form of appeal on facts as well as law to the probate, divorce and admiralty division of the High Court (Summary Jurisdiction [Married Women] Act 1895; Licensing Act 1902, s. 5).

SCOTLAND. *Civil.*—In the Court of Session there are certain forms of summary civil proceedings by petition, *e.g.* with reference to entails, custody of children, guardians and factors of minors and lunatics, which are applications for exercise of the *nobile officium* or extraordinary jurisdiction of the court (see Mackay, *Court of Session Practice*, i. 209, ii. 353). Summary jurisdiction is given to justices of the peace as to the recovery of small debts.

Criminal and Quasi-criminal.—The only act relating to summary jurisdiction procedure common to England and Scotland is the Summary Jurisdiction Process Act 1881. Summary jurisdiction in Scotland depends chiefly upon the Summary Jurisdiction (Scotland) Acts 1864 and 1881. The acts follow, to some extent, the lines of English legislation, but the sheriff and his deputies and substitutes are included in the definition of the court, as are stipendiary magistrates (1897, c. 48). The acts also apply to proceedings before burgh courts, or burgh magistrates, and to justices of the peace where they have by other statutes power to try offences or enforce penalties. All proceedings for summary conviction or for recovery of a penalty must be by way of complaint according to one of the forms in the schedule to the act of 1864. The English summons and warrant are represented in Scotland by the warrant of citation and the warrant of apprehension. Where no punishment is fixed for a statutory offence, the court cannot sentence to more than a fine of £5 or sixty days' imprisonment, in addition to ordering caution to keep the peace. The act of 1881 adopts certain of the provisions of the English act of 1879 as to mitigation of fines, terms of imprisonment, &c., and also gives a discretion as to punishment to a sheriff trying by jury in cases where the prosecution might have been by complaint under the acts. By the Youthful Offenders Act 1901, Scottish courts of summary jurisdiction have acquired the same jurisdiction as to offences by children as was conferred on English justices in 1879. Appeals from courts of summary jurisdiction are now mainly regulated by the act of 1875 (38 and 39 Vict. c. 62), and proceed on case stated by the inferior judge. A bill was submitted to parliament in 1907 for consolidating and amending the Scottish summary procedure.

IRELAND.—In Ireland the High Court has the same summary powers in cases of contempt, and the term "court of summary jurisdiction" has the same meaning as in England (Interpretation Act 1889, s. 13 [11]), subject to the definition of the Summary Jurisdiction (Ireland) Acts, which are, as regards the Dublin metropolitan police district, the acts regulating the powers and duties of justices of the peace or of the police of that district, and as respects any other part of Ireland the Petty Sessions (Ireland) Act 1851 (14 and 15 Vict. c. 93) and any act amending the same. The acts are more extensive in their purview than the English acts, as they form in a great degree a code of substantive law as well as of procedure. By an act of 1884 the same jurisdiction was given as to offences by children as by the act of 1879 in England. Stipendiary or resident magistrates may be appointed in the place of unpaid justices under an act of 1836 (6 & 7 W. IV. c. 13). The exceptional political circumstances of Ireland have led to the conferring at different times on courts of summary jurisdiction of an authority, generally temporary, greater than that which they can exercise in Great Britain. Recent instances are the Peace Preservation Act 1881, and the Prevention of Crimes Act 1882, both expired, and the Criminal Law and Procedure (Ireland) Act 1887.

BRITISH DOMINIONS BEYOND THE SEAS.—The legislation of British possessions as to summary jurisdiction follows the lines of English legislation, but, and especially in crown colonies, there is a disposition to dispense with the jury more than under English procedure, and in most colonies stipendiary magistrates are more freely employed than unpaid justices of the peace (see British Guiana, Ord. No. 10 of 1893). Many of the colonial criminal codes include a number of offences punishable on summary conviction. The procedure closely follows English models, but has in many cases been consolidated and simplified (*e.g.* Victoria, Justices Act 1890, No. 1105; British Guiana, Ord. No. 12 of 1893). In many colonies stipendiaries and justices of the peace exercise civil jurisdiction as to matters dealt with in England by the county court (*e.g.* British Guiana, Ord. No. 11 of 1893).

UNITED STATES.—By art. iii. s. 2 of the constitution, the trial of all crimes, except in cases of impeachment, is to be by jury. By art. v. of the amendments no person can be held to answer for a capital or otherwise infamous crime unless on a presentment or indictment of a grand jury. Considerable changes have been made by state legislation in the direction of enlarging the powers of courts of summary jurisdiction.

EUROPEAN COUNTRIES.—On the continent of Europe trial of criminal cases by a bench of judges without a jury is the original and normal method, and continues except in those cases as to which under the penal and procedure codes jury trial is made necessary. In France the place of courts of summary jurisdiction is filled by *tribunaux correctionels.* (W. F. C.)

SUMMIT, a city of Union county, New Jersey, U.S.A., in the north-east of the state, about 21 m. W. of New York City. Pop. (1900) 5302, of whom 1397 were foreign-born; (1905) 6845; (1910) 7500. It is served by the Morris & Essex and the Passaic & Delaware divisions of Delaware, Lackawanna & Western railroad, and by the Rahway Valley railroad extending to Roselle, 9 m. distant. Summit is picturesquely situated on the crest of a ridge called Second Mountain, with a mean elevation of 450 ft. It is a residential suburb of New York, and attracts a number of summer residents. Among its institutions are a public library (1874), a home for blind children, the Overlook hospital and the Kent Place school (1894) for girls. On Hobart Hill there is a monument marking the site of a beacon light and a signal gun used during the War of Independence. Summit was incorporated as a township in 1869 from parts of the townships at Springfield and New Providence, and was chartered as a city in 1899.

SUMMONS (Fr. *semonce*, from *semonner* or *semondre*; Lat. *summonere, summonitio*), in English law (1) a command by a superior authority to attend at a given time or place or to do some public duty; (2) a document containing such command, and not infrequently also expressing the consequences entailed by neglect to obey. The oral summons or citation seems to have preceded the written summons in England, just as in Roman law *in jus vocatio* existed for centuries before the *libellus conventionis*. The antiquity and importance of the summons as a legal form in England is shown by the presence of the "sompnour," or summoner of the ecclesiastical court, as one of the characters in the *Canterbury Tales*, and in *The History of Sir John Oldcastle*, where the sumner is made to eat a citation issued from the bishop of Rochester's court. The term is used with reference to a demand for the attendance of a person in the high court of parliament. As regards English courts of justice it is equivalent to what in the civil and canon law and in Scots law, and in English courts deriving their procedure from those sources, is known as "citation." That term is still preserved in English ecclesiastical courts and in matrimonial causes.

It is an essential principle of justice that a court should not adjudicate upon any question without giving the parties to be affected or bound by the adjudication the opportunity of being heard and of bringing their witnesses before the court. The most usual term in English law for the process by which attendance is commanded or required is the "summons."

Civil Proceedings.—In the High Court of Justice, civil actions are begun by obtaining from the officers of the court a document known as a "writ of summons." In this document are stated the names of the parties and the nature of the claim made (which in the case of liquidated sums of money must be precise and particular). It is sealed and issued to the party suing it out, and served on the opposing party, not by an officer of the court but by an agent of the plaintiff. The tenor of the writ is to require the defendant to appear and answer the claim, and to indicate the consequences of non-appearance, viz. adjudication in default.

Many proceedings in the High Court and some in the county court are initiated by forms of summons different from the writ of summons. Of those issued in the High Court three classes merit mention:—

1. For determining interlocutory matters of practice and procedure arising in "a pending cause or matter." These are now limited as far as possible to a general summons for directions, introduced in 1883 so as to discourage frequent and expensive applications to the masters or judges of the High Court on questions of detail. These summonses are sealed and issued on application at the offices of the High Court. The matters raised are dealt with by a master or judge in chambers summarily. In matters of practice and procedure there is no appeal from a judge at chambers without leave from him or from the court of appeal.

2. For determining certain classes of questions with more despatch and less cost than is entailed by action or petition. This kind of summons is known as an "originating summons," because under it proceedings may be originated without writ for certain kinds of relief specified in the rules (R. S. C., O. 55, r. 3). The originating summons may be used in all divisions of the High Court, but is chiefly employed in the chancery division, where it to a great extent supersedes actions for the administration of trusts or of the estates of deceased persons;[1] and for the foreclosure of mortgages a similar but not identical procedure was created by the Vendor and Purchaser Act 1874, and the Conveyancing Act 1881, with reference to questions of title, &c., to real property. In the king's bench and probate divisions the originating summons is used for determining summarily questions as to property between husband and wife, or the right to custody of children, and many other matters (O. 54, rr. 4 B–4 F). The proceedings on an originating summons are conducted summarily at chambers without pleadings, and the evidence is usually written. In the chancery division where the questions raised are important the summons is adjourned into court. An appeal lies to the court of appeal from decisions on originating summonses.

The forms of summonses and the procedure thereon in civil cases in the High Court are regulated by the Rules of the Supreme Court 1883 to 1907.

3. Certain proceedings on the crown side of the king's bench division are begun by summons, *e.g.* applications for bail; and in vacation writs of habeas corpus, *mandamus*, prohibition and *certiorari* are asked for by summons as the full court is not in session. (See Crown Office Rules, 1906).

In the county courts an action is begun by plaint and summons. Two kinds of summons are in use—the ordinary summons used for every form of county court action, and the default summons, which is an optional remedy of the plaintiff in actions for debts or liquidated demands exceeding £5, and in all actions for the price or hire of goods

[1] A similar practice existed before 1883 under the powers given by 15 & 16 Vict. c. 86, but was very limited in its operation, as it applied simply to the personal estate of a deceased person.

sold or let to the defendant to be used in the way of his calling. It may also issue by leave of the judge or registrar in other cases, with the single exception that no leave can be given in claims under £5 where the claim is not for the price or hire of goods sold or let as above, if the affidavit of debt discloses that the defendant is a servant or person engaged in manual labour. The advantage of a default summons is that judgment is entered for the plaintiff without hearing unless the defendant gives notice of defence within a limited time. A default summons must as a rule be served personally on the defendant; an ordinary summons need not be served personally, but may in most cases be delivered to a person at the defendant's house or place of business. A summons is also issued to a witness in the county court. Forms of summons are given in the County Court Rules 1903. These include certain special forms used in admiralty and interpleader actions and in proceedings under the Friendly Societies Acts and the Married Women's Property Acts. Summonses issued from county courts are usually served by a bailiff of the court and not by the party suing them out.

Justices of the peace have power to issue summonses to persons accused of indictable offences, or of offences summarily punishable, for their attendance, for preliminary inquiry or summary trial according to the nature of the charge, and also to persons against whom a complaint of a civil nature within the justices' jurisdiction is made. On failure to attend on summons, attendance may be enforced by warrant; and in the case of indictable offences this is the course always adopted. The forms in use for indictable offences are scheduled to the Indictable Offences Act 1848, and those for other purposes to the Summary Jurisdiction Rules 1886 (see SUMMARY JURISDICTION). The attendance of witnesses before justices of the peace may be required by witness summons, enforced in the event of disobedience by arrest under warrant (see WITNESS).

The attendance of jurors in civil or criminal trials is required by jury summons sent by registered post.

In courts for the trial of indictable offences the attendance of the accused and of the witnesses is not secured by summons. Both ordinarily attend in obedience to recognizances entered into before justices for their attendance. In the absence of recognizances the attendance of the accused is enforced by bench warrant of the court of trial, or by justices' warrant, and that of the witnesses by writ of *subpoenâ* issued from the crown office of the High Court. Disobedience to the writ is punished as contempt of court.

Scotland.—Summons is a term confined in strictness to the beginning of an action in the Court of Session. The summons is a writ in the sovereign's name, signed by a writer to the signet, citing the defender to appear and answer the claim. The "will of the summons" is the conclusion of a writ containing the will of the sovereign or judge, charging the executive officer to cite the party whose attendance is required. It is regulated by several acts, *e.g.* The Debtors (Scotland) Act 1838 (1 & 2 Vict. c. 114) and the Court of Session (Scotland) Act 1868 (31 & 32 Vict. c. 100). A privileged summons is one where the *induciae* are shortened to six days against defenders within Scotland (Court of Session [Scotland] Act 1825, s. 53). Defects in the summons are cured by amendment or by a supplementary summons. The summons goes more into detail than the English writ of summons, though it no longer states, as it once did, the grounds of action, now stated in the condescendence and pursuer's pleas in law annexed to the summons. The form of the summons is regulated by the Court of Session (Scotland) Act 1850, s. 1 and schedule A. After the action has been set on foot by summons, the attendance of the parties and witnesses is obtained by citation. The Citation Amendment Acts 1871 and 1882 give additional facilities for the execution of citations in civil cases by means of registered letters, instead of by the old process known as "lock hole citation." In the act of 1871 the term "summons" is used to denote part of the process of inferior civil courts.

In the sheriff court an action is now begun by writ (Sheriff Courts [Scotland] Act 1907), and not as formerly by petition or summons.

In criminal cases the summons of the accused, or of witnesses, is by warrant of citation, and of jurors by citation sent by registered post (1868, c. 95, s. 10).

Ireland.—In Ireland summonses are used substantially for the same purposes and in the same manner as in England, but generally speaking under statutes and rules applying only to the Irish courts. (W. F. C.)

SUMMUM BONUM (Lat. for "highest good"), in ethics, the ideal of human attainment. The significance of the term depends upon the character of the ethical system in which it occurs. It may be viewed as a perfect moral state: as pleasure or happiness (see HEDONISM; EUDAEMONISM); as physical perfection; as wealth, and so forth. If, however, we abandon intuitional ethics, it is reasonable to argue that the term summum bonum ceases to have any real significance inasmuch as actions are not intrinsically good or bad, while the complete sceptic strives after no systematic ideal.

SUMNER, CHARLES (1811–1874), American statesman, was born in Boston, Massachusetts, on the 6th of January 1811. He graduated in 1830 at Harvard College, and in 1834 graduated at the Harvard Law School. Here, in closest intimacy with Joseph Story, he became an enthusiast in the study of jurisprudence: at the age of twenty-three he was admitted to the bar, and was contributing to the *American Jurist*, and editing law texts and Story's court decisions. What he saw of Congress during a month's visit to Washington in 1834 filled him with loathing for politics as a career, and he returned to Boston resolved to devote himself to the practice of law. The three years (1837–1840) spent in Europe were years of fruitful study and experience. He secured a ready command of French, German and Italian, equalled by no American then in public life. He formed the acquaintance of many of the leading statesmen and publicists, and secured a deep insight into continental systems of government and of jurisprudence. In England (1838) his omnivorous reading in literature, history and jurisprudence made him *persona grata* to leaders of thought. Lord Brougham declared that he "had never met with any man of Sumner's age of such extensive legal knowledge and natural legal intellect." Not till many years after Sumner's death was any other American received so intimately into the best English circles, social, political and intellectual.

In his thirtieth year, a broadly cultured cosmopolitan, Sumner returned to Boston, resolved to settle down to the practice of his profession. But gradually he devoted less of his time to practice and more to lecturing in the Harvard Law School, to editing court reports and to contributions to law journals, especially on historical and biographical lines, in which his erudition was unsurpassed. In his law practice he had disappointed himself and his friends, and he became despondent as to his future. It was in a 4th of July oration on "The True Grandeur of Nations," delivered in Boston in 1845, that he first found himself. His oration was a tremendous arraignment of war, and an impassioned appeal for freedom and for peace, and proved him an orator of the first rank. He immediately became one of the most eagerly sought orators for the lyceum and college platform. His lofty themes and stately eloquence made a profound impression, especially upon young men; his platform presence was imposing, for he was six feet and four inches in height and of massive frame; his voice was clear and of great power; his gestures unconventional and individual, but vigorous and impressive. His literary style was somewhat florid. Many of his speeches were monuments of erudition, but the wealth of detail, of allusion, and of quotation, often from the Greek and Latin, sometimes detracted from their effect.

Sumner co-operated effectively with Horace Mann for the improvement of the system of public education in Massachusetts. Prison reform and peace were other causes to which he gave ardent support. In 1847 the vigour with which Sumner denounced a Boston congressman's vote in favour of the Mexican War Bill made him the logical leader of the "Conscience Whigs," but he declined to accept their nomination for Congress. He took an active part in the organizing of the Free Soil party, in revolt at the Whigs' nomination of a slave-holding southerner for the presidency; and in 1848 was defeated as a candidate for the national House of Representatives. In 1851 control of the Massachusetts legislature was secured by the Democrats in coalition with the Free Soilers, but after filling the state offices with their own men, the Democrats refused to vote for Sumner, the Free Soilers' choice for United States senator, and urged the selection of some less radical candidate. A deadlock of more than three months ensued, finally resulting in the election (April 24) of Sumner by a majority of a single vote.

Sumner thus stepped from the lecture platform to the Senate, with no preliminary training. At first he prudently abstained from trying to force the issues in which he was interested, while he studied the temper and procedure of the Senate. In the closing hours of his first session, in spite of strenuous efforts to prevent it, Sumner delivered (Aug. 26, 1852) a speech, "Freedom national; Slavery sectional," which it was immediately felt marked a new era in American history. The conventions of both the great parties had just affirmed the finality of every provision of the Compromise of 1850. Reckless of political expediency, Sumner moved that the Fugitive Slave Act be forthwith repealed; and for more than three hours he denounced it as a violation of the constitution, an affront to the public conscience, and an offence against the divine law. The speech provoked a storm of anger in the South, but the North was heartened to find at last a leader whose courage matched his conscience. In 1856, at the very time when "border ruffians" were drawing their lines closer about the doomed town of Lawrence, Kansas, Sumner in the Senate (May 19–20) laid bare the "Crime against Kansas." He denounced the Kansas-Nebraska Bill as in every respect a swindle, and held its authors, Stephen A. Douglas and Andrew P. Butler, up to the scorn of the world as the Don Quixote and Sancho Panza of "the harlot, Slavery." Two days later (May 22) Preston S. Brooks (1819–1857), a congressman from South Carolina, suddenly confronted Sumner as he sat writing at his desk in the Senate chamber, denounced his speech as a libel upon his state and upon Butler, his relative, and before Sumner, pinioned by his desk, could make the slightest resistance, rained blow after blow upon his head, till his victim sank bleeding and unconscious upon the floor. That brutal assault cost Sumner three years of heroic struggle to restore his shattered health—years during which Massachusetts loyally re-elected him, in the belief that in the Senate chamber his vacant chair was the most eloquent pleader for free speech and resistance to slavery. Upon returning to his post, in 1859, the approaching presidential campaign of 1860 did not deter him from delivering a speech, entirely free from personal rancour, on "The Barbarism of Slavery"—to this day one of the most comprehensive and scathing indictments of American slavery ever presented.

In the critical months following Lincoln's election Sumner was an unyielding foe to every scheme of compromise. After the withdrawal of the Southern senators, Sumner was made chairman of the committee on foreign relations (March 8, 1861), a position for which he was pre-eminently fitted by his years of intimate acquaintance with European politics and statesmen. While the war was in progress his letters from Cobden and Bright, from Gladstone and the duke of Argyll, at Lincoln's request were read by Sumner to the cabinet, and formed a chief source of light as to political thought in England. In the turmoil over the "'Trent' affair," it was Sumner's word that convinced Lincoln that Mason and Slidell must be given up, and that reconciled the public to that inevitable step. Again and again Sumner used the power incident to his chairmanship to block action which threatened to embroil the United States in war with England and France. Sumner openly and boldly advocated the policy of emancipation. Lincoln described Sumner as "my idea of a bishop," and used to consult him as an embodiment of the conscience of the American people.

The war had hardly begun when Sumner put forward his theory of reconstruction: that the seceded states by their own act had "become *felo de se*," had "committed state suicide," and that their status and the conditions of their readmission to membership in the Union lay absolutely at the determination of Congress, as if they were Territories and had never been states. He resented the initiative in Reconstruction taken by Lincoln, and later by Johnson, as an encroachment upon the powers of Congress. Throughout the war Sumner had constituted himself the special champion of the negro, being the most vigorous advocate of emancipation, of enlisting the blacks in the Union army, and of the establishment of the Freedmen's Bureau. The credit or the blame for imposing equal suffrage rights for negroes upon the Southern states as a condition of Reconstruction must rest with Charles Sumner more than with any other one man. Heedless of the teachings of science as to the slow evolution of any race's capacity for self-government, he insisted on putting the ballot forthwith into the hands of even the most ignorant blacks, lest their rights be taken from them by their former masters and the fruits of the war be lost. But it must be remembered that in Sumner's plan equal suffrage was to be accompanied by free homesteads and free schools for negroes.

In the impeachment proceedings against Johnson, Sumner was one of the president's most implacable assailants. Sumner's opposition to Grant's pet scheme for the annexation of San Domingo (1870), after the president mistakenly supposed that he had secured a pledge of support, brought upon him the president's bitter resentment. Sumner had always prized highly his popularity in England, but he unhesitatingly sacrificed it in taking his stand as to the adjustment of claims against England for breaches of neutrality during the war. Sumner laid great stress upon "national claims." He held that England's according the rights of belligerents to the Confederate states had doubled the duration of the war, entailing inestimable loss. He therefore insisted that England should be required not merely to pay damages for the havoc wrought by the "Alabama" and other cruisers fitted out for Confederate service in her ports, but that, for "that other damage, immense and infinite, caused by the prolongation of the war," the withdrawal of the British flag from this hemisphere could "not be abandoned as a condition or preliminary of such a settlement as is now proposed." (At the Geneva arbitration conference these "national claims" were abandoned.) Under pressure from the president, on the ground that Sumner was no longer on speaking terms with the secretary of state, he was deposed on the 10th of March 1871 from the chairmanship of the committee on foreign relations, in which he had served with great distinction and effectiveness throughout the critical years since 1861. Whether the chief cause of this humiliation was Grant's vindictiveness at Sumner's opposition to his San Domingo project or a genuine fear that the impossible demand, which he insisted should be made upon England, would wreck the prospect of a speedy and honourable adjustment with that country, cannot be determined. In any case it was a cruel blow to a man already broken by racking illness and domestic sorrows. Sumner's last years were further saddened by the misconstruction put upon one of his most magnanimous acts. In 1872 he introduced in the Senate a resolution providing that the names of battles with fellow citizens should not be placed on the regimental colours of the United States. The Massachusetts legislature denounced this battle-flag resolution as "an insult to the loyal soldiery of the nation" and as "meeting the unqualified condemnation of the people of the Commonwealth." For more than a year all efforts—headed by the poet Whittier—to rescind that censure were without avail, but early in 1874 it was annulled. On the 10th of March, against the advice of his physician, Sumner went to the Senate—it was the day on which his colleague was to present the rescinding resolution. With those grateful words of vindication from Massachusetts in his ears Charles Sumner left the Senate chamber for the last time. That night he was stricken with an acute attack of *angina pectoris*, and on the following day he died.

Sumner was the scholar in politics. He could never be induced to suit his action to the political expediency of the moment. "The slave of principles, I call no party master," was the proud avowal with which he began his service in the Senate. For the tasks of Reconstruction he showed little aptitude. He was less a builder than a prophet. His was the first clear programme proposed in Congress for the reform of the civil service. It was his dauntless courage in denouncing compromise, in demanding the repeal of the Fugitive Slave Act, and in insisting upon emancipation, that made him the chief initiating force in the struggle that put an end to slavery.

See Sumner's *Works* (15 vols., Boston, 1870–1883), and Edward L. Pierce's *Memoir and Letters of Charles Sumner* (4 vols., Boston, 1877–1893). Briefer biographies have been written by Anna L. Dawes (New York, 1892); Moorfield Storey (Boston, 1900); and George H. Haynes (Philadelphia, 1909).

SUMNER, CHARLES RICHARD (1790–1874), English bishop, was born at Kenilworth on the 22nd of November 1790, and was educated at Eton and at Trinity College, Cambridge. He graduated B.A. in 1814, M.A. in 1817, and was ordained deacon and priest. In the two winters of 1814–1816 he ministered to the English congregation at Geneva, and from 1816 to 1821 was curate of Highclere, Hampshire. In 1820 George IV. wished to appoint him canon of Windsor, but the prime minister, Lord Liverpool, objected; Sumner received instead a royal chaplaincy and librarianship, and other preferments quickly followed, till in 1826 he was consecrated bishop of Llandaff and in 1827 bishop of Winchester. In his long administration of his latter diocese he was most energetic, tactful and munificent. Though evangelical in his views he by no means confined his patronage to that school. In 1869 he resigned his see, but continued to live at the official residence at Farnham until his death on the 15th of August 1874. He published a number of charges and sermons, and *The Ministerial Character of Christ Practically Considered* (London, 1824). He also edited and translated John Milton's *De doctrina christiana*, which was found in the State Paper office in 1823, and formed the text of Macaulay's famous essay on Milton.

See the *Life*, by his son, G. H. Sumner (1876).

SUMNER, EDWIN VOSE (1797–1863), American soldier, was born at Boston, Massachusetts, and entered the United States army in 1819. He served in the Black Hawk War and in various Indian campaigns. In 1838 he commanded the cavalry instructional establishment at Carlisle, Pennsylvania. He took part in the Mexican War as a major, and for his bravery at Molino del Rey he received the brevet rank of colonel. In 1857 he commanded an expedition against the Cheyenne Indians. At the outbreak of the Civil War, four years later, Sumner had just been promoted brigadier-general U.S.A. and sent to replace Sidney Johnston in command on the Pacific coast. He thus took no part in the first campaign of the Civil War. But in the autumn he was brought back to the East to command a division, and soon afterwards, as a major-general U.S.V., a corps in the army that was being organized by McClellan. This corps, numbered II., retained its independent existence throughout the war, and under the command of Sumner, Couch, Hancock and Humphreys it had the deserved reputation of being the best in the Union army. Sumner, who was by far the oldest of the generals in the army of the Potomac, led his corps throughout the peninsular campaign, was wounded during the Seven Days' Battle, and received the brevet of major-general U.S.A., and was again wounded in the battle of Antietam. When Burnside succeeded to the command of the army of the Potomac he grouped the corps in "grand divisions," and appointed Sumner to command the right grand division. In this capacity the old cavalry soldier took part in the disastrous battle of Fredericksburg, in which the II. corps suffered most severely. Soon afterwards, on Hooker's appointment to command the army, Sumner was relieved at his own request. He died suddenly, on the 21st of March 1863, while on his way to assume supreme command in Missouri.

SUMNER, JOHN BIRD (1780–1862), English archbishop, elder brother of Bishop Charles Sumner, was born at Kenilworth, Warwickshire, and educated at Eton and Cambridge. In 1802 he became a master at Eton, and in the following year he took orders. He was elected a fellow of Eton in 1817, and in 1818 the college presented him to the living of Maple Durham, Oxfordshire. After holding a prebendaryship of Durham for some years, he was consecrated bishop of Chester in 1828. During his episcopate many churches and schools were built in the diocese. His numerous writings were much esteemed, especially by the evangelical party, to which he belonged; the best known are his *Treatise on the Records of Creation and the Moral Attributes of the Creator* (London, 1816) and *The Evidence of Christianity derived from its Nature and Reception* (London, 1821). In 1848 he was consecrated archbishop of Canterbury, in which capacity he dealt impartially with the different church parties. In the well-known "Gorham case"[1] he came into conflict with Bishop Henry Phillpotts of Exeter (1778–1869), who accused him of supporting heresy and refused to communicate with him. He supported the Divorce Bill in parliament, but opposed the Deceased Wife's Sister Bill and the bill for removing Jewish disabilities.

[1] George Cornelius Gorham (1787–1857) was refused institution by Bishop Phillpotts because of his Calvinistic views on baptismal regeneration. The court of arches upheld the bishop, but its decision was reversed by the privy council.

SUMNER, WILLIAM GRAHAM (1840–1910), American economist, was born, of English parentage, in Paterson, New Jersey, on the 30th of October 1840. He was brought up in Hartford, Connecticut, graduated at Yale College in 1863, studied French and Hebrew in Geneva in 1863–1864 and divinity and history at Göttingen in 1864–1866, and in 1866–1869 was a tutor at Yale. He was ordained a priest of the Protestant Episcopal Church in 1869, was assistant rector of Calvary Church, New York City, and in 1870–1872 was rector of the Church of the Redeemer, Morristown, New Jersey. From 1872 to 1909, when he became professor emeritus, he was professor of political and social science at Yale. In 1909 he was president of the American Sociological Society. He died at Englewood, New Jersey, on the 12th of April 1910.

He was notable especially as an opponent of protectionism, and was a great teacher. He wrote: *History of American Currency* (1874); *Lectures on the History of Protection in the United States* (1875); *Life of Andrew Jackson* (1882), in the "American Statesmen Series"; *What Social Classes Owe to Each Other* (1883); *Collected Essays in Political and Social Sciences* (1885); *Protectionism* (1885); *Alexander Hamilton* (1891), and *Robert Morris* (1891), in the "Makers of America Series"; *The Financier and Finances of the American Revolution* (2 vols., 1891); *A History of Banking in the United States* (1896); and *Folkways: a Study of the Sociological Importance of Usages, Manners, Customs, Mores and Morals* (1907), a valuable sociological summary.

SUMPTER, a pack-horse or mule, a beast for carrying burdens, particularly for military purposes. There were two words once in use, which in sense, if not in form, have coalesced. These are "sommer" or "summer" and "sumpter." The first comes through the Old French *sommier*, a pack-horse, the other through *sommetier*, a pack-horse driver. Both come ultimately from Late Lat. *salma*, from *sagma*, a pack, burden, Old French *somme*, *saume*; Greek *σάγμα*, burden, *σάττειν*, to load. "Sumpter" in the sense of a driver of a pack-horse is rare, and the word is always joined with another explanatory word.

SUMPTUARY LAWS (from Lat. *sumptuarius*, belonging to cost or expense, *sumptus*), those laws intended to limit or regulate the private expenditure of the citizens of a community. They may be dictated by political, or economic, or moral considerations. They have existed both in ancient and in modern states. In Greece, it was amongst the Dorian races, whose temper was austere and rigid, that they most prevailed. All the inhabitants of Laconia were forbidden to attend drinking entertainments, nor could a Lacedaemonian possess a house or furniture which was the work of more elaborate implements than the axe and saw. Among the Spartans proper simple and frugal habits of life were secured rather by the institution of the *pheidilia* (public meals) than by special enactments. The possession of gold or silver was interdicted to the citizens of Sparta, and the use of iron money alone was permitted by the Lycurgean legislation. "Even in the cities which had early departed from the Doric customs," says K. O. Müller, "there were frequent and strict prohibitions against expensiveness of female attire, prostitutes alone being wisely excepted." In the Locrian code of Zaleucus citizens were forbidden to drink undiluted wine. The Solonian sumptuary enactments were directed principally against the extravagance of female apparel and dowries of excessive amount; costly banquets also were forbidden, and expensive funeral solemnities. The Pythagoreans in Magna Graecia not only protested against the luxury of their time but encouraged legislation with a view to restraining it.

At Rome the system of sumptuary edicts and enactments was largely developed, whilst the objects of such legislation were concurrently sought to be attained through the exercise of the censorial power. The code of the Twelve Tables contained provisions limiting the expenditure on funerals. The most important sumptuary laws of the Roman commonwealth are the following:—

(1) The Oppian law, 215 B.C., provided that no woman should possess more than half an ounce of gold, or wear a dress of different colours, or ride in a carriage in the city or within a mile of it except on occasions of public religious ceremonies. This law, which had been partly dictated by the financial necessities of the conflict with Hannibal, was repealed twenty years later, against the advice of Cato. Livy (xxxiv. 1–8) gives an interesting account of the commotion excited by the proposal of the repeal, and of the exertions of the Roman women against the law, which almost amounted to a female *émeute.* (2) The Orchian law, 187 B.C., limited the number of guests at entertainments. An attempt being made to repeal this law, Cato offered strong opposition and delivered a speech on the subject, of which some fragments have been preserved. (3) The Fannian law, 161 B.C., limited the sums to be spent on entertainments; it provided amongst other things that no fowl should be served but a single hen, and that not fattened. (4) The Didian law, 143 B.C., extended to the whole of Italy the provisions of the Fannian law, and made the guests as well as the givers of entertainments at which the law was violated liable to the penalties. After a considerable interval, Sulla anew directed legislation against the luxury of the table and also limited the cost of funerals and of sepulchral monuments. We are told that he violated his own law as to funerals when burying his wife Metella, and also his law on entertainments when seeking to forget his grief for her loss in extravagant drinking and feasting (Plut. *Sull.* 35). Julius Caesar, in the capacity of *praefectus moribus*, after the African War re-enacted some of the sumptuary laws which had fallen into neglect; Cicero implies (*Ep. ad Att.* xiii. 7) that in Caesar's absence his legislation of this kind was not attended to. Suetonius tells us that Caesar had officers stationed in the market-places to seize such provisions as were forbidden by law, and sent lictors and soldiers to feasts to remove all illegal eatables (*Jul.* 43). Augustus fixed anew the expense to be incurred in entertainments on ordinary and festal days. Tiberius also sought to check inordinate expense on banquets, and a decree of the senate was passed in his reign forbidding the use of gold vases except in sacred rites, and prohibiting the wearing of silk garments by men. But it appears from Tacitus (*Ann.* iii. 5, where a speech is put into his mouth very much in the spirit of Horace's "Quid leges sine moribus vanae proficiunt?") that he looked more to the improvement of manners than to direct legislative action for the restriction of luxury. Suetonius mentions some regulations made by Nero, and we hear of further legislation of this kind by Hadrian and later emperors. In the time of Tertullian the sumptuary laws appear to have been things of the past (*Apol.* c. vi.).

In modern times the first important sumptuary legislation was: in Italy that of Frederick II.; in Aragon that of James I., in 1234; in France that of Philip IV.; in England that of Edward II. and Edward III. In 1294 Philip IV. made provisions as to the dress and the table expenditure of the several orders of men in his kingdom. Charles V. of France forbade the use of long-pointed shoes, a fashion against which popes and councils had protested in vain. Under later kings the use of gold and silver embroidery, silk stuffs and fine linen wares was restricted —at first moral and afterwards economic motives being put forward, the latter especially from the rise of the mercantile theory. In England we hear much from the writers of the 14th century of the extravagance of dress at that period. They remark both on the great splendour and expensiveness of the apparel of the higher orders and on the fantastic and deforming fashions adopted by persons of all ranks. The parliament held at Westminster in 1363 made laws (37 Edw. III. c. 8–14) to restrain this undue expenditure and to regulate the dress of the several classes of the people. These statutes were repealed in the following year, but similar ones were passed again in the same reign. They seem, however, to have had little effect, for in the reign of Richard II. the same excesses prevailed, apparently in a still greater degree. Another statute was passed in the year 1463 (3 Edw. IV. c. 5) for the regulation of the dress of persons of all ranks. In this it was stated that "the commons of the realm, as well men as women, wear excessive and inordinate apparel to the great displeasure of God, the enriching of strange realms, and the destruction of this realm." An act of 1444 had previously regulated the clothing, when it formed part of the wages, of servants employed in husbandry: a bailiff or overseer was to have an allowance of 5s. a year for his clothing, a hind or principal servant 4s., and an ordinary servant 3s. 4d.—sums equivalent respectively to 50s., 40s. and 33s. 4d. of our money (Henry). Already in the reign of Edward II. a proclamation had been issued against the "outrageous and excessive multitude of meats and dishes which the great men of the kingdom had used, and still used, in their castles," as well as "persons of inferior rank imitating their example, beyond what their stations required and their circumstances could afford"; and the rule was laid down that the great men should have but two courses of flesh meat served up to their tables, and on fish days two courses of fish, each course consisting of but two kinds. In 1336 Edward III. attempted also to legislate against luxurious living, and in 1363, at the same time when costumes were regulated, it was enacted that the servants of gentlemen, merchants and artificers should have only one meal of flesh or fish in the day, and that their other food should consist of milk, butter and cheese. Similar acts to those above mentioned were passed in Scotland also. In 1433 (*temp.* James I.), by an act of a parliament which sat at Perth, the manner of living of all orders in Scotland was prescribed, and in particular the use of pies and baked meats, which had been only lately introduced into the country, was forbidden to all under the rank of baron. In 1457 (*temp.* James II.) an act was passed against "sumptuous cleithing." A Scottish sumptuary law of 1621 was the last of the kind in Great Britain.

In Japan sumptuary laws have been passed with a frequency and minuteness of scope such as has no parallel in the history of the western world. At the beginning of the 11th century we find an Imperial edict regulating the size of a house and even imposing restrictions as to the materials of which it is to be built. But it was during the Tokugawa period that sumptuary laws and regulations were passed in the most bewildering profusion; every detail of a man's life was regulated down to the least particular—from the wearing of a beard or the dressing of the hair down to the cost of his wife's hairpins or the price of his child's doll.[1]

A. Ferguson and others have pointed out that "luxury" is a term of relative import and that all luxuries do not deserve to be discouraged. Roscher has called attention to the fact that the nature of the prevalent luxury changes with the stage of social development. He endeavours to show that there are three periods in the history of luxury—one in which it is coarse and profuse; a second in which it aims mainly at comfort and elegance; and a third, proper to periods of decadence, in which it is perverted to vicious and unnatural ends. The second of these began, in modern times, with the emergence of the Western nations from the medieval period, and in the ancient communities at epochs of similar transition. Roscher holds that the sumptuary legislation which regularly appears at the opening of this stage was then useful as promoting the reformation of habits. He remarks that the contemporary formation of strong governments, disposed from the consciousness of their strength to interfere with the lives of their subjects, tended to encourage such legislation, as did also the jealousy felt by the hitherto dominant ranks of the rising wealth of the citizen classes, who are apt to imitate the conduct of their superiors. It is certainly desirable that habits of wasteful expenditure and frequent and wanton changes of fashion should be discouraged. But such action belongs more properly to the spiritual than to the temporal power. In ancient, especially Roman, life, when there was a confusion of the two powers in the state system, sumptuary legislation was more natural than in the modern world, in which those powers have been in general really, though imperfectly, separated. Political economists are practically unanimous in their reprobation of the policy of legislative compulsion in these matters. In a well-known passage Adam Smith protests against the "impertinence and presumption of kings and ministers in pretending to watch over the economy of private people and to restrain their expense, being themselves always and without any exception the greatest spendthrifts in the society." Yet he does not seem to have been averse from all attempts to influence through taxation the expenditure of the humbler classes. The modern taxes on carriages, coats of arms, male servants, playing cards, &c., ought perhaps not to be regarded as resting on the principle of sumptuary laws, but only as means of proportioning taxation to the capacity of bearing the burden.

The *loci classici* on Roman sumptuary laws are Gellius, *Noctes atticae*, ii. 24, and Macrobius, *Saturn.* iii. 17. For Great Britain see Henry of Huntingdon, *Historia Anglorum* ("Rolls Series," ed. T. Arnold, 1879); W. Cunningham, *Growth of English Industry and*

[1] See Captain F. Brinkley's *Japan, its History, Arts and Literature* (1904), i. 138, 205, 140–144, ii. 98, 99, iv. 157–162; *Trans. of the Asiatic Soc. of Japan*, vol. xix., "Notes on Land Tenure and Local Institutions in Old Japan," ed. by Professor J. H. Wigmore; vol. xx., "Materials for the Study of Private Law in Old Japan," by Professor Wigmore.

Commerce; W. J. Ashley, *Introduction to English Economic History and Theory* (1893); W. Denton, *England in the Fifteenth Century* (1888). One of the best extant treatments of the whole subject is that by Roscher, in his essay, *Über den Luxus*, republished in his *Ansichten der Volkswirthschaft auf dem geschichtlichen Standpunkte* (3rd ed., 1878). (J. K. I.)

SUMTER, THOMAS (1736–1832), American soldier, was born in Hanover county, Virginia, on the 14th of July 1736. He served in the Virginia militia during the French and Indian War and was present at Braddock's defeat (1755). Some time after 1762 he removed to South Carolina. He is best known for his service during the War of Independence, but he saw little active service until after the fall of Charleston in May 1780. In July 1780 he became a brigadier-general of state troops. During the remainder of the war he carried on a partisan campaign, and earned the sobriquet of the "Gamecock." He failed in an attack upon Rocky Mount (Chester county) on the 1st of August 1780, but on the 6th defeated 500 Loyalists and regulars at Hanging Rock (Lancaster county), and on the 15th intercepted and defeated a convoy with stores between Charleston and Camden. His own regiment, however, was almost annihilated by Lieut.-Colonel Banastre Tarleton (1754–1833) at Fishing Creek (Chester county) on the 18th. A new force was soon recruited, with which he defeated Major James Wemys at Fishdam (Union county) on the night of the 8th–9th of November, and repulsed Tarleton's attack at Blackstock (Union county) on the 20th, when he was wounded. In January 1781 Congress formally thanked him for his services. He was a member of the state convention which ratified the Federal constitution for South Carolina in 1788, he himself opposing that instrument; of the national House of Representatives in 1789–1793 and again in 1797–1801, and of the United States Senate from 1801 to 1810. At the time of his death at South Mount, South Carolina, on the 1st of June 1832, he was the last surviving general officer of the War of Independence.

See Edward McCrady, *The History of South Carolina in the Revolution* (2 vols., New York, 1901–1902).

SUMTER, a city and the county-seat of Sumter county, South Carolina, U.S.A., 42 m. by rail E. by S. of Columbia. Pop. (1900) 5673 (3160 negroes); (1910) 8109. Sumter is served by several divisions of the Atlantic Coast line and by the Southern railways. It is the seat of St Joseph's Academy (Roman Catholic) for girls. The region produces tobacco, vegetables and cotton, and there are various manufactories in the city. Sumter was founded in 1800 and was named in honour of General Thomas Sumter; it was first chartered as a city in 1887.

SUMY, a town of Little Russia, in the government of Kharkov, 122 m. by rail N.W. of the city of Kharkov, founded in 1658. Pop. (1900), 28,519. It is an important centre for the trade of Great Russia with Little Russia—cattle and corn being sent to the north in exchange for manufactured and grocery wares. It has important sugar manufacture, and a technical school.

SUN (O. Eng. *sunne*, Ger. *sonne*. Fr. *soleil*, Lat. *sol*, Gr. ἥλιος, from which comes *helio-* in various English compounds), the name of the central body of the solar system, the luminous orb from which the earth receives light and heat; (see SUNSHINE); hence by analogy other heavenly bodies which form the centre of systems are called suns.

To understand the phenomena of the sun, we should reproduce them upon the earth; but this is clearly impossible since they take place at temperatures which volatilize all known substances. Hence our only guides are such general laws of mechanics and physics as we can hardly believe any circumstances will falsify. But it must be remembered that these require extrapolation from experience sometimes sufficiently remote, and it is possible they may lead to statements that are obscure, if not contradictory. The body of the sun must consist of uncombined gases; at the surface the temperature is some 2000° C. above the boiling point of carbon, and a little way within the body it may probably exceed the critical point at which increase of pressure can produce the liquid state in any substance. But as the mean density exceeds that of water, and probably falls but little from the centre to the surface, these gases are gases only in the sense that if the pressure of neighbouring and outward parts gravitating towards the centre were relaxed, they would expand explosively, as we see happening in the eruptive prominences. They have lost completely the gaseous characteristic of producing a line spectrum, and radiate like incandescent solids. The surface region which yields a continuous spectrum is called the *photosphere*; it possesses optically a sharp boundary, which is generally a perfect sphere, but shows occasionally at the rim slight depressions or more rarely elevations. Enclosing the photosphere is a truly gaseous envelope which is called the *chromosphere*, and which shows a spectrum of bright lines when we can isolate its emission from that of the photosphere. This envelope is also sharply defined, but its normal appearance is compared to the serrations which blades of grass show on the skyline of a hill, and it is disturbed by the outbursts, called prominences, of which details are given below. Outside this again is an envelope of matter of enormous extent and extreme tenuity, whether gaseous or partly minute liquid or solid drops, which is called the *corona*. It has no sharp boundary, its brightness diminishes rapidly as we recede from the limb, and such structure as it shows consists of long streaks or filaments extending outwards from the limb in broad curved sweeps. Finally there is the envelope of still vaster extent and of unknown constitution which gives the *zodiacal light* (*q.v.*); its greatest extent is along the ecliptic, but it can also be certainly traced for 35° in a perpendicular direction. The lower gaseous cloaks absorb a large part of the light admitted by the photosphere, and especially at the limb and for the more refrangible rays the loss of intensity is very marked.

General Appearance of Photosphere.

In the instants when a sharp image of the photosphere is seen or photographed, it shows a granulated appearance like white flakes strewed fairly evenly upon a dark ground. The figs. 1, 2, 3, 4 (plate) show enlargements from photographs by Hansky at Pulkowa (June 25, 1905); they are separated by intervals from 25 to 80 seconds, and he has succeeded in showing identity in many of the granules, or more properly, clouds represented. Thus they exhibit at once general appearance and its changes. The diameters range from 400 m. or less up to 1200 m., and the speeds relative to the spot range up to 2 or 3 m. per second. M. Hansky believes these motions may be the consequences of matter rising from below and thrusting the surface groups aside. Usually the changes are such that it is impossible even to recognize the formations in successive photographs. Besides granulations the sun's disk shows, as a rule, one or more spots or groups of spots. Each spot shows with more or less completeness a ring-shaped penumbra enclosing a darker umbra; the umbra, which looks black beside the photosphere, is actually about as brilliant as limelight. In the neighbourhood surrounding the penumbra the granules appear to be packed more closely, forming brilliant patches called *faculae*. In the shape of a spot there is neither rule nor permanence, though those that are nearly circular seem to resist change better than the others. They arise from combinations of smaller spots, or from nothing, in a short period, say a day. They are never wholly quiescent. Bridges, more brilliant than the rest of the photosphere, form across them, and they may divide into two parts which separate from one another with great velocity. The largest spots are easily seen by the naked eye, if the brilliancy of the disk is veiled; the umbra may be many—ten or more—diameters of the earth in breadth. The length of their life is difficult to assign, because there is some tendency for a new group to arise where an old one has disappeared; but one is recorded which appeared in the same place for eighteen months; the average is perhaps two months. They are carried across the disk by the sun's rotation, partaking in the equatorial acceleration; they also show marked displacements of their own, whether with, or relative to, the neighbouring photosphere does not appear; at the beginning of their life they usually outrun the average daily rotation appropriate to their latitude. Spots are rarely found on the equator, or more than 35° N. or S. of it, and at 45° are practically unknown. Their occurrence within these zones follows statistically a uniform law (see AURORA). Other information about the spots is given below, in connexion with their spectra. It may be said that nothing definite has been established as to what they are. The statement known as A. Wilson's theory (1774), that they are hollows in the photosphere, long supposed to be proved by perspective effects as the spot approached the limb, is discredited by F. Howlett's careful drawings, which, however, do not establish the contrary. To draw a trustworthy conclusion it is necessary that the spot should be quiescent, show a well-developed and fairly symmetrical penumbra, and be observed near the limb and also near the centre, and these conditions are satisfied in so few cases as to withdraw all statistical force from the conclusion. Figs. 5, 6, 7, 8 (plate) are reproductions of the Greenwich photographs of the sun from the 30th of January to the 8th of February 1905. The first, taken alone, might seem to bear out Wilson's theory, but the others show that the penumbra is really very unsymmetrical and much broader on the side towards the limb, apart from anything which perspective may have to say. The photosphere does not rotate in one piece, lower latitudes outrunning higher. This was discovered by R. C. Carrington from observations of the spots, extending from 1853 to 1861, from which he determined also the position of the sun's axis. But conclusions from the spots are full of anomalies. E. W. Maunder and Mrs Maunder found that different spots in the same zone differ more than do the means for different zones, while a long-lived spot settles down to give more consistent results than are furnished by spots of one apparition. In the span of two complete sunspot periods no evidence was found of periodic or other change with lapse of time. The problem still awaits complete discussion. The irregularities incidental to use of the spots are escaped by comparing the relative Doppler displacements of the same spectral line as given by the receding and advancing limbs of the sun. The observation is a delicate one, and was first successfully handled by N. C. Dunér in 1890. But his determinations, repeated recently (*Acta upsal.* IV. vol. i., 1907) as well as those of J. Halm at Edinburgh (*Ast. Nach.* vol. 173, 1907), are superseded by a photographic treatment of the problem by W. S. Adams (*Astrophys. Journ.*, xxvi., 1907).

Rotation of the Photosphere.

The diagram (fig. 9) shows Adams's value for the angular velocity ξ for different latitudes ϕ, the dots representing the actual observations. Fig. 10 shows the consequent distortion of a set of meridians after one revolution (at lat. 30°). An important feature added to the discussion by Adams is the different behaviour of spectral lines

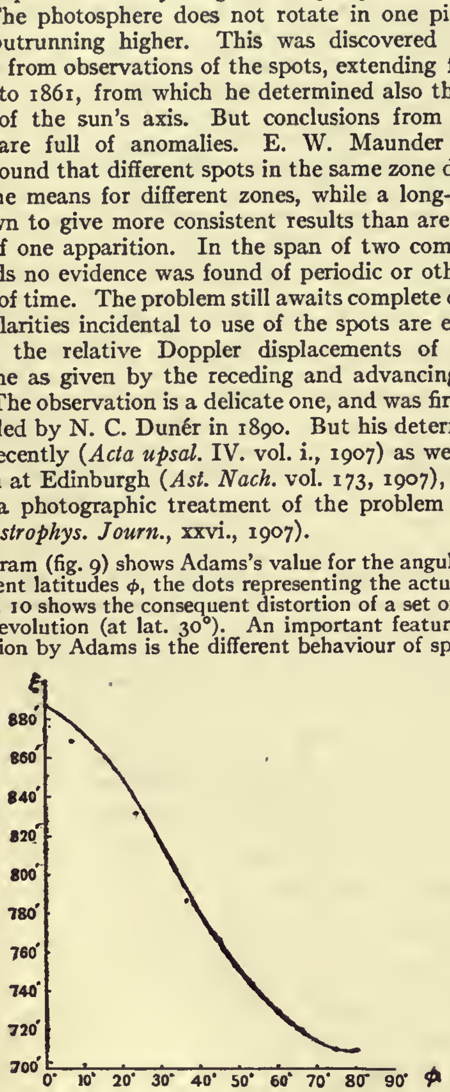


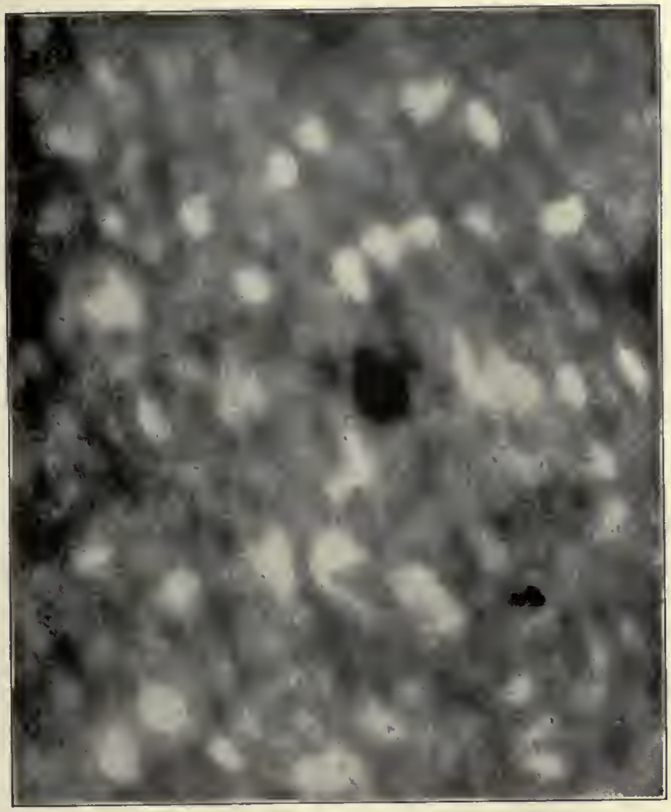
FIG. 9.

which are believed to originate at different levels. The data given above refer to the mean reversing layer. Lines of lanthanum and carbon which are believed to belong to a low level showed systematically smaller angular velocity than the average. This promises to be a fertile field for future inquiry. Pending more conclusive evidence from the spectroscope, the interpretation of the peculiar surface rotation of the sun appears to be that the central parts of the body are rotating faster than those outside them; for if such were the case the observed phenomenon would arise. For consider first a frictionless fluid. The equations of surfaces of equal angular motion would be of the form $r = \mathrm{R}\ (1 - \epsilon \cos^2\theta)$, where ϵ is proportional to the square of the angular motion, supposed small, and R increases as ϵ diminishes. Consider the traces these surfaces cut on any sphere $r = a$: we have $d\epsilon/d\theta = 2\epsilon \sin\theta \cos\theta / \{\cos^2\theta - a\mathrm{R}^{-2} d\mathrm{R}/d\epsilon\}$, which is positive and has a maximum in the middle latitudes; so that, proceeding from the pole to the equator along any meridian, the angular velocity would continually increase, at a rate which was greatest in the middle latitudes. This is exactly what the observations show. Now if this state be supposed established in a frictionless fluid, the consideration of internal friction would simply extend the characteristics found at any spot to the neighbourhood, and therefore if the boundary were a sphere and so for a frictionless fluid an exception, it would cease to be an exception when we allow for viscosity. But this theory gives no clue to the results relating to hydrogen, which belongs to a high level, and which Adams has shown to move with an angular velocity decidedly greater than the equatorial angular velocity below it, and not to show any sign of falling off towards the poles.

FIG. 10.

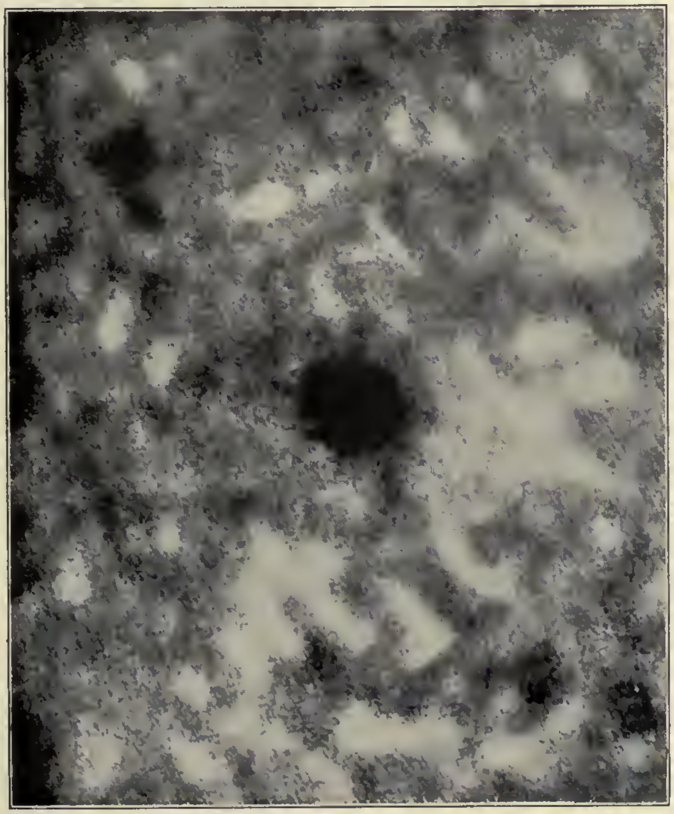
Mechanical State Internally.

It is useful to form a conception of the mechanical state within the sun's body. Its temperature must be dominated directly or indirectly by the surface radiation, and since the matter is gaseous and so open to redistribution, the same is true of density and pressure. It is true that within the body radiations must be stifled within a short distance of their source; none the less, they will determine a temperature gradient, falling from the centre to the borders, though for the most part falling very slowly, and we may ask what relative temperatures in different parts would maintain themselves if once established. Stefan's law of radiation according to the fourth power of the temperature is too difficult to pursue, but if we are content with cognate results we can follow them out mathematically in a hypothetical law of the first power. We then find that the density would increase as we go outwards, at first slowly, but finally with extreme rapidity, the last tenth of the radius comprising half the mass. The radiation from such a body would be practically nil, no matter how hot the centre was. Of course such a state would be statically unstable. It would never get established because currents would arise to exchange the positions of the hotter, less dense, inner parts and the cooler, more dense, outer ones. By this interchange the inner parts would be opened out and the total radiation raised. Since the only cause for these convection currents is the statical instability produced by radiation, and the rapid stifling of radiations within the body produces there a temperature gradient falling very slowly, they would be for the most part extremely slight. Only near the surface would they become violent, and only there would there be a rapid fall of temperature and density. Through the main body these would remain nearly constant. Indeed it seems that, in the final distribution of density throughout the part which is not subject to violent convection currents, it must increase slightly from the centre outwards, since the currents would cease altogether as soon as a uniform state was restored. In the outer strata a different state must prevail. Rapidly falling temperature must (and visibly does) produce furious motions which wholly outrun mere restoration of statical balance. Portions change places so rapidly and so continually, that we may take it, where any average is reached, the energy is so distributed that there is neither gain nor loss when such a change occurs. This is the law of convective equilibrium. But in the sun's atmosphere gravitation alone is a misleading guide. Convective equilibrium, which depends upon it, gives far too steep a temperature gradient, for it yields a temperature of 6000° only 200 m. within the free surface, whereas the chromosphere is of an average thickness of 5000 m., and attains that temperature only at its base. Probably the factor which thus diminishes the effective

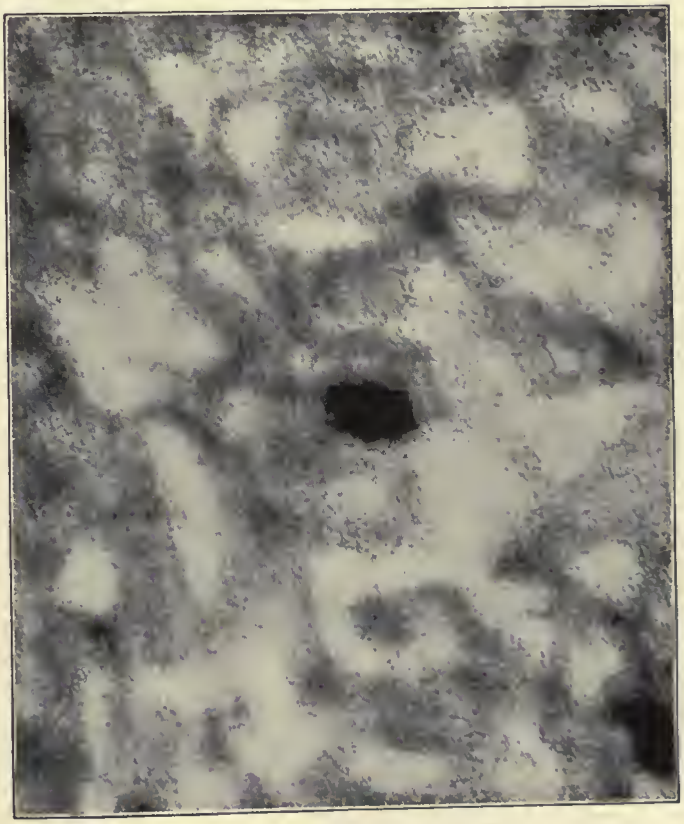


(1) 1905, June 25d. 4h. 16m. 15s.

(2) 1905, June 25d. 4h. 17m. 15s.



(3) 1905, June 25d. 4h. 17m. 40s.



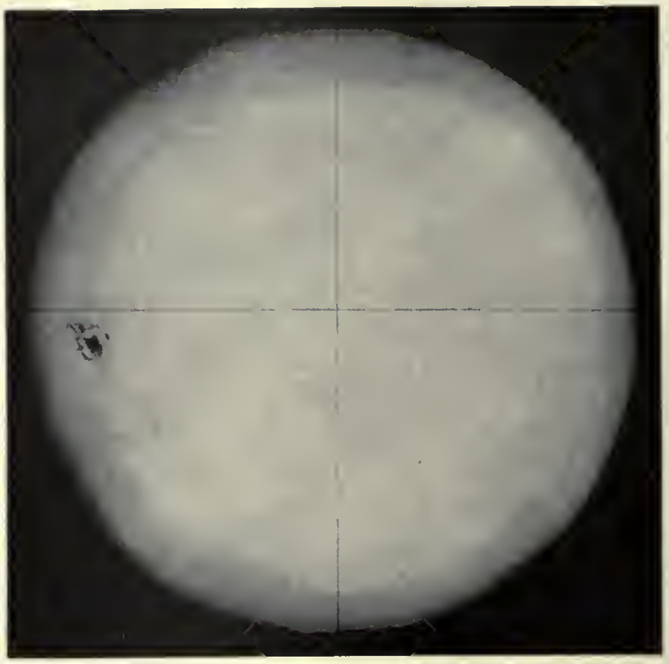
(4) 1905, June 25d. 4h. 19m. 0s.

ENLARGED PHOTOGRAPHS OF THE SOLAR SURFACE. Taken by M. A. Hansky at the Observatory of Pulkowa (1905, June 25), at intervals from 25s. to 80s.

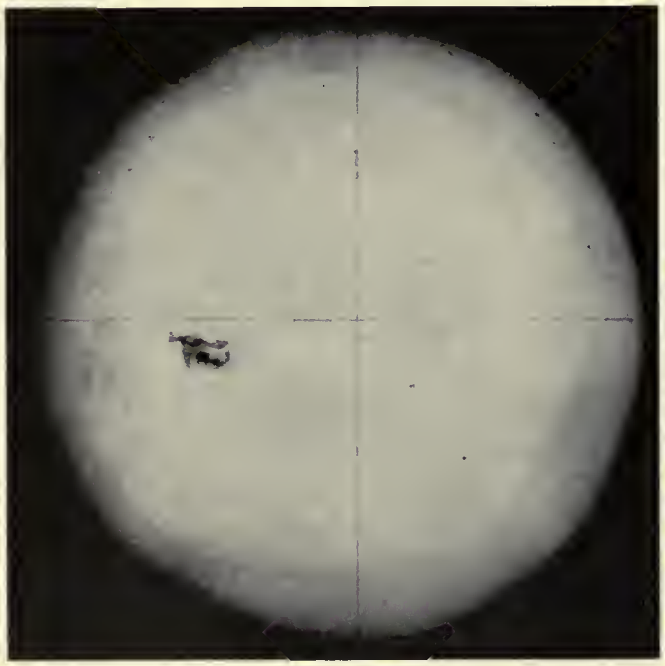
PLATE II.

SUN

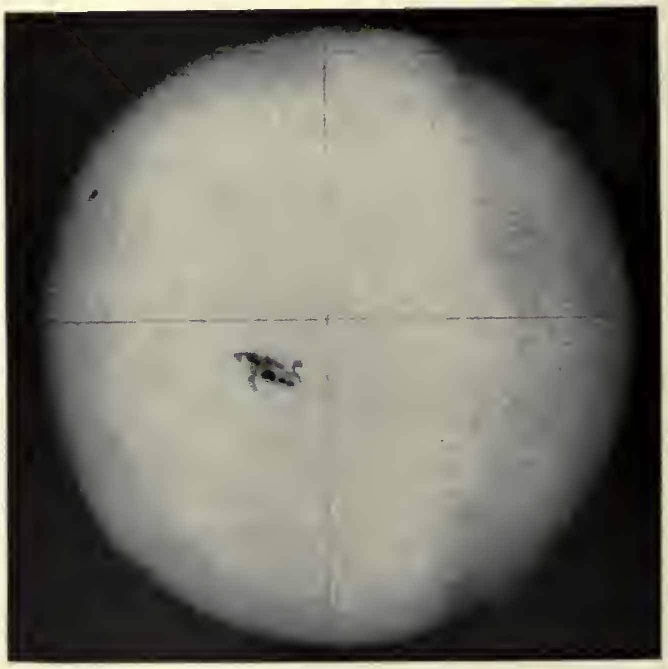
1905, Jan. 30d. 12h. 8m. 27s.



1905, Jan. 31d. 11h. 17m. 27s.



1905, Feb. 2d. 10h. 50m. 28s.



1905, Feb. 8d. 13h. 3m. 5s.

PHOTOGRAPHS OF THE SUN, TAKEN AT THE ROYAL OBSERVATORY, GREENWICH.

Observer: E. W. Maunder. Instrument, Thompson Photoheliograph. Focal length, 9 ft. Aperture, 9 in.

condensing power of gravitation at the sun's borders is the pressure of radiation.

The radiations from the sun must be considered in two parts, corresponding respectively to the continuous spectrum and the line-spectrum. The latter is considered below; it is indicative of the chemical elements from which the lines can proceed, and its state at the time of emission; the former is indicative only of the rate of loss of energy from the sun by radiation, and is inwoven with a remarkable group of physical theory and experiment, known as the theory of the black body, or as black radiation. The "black body" is an ideal body with surface so constituted as to reflect no part of any radiations that fall upon it; in the case of such a body Kirchhoff and Balfour Stewart showed that unless energy were to be lost the rate of emission and absorption must be in fixed ratio for each specific wave-length.

"The Black Body."

The name has no reference to the appearance of the body to the eye; when emitting energy, its radiations will be of all wave-lengths, and if intense enough will appeal to the eye as luminous between about wave-lengths 7600 and 4000 tenth-metres; this intensity is a question of temperature, and as it is exquisitely inappropriate to speak of the bulk of the solar radiations as black, the writer will speak instead of amorphous radiations from an ideal radiator. The ideal radiator is realized within any closed cavity, the walls of which are maintained at a definite temperature. The space within is filled with radiations corresponding to this temperature, and these attain a certain equilibrium which permits the energy of radiation to be spoken of as a whole, as a scalar quantity, without express reference to the propagation or interference of the waves of which it is composed. It is then found both by experiment and by thermodynamic theory that in these amorphous radiations there is for each temperature a definite distribution of the energy over the spectrum according to a law which may be expressed by $\theta^5\phi(\theta\lambda)d\lambda$, between the wave-lengths λ, $\lambda+d\lambda$; and as to the form of the function ϕ, Planck has shown (*Sitzungsber. Berlin Akad.* 544) that an intelligible theory can be given which leads to the form $\phi(\theta\lambda)=c_1/\{exp(c_2/\lambda\theta)-1\}$, a form which agrees in a satisfactory way with all the experiments. Fig. 11 shows the resulting distribution of energy. The enclosed area for each temperature represents the total emission of energy for that temperature, the abscissae are the wave-lengths, and the ordinates the corresponding intensities of emission for that wave-length. It will be seen that the maximum ordinates lie upon the curve $\lambda\theta=$ constant dotted in the figure, and so, as the temperature of the ideal body rises, the wave-length of most intense radiation shifts from the infra-red towards the luminous part of the spectrum. When we speak of the sun's radiation as a whole, it is assumed that it is of the character of the radiations from an ideal radiator at an appropriate temperature.

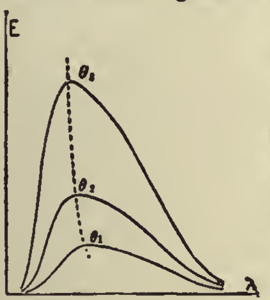
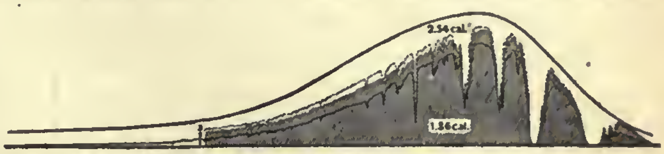


FIG. 11.

The Solar Constant.

The first adequate determination of the character as well as amount of solar radiation was made by S. P. Langley in 1893 at Mount Whitney in California (14,000 ft.), with the bolometer, an exceedingly sensitive instrument which he invented, and which enabled him to feel his way thermally over the whole spectrum, noting all the chief Fraunhofer lines and bands, which were shown by sharp serrations, or more prolonged depressions of the curve which gave the emissions, and discovering the lines and bands of the invisible ultra-red portion. The bolograph thus obtained must be cleared of the absorption of the earth's atmosphere, and that of the transmitting apparatus—a spectroscope and siderostat. The first in itself requires an elaborate study. The first essential is an elevated observatory; the next is a long series of bolographs taken at different times of the year and of the day, to examine the effect of interposing different thicknesses of air and its variation in transparency (chiefly due to water vapour). It is found that atmospheric absorption is generally greater in summer than in winter, a difference of 20% being found between March and August; morning hours show a rapid and often irregular increase of transparency, culminating shortly after noon, after which the diminution is slow and comparatively regular.

The resulting allowances and conclusion are illustrated in fig. 12, taken from an article by Langley in the *Astrophysical Journal* (1903), xvii. 2. The integrated emission of energy is given by the area of the outer smoothed curve (4), and the conclusion from this one bolograph is that the "solar constant" is 2·54 calories. The meaning of this statement is that, arguing away the earth's atmosphere, which wastes about one-half what is received, a square centimetre, exposed perpendicularly to the sun's rays, would receive sufficient energy per minute to raise 2·54 grams of water 1° C. Langley's general determination of the constant was greater than this—3·0 to 3·5 calories; more recently C. G. Abbot at Mount Wilson, with instruments and methods in which Langley's experience is embodied, has reduced it greatly, having proved that one of Langley's corrections was erroneously applied. The results vary between 1·89 and 2·22, and the variation appears to be solar, not terrestrial. Taking the value at 2·1 the earth is therefore receiving energy at the rate of 1·47 kilowatts per square metre, or 1·70 horse-power per square yard. The corresponding intensity at the sun's surface is $4{\cdot}62\times10^4$ as great, or $6{\cdot}79\times10^4$ kilowatts per square metre $=7{\cdot}88\times10^4$ horse-power per square yard—enough to melt a thickness of 13·3 metres (=39·6 ft.) of ice, or to vaporize 1·81 metres (=5·92 ft.) of water per minute.



(From *Astrophysical Journal*, xvii. 2, by permission of the University of Chicago Press.)

FIG. 12.

Temperature of the Sun.

If we assume that the bolograph of solar energy is simply a graph of amorphous radiation from an ideal radiator, so that the constants c_1, c_2, of Planck's formula determined terrestrially apply to it, the hyperbola of maximum intensity is $\lambda\theta=2{\cdot}921\times10^7$; and as the sun's maximum intensity occurs for about $\lambda=4900$, we find the absolute temperature to be 5960° abs. If we calculate from the total energy emitted, and not from the position of maximum intensity, the same result is obtained within a few degrees. But to call this the temperature of the sun's surface is a convention, which sets aside some material factors. We may ask first whether the matter of which the surface is composed is such as to give an ideal radiator; it is impossible to answer this, but even if we admit a departure as great as the greatest known terrestrial exception, the estimated temperature is diminished only some 10%. A second question relates to the boundaries. The theory refers to radiation homogeneous at all points within a single closed boundary maintained at uniform temperature; in the actual case we have a double boundary, one the sun's surface, and the other infinitely remote, or say, non-existent, and at zero temperature; and it is assumed that the density of radiation in the free space varies inversely as the squares of the distance from the sun. Though there is no experiment behind this assumption it can hardly lead to error.

A third question is more difficult. The temperature gradient at the confines of the photosphere must certainly ascend sharply at first. When we say the sun's temperature is 6000°, of what level are we speaking? The fact is that radiation is not a superficial phenomenon but a molar one, and Stefan's law, exact though it be, is not an ultimate theory but only a convenient halting-place, and the radiations of two bodies can only be compared by it when their surfaces are similar in a specific way. One characteristic of such surfaces is fixity, which has no trace of parallel in the sun. The confines of the sun are visibly in a state of turmoil, for which a sufficient cause can be assigned in the relative readiness with which the outer portions part with heat to space, and so condensing produce a state of static instability, so that the outer surface of the sun in place of being fixed is continually circulating, portions at high temperatures rising rapidly from the depths to positions where they will part rapidly with their heat, and then, whether perceived or not, descending again. It is clear that at least a considerable part of the solar radiations comes from a more or less diffuse atmosphere. With the help of theory and observation the part played by this atmosphere is tolerably precise. Its absorptive effects upon the radiations of the inner photosphere can be readily traced progressively from the centre to the rim of the sun's disk, and it has been measured as a whole by Langley, W. E. Wilson and others, and for each separate wave-length by F. W. Very (*Astrophys. Journ.*, vol. xvi.). The entries in the table on following page express the reduction of intensity for different wave-lengths λ, when the slit is set at distances $\gamma\times$radius from the centre of the disk.

Building upon these results A. Schuster has shown (*Astrophys. Journ.*, vol. xvi.) that, if for the sake of argument the solar atmosphere be taken as homogeneous in temperature and quality, forming a sheet which itself radiates as well as absorbs, the radiation which an unshielded ideal radiator at 6000° would give is represented well, both in sum and in the distribution of intensity with respect to wave-length, by another ideal radiator—now the actual body of the sun—at about 6700°, shielded by an atmosphere at an average temperature of 5500°, and that such an atmosphere itself provides about 0·3 of the total radiations that reach us.

In connexion with this subject it may be mentioned that the highest measured temperature produced terrestrially, that of the arc, is about 3500° to 4000° abs.

λ.	γ=0·5.	γ=0·75.	γ=0·95.
mm.			
1500	0·959	0·950	0·856
1010	0·943	0·894	0·765
781	0·941	0·885	0·749
615	0·948	0·845	0·681
550	0·933	0·831	0·587
468	0·902	0·764	0·462
416	0·858	0·744	0·471

Age of the Sun. The energy which the sun pours out into space is, so far as we know, and except for the minute fraction intercepted by the disks of the planets ($\frac{1}{120000000}$) absolutely lost for the purposes of further mechanical effect. The amount is such that, supposing the average specific heat of the sun's body as high as that of water, there would result a general fall of temperature of 2·0° to 2·5° C. in the lapse of each year. Hence, if no other agency is invoked, at an epoch say $x \times 1000$ years ago, the sun's heat would have been greater than now by the factor $1+x/3n$, where $n \times 6000°$ is taken for the sun's present mean temperature. It seems possible that n is not a large number, and if we take x equal, say, to 200, we come to the most recent estimate—the astronomical—of the date of the earth's glacial epoch, when the sun's radiation was certainly not much more than it is now, while this factor would differ materially from unity. Hence loss does not go on without regeneration, and we are apparently at a stage when there is an approximate balance between them. It is in fact an impossibility that loss should go on without regeneration, for if any part of the sun's body loses heat, it will be unable to support the pressure of neighbouring parts upon it; it will therefore be compressed, in a general sense towards the sun's centre, the velocities of its molecules will rise, and its temperature will again tend upwards. In consequence of the radiation of heat the whole body will be more condensed than before, but whether it is hotter or colder than before will depend on whether the contraction set up is more or less than enough to restore an exact balance. If we are dealing with comparatively recent periods there is no evidence of progressive change, but if we go to remote epochs and suppose the sun to have once been diffused in a nebulous state, it is clear that its shrinkage, in spite of radiation, has left it hotter, so that the shrinkage has outrun what would suffice to maintain its radiation. It is equally clear that there is a point beyond which contraction cannot go, and thereafter, if not before, the body will begin to grow colder. There is thus a turning-point in the life of every star. The movement towards contraction and consequent rise of temperature which radiation sets up, like other motions, overruns the equilibrium-point, only however by a minute amount; the accumulated excesses from all past time now stored in the sun would maintain its radiations at their present rate for $n \times 3000$ years, that is, for a few thousand years only.

There is a superior limit to the quantity of energy which can be derived from contraction. If we suppose the sun's mass once existed in a state of extreme diffusion, the energy yielded by collecting it into its present compass would not suffice to maintain its present rate of radiation for more than 17,000,000 years in the past; nor if its mean density were ultimately to rise to eight times its present amount, for more than the same period in the future. This supposes the present density nearly uniform; if it is not uniform, any amount added to the former period is subtracted from the latter. A contraction of 0·2″ or 90 m. in the sun's radius would maintain the present emission for 3500 years. Such a rate of change would be quite insensible, and we can affirm that for recent times there is no reason to look for any other factor than contraction; but if we consider the remote past it is a different matter. We know nothing quantitatively of the radiations from a nebulous body: and it is quite possible that the loss of radiant energy in this early stage was very small; but it is at least as certain as any other physical inference that 17,000,000 years ago the earth itself was of its present dimensions, a comparatively old body with sea and living creatures upon it, and it is impossible to believe that the sun's radiations were wholly different; but, if they were not, they have been maintained from some other source than contraction.

The fall of meteoric matter into the sun must be a certain source of energy; if considerable, this external supply would retard the sun's contraction and so increase its estimated age, but to bring about a reconciliation with geological theory, very nearly the whole amount must be thus supplied. It is easy to calculate that this would be produced by an annual fall of matter equal to one nineteen millionth of the sun's mass, which would make an envelope eight metres thick, at the sun's mean density; this would be collected during the year from a spherical space extending beyond the orbit of Jupiter. The earth would intercept an amount of it proportional to the solid angle it subtends at the sun; that is to say, it would receive a deposit of meteoric matter about one-tenth of a millimetre, of density say 2, over its whole surface in the course of the year. So far there is nothing impossible in the theory. But there are two fatal objections. The sun is a small target for a meteorite coming from infinity to hit, and if this considerable quantity reaches its mark, a much greater amount will circulate round the sun in parabolas, and there is no evidence of it where it would certainly make itself felt, in perturbations of the planets. A second objection is that it fails in its purpose, because 20,000,000 years ago it would give a sun quite as much changed as the contraction theory gave. If we examine chemical sources for maintenance of the sun's heat, combustion and other forms of combination are out of the question, because no combinations of different elements are known to exist at a temperature of 6000°. A source which seems plausible, perhaps only because it is less easy to test, is rearrangement of the structure of the elements' atoms. An atom is no longer figured as indivisible, it is made up of more or less complex, and more or less permanent, systems in internal circulation. Now under the law of attraction according to the inverse square of the distance, or any other inverse power beyond the first, the energy of even a single pair of material points is unlimited, if their possible closeness of approach to one another is unlimited. If the sources of energy within the atom can be drawn upon, and the phenomena of radio-activity leave no doubt about this, there is here an incalculable source of heat which takes the cogency out of any other calculation respecting the sources maintaining the sun's radiation. An equivalent statement of the same conclusion may be put thus: supposing a gaseous nebula is destined to condense into a sun, the elementary matter of which it is composed will develop in the process into our known terrestrial and solar elements, parting with energy as it does so.

Spectrum of the Sun. The continuous spectrum leads to no inference, except that of the temperature of the central globe; but the multitude of dark lines by which it is crossed reveal the elements composing the truly gaseous cloaks which enclose it. A table of these lines is a physical document as exact as it is intricate. The visual portion extends from about w.l.3700 to 7200 tenth-metres; the ultra-violet begins about 2970, beyond which point our atmosphere is almost perfectly opaque to it; the infra-red can be traced for more than ten times the visual length, but the gaps which indicate absorption-lines have not been mapped beyond 9870. The ultra-violet and the visual portion are recorded photographically; Rowland's classical work shows some 5700 lines in the former, and 14,200 in the latter, on a graduated scale of intensities from 1000 to 0, or 0000, for the faintest lines; between a quarter and a third of these lines have been identified, fully 2000 belonging to iron, and several hundred to water vapour and other atmospheric absorption. The infra-red requires special appliances; it has been examined visually by the help of phosphorescent plates (Becquerel), and with special photographic plates (Abney); but the most efficient way is to use the bolometer or radiomicrometer; by this means some 500 or 600 lines have been mapped.

The first problem of the spectrum is to identify the effects of atmospheric absorption, especially oxygen, carbonic acid and water vapour; this is done generally by comparing the spectra of the sun at great and small zenith-distances, or by reducing the atmospheric effect by observing from a great elevation, as did P. J. C. Janssen from the summit of Mont Blanc, but the only unquestionable test is to find those lines which are not touched by Doppler effect when the receding and advancing limbs of the sun are compared (Cornu); by this method H. F. Newall has verified the presence of cyanogen in the photosphere, and it had previously served to disprove the solar origin of certain oxygen lines. In fact, doubt long surrounded the presence of oxygen in the sun, and was not set at rest until K. D. T. Runge and F. Paschen in 1896 identified an unmistakable oxygen triplet in the infra-red, which is shown terrestrially only in the vacuum tube, where the spectrum is very different from that of atmospheric absorptions. The absence of lines of the spectrum of any element from the solar spectrum is no proof that the element is absent from the sun; apart from the possibility that the high temperature and other circumstances may show it transformed into some unknown mode, which is perhaps the explanation of the absence of nitrogen, chlorine and other non-metals; if the element is of high atomic weight we should expect it to be found only in the lowest strata of the sun's atmosphere, where its temperature was nearly equal to that of the central globe, and so any absorption line which it showed would be weak. This is undoubtedly the case with lead and silver, and probably with mercury also. In Rowland's table lines from the arc-spectra of the following are identified. The order is approximately that of the numbers of identified lines. Excepting strontium, those which are low upon the list are represented also by lines of small intensity. The chromosphere adds the three last of the list. The strongest lines are those due to calcium, iron, hydrogen, sodium, nickel, in the order named.

Iron	Neodymium	Aluminium	Bismuth (?)
Nickel	Lanthanum	Cadmium	Tellurium
Titanium	Yttrium	Rhodium	Indium
Manganese	Niobium	Erbium	Oxygen
Chromium	Molybdenum	Zinc	Tungsten
Cobalt	Palladium	Copper	Mercury (?)
Carbon	Magnesium	Silver	———
Vanadium	Sodium	Germanium	Helium
Zirconium	Silicon	Glucinum	Ytterbium
Cerium	Hydrogen	Tin	Europium
Calcium	Strontium	Lead	
Scandium	Barium	Potassium	

The spectrum taken near the limb of the sun shows increased general absorption, but also definite peculiarities of great interest in connexion with the spectra of the spots, which it will be convenient to describe first.

Sun-spot Spectrum.

When the slit of the spectroscope is set across a spot, it shows, as might be expected, a general reduction of brightness as we pass from the photosphere to the penumbra; and a still greater one as we pass to the umbra. This is not a uniform shade over the whole length of the spectrum, but shows in bands or flutings of greater or less darkness, which in places and at intervals have been resolved by Young, Dunér and other unquestionable observers into hosts of dark lines. Besides this the spectrum shows very many differences from the mean spectrum of the disk, the interpretation of which is at present far from clear. Generally speaking, the same absorption lines are present, but with altered intensities, which differ from one spot to another. Some lines of certain elements are always seen fainter or thinner than on the photosphere, or even wholly obliterated; others sometimes show the same features, but not always; other lines of the same elements, perhaps originating at a level above the spot, are not affected; there are also bright streaks where even the general absorption of the spot is absent, and sometimes such a bright line will correspond to a dark line on the photosphere; most generally the lines are intensified, generally in breadth, sometimes in darkness, sometimes in both together, sometimes in one at the expense of the other; certain lines not seen in the photosphere show only across the umbra, others cross umbra and penumbra, others reach a short distance over the photosphere. A few of the lines show a double reversal, the dark absorption line being greatly increased in breadth and showing a bright emission line in its centre. The umbra of a spot is generally not tormented by rapid line-of-sight motions; where any motion has been found G. E. Hale and W. S. Adams make its direction downwards; but round the rim and on bridges the characteristic distortions due to eruptive prominences are often observed. There appears to be some connexion between prominences and spots; quiescent prominences are sometimes found above the spots, and W. M. Mitchell records an eruptive prominence followed next day in the same place by the appearance of a small spot. It does not appear that the affected lines follow in any way the sun-spot cycle. The radiation from a spot changes little as it approaches the sun's limb; in fact Hale and Adams find that the absorption from the limb itself differs from that of the centre of the disk in a manner exactly resembling that from a spot, the same lines being strengthened or weakened in the same way, though in much less degree, with, however, one material exception: if a line is winged in the photosphere the wings are generally increased in the spot, but on the limb they are weakened or obliterated. If the spot spectrum is compared with that of the chromosphere it appears that the lines of most frequent occurrence in the latter are those least affected in the spot, and the high level chromospheric lines not at all; the natural interpretation is that the spot is below the chromosphere. As to whether the spots are regions of higher or lower temperature than the photosphere, the best qualified judges are reserved or discordant, but recent evidence seems to point very definitely to a lower temperature. Hale and Adams have shown that the spectrum contains, besides a strong line-spectrum of titanium, a faint banded spectrum which is that of titanium oxide, and a second banded part remarked by Newall has been identified by A. L. Fowler as manganese hydride. The band spectrum, which corresponds to the compound or at least to the molecule of titanium, certainly belongs to a lower temperature than the line spectrum of the same metal. Hence above the spots there are vapours of temperature low enough to give the banded spectra of this refractory metal, while only line spectra of sodium, iron and others fusible at more moderate temperatures are found (see also SPECTROHELIOGRAPH).

Chromosphere.

The chromosphere, which surrounds the photosphere, is a cloak of gases of an average depth of 5000 m., in a state of luminescence less intense than that of the photosphere. Hence when the photosphere is viewed through it an absorption spectrum is shown, but when it can be viewed separately a bright line spectrum appears. Most of the metallic vapours that produce this lie too close to the photosphere for the separation to be made except during eclipses, when a flash spectrum of bright lines shines out for, say, five seconds after the continuous spectrum has disappeared, and again before it reappears (see ECLIPSE). F. W. Dyson has measured some eight hundred lines in the lower chromosphere and identified them with emission spectra of the following elements: hydrogen, helium, carbon with the cyanogen band, sodium, magnesium, aluminium, silicon, calcium, scandium, titanium, vanadium, chromium, manganese, iron, zinc, strontium, yttrium, zirconium, barium, lanthanum, cerium, neodymium, ytterbium, lead, europium, besides a few doubtful identifications; it is a curious fact that the agreement is with the spark spectra of these elements, where the photosphere shows exclusively or more definitely the arc lines, which are generally attributed to a lower temperature. In the higher chromosphere the following were recognized: helium and parhelium, hydrogen, strontium, calcium, iron, chromium, magnesium, scandium and titanium.

In the higher chromosphere on occasions metallic gases are carried up to such a level that without an eclipse a bright line spectrum of many elements may be seen, but it is always possible to see those of hydrogen and helium, and by opening the slit of the spectroscope so as to weaken still further the continuous spectrum from the photosphere (now a mere reflection) the actual forms of the gaseous structures called prominences round the sun's rim may be seen. In the visual spectrum there are four hydrogen lines and one helium line in which the actual shapes may be examined. The features seen differ according to the line used, as the circumstances prevailing at different levels of the chromosphere call out one line or another with greater intensity. The helium formations do not reach the sun's limb, and it is another puzzling detail that the spectrum of the disk shows no absorption line of anything like an intensity to correspond with the emission line of helium in the chromosphere. The prominences are of two kinds, quiescent and eruptive. Some of the former are to be seen at the limb on most occasions; they may hang for days about the same place; they reach altitudes of which the average is perhaps 20,000 m., and show the spectral lines of hydrogen and helium. Sometimes they float above the surface, sometimes they are connected with it by stems or branches, and they show delicate striated detail like cirrus cloud. The eruptive prominences, called also metallic, because it is they which show at their bases a complete bright line spectrum of the metallic elements, rush upwards at speeds which it is difficult to associate with transfers of matter; the velocity *often* exceeds 100 m. a second; W. M. Mitchell watched one rise at 250 m. a second to the height of 70,000 m., and in five minutes after it had faded away and the region was quiet. This is remarkable only in point of velocity. Much greater heights occur. Young records one which reached an elevation of 350,000 m., or more than three-quarters of the sun's radius. Since identification of spectral lines is a matter of extreme refinement, any cause which may displace lines from their normal places, or otherwise change their features, must be examined scrupulously. We have seen above numerous applications of the Doppler effect. Two other causes of displacement call for mention in their bearing on the solar spectrum—pressure and anomalous dispersion. The pressure which produces a continuous spectrum in gases at a temperature of 6000° must be very great. Recent experiments on arc spectra at pressures up to 100 atmospheres by W. J. Humphreys and by W. C. Duffield show several suggestive peculiarities, though their bearing on solar phenomena is not yet determined. The lines are broadened (as was already known), the intensity of emission is much increased, but some are weakened and some strengthened, nor is the amount of broadening the same for all lines, nor is it always symmetrical, being sometimes greater on the red side; but besides the effect of unsymmetrical broadening, every line is displaced towards the red; different lines again behave differently, and they may be arranged somewhat roughly in a few groups according to their behaviour; reversals are also effected, and the reversed line does not always correspond with the most intense part of the emission line. For example, in the iron spectrum three groups about wave-length 4500 are found by Duffield to be displaced respectively 0·17, 0·34, 0·66 tenth-metres, at 100 atmospheres. This shift towards the red J. Larmor suggests is due to relaxation of the spring of the surrounding ether by reason of the crowding of the molecules; a shift of 0·17 tenth-metres would, if interpreted by Doppler's principle, have been read as a receding velocity of 11 km. per second. It is clear that these results may give a simple key to some puzzling anomalies, and on the other hand, they may throw a measure of uncertainty over absolute determinations of line-of-sight velocities.

Effect of Pressure on Spectral Lines.

Anomalous Dispersion.

The possible applications of anomalous dispersion are varied and interesting, and have recently had much attention given to them. W. H. Julius holds that this sole fact robs of objective reality almost all the features of the sun, including prominences, spots, faculae and flocculi, and even the eleven-year period. Though few follow him so far, an explanation of the principle will make it clear that there are numerous possible opportunities for anomalous dispersion to qualify inferences from the spectrum. Theoretically anomalous dispersion is inseparable from absorption. When a system vibrating in a free period of its own encounters, say through the medium of an enveloping aether, a second system having a different free period, and sets it in vibration, the amplitude of the second vibration is inconsiderable, except when the periods approach equality. In such a case the two systems must be regarded as a single more complex one, the absorbed vibration becomes large, though remaining always finite, and the transmitted vibration undergoes a remarkable change in its period. This is illustrated in fig. 13, where the effect of a single absorbing system upon vibrations of all wave-lengths is shown. The line η shows the factor by which the index of refraction of the transmitted vibration is multiplied, and the curve ρ the intensity of the absorbed vibration for that wave-length. The relative increase of index takes place on the side where the wave-length is greater than that of the absorbing system. The effect of such a change may be to bend back the coloured ribbon of the spectrum upon itself, but just where this is done all its light will be robbed to maintain the absorbing system in vibration. Theory is here much less intricate than fact, but it seems to cover the most important features and to be well confirmed. Omitting extreme examples, like fuchsin, where the spectrum is actually cut in two, it is of more general importance to detect the phenomenon in the ordinary absorption lines of the metallic elements. This has been done most completely by L. Puccianti, who measured it by the interferometer in the case of more than a hundred lines of different metals; he found its degree to differ much in different lines of the same spectrum.

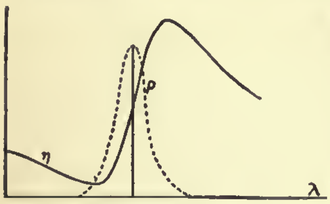


FIG. 13.

Differences of refractive index produce their greatest dispersive effects when incidence on the refracting surface is nearly tangential. W. H. Julius has used this fact in an admirable experiment to make the effects visible in the case of the D lines of sodium. A burner was constructed which gave a sheet of flame 750 mm. long and 1 mm. thick and to which sodium could be supplied in measured quantity. Light from an arc lamp was so directed that only that part reached the spectroscope which fell upon the flame of the burner at grazing incidence, and was thereby refracted. As the supply of sodium was increased, the lines, besides becoming broader, did so unsymmetrically, and a shaded wing or band appeared on one side or the other according as the beam impinged on one side or the other of the flame. These bands Julius calls dispersion bands, and then, assuming that a species of tubular structure prevails within a large part of the sun (such as the filaments of the corona suggest for that region), he applies the weakening of the light to explain, for instance, the broad dark H and K calcium lines, and the sun-spots, besides many remoter applications. But it should be noted that the bands of his experiment are not due to anomalous dispersion in a strict sense. They are formed now on one side, now on the other, of the absorption line; but the rapid increase of refractive index which accompanies true anomalous dispersion, and might be expected to produce similar bands by scattering the light, appears both from theory and experiment to belong to the side of greater wave-length exclusively. Julius's phenomenon seems inseparable from grazing incidence, and hence any explanation it supplies depends upon his hypothetical tubular structure for layers of equal density. There are other difficulties. In calcium, for instance, the g line shows in the laboratory much stronger anomalous dispersion than H and K; but in the solar spectrum H and K are broad out of all comparison to g. Hale has pointed out other respects in which the explanation fails to fit facts. In connexion with the question whether the phenomena of the sun are actually very different from what they superficially appear, A. Schmidt's theory of the photosphere deserves mention; it explains how the appearance of a sharp boundary might be due to a species of mirage.

Schmidt's Theory of the Photosphere.

Consider the rays which meet the eye (at unit distance) at an angle d from the centre of the sun's disk; in their previous passage through the partially translucent portions of this body we have the equation $\sin d = r\mu \sin i$ (fig. 14). Now generally μ will decrease as r increases, but the initial value of μ is not likely to be more than, say, twice its final value of unity, while r increases manifold in the same range, hence in general $r\mu$ will increase with r, and therefore for a given value of d, i will continually increase as we go inwards up to 90°, which it will attain for a certain value of r, and this will be the deepest

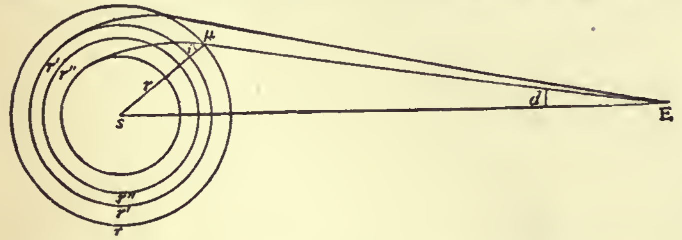


FIG. 14.

level of the sun's body from which rays will reach the eye at the given angle d. But if there is a region, say from r' to r'' throughout which $r\mu$ decreases as r increases, any ray which cuts the outer envelope r' at an acute angle will cut the inner one r'' also, and can be traced still further inwards before the angle i amounts to 90°. Apart then from absorption there will be a discontinuous change in brightness in the apparent disk at that value of the angular radius d which corresponds to tangential emission from the upper lever r' of this mirage-forming region. Of course we are unable to say whether such a region is an actuality in the sun, on the earth it is an exception and transient, but the greater the dimensions of the body the more probable is its occurrence. The theory can be put to a certain test by considering its implications with respect to colour. The greater μ is, the greater would be the value of d, the apparent angular radius, corresponding to horizontal emission from a given level r, and that whether we accept Schmidt's theory or not. Hence if the sun's diameter were measured through differently coloured screens, the violet disk must appear greater than the red. Now measures made by Auwers with the Cape heliometer showed no difference, amounting to 0·1″, and so far negative the idea that the rays reach us after issuing from a level where μ is sensibly different from unity. Presumably, then, the inner emissions are absorbed and those which reach us start from very near the surface.

The Sun's Distance.

The sun's distance is the indispensable link which connects terrestrial measures with all celestial ones, those of the moon alone excepted; hence the exceptional pains taken to determine it. The transits of Venus of 1874 and 1882 were observed by expeditions trained for the purpose beforehand with every possible foresight, and sent out by the British, French and German governments to occupy suitable stations distributed over the world, but they served only to demonstrate that no high degree of accuracy can ever be expected from this method. It is the atmosphere of Venus that spoils the observation. Whatever be the subsequent method of reduction, the instant is required when the planet's disk is in internal contact with that of the sun; but after contact has plainly passed it still remains connected with the sun's rim by a "black drop," with the result that trained observers using similar instruments set up a few feet from one another sometimes differed by half a minute of time in their record. It is little wonder, then, that the several reductions of the collected results were internally discordant so as to leave outstanding a considerable "probable error," but showed themselves able to yield very different conclusions when the same set was discussed by different persons. Thus from the British observations of 1874 Sir G. B. Airy deduced a parallax of 8·76″ and E. J. Stone 8·88″; from the French observations of the same date Stone deduced 8·88″ and V. Puiseux 8·91″. The first really adequate determinations of solar parallax were those of Sir David Gill, measured by inference from the apparent diurnal shift of Mars among the stars as the earth turned diurnally upon its axis; the observations were made at the island of Ascension in 1878. The disk of Mars and his colour are certain disadvantages, and Gill afterwards superseded his own work by treating in the same way the three minor planets Victoria, Iris and Sappho—the last was observed by W. L. Elkin. These planets are more remote than Mars, but that loss is more than outweighed by the fact that they are indistinguishable in appearance from stars. The measures were made with the Cape heliometer and have never been superseded, for the latest results with the minor planet Eros exactly confirm Gill's result—8·80″—while they decidedly diminish the associated probable error. The planet Eros was discovered in 1899, and proved to have an orbit between the earth and Mars, while every one of the other five or six hundred known asteroids lies between Mars and Jupiter. Its mean distance from the sun is 1·46 times that of the earth; but, besides, the eccentricity of its orbit is large (0·22), so that at the most favourable opportunity it can come within one-seventh of the distance of the sun. This favourable case is not realized at every opposition, but in 1900 the distance was as little as one-third of that of the sun, and it was observed from October 1900 to January 1901 photographically upon a concerted but not absolutely uniform plan by many observatories, of which the chief were the French national observatories, Greenwich, Cambridge, Washington and Mount Hamilton. The planet showed a stellar disk varying in magnitude from 9 to 12. On some plates the stars were allowed to trail and the planet was followed, in others the reverse procedure was taken; in either case the planet's position is measured by referring it to "comparison stars" of approximately its own magnitude situated within 25′ to 30′ of the centre of the plate, while these stars are themselves fixed by measurement from brighter "reference stars," the positions of which are found by meridian observations if absolute places are desired. The best results seem to be obtained by comparing an evening's observations with those of the following morning at the same observatory; the reference can then be made to the same stars and errors in their position are therefore virtually eliminated; even if the observations of a morning with those of the following evening are used the probable error is doubled. The observations at Greenwich thus reduced gave errors ±0·0036″ and ±0·0080″ respectively. The general result is 8·800″±0·0044″. To collate the whole of the material accumulated at different parts of the world is a much more difficult task; it requires first of all a most carefully constructed star-catalogue, upon which the further discussion may be built. The discussion was completed in 1909 by A. R. Hinks, and includes the material from some hundreds of plates taken at twelve observatories; in general it may be said the discussion proves that the material is distinctly heterogeneous, and that in places where it would hardly be expected. The result is nearly the same as found at Greenwich alone, 8·806″ ±0·0026″, or a mean distance of 92,830,000 m. $=1·493\times10^{13}$ cm. with an error which is as probably below as above 30,000 miles.

The sun's distance enters into other relations, three of which permit of its determination, viz. the equation of light, the constant of aberration, and the parallactic inequality of the moon; the value of the velocity of propagation of light enters in the reduction of the two first, but as this is better known than the sun's parallax, no disadvantage results. The equation of light is the time taken by light to traverse the sun's mean distance from the earth; it can be found by the acceleration or retardation of the eclipses of Jupiter's satellites according as Jupiter is approaching opposition or conjunction with the sun; a recent analysis shows that its value is 498·6″, which leads to the same value of the parallax as above, but the internal discrepancies of the material put its authority upon a much lower level. The constant of aberration introduces the sun's distance by a comparison between the velocity of the earth in its orbit and the velocity of light. Its determination is difficult, because it is involved with questions of the changing orientation of the earth's axis of rotation. S. C. Chandler considers the value 20·52″ is well established; this would give a parallax of 8·78″. The chief term in the lunar longitude which introduces the ratio of the distances of the sun and moon from the earth explicitly is known as the parallactic inequality; by analysis of the observations P. H. Cowell finds that its coefficient is 124·75″, which according to E. W. Brown's lunar theory would imply a parallax 8·778″.

The Sun's Dimensions. The best discussion of the sun's apparent diameter has been made by G. F. J. A. Auwers, in connexion with his reduction of the German observations of the transit of Venus of 1874 and 1882. It was found that personality played an important part; the average effect might be 1″, but frequently it reached 3″, 4″, 5″ or even 10″, with the same instrument and method, nor was it fixed for the same observer. Some 15,000 observations, from 1851 to 1883, taken by one hundred observers at Greenwich, Washington, Oxford and Neuchâtel, cleared as far as possible of personal equation, showed no sign of change that could with probability be called progressive or periodic, particularly there was no sign of adhesion to the sun-spot period. Better determinations of the actual value came from the heliometer, and gave an angular diameter of 31′ 59·26″±0·10″, and the value of the polar diameter exceeded the equatorial by 0·038″±0·023″. The conclusion is that the photosphere is very sharply defined and shows no definite departure from a truly spherical shape. Using the parallax 8·80″, the resulting diameter of the sun is 864,000 m. $=1·390\times10^{11}$ cm.

The Sun as a Star. If we regard the sun as one of the stars, the first four questions we should seek to answer are its distance from its neighbours, proper motion, magnitude and spectral type. In some respects the systematic prosecution of these inquiries has only begun, and properly considered they involve vast researches into the whole stellar system. It would take us too far to treat them at any length, but it may be convenient to summarize some of the results. The sun's nearest neighbour is α Centauri, which is separated from it by 270,000 times the earth's distance, a space which it would take light four years to traverse. It is fairly certain that not more than six stars lie within twice this distance. No certain guide has been found to tell which stars are nearest to us; both brightness and large proper motion, though of course increased by proximity, are apparently without systematic average relation to parallax.

The sun's proper motion among the stars has been sought in the past as the assumption that the universe of stars showed as a whole no definite displacement of its parts, and, on this assumption, different methods of reduction which attributed *apparent* relative displacement of parts to *real* relative displacement of the sun agreed fairly well in concluding that the "apex of the sun's way" was directed to a point in right ascension 275°, declination +37° (F. W. Dyson and W. G. Thackeray), that is to say, not far from the star Vega in the constellation Lyra, and was moving thither at a rate of twelve miles per second. But recent researches by J. C. Kapteyn and A. S. Eddington, confirmed by Dyson, show that there is better ground for believing that the universe is composed mainly of two streams of stars, the members of each stream actuated by proper motions of the same sense and magnitude on the average, than that the relative motions of the stars with one another are fortuitous (see Star). This removes completely the ground upon which the direction of the sun's way has hitherto been calculated, and leaves the question wholly without answer.

A star is said to rise one unit in magnitude when the logarithm of its brightness diminishes by 0·4. Taking as a star of magnitude 1 α Tauri or α Aquilae, where would the sun stand in this scale? Several estimates have been made which agree well together; whether direct use is made of known parallaxes, or comparison is made with binaries of well-determined orbits of the same spectral type as the sun, in which therefore it may be assumed there is the same relation between mass and brilliancy (Gore), the result is found that the sun's magnitude is −26·5, or the sun is 10^{11} times as brilliant as a first magnitude star; it would follow that the sun viewed from α Centauri would appear as of magnitude 0·7, and from a star of average distance which has a parallax certainly less than 0·1″, it would be at least fainter than the fifth magnitude, or, say, upon the border-line for naked-eye visibility. We cannot here do more than refer to the spectral type of the sun. It is virtually identical with a group known as the "yellow stars," of which the most prominent examples are Capella, Pollux and Arcturus; this is not the most numerous group, however; more than one half of all the stars whose spectra are known belong to a simpler type in which the metallic lines are faint or absent, excepting hydrogen and sometimes helium, which declare themselves with increased prominence. These are the white stars, and the most prominent examples are Sirius, Vega and Procyon. It is commonly though not universally held that the difference between the white and yellow stars arises from their stages of development merely, and that the former represent the earlier stage. This again is disputed, and there is indeed as yet slight material for a decisive statement.

Summary of Numerical Data.

Parallax: 8·806″ ± 0·003″.
Mean distance from earth: 92,830,000 m. $=1·493\times10^{13}$ cm.
(Time taken by light to traverse this distance: 498·6″).
Diameter: Angular, at mean distance, 1919·3″.
Linear, 109×earth's equatorial diameter=864,000 m.= $1·390\times10^{11}$ cm.
Mass: 332,000×mass of the earth.
Mean density: ·256×mean density of earth=1·415.
Equator; inclination to ecliptic: 7° 15′.
Longitude of ascending node (1908·0), 74° 28·6′.
Rotation period; latitude 0°: 24·46^d
30°: 26·43^d
60°: 29·63^d
80°: 30·56^d
Solar constant, or units of energy received per minute per square centimetre at earth's mean distance: 2·1 calories.
Effective temperature, as an ideal radiator or "black body": 6000° abs.

Bibliography.—Nearly all the chief data respecting the sun have lately been and still are under active revision, so that publications have tended to fall rapidly out of date. The most important series is the *Astrophysical Journal*, which is indispensable, and in itself almost sufficient; among other matter it contains all the publications of Mount Wilson Solar Observatory (Professor G. E. Hale), H. A. Rowland's *Tables of Wave-Lengths*, many theoretical papers, and some reproductions of important papers issued elsewhere. But there are also papers which cannot be disregarded in *Monthly Notices* and *Memoirs of the Royal Astronomical Society*, and in *Astronomische Nachrichten*. S. P. Langley's *Researches on Solar Heat* are published by the War Department (Signal Service, xv.) (Washington, 1884), and Gill's parallax researches in *Cape Annals*, vols. vi., vii. Auwer's discussion of the sun's diameter is in the discussion of the transit of Venus observations for 1874 and 1882. The best single volume upon the whole subject is C. A. Young's *The Sun*, 2nd ed. (Inter. Sci. Series), and an excellent summary of solar spectroscopy, as far as rapid progress permits, is in Frost's translation of Scheiner, *Astronomical Spectroscopy* (1894). Scheiner's volume, *Strahlung u. Temperatur d. Sonne* (1899), contains a great quantity of interesting matter carefully collected and discussed. For authoritative declarations upon the latest moot points the *Transactions of the International Union for Solar Research* (Manchester) may be consulted, vol. i. having been issued in 1906, and vol. ii. in 1908. (R. A. Sa.)

SUN-BIRD, a name more or less in use for many years,[1] and now generally accepted as that of a group of over 100 species of small birds, but when or by whom it was first applied is uncertain. Those known to the older naturalists were for a long while referred to the genus *Certhia* (Tree-creeper, *q.v.*) or some other group, but they are now fully recognized as forming a valid Passerine family Nectariniidae, from the name *Nectarinia* invented in 1881 by Illiger. They inhabit the Ethiopian, Indian, and Australian regions,[2] and, with some notable exceptions, the species mostly have but a limited range. They are considered to have their nearest allies in the Meliphagidae (see Honey-eater) and the members of the genus *Zosterops*;

[1] Certainly since 1826 (cf. Stephens, *Gen. Zoology*, vol. xiv. pt. 1, p. 292). W. Swainson (*Nat. Hist. and Classif. Birds*, i. 145) says they are "so called by the natives of Asia in allusion to their splendid and shining plumage," but gives no hint as to the nation or language wherein the name originated. By the French they have been much longer known as "Souimangas," from the Madagascar name of one of the species given in 1658 by Flacourt as *Soumangha*.

[2] One species occurs in Baluchistan, which is perhaps outside of the Indian region, but the fact of its being found there may be a reason for including that country within the region, just as the presence of another species in the Jordan valley induces zoographers to regard the Ghór as an outlier of the Ethiopian region.

but their relations to the last require further investigation. Some of them are called "humming-birds" by Anglo-Indians and colonists, but with that group, which, as before indicated (see HUMMING-BIRD), belongs to the *Picariae*, the sun-birds, being true *Passeres*, have nothing to do. Though part of the plumage in many sun-birds gleams with metallic lustre, they owe much of their beauty to feathers which are not lustrous, though almost as vivid,[1] and the most wonderful combination of the brightest colours—scarlet, purple, blue, green and yellow —is often seen in one and the same bird. One group, however, is dull in hue, and but for the presence in some of its members of yellow or flame-coloured precostal tufts, which are very characteristic of the family, might at first sight be thought not to belong here. Graceful in form and active in motion, sun-birds flit from flower to flower, feeding on small insects which are attracted by the nectar and on the nectar itself; but this is usually done while perched and rarely on the wing as is the habit of humming-birds. The extensible tongue, though practically serving the same end in both groups, is essentially different in its quasi-tubular structure, and there is also considerable difference between this organ in the Nectariniidae and the Meliphagidae.[2] The nests of the sun-birds, domed with a penthouse porch, and pensile from the end of a bough or leaf, are very neatly built. The eggs are generally three in number, of a dull white covered with confluent specks of greenish grey.

The Nectariniidae form the subject of a sumptuous *Monograph* by G. E. Shelley (4to, London, 1876–1880), in the coloured plates of which full justice is done to the varied beauties which these gloriously arrayed little beings display, while almost every available source of information has been consulted and the results embodied. This author divides the family into three sub-families: Neodrepaninae, consisting of a single genus and species peculiar to Madagascar; Nectariniinae, containing 9 genera, one of which, *Cinnyris*, has more than half the number of species in the whole group; and Arachnotherinae (sometimes known as "spider-hunters"), with 2 genera including 11 species—all large in size and plain in hue. To these he also adds the genus *Promerops*,[3] composed of 2 species of South African birds, of very different appearance, whose affinity to the rest can as yet hardly be taken as proved. According to E. L. Layard, the habits of the Cape *Promerops*, its mode of nidification, and the character of its eggs are very unlike those of the ordinary Nectariniidae. In the British Museum *Catalogue of Birds* (ix. 1–126 and 291) H. J. Gadow has more recently treated of this family, reducing the number of both genera and species, though adding a new genus discovered since the publication of Shelley's work.

(A. N.)

SUN-BITTERN, the *Eurypyga helias* of ornithology, a bird that has long exercised systematists and one whose proper place can scarcely yet be said to have been determined to everybody's satisfaction.

According to Pallas, who in 1781 gave (*N. nördl. Beyträge*, vol. ii. pp. 48–54, pl. 3) a good description and fair figure of it, calling it the "Surinamische Sonnenreyger," *Ardea helias*, the first author to notice this form was Fermin, whose account of it, under the name of "Sonnenvogel," was published at Amsterdam in 1759 (*Descr., &c., de Surinam*, ii. 192), but was vague and meagre. In 1772, however, it was satisfactorily figured and described in Rozier's *Observations sur la physique*, &c. (vol. v. pt. 1, p. 212, pl. 1), as the *Petit paon des roseaux*—by which name it was known in French Guiana.[4] A few years later D'Aubenton figured it in his well-known series (*Pl. Enl.*, p. 782), and then in 1781 came Buffon (*H.N.*, *Oiseaux*, vol. viii. pp. 169, 170, pl. xiv.), who, calling it "Le Caurlâ ou petit paon des roses," announced it as hitherto undescribed and placed it among the Rails. In the same year appeared the above-cited paper by Pallas, who, notwithstanding his remote abode, was better informed as to its history than his great contemporary, whose ignorance, real or affected, of his fellow-countryman's priority in the field is inexplicable; and it must have been by inadvertence that, writing "roses" for "roseaux," Buffon turned the colonial name from one that had a good meaning into nonsense. In 1783 Boddaert, equally ignorant of what Pallas had done, called it *Scolopax solaris*,[5] and in referring it to that genus he was followed by Latham (*Synopsis*, iii. 156), by whom it was introduced to English readers as the "Caurale Snipe." Thus within a dozen years this bird was referred to three perfectly distinct genera, and in those days genera meant much more than

(From *Cambridge Natural History*, vol. ix., "Birds," by permission of Macmillan & Co., Ltd.)

FIG. 1.—Sun-Bittern (*Eurypyga helias*).

they do now. Not until 1811 was it recognized as forming a genus of its own. This was done by Illiger, whose appellation, *Eurypyga* has been generally accepted.

The sun-bittern is about as big as a small curlew, but with much shorter legs and a rather slender, straight bill. The wings are moderate, broad, and rounded, the tail rather long and broad. The head is black with a white stripe over and another under each eye, the chin and throat being also white. The rest of the plumage is not to be described in a limited space otherwise than generally, being variegated with black, brown, chestnut, bay, buff, grey and white—so mottled, speckled and belted either in wave-like or zigzag forms as somewhat to resemble certain moths. The bay colour forms two conspicuous patches on each wing, and also an antepenultimate bar on the tail, behind which is a subterminal band of black. The irides are red; the bill is greenish olive; and the legs are pale yellow. As in the case of most South American birds, very little is recorded of its habits in freedom, except that it frequents the muddy and wooded banks of rivers, feeding on small fishes and insects. In captivity it soon becomes tame, and has several times made its nest and reared its young (which, when hatched, are clothed with mottled down; *Proc. Zool. Soc.*, 1866, p. 76, pl. ix. fig. 1) in the Zoological Gardens (London), where examples are generally to be seen and their plaintive piping heard. It ordinarily walks with slow and precise steps, keeping its body in a horizontal position, but at times, when excited, it will go through a series of fantastic performances, spreading its broad wings and tail so as to display their beautiful markings. This species inhabits Guiana and the interior of Brazil; but in Colombia and Central America occurs a larger and somewhat differently coloured form which is known as *E. major*.

For a long while it seemed as if *Eurypyga* had no near ally, but on the colonization of New Caledonia by the French, an extremely curious bird was found inhabiting most parts of that island, to which it is peculiar. This the natives called the Kagu, and it is the *Rhinochetus jubatus* of ornithology. Its original describers, MM. Jules Verreaux and Des Murs, regarded it first as a heron and then as a crane (*Rev. et Mag. de Zoologie*, 1860, pp. 439–441, pl. 21; 1862, pp. 142–144); but, on Mr George Bennett sending two live examples to the Zoological Gardens, Mr Bartlett quickly detected in them an affinity to *Eurypyga* (*Proc. Zool. Soc.*, 1862, pp. 218, 219, pl. xxx.), and in due time anatomical investigation showed him to be right. The kagu, however, would not strike the ordinary observer as having much outward resemblance to the sun-bittern, of which it has neither the figure nor posture. It is rather a long-legged bird, about as large as an ordinary fowl, walking quickly

[1] Cf. H. J. Gadow, *Proc. Zool. Soc.* (1882), pp. 409–421, pls. xxvii., xxviii.

[2] Ibid. (1883), pp. 62–69, pl. xvi.

[3] According to M. J. Brisson (*Ornithologie*, ii. 460), this name was the invention of Réaumur. It seems to have become Anglicized.

[4] This figure and description were repeated in the later issue of this work in 1777 (vol. i. pp. 679–781, pl. 1).

[5] Possibly he saw in the bird's variegated plumage a resemblance to the painted snipes, *Rhynchaea*. His specific name shows that he must have known how the Dutch in Surinam called it.

and then standing almost motionless, with bright red bill and legs, large eyes, a full pendent crest, and is generally of a light slate-colour, paler beneath, and obscurely barred on its longer wing-coverts and tail with a darker shade. It is only when it spreads its wings that these are seen to be marked and spotted with white, rust-colour, and

FIG. 2.—Kagu (*Rhinochetus jubatus*).

black, somewhat after the pattern of those of the sun-bittern. Like that bird, too, the kagu will, in moments of excitement, give up its ordinary placid behaviour and execute a variety of violent gesticulations, some of them even of a more extraordinary kind, for it will dance round, holding the tip of its tail or one of its wings in a way that no other bird is known to do. Its habits in its own country were described at some length in 1863 by M. Jouan (*Mém. Soc. Sc. Nat. Cherbourg*, ix. 97 and 235), and in 1870 by M. Marie (*Actes Soc. Linn. Bordeaux*, xxvii. 323–326), the last of whom predicts the speedy extinction of this interesting form, a fate foreboded also by the statement of Messrs Layard (*Ibis*, 1882, pp. 534, 535) that it has nearly disappeared from the neighbourhood of the more settled and inhabited parts.

The internal and external structure of both these remarkable forms is now fully known and it appears that they, though separable as distinct families, Eurypygidae and Rhinochetidae, must be deemed the relics of very ancient and generalized types more or less related to the Rallidae (see RAIL), and Psophiidae (see TRUMPETER). It is only to be remarked that the eggs of both *Eurypyga* and *Rhinochetus* have a very strong ralline appearance—stronger even than the figures published (*Proc. Zool. Soc.*, 1868, pl. 12) would indicate. (A. N.)

SUNBURY, a borough and the county seat of Northumberland county, Pennsylvania, U.S.A., on the Susquehanna river about 53 m. by rail N. by E. of Harrisburg. Pop. (1900), 9810, of whom 197 were foreign-born; (1910 U.S. census) 13,770. It is served by the Pennsylvania, the Northern Central (controlled by the Pennsylvania) and the Philadelphia & Reading railways. Sunbury's principal industry is the manufacture of silk; the Pennsylvania railway has repair shops here. The total value of the borough's factory products increased from $1,868,157 in 1900 to $2,592,829 in 1905, or 38·8%. The borough stands on the site of the old Indian village, Shamokin, which was occupied by Delawares, Senecas and Tutelos, and was long the most prominent Indian village in the province; in 1747–1755 there was a Moravian mission here. Owing to the strategic importance of the place the provincial government erected Fort Augusta here in 1756; during the War of Independence many of the fugitives from the Wyoming Massacre came to this fort. Sunbury was first surveyed in 1772 and was incorporated as a borough in 1797.

SUNBURY-ON-THAMES, an urban district in the Uxbridge parliamentary division of Middlesex, England, 17 m. S.W. of St Paul's Cathedral, London, on a branch of the London & South Western railway. Pop. (1901), 4544. It is a favourite riverside resort and has grown considerably as a residential district. The church of St Mary, Byzantine in style, dates from 1752. There are pumping works and filtration beds for the water-supply of London. To the north-east is Kempton Park, the manor-house of which was a royal residence early in the 14th century. The park is famous for its race-meetings, the principal fixture being the Jubilee Handicap, established in 1887. The manor was granted by Edward the Confessor to Westminster Abbey, and passed in the 13th century to the see of London and in the 16th to the Crown; but was not so held later than 1603.

SUN COPYING, or PHOTO COPYING, the name given to that branch of photographic contact printing which is carried out without the aid of a camera-made negative. It is now used very extensively for copying documents, especially the plans of architects and engineers.

The earliest discovered process, the ferroprussiate, is still the one most largely used, on account of its economy and permanence, combined with a simplicity of manipulation that renders it highly suitable for office use; it was invented in 1840 by Sir John Herschel. This method has the disadvantage that the copies are blue in colour, and, as it is a negative process, the black lines of the original become the white lines of the print; the development is by washing in water, so that the important feature of accuracy of scale is lost. The next step of importance was in 1864, when William Willis of Birmingham, the father of the inventor of the platinotype system of photographic printing, invented the aniline process. In this method a paper sensitized with bichromate of potassium is exposed to light, with the document (generally a tracing) in front of it; the unprotected lines are bleached out, but the protected ones remain and are developed by contact with vapour of aniline, a subsequent washing for the removal of chemicals completing the print. For twenty years this process was successfully used with little opposition other than that of the blue prints previously referred to, and of the Pellet process, which gave a blue line on a white ground, the inventor being associated throughout with the firm of Vincent Brooks, Day & Son; but since that time a large number of other methods have come into use, some requiring a paper negative in the first instance and some not, but all much aided by improved methods of applying electric light. The earliest of these improved systems utilizing electric light was that invented by Mr B. J. Hall, whose photo-copier consists of two semi-circular glasses forming a cylinder, which may be revolved, and through which an arc lamp travels, while the tracing and sensitized paper are strapped to its outer surface.

Between 1900 and 1908 attention was chiefly directed to overcoming the variation of scale that is inevitable in all systems that require a final washing in water either for development or for the removal of chemicals; and at least four excellent systems have arisen. While Mr F. R. Vandyke was perfecting the system which he patented in 1901 and which has been adopted by the Ordnance Survey Department at Southampton, Messrs Vincent Brooks, Day & Son were working along somewhat similar lines, the outcome of which was their "True-to-Scale Photo Litho" system. In both these methods a reversed positive print is secured on zinc, from which copies can be made in printer's ink of any colour by the usual lithographic method on almost any material that may be desired. The plates prepared by these methods are so sensitive to light that excellent results can be secured from drawings made even on semi-transparent material such as drawing paper, and of course the plates when made are capable of alteration or addition and can be stored for reprints.

An admirable process had since been invented by MM. Dorel Frères of Paris, which is even more expeditious, and being less in prime cost is more suitable when only a small number of prints is required. In this case a large sheet of thin zinc is coated with chemically-treated gelatin, with the result that when a ferroprussiate print is pressed down on it either with the hand or by a roller the protected lines affect the gelatin in such a way that the parts that have been in contact with them receive a greasy ink while the remainder of the surface rejects it, so that a small number (not generally exceeding six) of very excellent prints can be secured. The inventors refrained from taking out a patent either in France or elsewhere, preferring to work their invention as a secret process, but the formula appears either to have leaked out or to have been discovered, so that the process is, perhaps with slight variations, used under numerous names. With the aid of the various systems of rotary copiers, by which blue prints of almost any length can be secured, Dorel prints identical in scale with the originals have been made of the length of 22 feet. An interesting kindred process but with well defined variations is known as velography.

For the technical and chemical details of the various methods reference may be made to *Ferric and Heliographic Processes* by G. E. Brown (Dawbarn & Ward). (F. V. B.)

SUNDA ISLANDS, the collective name of the islands in the Malay Archipelago which extend from the Malay Peninsula to the Moluccas. They are divided into the Great Sunda Islands—*i.e.* Sumatra, Java, Borneo, Celebes, Banka and Billiton, with their adjacent islands—and the Little Sunda Islands, of which the more important are Bali, Lombok, Sumbawa, Flores, Sumba and Timor.

Sunda Strait is the channel separating Sumatra from Java and uniting the Indian Ocean with the Java Sea. It is 15 m. broad between the south-eastern extremity of Sumatra and the town of Anjer in Java. In the middle is the low-lying well-wooded island of Dwars-in-den-Weg ("right in the way"), otherwise Middle Island or Sungian. In 1883 Sunda Strait was the scene of the most terrific results of the eruption of Krakatoa (*q.v.*), a volcanic island further west in the strait.

SUNDARBANS, or Sunderbunds, a tract of waste country in Bengal, India, forming the seaward fringe of the Gangetic delta. It has never been surveyed, nor has the census been extended to it. It stretches for about 165 m., from the mouth of the Hugli to the mouth of the Meghna, and is bordered inland by the three settled districts of the Twenty-four Parganas, Khulna and Backergunje. The total area (including water) is estimated at 6526 sq. m. It is a water-logged jungle, in which tigers and other wild beasts abound. Attempts at reclamation have not been very successful. The forest department realizes a large revenue, chiefly by tolls on produce removed. The characteristic tree is the *sundri* (*Heritiera littoralis*), from which the name of the tract has probably been derived. It yields a hard wood, used for building, and for making boats, furniture, &c. The Sundarbans are everywhere intersected by river channels and creeks, some of which afford water communication between Calcutta and the Brahmaputra valley, both for steamers and for native boats.

SUNDAY, or the Lord's Day (ἡ τοῦ ἡλίου ἡμέρα, *dies solis*; ἡ κυριακὴ ἡμέρα, *dies dominica*, *dies dominicus*[1]), in the Christian world, the first day of the week, celebrated in memory of the resurrection of Christ, as the principal day for public worship. An additional reason for the sanctity of the day may have been found in its association with Pentecost or Whitsun.[2] There is no evidence that in the earliest years of Christianity there was any formal observance of Sunday as a day of rest or any general cessation of work. But it seems to have from the first been set apart for worship. Thus according to Acts xx. 7, the disciples in Troas met weekly on the first day of the week for exhortation and the breaking of bread; 1 Cor. xvi. 2 implies at least some observance of the day; and the solemn commemorative character it had very early acquired is strikingly indicated by an incidental expression of the writer of the Apocalypse (i. 10), who for the first time gives it that name ("the Lord's Day") by which it is almost invariably referred to by all writers of the century immediately succeeding apostolic times.[3] Indications of the manner of its observance during this period are not wanting. *Teaching of the Apostles* (c. 14) contains the precept: "And on the Lord's day of the Lord (κατὰ κυριακὴν κυρίου) come together and break bread and give thanks after confessing your transgressions, that your sacrifice may be pure." Ignatius (*Ad Magn.* c. 9) speaks of those whom he addresses as "no longer Sabbatizing, but living in the observance of the Lord's day (κατὰ κυριακὴν ζῶντες) on which also our life sprang up again."[4] Eusebius (*H.E.* iv. 23) has preserved a letter of Dionysius of Corinth (A.D. 175) to Soter, bishop of Rome, in which he says: "To-day we have passed the Lord's holy day, in which we have read your epistle"; and the same historian (*H.E.* iv. 26) mentions that Melito of Sardis (A.D. 170) had written a treatise on the Lord's day. Pliny's letter to Trajan in which he speaks of the meetings of the Christians "on a stated day" need only be alluded to. The first writer who mentions the name of Sunday as applicable to the Lord's day is Justin Martyr; this designation of the first day of the week, which is of heathen origin (see Sabbath), had come into general use in the Roman world shortly before Justin wrote. He describes (*Apol.* i. 67) how "on the day called Sunday" town and country Christians alike gathered together in one place for instruction and prayer and charitable offerings and the distribution of bread and wine; they thus meet together on that day, he says, because it is the first day in which God made the world, and because Jesus Christ on the same day rose from the dead.

As long as the Jewish Christian element continued to have any influence in the Church, a tendency to observe Sabbath as well as Sunday naturally persisted. Eusebius (*H.E.* iii. 27) mentions that the Ebionites continued to keep both days, and there is abundant evidence from Tertullian onwards that so far as public worship and abstention from fasting are concerned the practice was widely spread among the Gentile churches. Thus we learn from Socrates (*H.E.* vi. c. 8) that in his time public worship was held in the churches of Constantinople on both days; the *Apostolic Canons* (can. 66 [65]) sternly prohibit fasting on Sunday or Saturday (except Holy Saturday); and the injunction of the *Apostolic Constitutions* (v. 20; cf. ii. 59, vii. 23) is to "hold your solemn assemblies and rejoice every Sabbath day (excepting one), and every Lord's day." Thus the earliest observance of the day was confined to congregational worship, either in the early morning or late evening. The social condition of the early Christians naturally forbade any general suspension of work. Irenaeus (*c.* 140–202) is the first of the early fathers to refer to a tendency to make Sunday a day of rest in his mention that harvesting was forbidden by the Church on the day. Tertullian, writing in 202, says "On the Lord's day we ought abstain from all habit and labour of anxiety, putting off even our business." But the whole matter was placed on a new footing when the civil power, by the constitution of Constantine mentioned below, began to legislate as to the Sunday rest. The fourth commandment, holding as it does a conspicuous place in the decalogue, the precepts of which could not for the most part be regarded as of merely transitory obligation, and never of course escaped the attention of the fathers of the Church; but, remembering the liberty given in the Pauline writings "in respect of a feast day or a new moon or a Sabbath" (Col. ii. 16; cf. Rom. xiv. 5, Gal. iv. 10, 11), they usually explained the "Sabbath day" of the commandment as meaning the new era that had been introduced by the advent of Christ, and interpreted the rest enjoined as meaning cessation from sin. But when a series of imperial decrees had enjoined with increasing stringency an abstinence from labour on Sunday, it was inevitable that the Christian conscience should be roused on the subject of the Sabbath rest also, and in many minds the tendency would be such as finds expression in the *Apostolic Constitutions* (viii. 33): "Let the slaves work five days; but on the Sabbath day and the Lord's day let them have

[1] The Teutonic and Scandinavian nations adopt the former designation (Sunday, *Sonntag*, *Söndag*, &c.), the Latin nations the latter (*dimanche*, *domenica*, *domingo*, &c.).

[2] From an expression in the Epistle of Barnabas (c. 15), it would almost seem as if the Ascension also was believed by some to have taken place on a Sunday.

[3] In the Epistle of Barnabas already referred to (c. 15) it is called "the eighth day": "We keep the eighth day with joyfulness, the day also in which Jesus rose again from the dead." Cf. Justin Martyr, *Dial. c. Tryph.* c. 138.

[4] The longer recension runs: "But let every one of you keep the Sabbath after a spiritual manner . . . And after the observance of the Sabbath let every friend of Christ keep the Lord's day as a festival, the resurrection day, the queen and chief of all the days." The writer finds a reference to the Lord's day in the titles to Ps. vi. and xii., which are "set to the eighth."

leisure to go to church for instruction in piety." There is evidence of the same tendency in the opposite canon (29) of the council of Laodicea (363), which forbids Christians from Judaizing and resting on the Sabbath day, and actually enjoins them to work on that day, preferring the Lord's day and so far as possible resting as Christians. About this time accordingly we find traces of a disposition in Christian thinkers to distinguish between a temporary and a permanent element in the Sabbath day precept; thus Chrysostom (10th homily on Genesis) discerns the fundamental principle of that precept to be that we should dedicate one whole day in the circle of the week and set it apart for exercise in spiritual things. The view that the Christian Lord's day or Sunday is but the Christian Sabbath transferred from the seventh to the first day of the week does not find categorical expression till a much later period, Alcuin being apparently the first to allege of the Jewish Sabbath that "ejus observationem mos Christianus ad diem dominicam competentius transtulit" (cf. DECALOGUE).

LAW RELATING TO SUNDAY

The earliest recognition of the observance of Sunday as a legal duty is a constitution of Constantine in 321 A.D., enacting that all courts of justice, inhabitants of towns, and workshops were to be at rest on Sunday (*venerabili die solis*), with an exception in favour of those engaged in agricultural labour. This was the first of a long series of imperial constitutions, most of which are incorporated in the Code of Justinian, bk. iii. tit. 12 (*De feriis*). The constitutions comprised in this title of the code begin with that of Constantine, and further provide that emancipation and manumission were the only legal proceedings permissible on the Lord's day (*die dominico*), though contracts and compromises might be made between the parties where no intervention of the court was necessary. Pleasure was forbidden as well as business. No spectacle was to be exhibited in a theatre or circus. If the emperor's birthday fell on a Sunday, its celebration was to be postponed. The seven days before and after Easter were to be kept as Sundays. In Cod. i. 4, 9, appears the regulation that prisoners were to be brought up for examination and interrogation on Sunday. On the other hand, Cod. iii. 12, 10, distinctly directs the torture of robbers and pirates, even on Easter Sunday, the divine pardon (says the law) being hoped for where the safety of society was thus assured. After the time of Justinian the observance of Sunday appears to have become stricter. In the West, Charlemagne forbade labour of any kind. A century later in the Eastern Empire No. liv. of the Leonine constitutions abolished the exemption of agricultural labour contained in the constitution of Constantine; but this exemption was specially preserved in England by a constitution of Archbishop Meopham. The canon law followed the lines of Roman law. The decrees of ecclesiastical councils on the subject have been numerous. Much of the law is contained in the Decretals of Gregory, bk. ii. tit. 9 (*De feriis*), c. 1 of which (translated) runs thus: "We decree that all Sundays be observed from vespers to vespers (*a vespera ad vesperam*), and that all unlawful work be abstained from, so that in them trading or legal proceedings be not carried on, or any one condemned to death or punishment, or any oaths be administered, except for peace or other necessary reason." Works of necessity (especially in the case of perishable materials or where time was important, as in fishing) were allowed, on condition that a due proportion of the gain made by work so done was given to the church and the poor. The consent of parties was insufficient to give jurisdiction to a court of law to proceed on Sunday, though it was sufficient in the case of a day sanctified by the ecclesiastical authority for a temporary purpose, *e.g.* a thanksgiving for vintage or harvest.

In England legislation on the subject began early and continues down to the most modern times. As early as the 7th century the laws of Ina, king of the West Saxons, provided that, if a "theowman" worked on Sunday by his lord's command, he was to be free and the lord to be fined 30s.; if a freeman worked without his lord's command, the penalty was forfeiture of freedom or a fine of 60s., and twice as much in the case of a priest. The laws of Æthelstan forbade marketing, of Æthelred folkmoots and hunting, on the Sunday. In almost all the pre-Conquest compilations there are admonitions to keep the day holy. The first allusion to Sunday in statute law proper is in 1354 (28 Edw. III. c. 14 rep.), forbidding the sale of wool at the staple on Sunday. The mass of legislation from that date downwards may be conveniently, if not scientifically, divided into five classes—ecclesiastical, constitutional, judicial, social and commercial. The terms "Sunday" and "Lord's day" are used in the statutes, but the term "Sabbath" occurs only in ordinances of the Long Parliament. "Sabbath-breaking" is sometimes used to describe a violation of the Sunday observance acts, but is objected to by Blackstone as legally incorrect. Good Friday and Christmas Day are as a rule in the same legal position as Sunday. In English law Sunday is reckoned from midnight to midnight, not as in canon law *a vespera ad vesperam*.

The acts to be mentioned are still law unless the contrary is stated.

Ecclesiastical.—Before the Reformation there appears to be little or no statutory recognition of Sunday, except as a day on which trade was interdicted or national sports directed to be held. Thus the repealed acts of 1388 (12 Ric. II. c. 6) and 1409 (11 Hen. IV. c. 4) enjoined the practice of archery on Sunday. The church itself by provincial constitutions and other means declared the sanctity of the day, and was strong enough to visit with its own censures those who failed to observe Sunday. At the Reformation it was thought necessary to enforce the observance of Sunday by the state in face of the question mooted at the time as to the divine or merely human institution of the day as a holy day. Sunday observance was directed by injunctions as well as by statutes of Edward VI. and Elizabeth. The second Act of Uniformity of 1551 (5 & 6 Edw. IV. c. 1.) enacted that all inhabitants of the realm were to endeavour themselves to resort to their parish church or chapel accustomed, or upon reasonable let thereof to some usual place where common prayer is used every Sunday, upon pain of punishment by the censures of the church. The same principle was re-enacted by the Act of Uniformity of 1558 (1 Eliz. c. 2), with the addition of a temporal punishment, viz. a fine of twelve pence for each offence. This section of the act is, however, no longer law, and it appears that the only penalty now incurred by non-attendance at church is the shadowy one of ecclesiastical censure. Protestant dissenters, Jews and Roman Catholics were in 1846 (9 & 10, Vict. c. 59) exempted from the act, and the pecuniary penalties were abrogated as to all persons; but the acts as to Sundays and holy days are still binding on members of the Church of England [*Marshall* v. *Graham*, 1907, 2 K.B. 112].

An act of 1551 (5 & 6 Edw. VI. c. 3) directed the keeping of all Sundays as holy days, with an exception in favour of husbandmen, labourers, fishermen and other persons in harvest or other time of necessity. Canon 13 of the canons of 1603 provides that "all manner of persons within the Church of England shall celebrate and keep the Lord's day, commonly called Sunday, according to God's holy will and pleasure and the orders of the Church of England prescribed in that behalf, that is, in hearing the word of God read and taught, in private and public prayers, in acknowledging their offences to God and amendment of the same, in reconciling themselves charitably to their neighbours where displeasure hath been, in oftentimes receiving the communion of the body and blood of Christ, in visiting the poor and sick, using all godly and sober conversation." The Long Parliament, by an ordinance of 1644, c. 51, directed the Lord's day to be celebrated as holy, as being the Christian Sabbath. Ordinances of 1650, c. 9, and 1656, c. 15, contained various minute descriptions of crimes against the sanctity of the Lord's day, including travelling and "vainly and profanely walking." These ordinances lapsed at the Restoration. The Act of Uniformity of 1661 (13 & 14 Car. II. c. 4) enforced the reading on every Lord's day of the morning and evening prayer according to the form in the Book of Common Prayer—a duty which had been previously enjoined by canon 14 of 1603. By the Church Building Act 1818, the bishop may direct a third service, morning or evening, where necessary, in any church built under the act (s. 65). By the Church Building Act 1838, he may order the performance of two full services, each if he so direct to include a sermon (s. 8). The Burial Laws Amendment Act 1880, which authorizes burials in churchyards of the Church of England without the use of the funeral office of that church, does not allow such burials to take place on Sunday, Good Friday or Christmas Day if the parson of the church objects. Under the Metropolitan Police and Streets Acts, the Town Police Clauses Act 1841 and the Public Health Acts, street traffic may be regulated during the hours of divine service.

Constitutional.—Parliament has occasionally sat on Sunday in cases of great emergency, as on the demise of the Crown. Occasionally divisions in the House of Commons have taken place early on Sunday morning. The Ballot Act 1872 enacts that in reckoning time for election proceedings Sundays are to be excluded. A similar provision is contained in the Municipal Corporations Act 1882, as to proceedings under that act.

Judicial.—As a general rule Sunday for the purpose of judicial proceedings is a *dies non juridicus* on which courts of justice do not sit (9 Co. Rep. 66*b*). By s. 6 of the Sunday Observance Act 1677 legal process cannot be served or executed on Sunday, except in cases of treason, felony or breach of the peace. Proceedings which do not need the intervention of the court are good, *e.g.* service of a citation or notice to quit or claim to vote. By s. 4 of the Indictable Offences Act 1848 justice may issue a warrant of apprehension or a search warrant on Sunday. The rules of the Supreme Court provide that the offices of the Supreme Court shall be closed on Sundays, that Sunday is not to be reckoned in the computation of any limited time less than six days allowed for doing any act or taking any proceeding, and that, where the time for doing any act or taking any proceeding expires on Sunday, such act or proceeding is good if done or taken on the next day. In the divorce rules Sundays are excluded from compilation. In the county court rules they are excluded if the time limited is less than forty-eight hours, and the only county court process which can be executed on Sunday is a warrant of arrest in an Admiralty action. Where a time is fixed by statute, the Sundays are counted in. Where a term of imprisonment expires on Sunday, Christmas Day or Good Friday, the prisoner is entitled to discharge on the day next preceding (Prison Act 1898, s. 11).

Social.—Under this head may be grouped the enactments having for their object the regulation of Sunday travelling and amusements. The earliest example of non-ecclesiastical interference with recreation appears to be the *Book of Sports* issued by James I. in 1618. Royal authority was given to all but recusants to exercise themselves after evening service in dancing, archery, leaping, vaulting, May-games, Whitsun-ales, morris-dances and setting up of Maypoles; but bear and bull-baiting, interludes and bowling by the meaner sort were prohibited. The Sunday Observance Act 1625 (1 Car. I. c. 1), following the lines of the *Book of Sports*, inhibited meetings, assemblies or concourse of people out of their own parishes on the Lord's day for any sports and pastimes whatsoever, and any bear-baiting, bull-baiting, interludes, common plays or other unlawful exercises and pastimes used by any person or persons within their own parishes, under a penalty of 3s. 4d. for every offence. The right to enforce ecclesiastical censures is left untouched by the act. The act impliedly allows sports other than the excepted ones as long as only parishioners take part in them. In 1897 some lads were prosecuted at Streatley under this act for playing football in an adjoining parish, but the justices dismissed the charge, treating the act as obsolete. But in 1906 the Society for the Prevention of Cruelty to Animals instituted a prosecution under the act with the object of preventing extra-parochial rabbit-coursing on Sundays. The Game Act 1831 (1 & 2 Will. IV. c. 32, s. 3) makes it punishable to kill or take game, or to use a dog, net or other instrument (*e.g.* a snare), for that purpose on Sunday. The prohibition only applies to game proper and does not extend to rabbits.

There is no law in England against fishing on Sunday except as to salmon. Fishing for salmon on Sunday by any means other than a rod and line is prohibited by the Salmon Fishery Act 1861, and free passage for salmon through all cribs, &c., used for fishery is to be left during the whole of Sunday.

The Sunday Observance Act 1781 (21 Geo. III. c. 49), drawn by Dr Porteus, bishop of London, enacts that any place opened or used for public entertainment and amusement or for public debate upon any part of the Lord's day called Sunday, to which persons are admitted by payment of money or by tickets sold for money, is to be deemed a disorderly house. The keeper is to forfeit £200 for every day on which it is opened or used as aforesaid on the Lord's day, the manager or master of the ceremonies £100 and every doorkeeper or servant £50. The advertising or publishing any advertisement of such an entertainment is made subject to a penalty of £50. Proceedings under this act for penalties may be instituted by a common informer within six months of the offence. It was held in 1868 that a meeting the object of which was not pecuniary gain (though there was a charge for admission), but an honest intention to introduce religious worship, though not according to any established or usual form, was not within the act. The hall used was registered for religious worship. On this principle, forms of worship such as Mormonism or Mahommedanism are protected. In 1875 actions were brought against the Brighton Aquarium Company and penalties recovered under the act. As doubts were felt as to the power of the Crown to remit the penalties in such a case, an act was passed in 1875 to remove such doubts and to enable the sovereign to remit in whole or in part penalties recovered for offences against the act of 1781.

The substantive effect of the act is to hit all Sunday exhibitions or performances where money is charged for admission. In 1895 it was decided that the chairman of a meeting held to hear a lecture was not liable as manager of the meeting, and the solicitor of the liquidator of a company was held not to be liable for merely letting the hall for the meeting. In 1906 an attempt was unsuccessfully made to apply the act of 1781 to open-air meetings for rabbit-coursing. The rules for the government of theatres and places of public entertainment, and the terms of the licences issued, usually prohibit performances on Sundays. The lessees of certain places of public resort in London have in some cases obtained their licences from the London County Council on condition that they do not hold Sunday concerts, but the recent policy of the Council has been not to interfere with or restrict the giving of Sunday concerts unless they are given for private gain or by way of trade. The Council has no legal authority to dispense with the Sunday Observance Act 1781, which enforces penalties on giving entertainments to which persons are admitted by payment of money or by tickets sold for money. The law has been judicially interpreted, however, to mean that charges for reserved seats are not incompatible with free admission. In consequence of this ruling Sunday concerts have been regularly given at the Albert Hall, which is not under the licensing jurisdiction of the London County Council, and at the Queen's Hall and other places within that jurisdiction. No charge is made for admission, but those who wish for seats must pay for them, and the proceeds of the concerts are not made the subject of profit. At the licensing sessions conflicts have annually arisen on this subject between the advocates and opponents of Sunday music.

Bands play on Sundays in most of the parks in London, whether royal or under municipal control; and it is said that local authorities cannot make bylaws forbidding bands of music in the streets on Sunday (*Johnson* v. *Croydon Corporation*, 1886, 16 Q.B.D. 708). Libraries, museums and gymnasiums maintained by local authorities may, it would seem, be lawfully opened on Sundays, and the national galleries and museums are now so open for part of Sunday.

Commercial.—At common law a contract made on Sunday is not void, nor is Sunday trading or labour unlawful, and enlistment of a soldier on a Sunday has been held valid. At an early period, however, the legislature began to impose restrictions, at first by making Sunday trade impossible by closing the places of ordinary business, later by declaring certain kinds of trade and labour illegal, still later by attempting to prohibit all trade and labour. 28 Edw. III. c. 14 (1354, now repealed) closed the wool market on Sunday. An act of 1448 (27 Hen. VI. c. 5) prohibits fairs and markets on Sunday (necessary victual only excepted), unless on the four Sundays in harvest—an exemption repealed in 1850 (by 13 & 14 Vict. c. 23) 4 Edw. IV. c. 7 (1464 rep.) restrained the shoemakers of London from carrying on their business on Sunday. An act of 1627 (3 Car. I. c. 2) imposes a penalty of 20s. on any carrier, wagoner or drover travelling on the Lord's day, and a penalty of 6s. 8d. on any butcher killing or selling on that day. The act does not apply to stage coaches. Both this and the act of 1625 were originally passed only for a limited period, but by subsequent legislation they have become perpetual. Next in order is the Sunday Observance Act 1677 (29 Car. II. c. 7), "An act for the better observance of the Lord's day, commonly called Sunday."

After an exhortation to the observation of the Lord's day by exercises in the duties of piety and true religion, publicly and privately, the act provides as follows: No tradesman, artificer, workman, labourer or other person (*ejusdem generis*) whatsoever shall do or exercise any worldly labour, business or work of their ordinary callings upon the Lord's day or any part thereof (works of necessity and charity only excepted); and every person being of the age of fourteen years or upwards offending in the premises shall for every such offence forfeit the sum of 5s.; and no person or persons whatsoever shall publicly cry, show forth or expose to sale any wares, merchandises, fruit, herbs, goods or chattels whatsoever upon the Lord's day or any part thereof upon pain that every person so offending shall forfeit the same goods so cried, or showed forth, or exposed to sale (s. 1). A barber was held in 1900 not to be a tradesman, artificer, &c. within the act, and to be free to shave customers on Sunday[1]; nor is a farmer. No drover, horse-courser, wagoner, butcher, higgler or any of their servants, shall travel or come into his or their lodging upon the Lord's day or any part thereof, upon pain that each and every such offender shall forfeit 20s. for every such offence; and no person or persons shall use, employ or travel upon the Lord's day with any boat, wherry, lighter or barge, except it be upon extraordinary occasion to be allowed by some justice of the peace, &c., upon pain that every person so offending shall forfeit and lose the sum of 5s. for every such offence. In default of distress or non-payment of forfeiture or penalty the offender may be set publicly in the stocks for two hours (s. 2), a punishment now obsolete. Nothing in the act is to prohibit the dressing of meat in families, or the dressing or selling of meat in inns, cooks' shops—which include fried fish shops (*Bullen* v. *Ward*, 1905, 74 L.J.K.B. 916)—or victualling houses for such as cannot be otherwise provided, nor the crying or selling of milk before nine in the morning or after four in the afternoon (s. 3). Prosecutions must be within ten days after the offence (s. 4). The hundred is not responsible for robbery of persons travelling upon the Lord's day (s. 5). This act has frequently received judicial construction. The use of the word "ordinary" in section 1 has led to the establishment by a series of decisions of the principle that work done out of the course of the ordinary calling of the person doing it is not within the act. Thus the sale of a horse on Sunday by a horse-dealer would not be enforceable by him and he would be liable to the penalty, but these results would not follow in the case of a sale by a person not a horse-dealer. Certain acts have been held to fall within the exception as to works of necessity and charity, *e.g.* baking provisions for customers (but not baking bread in the ordinary course of business), running stage-coaches, or hiring farm-labourers. The legislature also intervened to obviate some of the inconveniences caused by the act. By 10 Will. III. c. 13 (1698) mackerel was allowed to be sold before and after service. By 11 Will. III. c. 21 (1699), forty watermen were allowed to ply on the Thames on Sunday. By 9 Anne, c. 23 (1710), licensed coachmen or chairmen might be hired on Sunday. By an act of 1794 (34 Geo. III. c. 61), bakers were allowed to bake and sell bread at certain hours. These acts are all repealed. Still law are the acts of 1762 (2 Geo. III. c. 15 s. 7), allowing fish carriages to travel on Sunday in London and Westminster; 1827 (8 Geo. IV. c. 75), repealing s. 2 of the act of 1677 as far as regards Thames boatmen. The Bread Acts of 1822 (3 Geo. IV. c. 106) allow bakers in London, and of 1836 (6 & 7 Will. IV. c. 37) allow bakers out of London, to carry on their trade up to 1.30 p.m. Since 1871, by an act annually continued (34 & 35 Vict. c. 87), no prosecution or proceeding for penalties under the act of 1677 can be instituted except with the consent in writing of the chief officer of a police district or the consent of two justices or a stipendiary magistrate, which must be obtained before beginning the prosecution, *i.e.* before applying for a summons (*Thorpe* v. *Priestnall*, 1897, 1, Q.B. 159). The act of 1871 does not apply to breaches of the Bread Acts (*R.* v. *Mead*, 1902, 2 K.B. 212).

A good many bills have been introduced with respect to Sunday trading. Most have been directed to the closing of public-houses on that day; but the Shop Hours Bill introduced in 1907 contained clauses for closing shops on Sundays, with the exception of certain specified trades. The result of the act of 1871 in London has been in substance to make the Lord's Day acts a dead letter as to Sunday trading. The commissioner of police rarely if ever allows a prosecution for Sunday trading. Sunday markets are usual in all the poorer districts, and shopkeepers and hawkers are allowed freely to ply their trades for the sale of eatables, temperance drinks and tobacco. But the conditions of licences for the sale of intoxicants and for refreshment houses are strictly enforced with respect to Sunday. In districts where the town councils have control of the police, prosecutions for Sunday trading are not infrequent; but they seem to be instituted rather from objection to the annoyance caused by street traders than from religious scruples. The limitation of the time for prosecution to ten days, and the necessity of the previous consent of the chief constable, have a great effect in restricting prosecutions. In most districts there is a distinct disposition to refrain from enforcing the strict letter of the older law, and to permit the latitude of what is described as the "Continental Sunday," except in the case of businesses carried on so as to interfere with the public comfort. In most districts liberality in administration has progressed *pari passu* with a change in public opinion as to the uses to which Sunday may properly be put; it is becoming less of a holy day and more of a holiday.

There is great activity among those interested in different theories as to the proper use of Sundays. On the one side, Lord's day observance societies and the organizations concerned in the promotion of "temperance" (*i.e.* of abstinence from alcoholic drinks) have been extremely anxious to enforce the existing law against Sunday trading and against the sale of intoxicants to persons other than bona fide travellers, and to obtain legislation against the sale of any alcohol on Sundays. On the other side, the Sunday League and other like organizations have been active to organize lectures and concerts and excursions on Sundays, and to promote so far as possible every variety of recreation other than attendance at the exercises of any religious body. Travelling and boating on Sunday are now freely resorted to, regardless of any restrictions in the old acts, and railway companies run their trains at all hours, the power to run them being given by their special acts. Tram-cars and omnibuses run freely on Sundays, subject only to certain restrictions. Hackney carriages may in London ply for hire on Sundays (1 & 2 Will. IV. c. 22).

Besides the general act of 1677, there are various acts dealing with special trades; of these the Licensing Acts and the Factory and Workshop Acts are the most important. By the Licensing Acts, 1872 and 1874, premises licensed for the sale of intoxicating liquors by retail are to be open on Sunday only at certain hours, varying according as the premises are situate in the metropolitan district, a town or populous place, or elsewhere. The hours may be varied to fit in with the hours of religious worship in the district. An exception is made in favour of a person lodging in the house or a bona fide traveller, who may be served with refreshment during prohibited hours, unless in a house with a six-day licence. In the case of six-day licences, no sale of liquor may be made except to persons lodging in the house. Attempts have often been made to induce the legislature to adopt the principle of complete Sunday closing in England as a whole, or in particular counties.[2] In the session of 1886 a bill for Sunday closing in Durham was passed by the Commons but rejected by the Lords. The advocates of Sunday closing in Wales have been more successful. The Sunday Closing (Wales) Act 1881 contains no exceptions of towns and the only exemption is the sale of intoxicating liquors at railway stations. Public billiard tables may not be used on Sunday (8 & 9 Vict. c. 109). The Factory and Workshop Act (1901) forbids the employment of women, young persons or children on Sunday in a factory or workshop (s. 34). But a woman or young person of the Jewish religion may be employed on Sunday by a Jewish manufacturer if he keeps his factory or workshop closed throughout Saturday, and does not open it for traffic on Sunday, and does not avail himself of the exceptions authorizing employment of women or young persons on Saturday evening or for an additional hour on other weekdays (ss. 47, 48). There are a few other legislative provisions of less importance which may be noticed. Carrying on the business of a pawnbroker on Sunday is an offence within the Pawnbrokers Act 1872. Distilling and rectifying spirits on Sunday is forbidden by the Spirits Act 1880. The effect of Sunday upon bills of exchange is declared by the Bills of Exchange Act 1882. A bill is not invalid by reason only of its bearing date on a Sunday (s. 13). Where the last day of grace falls on a Sunday, the bill is payable on the preceding business day (s. 14). Sunday is a "non-business day" for the purposes of the act (s. 92).

Scotland.—The two earliest acts which dealt with Sunday are somewhat out of harmony with the general legislation on

[1] It is curious that by an order in council of Hen. VI. to regulate the sanctuary of St Martin-le-Grand it was provided that all artificers dwelling within the said sanctuary (as well barbers as others) keep holy the Sundays and other great festival days without breach or exercising their craft as do the citizens of London (Gomme, *Governance of London*, 1907, p. 329).

[2] The act 1 James I. c. 9 (now repealed) appears, however, to have provided for closing ale-houses in most cases, except on usual working days.

the subject. That of 1457, c. 6, ordered the practice of archery on Sunday; that of 1526, c. 3, allowed markets for the sale of flesh to be held on Sunday at Edinburgh. Then came a long series of acts forbidding the profanation of the day, especially by salmon-fishing, holding fairs and markets, and working in mills and salt-pans. The act of 1579, c. 70, and 1661, c. 18, prohibit handy labouring and working, and trading on the Sabbath. Under the act of 1579 the House of Lords in 1837 held that it was illegal for barbers to shave their customers on Sundays, although the deprivation of a shave might prevent decently disposed men from attending religious worship, or associating in a becoming manner with their families and friends through want of personal cleanliness. The later legislation introduced an exception in favour of duties of necessity and mercy, in accordance with ch. 21 of the Confession of Faith (1690, c. 5).

In more modern times the exigencies of travelling have led to a still further extension of the exception. In these acts the word Sabbath is generally used as in the Commonwealth ordinances. The Sabbath Observance Acts were frequently confirmed, the last time by the Scots parliament in 1696. The Scottish Episcopalians Act 1711 (10 Anne, c. 10) contains a proviso that all the laws made for the frequenting of divine service on the Lord's day commonly called Sunday shall be still in force and executed against all persons who shall not resort either to some church or to some congregation or assembly of religious worship allowed and permitted by this act. The Scots acts were held by the High Court of Justiciary in 1870 to be still subsisting, as far as they declare the keeping open shop on Sunday to be an offence by the law of Scotland (Bute's Case, 1 Couper's *Reports*, 495), but all except those of 1579 and 1661 above specified were repealed in 1906. The Licensing (Scotland) Act 1903 provides by the scheduled forms of certificate for the closing on Sunday of public-houses, and places licensed for the sale of excisable liquor, and in the case of inns and hotels forbids the sale of intoxicants except for the accommodation of lodgers or travellers. There has been litigation as to the legality of running tram-cars on the Sabbath.

By the Herring Fishery (Scotland) Act 1815, s. 11, herring nets set or hauled on the coast or within two leagues thereof on Sundays are forfeited. By the Salmon Fisheries (Scotland) Act 1868, s. 15, fishing for salmon on Sunday, even with a rod and line, is an offence, as is taking or attempting to take or assisting in fishing for salmon.

As to contracts and legal process, the law is in general accordance with that of England. Contracts are not void, apart from statute, simply because they are made on Sunday. Diligence cannot be executed but a warrant of imprisonment or *meditatio fugae* is "exercisable."

Ireland.—In Ireland an act of 1695 (7 Will. III. c. 17) covers the same ground as the English act of 1677, but the acts referred to under England do not apply. An act of 1851 (14 & 15 V. c. 93, s. 11) provides for the issue and execution of warrants for indictable offences and search-warrants on Sundays. But proceedings to obtain sureties for the peace taken on Sunday are void. The Irish act of 1787 against killing game on Sunday (27 Geo. III. c. 35, s. 4) includes rabbits and quail, landrail or other wild fowl. The Sunday closing of public-houses with exemptions as to certain cities and as to railway stations, packet-boats and canteens, is enforced by legislation of 1878, continued annually until 1906 and then made perpetual with certain modifications (1906, c. 39, s. 1), and in the case of six-day licences by acts of 1876, 1877 and 1880.

In 1899 a race-course used for Sunday racing was closed by injunction as causing a nuisance to the Sunday peace and quiet of the neighbourhood and the services of the adjacent churches.

Where railway trains are run on Sundays one cheap train each way is to be provided (7 & 8 Vict. c. 85, s. 10; repealed in 1883 as to Great Britain).

British Colonies.—The English law as to Sunday observance was the original law of the colonies acquired by settlement, and in many of them so much of it as does not relate to the Church of England is left to operate without colonial legislation. In other colonies it is supplemented or superseded by colonial acts. Canada has an act (No. 27 of 1906) prohibiting all buying and selling and all exercise by a man of his ordinary vocations or business, either by himself or his employees on the Lord's day, except in case of works of necessity or mercy. In New Zealand an act of 1884 (c. 24, s. 16; amended 1906, c. 36) prohibits the carrying on on Sunday of any trade or calling, but the exceptions are numerous, and, besides works of necessity or charity, include driving live stock, sale of medicines, sale or delivery of milk, hairdressing or shaving before 9 a. m., driving public or private carriages, keeping livery stables, working railways, ships and boats, and letting boats for hire, and work in connexion with post offices and telegraphs and with daily newspapers. (W. F. C.)

Foreign Countries.—Consequent on the introduction of a Weekly Rest Day Bill (which obtained a second reading) in the English House of Lords in 1908, a parliamentary paper was published in 1909 (cd. 4468) containing "Reports from His Majesty's Representatives Abroad as to Legislation in Foreign Countries Respecting a Weekly Rest Day." The principal points are summarized below:—

Austria.—Legislation is embodied in laws of 1895 and 1905, which prohibit any industrial work on Sunday, rest on that day beginning not later than 6 a.m., and lasting for not less than twenty-four hours. Permission is given for absolutely necessary work, provided the employer submits to the authorities a list giving the names of the persons employed, and the place, duration and nature of their employment. Sunday work is permitted in certain industries. As to buying and selling, Sunday trading is permitted for not more than four hours, local authorities being the power for arranging the time; they may also forbid Sunday trading altogether, if they think it necessary. Traders who do not employ workmen may not work for themselves unless the doors by which the public may enter are closed. On feast-days, employees must, according to their respective religious beliefs, be allowed the necessary time for attendance at morning service. Offences are punishable by fine; a warning, however, is given on the first offence, and the fine (4s. 2d. for the first offence) rises for each subsequent offence.

Belgium.—Laws of 1905 and 1907 forbid work on Sunday to persons engaged in industrial and commercial enterprises, with certain exceptions, such for example, as industries which exist only at certain periods of the year, or which have a press of work at certain times, or open-air industries which depend on the weather.

Denmark.—The only legislation is a law of 1904 concerning the public peace on the National Church holidays and Constitution Day. It forbids all kinds of occupations, which, on account of noise, might disturb the holiday's peace. In the large towns carriage traffic for business purposes is also forbidden after 10 a.m.

France.—A law of the 13th of July 1906 established a weekly day of rest, for every workman or employee of not less than twenty-four consecutive hours. The weekly day of rest must be Sunday. The law applies irrespective of the duration or character of the work done, and to employees in all establishments of a commercial or industrial character. There are certain necessary exceptions, such as shops for retailing food, occupations in which place, season, the habits of the public, &c., make observance impossible, and in such the weekly day of rest must be given in rotation to the employees or a compensating holiday instead.

Germany.—Regulations as to Sunday rest are contained in the Trade Regulations (*Gewerbeordnung*) of the 26th of July 1900, according to which manufacturers cannot compel workmen to work on Sundays or holidays, except in certain cases of necessity. Nor in trading businesses may assistants, apprentices or workmen be employed at all on Christmas Day, Easter Sunday and Whitsunday, or on other Sundays and holidays more than five hours. The regulations do not apply to hotels, cafés, &c., or to theatres or other places of amusement, or to means of communication. Infringement of the regulations is punishable by a fine, not exceeding 600 marks or by imprisonment.

Hungary.—By a law of 1891 and others of 1903 and 1908 all industrial work is prohibited on Sundays and St Stephen's Day (the patron saint of Hungary). Certain categories of industries are exempted on account of necessity or the needs of the consuming public; independent small craftsmen who work at home without assistants are also exempted. The law is enforced by the police authorities and infringement is punished by fine.

Italy.—A weekly rest day has been enacted by a law of the 7th of July 1907. Exceptions to the law are river, lake and maritime navigation; agricultural, hunting and fishing industries; state railways and tramways and state public services and industrial undertakings.

Other European countries which have legislation are the Netherlands (law of 1889, as amended by a law of 1906; Spain (law of March 1904, Regulations of April 1905); and Switzerland (1906).

United States.—In the United States there is no Federal law, the question of a rest day being left entirely to the state legislatures, consequently "there exists considerable diversity of legislation on the subject, ranging from the old Quaker laws of the state of Pennsylvania of the beginning of the 18th century to the modern regulations of the Far Western agricultural and mining states . . . There is no state, however, where it is specifically laid down that an employee who is forced to work on Sunday shall receive another equivalent day of rest." (*Report of H.M. Ambassador to the U.S. vide supra*). In Massachusetts, which may be fairly taken as representing the Eastern states, public service corporations, such as railway, street railway, steamboat, telegraph, telephone, electric lighting, water and gas companies, are permitted to serve the public in the usual manner. Public parks and baths are open. Tobacco may be sold by licensed innholders, common victuallers, druggists and newsdealers. Bake shops may be open during certain hours. All other shops must be closed. Saloons are closed, and liquor can be served only to the guests of licensed innholders. Horses, carriages, boats and yachts may be let for hire. All games and entertainments, except licensed sacred concerts, are prohibited. In Connecticut Sunday recreation is still prohibited, but electric and steam cars are allowed to run. Sunday is a close time for game and birds (1899). In many of the Western states base-ball, games and various entertainments for pay are permitted, and in some saloons are open. In many but not all the states such persons as by their religion are accustomed to observe Saturday are allowed to pursue their ordinary business on Sunday. In Delaware and Illinois barbers may not shave customers on Sundays; and in Georgia guns and pistols may not be fired (1898). In North Dakota the fines for Sabbath-breaking have been raised.

SUNDERLAND, CHARLES SPENCER, 3RD EARL OF (*c.* 1674–1722), English statesman, was the second son of the 2nd earl, but on the death of his elder brother Henry in Paris in September 1688 he became heir to the peerage. Called by John Evelyn "a youth of extraordinary hopes," he completed his education at Utrecht, and in 1695 entered the House of Commons as member for Tiverton. In the same year he married Arabella, daughter of Henry Cavendish, 2nd duke of Newcastle; she died in 1698 and in 1700 he married Anne Churchill, daughter of the famous duke of Marlborough. This was an important alliance for Sunderland and for his descendants; through it he was introduced to political life and later the dukedom of Marlborough came to the Spencers. Having succeeded to the peerage in 1702, the earl was one of the commissioners for the union between England and Scotland, and in 1705 he was sent to Vienna as envoy extraordinary. Although he was tinged with republican ideas and had rendered himself obnoxious to Queen Anne by opposing the grant to her husband, Prince George, through the influence of Marlborough he was foisted into the ministry as secretary of state for the southern department, taking office in December 1706. From 1708 to 1710 he was one of the five whigs, called the Junta, who dominated the government, but he had many enemies, the queen still disliked him, and in June 1710 he was dismissed. Anne offered him a pension of £3000 a year, but this he refused, saying "if he could not have the honour to serve his country he would not plunder it."

Sunderland continued to take part in public life, and was active in communicating with the court of Hanover about the steps to be taken in view of the approaching death of the queen. He made the acquaintance of George I. in 1706, but when the elector became king the office which he secured was the comparatively unimportant one of lord-lieutenant of Ireland. In August 1715 he joined the cabinet as lord keeper of the privy seal, and after a visit to George I. in Hanover he secured in April 1717 the position of secretary of state for the northern department. This he retained until March 1718, when he became first lord of the treasury, holding also the post of lord president of the council. He was now prime minister. Sunderland was especially interested in the proposed peerage bill, a measure designed to limit the number of members of the House of Lords, but this was defeated owing partly to the opposition of Sir Robert Walpole. He was still at the head of affairs when the South Sea bubble burst and this led to his political ruin. He had taken some part in launching the scheme of 1720, but he had not profited financially by it; however, public opinion was roused against him and it was only through the efforts of Sir Robert Walpole that he was acquitted by the House of Commons, when the matter was investigated. In April 1721 he resigned his offices, but he retained his influence with George I. until his death on the 19th of April 1722.

Sunderland inherited his father's passion for intrigue, while his manners were repelling, but he stands high among his associates for disinterestedness and had an alert and discerning mind. From his early years he had a great love of books, and he spent his leisure and his wealth in forming the library at Althorp, which in 1703 was described as "the finest in Europe." In 1749 part of it was removed to Blenheim.

The earl's second wife having died in April 1716, after a career of considerable influence on the political life of her time, in 1717 he married an Irish lady of fortune, Judith Tichborne (d. 1749). By Lady Anne Churchill he had three sons and two daughters. Robert (1701–1729), the eldest son, succeeded as 4th earl, and Charles (1706–1758), the second son, became the 5th earl. In 1733 Charles inherited the dukedom of Marlborough and he then transferred the Sunderland estates to his brother John, father of the 1st Earl Spencer (see MARLBOROUGH, EARLS AND DUKES OF).

For the career of Sunderland see W. Coxe, *Memoirs of Marlborough* (1847–1848); Earl Stanhope, *History of England* (1853), and I. S. Leadam, *Political History of England, 1702–1760* (1909).

SUNDERLAND, ROBERT SPENCER, 2ND EARL OF (1640–1702), English politician, was the only son of Henry Spencer (1620–1643), who succeeded his father, William, as 3rd Baron Spencer of Wormleighton in 1636. This barony had been bestowed in 1603 upon Sir Robert Spencer (d. 1627), the only son of Sir John Spencer (d. 1600) of Althorp, Northamptonshire, who claimed descent from the baronial family of Despenser. The fortunes of the family were founded by Sir John Spencer (d. 1522) of Snitterfield, Warwickshire, a wealthy grazier. His descendant, Sir Robert Spencer, the 1st baron, was in 1603, "reputed to have by him the most money of any person in the kingdom." Sir Robert's grandson, Henry, the 3rd baron, was created earl of Sunderland in June 1643, and was killed at the battle of Newbury when fighting for the king a little later in the same year. He married Dorothy (1617–1684), daughter of Robert Sidney, 2nd earl of Leicester. She was the *Sacharissa* of the poems of her admirer, Edmund Waller, and for her second husband she married Sir Robert Smythe. Their son Robert, the 2nd earl, was educated abroad and at Christ Church, Oxford, and in 1665 married Anne (d. 1715), daughter of John Digby, 3rd earl of Bristol; she was both a beauty and an heiress, and is also famous for her knowledge and love of intrigue. Having passed some time in the court circle, Sunderland was successively ambassador at Madrid, at Paris and at Cologne; in 1678 he was again ambassador at Paris. In February 1679, when the country was agitated by real or fancied dangers to the Protestant religion, the earl entered political life as secretary of state for the northern department and became at once a member of the small clique responsible for the government of the country. He voted for the exclusion of James, duke of York, from the throne, and made overtures to William, prince of Orange, and consequently in 1681 he lost both his secretaryship and his seat on the privy council. Early in 1683, however, through the influence of the king's mistress, the duchess of Portsmouth, Sunderland regained his place as secretary for the northern department, the chief feature of his term of office being his rivalry with his brother-in-law, George Savile, marquess of Halifax. By this time he had made his peace with the duke of York, and when in February 1685 James became king, he retained his position of secretary, to which was soon added that of lord president of the council. He carried out the wishes of the new sovereign and after the intrigues of a few months he had the satisfaction of securing the dismissal of Lawrence Hyde, earl of Rochester, from his post as lord treasurer. He was a member of the commission for ecclesiastical causes, and although afterwards he claimed that he had used all his influence to dissuade James from removing the tests, and in other ways illegally favouring the Roman Catholics, he signed the warrant for the committal of the seven bishops, and appeared as a witness against them. It should be mentioned that while Sunderland was thus serving James II., he was receiving a pension from France, and through his wife's lover, Henry Sidney, afterwards earl of Romney, he was furnishing William of Orange with particulars about affairs in England.

In the last months of James's reign he was obviously uncomfortable. Although he had in 1687 openly embraced the Roman Catholic faith, he hesitated to commit himself entirely to the acts of the fierce devotees who surrounded the king, whom he advised to reverse the arbitrary acts of the last year or two, and in October 1688 he was dismissed by James with the remark "I hope you will be more faithful to your next master than you have been to me."

Sunderland now took refuge in Holland, and from Utrecht he sought to justify his recent actions in *A letter to a friend in the country*. He had been too deeply involved in the arbitrary acts of James II. to find a place at once among the advisers of William and Mary, and he was excepted from the act of indemnity of 1690. However, in 1691, he was permitted to return to England, and he declared himself a Protestant and began to attend the sittings of parliament. But his experience was invaluable and soon he became prominent in public affairs, a visit which William III. paid him at Althorp, his Northamptonshire seat, in 1691, being the prelude to his recall into the royal counsels. It was his advice which led the king to choose all his ministers from one political party, to adopt the modern system, and he managed to effect a reconciliation between William and his sister-in-law, the princess Anne. From April to December 1697 he discharged the duties of lord chamberlain, and for part of this time he was one of the lords justices, but the general suspicion with which he was regarded terrified him, and in December he resigned. The rest of his life was passed in seclusion at Althorp, where he died on the 28th of September 1702. The earl was a great gambler, but he was wealthy enough also to spend money on improving his house at Althorp, which he beautified both within and without. His only surviving son was Charles Spencer, 3rd earl of Sunderland (*q.v.*).

Lord Sunderland possessed a keen intellect and was consumed by intense restlessness; but his character was wanting in steadfastness, and he yielded too easily to opposition. His adroitness in intrigue and his fascinating manners were exceptional even in an age when such qualities formed part of every statesman's education; but the characteristics which ensured him success in the House of Lords and in the royal closet led to failure in his attempts to understand the feelings of the mass of his countrymen. Consistency of conduct was not among the objects which he aimed at, nor did he shrink from thwarting in secret a policy which he supported in public. A large share of the discredit attaching to the measures of James II. must be assigned to the earl of Sunderland.

The best account of Sunderland is the article by T. Seccombe in the *Dict. Nat. Biog.*, which gives a full bibliography.

SUNDERLAND, a seaport and municipal, county and parliamentary borough of Durham, England, at the mouth of the river Wear, on the North-Eastern railway, 261 m. N. by W. from London. Pop. (1891), 131,686; (1901) 146,077. The borough includes the township of Bishopwearmouth, to the south of Sunderland proper, which lies on the south bank of the river; and that of Monkwearmouth, on the north bank. Adjacent to Monkwearmouth on the north-west is the extensive urban district of Southwick, within the parliamentary borough. A great cast-iron bridge crosses the river with a single span of 236 ft. and a height of 100 ft. above low water. It was designed by Rowland Burdon, opened in 1796, and widened under the direction of Robert Stephenson in 1858. The only building of antiquarian interest is the church of St Peter, Monkwearmouth, in which part of the tower and other portions belong to the Saxon building attached to the monastery founded by Benedict Biscop in 674. The church of St Michael, Bishopwearmouth, is on an ancient site, but is a rebuilding of the 19th century. There is a large park at Roker on the north-east of the town, a favourite seaside resort, and (among other parks) that at Bishopwearmouth contains a bronze statue of Sir Henry Havelock, who was born (1795) at Ford Hall in the neighbourhood.

The prosperity of Sunderland rests on the coalfields of the neighbourhood, the existence of which gave rise to an export trade in the reign of Henry VII., which has grown to great importance. Manufacturing industries include shipbuilding, iron and steel works, engineering, anchor and chain cable, glass and bottle and chemical works and paper mills. Limestone is largely worked. For 5 m. above its mouth the Wear resembles on a reduced scale the Tyne in its lower course. The harbour is constantly undergoing improvement. The docks cover an area of upwards of 200 acres, and there are several graving docks up to 441 ft. in length. The parliamentary borough returns two members. The municipal borough is under a mayor, 16 aldermen and 42 councillors, and has an area of 3357 acres.

The history of Sunderland is complicated by the name Wearmouth (*Wiramuth*, *Wermuth*) being applied impartially to the Monk's town on the north bank of the Wear; the Bishop's town on the south and the neighbouring port now known as Sunderland. In both Monk's and Bishop's Wearmouth the settlement was connected with the church. Benedict Biscop in 674 obtained from Ecgfrith king of Northumbria seventy hides of land on the north bank of the river, on which he founded the Benedictine monastery of St Peter. Not more than a year after the foundation Benedict brought over skilled masons and glass-workers from Gaul who wrought his church in the Roman fashion, the work being so speedily done that Mass was celebrated there within the year. A subsequent visit to Rome resulted in a letter from Pope Agatho exempting his monastery from all external control. Later Benedict acquired three hides on the south side of the river. The abbey, where Bede was educated, was destroyed by the Danes and probably not rebuilt until Bishop Walcher (1071–1081) settled Aldwin and his companions there. They found the walls in ruins from the neglect of 208 years, but the church was soon rebuilt. Bishop William of St Carileph (1081–1099), desiring to acquire the possessions of the house for his new foundation of Durham, transferred the monks there, Wearmouth becoming henceforward a cell of the larger house. Meanwhile Bishop's Wearmouth was becoming important, having been granted to the bishops by Æthelstan in 930. As a possession of the see it is mentioned in Boldon Book in conjunction with Tunstall as an ordinary rural vill rendering one milch cow to the bishop, while the demesne and its mill rendered £20, the fisheries £6 and the borough of Wearmouth 20s. There seems no doubt but that the borough, identical with that to which Bishop Robert de Pinset granted his charter, was in reality Sunderland, the name Wearmouth being used to cover Bishop's and Monk's Wearmouth and the modern Sunderland. It was from Wearmouth that Edgar Ætheling set sail for Scotland, the account implying that this was a frequented port. In 1197 the town of Wearmouth rendered 37s. 4d. tallage during the vacancy of the see, and in 1306–1307 the assessment of a tenth for Bishop's Wearmouth was £5, 5s. 4d., while that of Monk's Wearmouth was £1, 6s. 8d. Probably the northern town remained entirely agricultural, while the shipping trade of Bishop's Wearmouth was steadily increasing. In 1382 what was probably a dock there rendered 2s., and in 1385 the issues of the town were worth £45, 9s. 2d. annually. In 1431 the rent of assize from the demesne lands of Monk's Wearmouth was £5, 1s. 0d. A further contrast is shown by the number of houseling persons, or those who received the sacrament, returned in 1548: Bishop's Wearmouth had 700 and Monk's Wearmouth 300. From this time, at least, Bishop's Wearmouth seems to have been completely identified with Sunderland: in 1567 Wearmouth was one of the three ports in Durham where precautions were to be taken against pirates, while no mention is made of Sunderland. Monk's Wearmouth remained purely agricultural until 1775, when a shipbuilding yard was established and prospered to such an extent that by 1795 five similar yards were at work.

The Boldon Book states that Sunderland was at farm in 1183 and rendered 100 shillings and the town of Sunderland rendered 58 shillings tallage in 1197 during the vacancy of the see. In 1382 Thomas Menvill held the borough, which with its yearly free rent, courts and tolls was worth £1, 12s. 8d. Edward IV. in 1464, sede vacante, granted a lease of the borough, and in 1507, Cardinal Bainbridge granted it by copyhold at a rent of £6, which dropped to £4 in 1590. Bishop Morton incorporated Sunderland in 1634, stating that it had been a borough from time immemorial under the name of the New Borough of Wearmouth. This charter lapsed during the Civil Wars, when the borough was sold with the manor of Houghton-le-Spring for £2851, 9s. 6d. Nevertheless the inhabitants retained their rights. Sunderland became a parliamentary borough returning two members in 1834. The charter of 1634 granted a market and annual fair which are still held. The charter of Bishop Hugh provided for pleas between burgesses and foreign merchants, and directed that merchandise brought by sea should be landed before sale, except in the case of salt and herrings. Bishop Hatfield gave a lease of the fisheries in 1358. In the 15th century commissions were held touching salmon-fisheries and obstructions in the Wear, while Bishop Barnes (1577–1587) appointed a water-bailiff for the port, and licensed the building of wharves for the sale of coal. During the 17th century Sunderland was the seat of a vice-admiralty court for the county palatine and in 1669 letters patent permitted the erection of a pier and lighthouse as the harbour was "very commodiously situate for the shipping of vast quantities of sea-coles plentifully gotten and wrought there."

See William Hutchinson, *History and Antiquities of the County Palatine of Durham* (Newcastle, 1785–1794); J. W. Summers, *History and Antiquities of Sunderland* (Sunderland, 1858); *Victoria County History*: *Durham.*

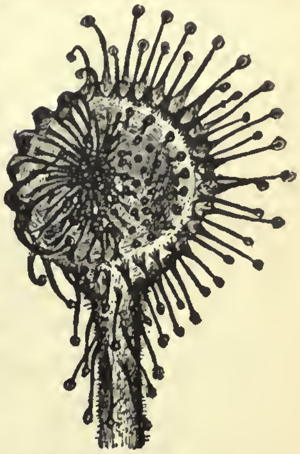
SUNDEW, in botany, the popular name for a genus of plants known as *Drosera* (Gr. *δρόσος*, dew; Fr. *rossolis*, Ger. *Sonnenthau*) so called from the drops of viscid transparent glittering secretion borne by the tentacles which cover the leaf-surface. It is a cosmopolitan genus of slender glandular herbs, with leaves arranged in a basal rosette or alternately on an elongated stem, and is represented in Britain by three species, which are found in spongy bogs and heaths.

The common sundew (*D. rotundifolia*) has extremely small roots, and bears five or six radical leaves horizontally extended in a rosette around the flower-stalk. The upper surface of each leaf is covered with gland-bearing filaments or "tentacles," of which there are on an average about two hundred. Each gland is surrounded by a large dew-like drop of the viscid secretion. A small fibro-vascular bundle (*b*, fig. 3, B), consisting mainly of spiral

(After Darwin.)

FIG. 1.—Leaf of Sundew (*Drosera rotundifolia*). (× 4.)

vessels, runs up through the stalk of the tentacle and is surrounded by a layer of elongated parenchyma cells outside of which is the epidermis filled with a homogeneous fluid tinted purple by a derivative of chlorophyll (eryhrophyll). The epidermis bears small multicellular prominences. The glandular head of the tentacle contains a central mass of spirally thickened cells (tracheïds) in immediate contact with the upper end of the fibrovascular bundle. Around these is a layer of large colourless thin walled cells which reaches the surface at the base of the head and acts as absorbing cells. Outside these are two layers (the outer one the epidermis) filled with purple fluid.

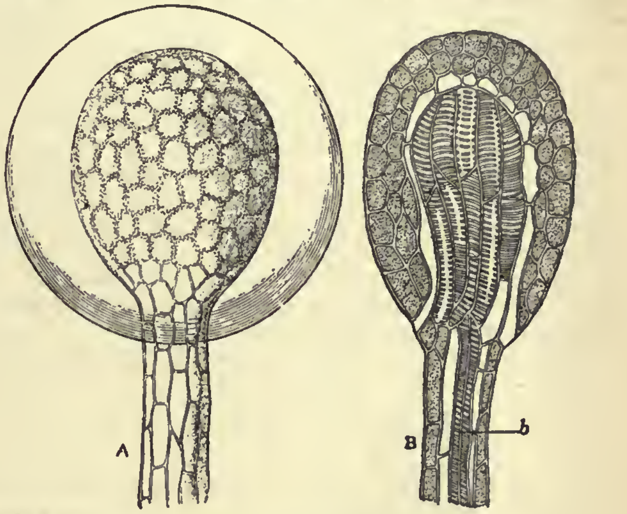


After Darwin.

FIG. 2.—Leaf of Sundew, enlarged, with the tentacles on one side inflected over a bit of meat placed on the disk.

Insects are attracted by the leaves; a fly alighting on the disk, or even only touching one or two of the exterior tentacles, is immediately entangled by the viscid secretion; the tentacles to which it is adhering begin to bend, and thus pass on their prey to the tentacles next succeeding them inwards, and the insect is thus carried by a curious rolling movement to the centre of the leaf. The tentacles on all sides become similarly inflected; the blade or the leaf may even become almost cup-shaped; and the insect, bathed in the abundant secretion which soon closes up its tracheae, is drowned in about a quarter of an hour. The leaves clasp also, but for a much shorter time, over inorganic bodies.

The bending of the tentacle takes place near its base, and may be excited (1) by repeated touches, although not by gusts of wind or drops of rain, thus saving the plant from much useless movement; (2) by contact with any solid, even though insoluble and of far greater minuteness than could be appreciated by our sense of touch—a morsel of human hair weighing only $\frac{1}{78740}$ of a grain, and this



(After Dodel-Port.)

FIG. 3.—Glands of Sundew magnified.
A, External aspect with drop of secretion; B, Internal structure.

largely supported too by the viscid secretion, sufficing to induce movement; (3) by the absorption of a trace of certain fluids, mostly nitrogenous. During the inflexion of the tentacle, and even before it touches the stimulating object, the secretion of the gland increases in quantity, and, instead of remaining neutral, becomes acid. The secretion contains a digestive enzyme which renders soluble the nitrogenous substances of the insect's body; these are then absorbed through thin-walled cells at the base of the gland. After absorption the tentacles recurve and the leaf assumes its normal appearance.

FIG. 4.—Part of Leaf of *Drosophyllum lusitanicum.* (× 7.)

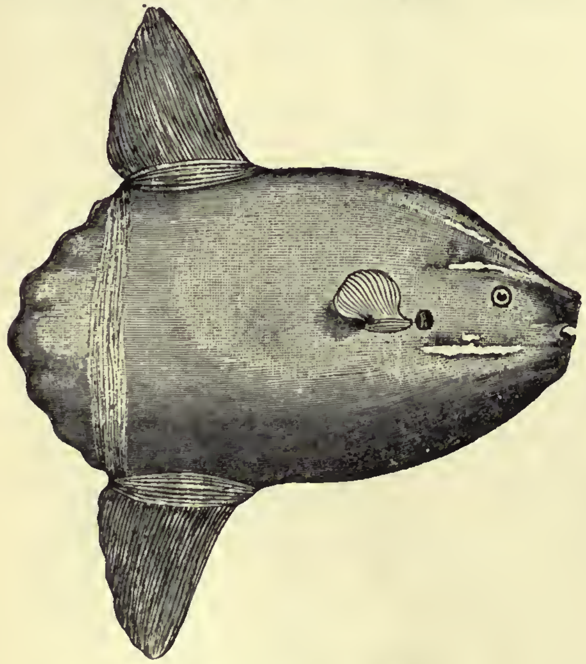
Closely allied to *Drosera* is *Drosophyllum lusitanicum*, which catches such vast numbers of flies in a state of nature that the Portuguese cottagers call it the fly-catcher, and hang up branches of it in their houses for this purpose. Its long narrow leaves are thickly covered with stalked glands, which resemble in the main the tentacles of *Drosera*, save in that they are incapable of movement, and that the secretion is less viscid and freely leaves the gland to wet the insect, which, creeping onward, soon clogs its wings and dies. There are, moreover, many minute colourless sessile glands, which, when stimulated by the absorption of nitrogenous matter, excrete an acid digestive secretion similar to that of the sundew, by means of which the body of the captured insect is digested and absorbed.

SUNDSVALL, a seaport of Sweden in the district (*län*) of Vesternorrland, on a wide bay of the Baltic, at the north of the Selånger River, 360 m. N. by W. of Stockholm, the terminus of a branch from Ange on the northern railway. Pop. (1900), 14,831. It was rebuilt in brick and stone after a destructive fire in 1888. In the town and its vicinity are numerous steam saw-mills, besides wood-pulp factories, steelworks, brickworks, engineering shops, breweries and joineries, but Sundsvall owes its chief importance to its export trade in timber (6 to 7 million cub. ft. annually), the bulk of which goes to Germany, France and Great Britain. It also exports wood-pulp, iron and fish. There is a special trade with Finland. The harbour, which is usually closed by ice from about the middle of December to the second week in May, is sheltered against the east winds by a group of islands.

SUNFISH, a name chiefly and properly applied to a marine fish (*Orthagoriscus*) of the order Plectognathi, which by its large size, grotesque appearance and numerous peculiarities of organization has attracted the attention equally of fishermen as of naturalists. Only two species are known, the rough or short sunfish (*O. mola*), which is found in all seas of the temperate and tropical zones; and the smaller and scarcer smooth or oblong sunfish (*O. truncatus*), of which only a small number of specimens have been obtained from the Atlantic and Indian oceans.

Sunfishes have the appearance of tailless fish. This is due to the extreme shortening of the caudal region which is supported by only a few short vertebrae; the caudal fin is absent, what appears to be a tail being formed by the confluence of dorsal and ventral fins: pelvic fins are also wanting. The anterior parts of the dorsal and ventral fins are high and broad, similar to each other in size and triangular in form. The head is completely merged in the trunk, the boundary between them being indicated only by a very small and narrow gill-opening and a comparatively small pectoral fin. This fin can be of but little use in locomotion, and the horizontal and vertical movements of the fish, as well as the maintenance of its body in a vertical position, are evidently executed by the powerful dorsal and anal fins. The small mouth, situated in front of the head, is armed with an undivided dental plate above and below, similar to but weaker than the teeth of the globe-fish (*Diodon*).

Sunfishes are truly pelagic, propagating their species in the open sea, and only occasionally approach the coast. During the stormy season they live probably at some depth, but in calm, bright weather they rise and rest or play on the surface with their dorsal fin high above the water. This habit has given rise to the popular name "sunfish," a term also sometimes applied to the basking-shark. In some years the rough sunfish is by no means scarce on the south coast of England and on the Irish coasts, where it appears principally in the summer months. The usual size is from 3 to 4 ft. in length, but this species attains to 7 ft. and more. One of the largest specimens (shown in the figure) was caught near Portland (Dorsetshire) in 1846, and is now in the British Museum; its length is 7 ft. 6 in. The sunfish has no economic value, and is rarely, if ever, eaten.



Sunfish (*Orthagoriscus mola*).

Whilst the rough sunfish has a granulated, rough, shagreen-like skin, the second species (*O. truncatus*) has the surface of the body smooth and polished, with its small dermal scutes arranged in a tesselated fashion. It is oblong in shape, the body being much longer than it is deep. The sides are finely ornamented with transverse silvery, black-edged stripes running downwards to the lower part of the abdomen. It has not been found to exceed 2 ft. in length. Only a few specimens have been captured on the coasts of Europe, at the Cape of Good Hope and off Mauritius.

SUNFLOWER. The common sunflower, known botanically as *Helianthus annuus*, a member of the natural order Compositae, is a native of the western United States. It is an annual herb with a rough hairy stem 3 to 12 ft. high, broad coarsely toothed rough leaves 3 to 12 in. long, and heads of flowers 3 to 6 in. wide in wild specimens and often a foot or more in cultivated. Double forms are in cultivation, one (*globosus fistulosus*) having very large globular heads. The plant is valuable from an economic as well as from an ornamental point of view. The leaves are used as fodder, the flowers yield a yellow dye, and the seeds contain oil and are used for food. It is cultivated in Russia and other parts of Europe, in Egypt and India and in several parts of England hundreds of plants are grown on sewage farms for the seeds. The yellow sweet oil obtained by compression from the seeds is considered equal to olive or almond oil for table use. Sunflower oilcake is used for stock and poultry feeding, and largely exported by Russia to Denmark, Sweden and elsewhere. The genus *Helianthus* contains about fifty species, chiefly natives of North America, a few being found in Peru and Chile. They are tall, hardy annual or perennial herbs, several of which are well known in gardens where they are of easy cultivation in moderately good soil. *H. decapetalus* is a perennial about 5 ft. high with solitary heads about 2 in. across in slender twiggy branchlets; *H. multiflorus* is a beautiful species with several handsome double varieties; *H. orygalis* is a graceful perennial 6 to 10 ft. high, with drooping willow-like leaves and numerous comparatively small yellow flower-heads. *H. atrorubens*, better known as *Harpalium rigidum*, is a smaller plant, 2 to 3 ft. high, the flower heads of which have a dark red or purple disk and yellow rays. There are many fine forms of this now, some of which grow 6 to 9 ft. high and have much larger and finer flowers than the type. Other fine species are *H. giganteus*, 10 to 12 ft.; *H. laetiflorus*, 6 to 8 ft., and *H. mollis*, 3 to 5 ft. *H. tuberosus* is the Jerusalem artichoke.

Since the word "sunflower," or something corresponding to it, existed in English literature before the introduction of *Helianthus annuus*, or, at any rate, before its general diffusion in English gardens, it is obvious that some other flower must have been intended. The marigold (*Calendula officinalis*) is considered by Dr Prior to have been the plant intended by Ovid (*Met.* iv. 269–270)—

> ". . . Illa suum, quamvis radice tenetur,
> Vertitur ad solem; mutataque servat amorem "—

and likewise the *solsaece* of the Anglo-Saxon, a word equivalent to *solsequium* (sun-following). But this movement with the sun is more imaginary than real, the better explanation for the application of the name to a flower being afforded by the resemblance to "the radiant beams of the sun," as Gerard expresses it. The rock-rose (*Helianthemum vulgare*) was also termed sunflower in some of the herbals from its flowers opening only in the sunshine. *Actinella grandiflora*, a pretty perennial 6 to 9 in. high, from the Colorado mountains, is known as the Pigmy sunflower.

SUNIUM (*Σούνιον*; mod. Cape Colonna), a cape at the southern extremity of Attica, with a temple of Poseidon upon it, which serves as a landmark for all ships approaching Athens from the east. The rocky promontory on which the temple stands was fortified by a wall with towers, in 413 B.C., as a protection against the Spartans in Decelea; but it was soon after seized by a body of fugitive slaves from the Laurium mines. In the 4th century it was still kept up as a fortress. The temple was shown by an inscription found in 1898 to be dedicated to Poseidon, not, as formerly supposed, to Athena, the remains of whose temple are to be seen about a quarter of a mile away to the north-east; they are of a peculiar plan, consisting of a hall with a colonnade on two sides only. The extant temple on the promontory was probably built in the time of Pericles. It took the place of an earlier one, of similar proportions but built of tufa or "poros" stone. There are still standing nine columns of the south side and two of the north of the peristyle, and one of the *antae* and an inner column of the *pronaos*. They are built of local white marble, which has suffered much from the weather. In form they resemble those of the Parthenon and Theseum, but they have only sixteen flutings. Recent excavations have revealed porticoes, a gateway and other buildings, and also the remains of several colossal early statues, the best preserved of which is now in the museum at Athens. The site of Cape Colonna is extolled by Byron, and is the scene of Falconer's "Shipwreck." (E. Gr.)

SUNN, or India Hemp (*Crotalaria juncea*), a plant which is a native of India and Ceylon. It frequently receives other names, *e.g.* false hemp, brown hemp, Bombay hemp, Jubbulpore hemp, sana, &c. The plant is an annual, requires a light soil, and is easily cultivated. The ground is ploughed two or three times, and from 80 to 100 ℔ of seed are sown broadcast. The seedlings quickly appear above the surface, but it is about four months before the plant begins to flower. Sometimes the seed is sown in October for the winter crop, and sometimes in May or June for the summer crop. When the seeds are sown in May, the bright yellow flowers appear in August, when the plant may be gathered. It is not unusual, however, to defer this operation until the seed is ripe, especially if a fibre of great strength is desired. The stems may be pulled up, as is the case with flax, or they may be cut down. Different opinions exist as to whether the stems should be steeped immediately after they are pulled, or left to dry and then steeped: in the wet districts they are taken direct to the water. Since the root ends are much thicker and coarser than the tops, it is common to place the bundles erect, and to immerse the root ends in about a foot of water. Afterwards the bundles are totally immersed in the ponds, and in two to four days the fibre should be ready for stripping. There is the same danger of over-retting and under-retting as in other fibres, but when the retting is complete, the workmen enter the ponds, take up a handful of stems, and swish them upon the surface of the water until the fibre becomes loose. After the fibre has been peeled off it is hung over poles to dry. When intended for cloth it is combed in order to remove any foreign matter, but if it is intended to be used for rope or similar purposes, the fibres are simply separated and the woody matter combed out with the fingers. The fibre is of a light grey colour, and has an average length of 3 to 4 ft. It is extensively used for rope and cordage and also for paper-making in its native country, but it has made little, if any, progress in this country. According to Warden, the fibre was tried in Dundee in the beginning of the 19th century. About 1820 the price of India hemp bagging, as quoted in the *Dundee Advertiser*, was 1½d. per yard below hemp bagging, and ¾d. a yard below tow warp bagging.

It is stated in Sir G. Watt's *Dictionary of the Economic Products of India* that a cord 8 in. in size of best Petersburg hemp broke with 14 tons, 8 cwt. 1 qr., while a similar rope of sunn only gave way with 15 tons, 7 cwt. 1 qr. Roxburgh's experiments with ropes made from this and other fibres appear on p. 607 of the above work. The ropes were tested in the fresh state, and also after having been immersed in water for 110 days. His results, reproduced in the following table, show the comparison.

Names of the Plants.	Average Weight at which each sort of line broke.					
	When fresh.			After 110 days' maceration.		
	White.	Tanned.	Tarred.	White.	Tanned.	Tarred.
English hemp, a piece of new tiller-rope	105	—	—	Rotten, as was also the English log-line.		
Hemp from the East India Company's farm near Calcutta	74	139	45	All rotten.		
Sunn hemp of the Bengalese	68	69	60	Rotten	51	65
Jute (Bunghi-pāt)	68	69	61	40	49	60

It would appear that, after maceration, neither ordinary hemp nor sunn hemp can compare with jute for strength.

SUNNITES, literally, "those of the path," *sunna*, *i.e.* followers of the Prophet's directions, the name of one of the two main divisions of Islam, the other being the Shīʽites (*q.v.*). The Sunnites, who accept the orthodox tradition (*Sunna*) as well as the Koran as a source of theologico-juristic doctrines, predominate in Arabia, the Turkish Empire, the north of Africa, Turkestan, Afghanistan and the Mahommedan parts of India and the east of Asia; the Shīʽites have their main seat in Persia, where their confession is the state religion, but are also scattered over the whole sphere of Islam, especially in India and the regions bordering on Persia, except among the nomad Tatars, who are all nominally Sunnite. Even in Turkey there are many native Shīʽites, generally men of the upper classes, and often men in high office (see generally Mahommedan Religion).

Orthodox Islam preserves unchanged the form of doctrine established in the 10th century by Abū 'l-Ḥasan al-Ashʽarī (see Ashʽarī). The attacks of rationalism, aided by Greek philosophy, were repelled and vanquished by the weapons of scholastic dialectic borrowed from the enemy; on most points of dispute discussion was forbidden altogether, and faith in what is written in Koran and tradition was enjoined without question as to how these things were true (*bilā kaifa*). Freer allegorical views, however, were admitted on some specially perplexing points, such as the doctrine of the eternity of the Koran, the crude anthropomorphisms of the sacred text, &c.; and, since Moʽtazilite (Muʽtazilite) views had never taken deep root among the masses, while the caliphs required the help of the clergy, and from the time of Motawakkil (A.D. 847) became ever more closely bound to orthodox views, the freethinking tendency was thoroughly put down, and to the present day no rationalizing movement has failed to be crushed in the bud. Philosophy still means no more than scholastic dialectic, and is the humble servant of orthodoxy, no man venturing on devious paths except in secret. In the years 1872–1878 the Afghan Jamāl ud-Dīn, a professor in the Azhar mosque at Cairo, attempted to read Avicenna with his scholars, and to exercise them in things that went beyond theology, bringing, for example, a globe into the mosque to explain the form of the earth. But the other professors rose in arms, forbade him to enter the mosque, and in 1879 procured his exile on the pretext that he entertained democratic and revolutionary ideas. Thus the later movements of thought in Islam never touch on the great questions that exercised Mahommedanism in its first centuries, *e.g.* the being and attributes of God, the freedom of the will, sin, heaven and hell, &c. Religious earnestness, ceasing to touch the higher problems of speculative thought, has expressed itself in later times exclusively in protest against the extravagances of the dervishes, of the worship of saints, and so forth, and has thus given rise to movements analogous to Puritanism.

Ulemā.

That even in early times the masses were never shaken in their attachment to the traditional faith, with all its crude and grotesque conceptions, is due to the zeal of the ulemā (clergy). Mahommedanism has no priesthood standing between God and the congregation, but Koran and Sunna are full of minute rules for the details of private and civil life, the knowledge of which is necessarily in the hands of a class of professed theologians. These are the *'ulemā* (*q.v.*), "knowers," theology being briefly named "the knowledge" (*'ilm*). Their influence is enormous and hardly has a parallel in the history of religions. For it is not supported by temporal agencies like the spiritual authority of the Christian priesthood in the middle ages, but is a pure power of knowledge over the ignorant masses, who do nothing without consulting their spiritual advisers. When the vigorous Spanish sultan Manṣūr b. Abī 'Āmir proposed to confiscate a religious foundation and the assembled ulemā refused to approve the act, and were threatened by his vizier, one of them replied, "All the evil you say of us applies to yourself; you seek unjust gains and support your injustice by threats; you take bribes and practise ungodliness in the world. But we are guides on the path of righteousness, lights in the darkness, and bulwarks of Islam; we decide what is just or unjust and declare the right; through us the precepts of religion are maintained. We know that the sultan will soon think better of the matter; but, if he persists, every act of his government will be null, for every treaty of peace and war, every act of sale and purchase, is valid only through our testimony." With this answer they left the assembly, and the sultan's apology overtook them before they had passed the palace gate.[1] The same consciousness of independent authority and strength still survives among the ulemā. Thus the sheikh ul-Islām 'Abbāsī (who was deposed by the professors of the Azhar in 1882) had in the first period of his presidency a sharp conflict with 'Abbās Pasha, viceroy of Egypt, who asked of him an unjust legal opinion in matters of inheritance. When bribes and threats failed, the sheikh was thrown into chains and treated with great severity, but it was the pasha who finally yielded, and 'Abbāsī was recalled to honours and rich rewards.

The way in which the ulemā are recruited and formed into a hierarchy with a vigorous *esprit de corps* throws an instructive light on the whole subject before us. The brilliant days are past when the universities of Damascus, Bagdād, Nīshāpūr, Cairo, Kairawān, Seville, Cordova, were thronged by thousands of students of theology, when a professor had often hundreds or even, like Bukhārī, thousands of hearers, and when vast estates in the hands of the clergy fed both masters and scholars. Of the great universities but one survives—the Azhar mosque at Cairo—where thousands of students still gather to follow a course of study which gives an accurate picture of the Mahommedan ideal of theological education.

Theological Students.

The students of theology generally begin their course in early youth, but not seldom in riper years. Almost all come from the lowest orders, a few from the middle classes, and none from the highest ranks of society—a fact which in itself excludes all elements of freer and more refined education. These sons of poor peasants, artisans or tradesmen are already disposed to narrow fanaticism, and generally take up study as a means of livelihood rather than from genuine religious interest. The scholar appears before the president's secretary with his poor belongings tied up in a red handkerchief, and after a brief interrogatory is entered on the list of one of the four orthodox rites—Shāfi'ite, Ḥanifite, Mālikite and Ḥanbalite (see MAHOMMEDAN LAW). If he is lucky he gets a sleeping-place within the mosque, a chest to hold his things, and a daily ration of bread. The less fortunate make shift to live outside as best they can, but are all day in the mosque, and are seldom deserted by Moslem charity. Having kissed the hands of the sheikh and teachers of his school, the pupil awaits the beginning of the lectures. For books a few compendiums suffice him. Professors and students gather every morning for the daily prayer; then the professors take their seats at the foot of the pillars of the great court and the students crouch on mats at their feet. The beginner takes first a course in the grammar of classical Arabic, for he has hitherto learned only to read, write and count. The rules of grammar are read out in the memorial verses of the *Ajrūmīya*, and the teacher adds an exposition, generally read from a printed commentary. The student's chief task is to know the rules by heart; this accomplished, he is dismissed at the end of the year with a certificate (*ijāza*), entered in his textbook, which permits him to teach it to others. The second year is devoted to dogmatic (*kalām* and *tawḥīd*), taught in the same mechanical way. The dogmas of Islam are not copious, and the attributes of God are the chief subject taken up. They are demonstrated by scholastic dialectic, and at the end of his second year the student, receiving his certificate, deems himself a pillar of the faith. The study of law (*fiqh*), which rests on Koran and tradition, is more difficult and complex, and begins, but is often not completed, in the third year. The student had learned the Koran by heart at school and has often repeated it since, but only now is the sense of its words explained to him. Of the traditions of the Prophet he has learned something incidentally in other lectures; he is now regularly introduced to their vast artificial system. From these two sources are derived all religious and civil laws, for Islam is a political as well as a religious institution. The five main points of religious law, "the pillars of Islam," have been enumerated in the article MAHOMMEDAN RELIGION; the civil law, on the development of which Roman law had some influence, is treated under heads similar to those of Western jurisprudence. It is here that the differences between the four schools come most into notice: the Ḥanifite praxis is the least rigorous, then the Shāfi'ite; the Ḥanbalites, whose system is the strictest, have practically disappeared in the Mālikites. The Ḥanifite rite is official in the Turkish Empire, and is followed in all government offices whenever a decision still depends on the sacred law, as well as by all Mahommedans of Turkish race. In this as in the previous studies a compendium is learned by heart, and explanations are given from commentaries and noted down by the students word for word. The professors are expressly forbidden to add anything of their own. The recognized books of jurisprudence, some of which run to over twenty folio volumes, are vastly learned, and occasionally show sound sense, but excel mainly in useless hair-splitting and feats of scholastic gymnastics, for which the Arabian race has a natural gift.

Besides the three main disciplines the student takes up according to his tastes other subjects, such as rhetoric (*ma'ānī wabayān*), logic (*manṭiq*), prosody (*'arūḍ*), and the doctrine of the correct pronunciation of the Koran (*qirā'a watajwīd*). After three or four years, fortified with the certificates of his various professors, he seeks a place in a law-court or as a teacher, preacher, cadi, or mufti of a village or minor town, or else one of the innumerable posts of confidence for which the complicated ceremonial of Mahommedanism demands a theologian, and which are generally paid out of pious foundations. A place is not hard to find, for the powerful corporation of the ulemā seeks to put its own members into all posts, and, though the remuneration is at first small, the young *'ālim* gradually accumulates the revenues of several offices. Gifts, too, fall in, and with his native avarice and economy he rises in wealth, position and reputation for piety. The commonalty revere him and kiss his hand; the rich show him at least outward respect; and even the government treats him as a person to whom consideration is due for his influence with the masses.

This sketch of his education is enough to explain the narrow-mindedness of the *'ālim*. He deems all non-theological science to be vain or hurtful, has no notion of progress, and regards true science—*i.e.* theology—as having reached finality, so that a new supercommentary or a new students' manual is the only thing that is perhaps still worth writing. How the mental faculties are blunted by scholasticism and mere memory work must be seen to be believed; such an education is enough to spoil the best head. All originality is crushed out and a blind and ludicrous dependence on written tradition—even in things profane—takes its place. Acuteness degenerates into hair-splitting and clever plays on words after the manner of the rabbins. The Azhar students not seldom enter government offices and even hold important administrative posts, but they never lose the stamp of their education—the narrow, unteachable spirit, incapable of progress, always lost in external details, and never able to grasp principles and get behind forms to the substance of a matter.

Schools.

Yet it is but a small fraction of the ulemā of the Moslem world that enjoy even such an education as the Azhar affords. It draws few students from foreign parts,[2] where the local schools are of the poorest kind, except in India (thanks to a British government) and perhaps in Constantinople.[3] Bokhārā was once a chief seat of learning, but is now so sunk in narrow fanaticism that its eighty *madrasas* (*medresses*) with their 5000 students only turn out a bigoted and foolish clergy (Vámbéry).[4] But for this very reason Bokhārā is famed as a luminary of pure theology and spreads its influence over Turkestan, Siberia, China, Kashmir, Afghanistan, and even over India. Minor schools attached to mosques are found in other places, but teach still less than the great schools already mentioned.

Except in India, where it is controlled by the government,

[1] Von Kremer, *Gesch. d. herrschenden Ideen d. Islams*, p. 464 (Leipzig, 1868).

[2] In 1878 seventeen lecture-rooms of the Azhar had 3707 students, of whom only 64 came from Constantinople and the northern parts of the Ottoman Empire, 8 from North Arabia, 1 from the government of Bagdād, 12 from Kurdistan, and 7 from India with its thirty million Sunnites.

[3] In Kazan also the standard of learning seems to have been raised by Russian and Western scholars.

[4] The *madrasa* is here a college, generally attached to a mosque, with lands whose revenues provide the means of instruction and in part also food and residence for scholars and teachers.

the organization of the priestly and judicial persons trained in the schools is a compromise between what theological principles dictate and what the state demands. Neither Koran nor Sunna distinguishes between temporal and spiritual powers, and no such distinction was known as long as the caliphs acted in all things as successors of the prophets and heads of the community of the faithful. But, as the power of the 'Abbāsids declined (see article CALIPHATE, *ad fin.*) and external authority fell in the provinces into the hands of the governors and in the capital into those of the *amīr al-omarā*, the distinction became more and more palpable, especially when the Būyids, who were disposed to Shī'ite views, proclaimed themselves sultans, *i.e.* possessors of all real authority. The theologians tried to uphold the orthodox theory by declaring the sultanate to be subordinate to the imāmate or sovereignty of the caliphs, and dependent on the latter especially in all religious matters; but their artificial theories have never modified facts. The various dynasties of sultans (Būyids, Ghaznevids, Seljūks, and finally the Mongols) never paid heed to the caliphs, and at length abolished them; but the fall of the theocracy only increased the influence of the clergy, the expounders and practical administrators of that legislation of Koran and Sunna which had become part of the life of the Mahommedan world. The Mamelukes in Egypt tried to make their own government appear more legitimate by nominally recognizing a continuation of the spiritual dignity of the caliphate in a surviving branch of the 'Abbāsid line which they protected, and in 923 A.H. (1517) the Ottoman Selim, who destroyed the Mameluke power, constrained the 'Abbāsid Motawakkil III., who lived in Cairo, to make over to him his nominal caliphate. The Ottoman sultans still bear the title of "successors of the Prophet," and still find it useful in foreign relations, since there is or may be some advantage in the right of the caliph to nominate the chief cadi (*ḳāḍī*) of Egypt and in the fact that the spiritual head of Khiva calls himself only the *naḳīb* (vicegerent) of the sultan.[1] In India too the sultan owes something perhaps to his spiritual title. But among his own subjects he is compelled to defer to the ulemā and has no considerable influence on the composition of that body. He nominates the *Sheikh ul-Islam* or mufti (*q.v.*) of Constantinople (grand mufti), who is his representative in the imāmate and issues judgments in points of faith and law from which there is no appeal; but the nomination must fall on one of the *mollahs*,[2] who form the upper stratum of the hierarchy of ulemā. And, though the various places of religious dignity are conferred by the sultan, no one can hold office who has not been examined and certified by older ulemā, so that the corporation is self-propagating, and palace intrigues, though not without influence, can never break through its iron bonds. The deposition of 'Abd ul-Azīz is an example of the tremendous power that can be wielded by the ulemā at the head of their thousands of pupils,[3] when they choose to stir up the masses; nor would Maḥmūd II. in 1826 have ventured to enter on his struggle with the janissaries unless he had had the hierarchy with him.

Caliphate and Temporal Sovereignty.

The student who has passed his examinations at Constantinople or Cairo may take up the purely religious office of *imām* (president in worship) or *khaṭīb* (preacher) at a mosque. These offices, however, are purely ministerial, are not necessarily limited to students, and give no place in the hierarchy and no particular consideration or social status. On the other hand, he may become a judge or cadi. Every place of any importance has at least one cadi, who is nominated by the government,[4] but has no further dependence on it, and is answerable only to a member of the third class of the ulemā, viz. the mufti or pronouncer of *fatwas*. A fatwa is a decision according to Koran and Sunna, but without reasons, on an abstract case of law which is brought before the mufti by appeal from the cadi's judgment or by reference from the cadi himself. For example, a dispute between master and slave may be found by the cadi to turn on the general question, "Has Zaid, the master of 'Amr,[5] the absolute right to dispose of his slave's earnings?" When this is put to the mufti, the answer will be simply "Yes," and from this decision there is no appeal, so that the mufti is supreme judge in his own district. The grand mufti of Constantinople is, as we have seen, nominated by the sultan, but his hold on the people makes him quite an independent power in the state; in Cairo he is not even nominated by the government, but each school of law chooses its own sheikh, who is also mufti, and the Ḥanifite is head mufti because his school is official in the Turkish Empire.

Judicial Offices.

All this gives the judges great private and political influence. But the former is tainted by venality, which, aggravated by the scantiness of judicial salaries or in some cases by the judge having no salary at all, is almost universal among the administrators of justice. Their political influence, again, which arises from the fusion of private and political law in Koran and Sunna, is highly inconvenient to the state, and often becomes intolerable now that relations with Western states are multiplied. And even in such distant parts as Central Asia the law founded on the conditions of the Prophet's lifetime proves so unsuited to modern life that cases are often referred to civil authorities rather than to canonical jurists. Thus a customary law (*'orf*) has there sprung up side by side with the official sacred law (*sharī'a*), much to the displeasure of the mollahs. In Turkey, and above all in Egypt, it has been found necessary greatly to limit the sphere and influence of the canonical jurists and to introduce institutions nearer to Western legal usage. We do not here speak of the paper constitutions (*khait-i-sherīf*) and the like, created to impose upon Western diplomatists, but of such things as consular and commercial courts, criminal codes, and so forth.

Modern Changes.

The official hierarchy, strong as it is, divides its power with the dervishes. A religion which subdues to itself a race with strongly marked individuality is always influenced in cultus and dogma by the previous views and tendencies of that race, to which it must in some measure accommodate itself. Mahomet himself made a concession to heathen traditions when he recognized the Ka'ba and the black stone; and the worship of saints, which is now spread throughout Islam and supported by obviously forged traditions, is an example of the same thing. So too are the religious orders now found everywhere except in some parts of Arabia. Mystical tendencies in Mahommedanism arose mainly on Persian soil (see ṢŪFĪISM), and Von Kremer has shown that these Eastern tendencies fell in with a disposition to asceticism and flight from the world which had arisen among the Arabs before Islam under Christian influence.[6] Intercourse with India had given Persian mysticism the form of Buddhistic monkery, while the Arabs imitated the Christian anchorites; thus the two movements had an inner kinship and an outer form so nearly identical that they naturally coalesced, and that even the earliest organizations of orders of dervishes, whether in the East or the West, appeared to Mahommedan judgment to be of one type. Thus, though the name of *Ṣūfī* (see ṢŪFĪISM) is first applied to Abū Hāshim, who died in Syria in 150 A.H. (767), we find it transferred without question to the mystical brotherhood which appears in Khorāsān under Abū Sa'īd about 200 A.H. (815/816). Yet these two schools of Ṣūfīs were never quite similar; on Sunnite soil Ṣūfīism could not openly impugn orthodox views, while in Persia it was saturated with Shī'ite heresy and the pantheism of the extreme devotees of 'Alī. Thus there have always been two kinds of Ṣūfīs, and, though the course of history and the wandering habits which various orders borrowed from Buddhism

Ṣūfīs and Dervishes.

[1] Till the Russians gained preponderating influence the khān of Khiva also acknowledged the sultan as his suzerain.

[2] Mollah is the Perso-Turkish pronunciation of the Arabic *maulā*, literally "patron," a term applied to heads of orders and other religious dignitaries of various grades.

[3] Called in Constantinople *softa*, Persian *sōkhta*, burned up, *scil.*, with zeal or love to God.

[4] In Egypt before the time of Sa'īd Pasha (1854–1863) the local judges were appointed by the chief cadi of Cairo, who is sent from Constantinople. Since then they have been nominated by the Egyptian government.

[5] Zaid and 'Amr are the Caius and Sempronius of Arabian law.

[6] *Op. cit.* p. 52 seq.

have tended to bring them closer to one another, we still find that of the thirty-six chief orders three claim an origin from the caliph Abūbekr, whom the Sunnites honour, and the rest from 'Alī, the idol of the Shī'ites.[1] Mystic absorption in the being of God, with an increasing tendency to pantheism and ascetic practices, are the main scope of all Ṣūfīism, which is not necessarily confined to members of orders; indeed the secret practice of contemplation of the love of God and contempt of the world is sometimes viewed as specially meritorious. And so ultimately the word *ṣūfī* has come to denote all who have this religious direction, while those who follow the special rules of an order are known as dervishes (beggars, in Arabic *fuqarā*, sing. *faqīr* —names originally designating only the mendicant orders). In Persia at the present day a Ṣūfī is much the same as a free-thinker.[2]

Bibliography.—The work of Shahrastānī (*q.v.*) on the Moslem sects: A. von Kremer, *Geschichte der herrschenden Ideen des Islams* (Leipzig, 1868); I. Goldziher, *Muhammedanische Studien*, vol. ii. (Halle, 1890); D. B. Macdonald, *Muslim Theology* (London, 1903); the *Hidaya* (trans. C. Hamilton, 2nd ed., London, 1870); N. B. E. Baillie, *A Digest of Muhammadan Law* (London, 1865); E. Sachau, *Muhammadanisches Recht nach Schafiitischer Lehre* (Stuttgart and Berlin, 1897); *El-Bokhari, les traditions islamiques* (trans. by Houdas and Marçais, Paris, 1903); Lane, *An Account of the Manners and Customs of the Modern Egyptians* (London, 1836). For the organization of the 'ulemā in the Ottoman Empire during the middle ages see E. J. W. Gibb, *A History of Ottoman Poetry*, ii. 394 sqq. (London 1902). (A. Mü.; R. A. N.)

SUNSHINE. As a meteorological element sunshine requires some conventional definition. There is uninterrupted continuance of gradation from the burning sunshine of a tropical noon to the pale luminosity that throws no shadow, but just identifies the position and shape of the sun through the thin cloud of northern skies.

The Campbell-Stokes Sunshine Recorder.—In the British Isles the sun is allowed to be its own timekeeper and the scorch of a specially prepared card used as the criterion for bright sunshine. The practice arose out of the use of the sunshine recorder which depends upon the scorching effect of a glass sphere in the sun's rays. The original form of the instrument was suggested by J. F. Campbell of Islay in 1857. He used a glass sphere within a hemispherical bowl of wood. The scorching of the wood along successive lines of the bowl as the sun alters its declination from solstice to solstice leaves a rugged monument of the duration and intensity of the sunshine during the half-year, but does not lend itself to numerical measurement. The design of a metal frame to carry movable cards and thus give a decipherable record of each day's sunshine is due to Sir G. G. Stokes. The excursions of the sun to the north and south of the equator are limited by the tropical circles, and the solar record on the hemispherical bowl will be confined within a belt 23° 27′ north and south of the plane through the centre parallel to the equator or perpendicular to the polar axis. Thus a belt 46° 54′ in angular width will be suitable for a sunshine recorder for any part of the world. Whatever place be chosen for the observation the same belt will do if it is set up perpendicular to the earth's polar axis. But there can be no record if the sun is below the horizon; hence any part of the belt projecting above the horizon is not only useless for recording but is liable to shadow a part of the belt where there might be a record. Hence to meet the requirements of a particular locality the belt as set up round the polar axis should be cut in two by a horizontal plane through the centre and the half projecting above the horizontal removed. Reversed it makes a half belt, exactly similar to what is left, and thus each complete belt is cut by a horizontal plane through the centre into two frames suitable for sunshine recorders for the particular locality.

The cutting of the belt may, of course, vary between the direct transverse cut along the polar axis which gives a half-ring belt to be set vertical in order to receive the record for a point on the equator, and the cut perpendicular to the polar axis which divides the belt into two similar rings suitable for recording the sunshine at the poles. Clearly, when the belt is so cut that two complete rings are formed, a continuous record of sunshine throughout the twenty-four hours may be expected, so that for the polar circles the cut will run diagonally between opposite points of the extreme circles of the sun's records. As examples of the cutting of the belt for different latitudes we may put side by side the recorder as used in temperate latitudes (fig. 1) and

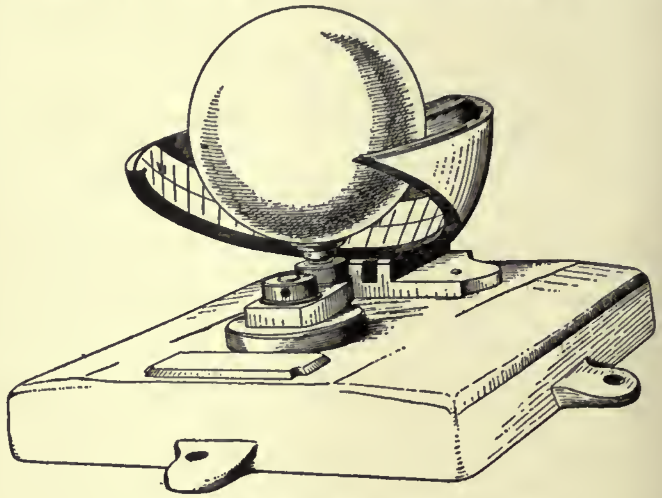
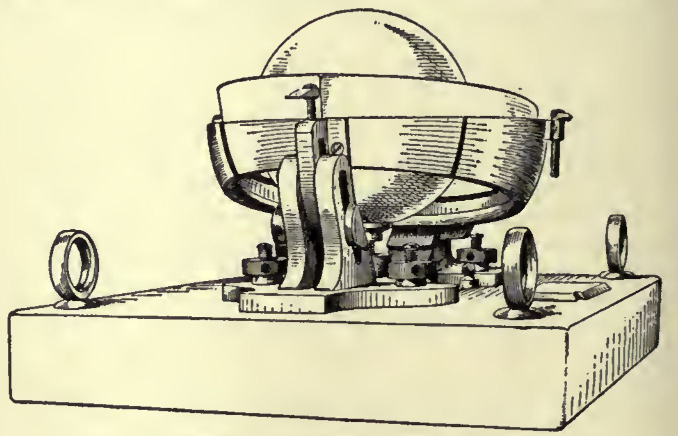


Fig. 1.—Campbell-Stokes Sunshine Recorder.

the special form designed in the Meteorological Office, London, for use on the National Antarctic Expedition, 1901–1904 (fig. 2). A belt cut for a particular latitude is serviceable for some 10°



Antarctic Sunshine Recorder, to carry 24-hour record.

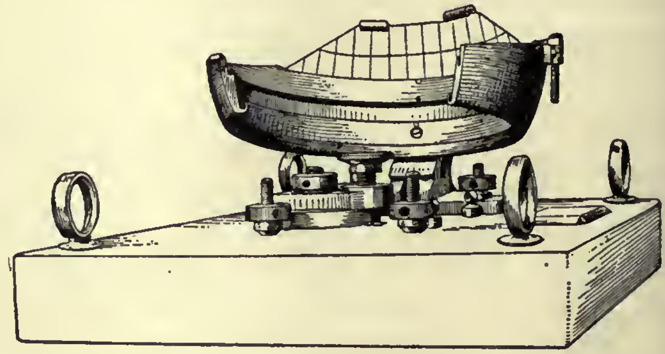


Fig. 2.—Antarctic Sunshine Recorder, to carry 12-hour record.

on either side of that latitude if the cards are not trimmed too closely to the cutting of the belt. The belt must always be adjusted round the parallel to the polar axis. If the cut of the belt is too oblique for the latitude of the place where it is exposed, and the cards are cut strictly to the belt, the northern side of the cut will be below the horizon and the southern side above it,

[1] These claims to early origin are mere fables, like the claim of the Oweisī order to spring from Oweis, one of the oldest traditionalists, and so forth.

[2] For the dervish orders see Dervish.

some sunshine may be lost near sunrise or sunset in the winter because there is no card to receive it. The part projecting above the horizon in summer will partly shadow the globe, and faint sunshine may be lost, for at most only half the globe can be solarized at sunset. But the loss due to this cause is unimportant. Stokes designed the complete belt to use successively three cards

(From the *Observer's Handbook*, by permission of the Controller of H.M. Stationery Office.)

FIG. 3.

of different shape for different times of the year. The equinoctial card forms a portion of a cylinder round the polar axis for spring and autumn, the summer card and the winter card each forms a part of a cone making a vertical angle of 16° with the polar axis as indicated in fig. 3.

Adjustments.—The adjustments of the instrument are to set the belt so that its axis is parallel to the polar axis and symmetrically adjusted with reference to the meridian of the place, and to set the sphere so that its centre coincides precisely with the centre of the belt. No one of the three adjustments is easy to make or to test because neither the centre of the sphere nor the centre (nor indeed the axis) of the belt can be easily identified. For an instrument for testing these adjustments see *Quart. Journ. Roy. Met. Soc.* xxxii. 249.

Instruments differ according to the means provided for mounting or adjusting the positions of the belt or sphere, and in that known as the Whipple Casella instrument the fixed belt is replaced by a movable card holder. The chief advantage of Stokes's specification is the simplicity of the use of the instrument when once it has been properly adjusted and fixed.

It is essential that the glass sphere should be of the proper size and refractive index to give an image of the sun on the prepared card or within the 20th of an inch of it nearer the centre. It is also essential that the cards used should not only be of suitable material but also of the right dimensions for the bowl. The colour and material of the cards were selected by Stokes in consultation with Warren De la Rue, who was at that time his colleague on the Meteorological Council, and the cards used by the meteorological office are still supplied by Messrs De la Rue & Co. Accuracy in the comparative measurements of sunshine by this method depends upon the proper adjustment of the dimensions of the different constituent parts of the recorder and accordingly the following specification of standard dimensions has been adopted by the meteorological office.

The Time Scale.—On the time scale of the equinoctial card twelve hours are represented by 9·00 in.

The Bowl.—The diameter of the bowl, measured between the centres of the 6 o'clock marks on a metal equinoctial card of thickness 0·02 in. when in its place, is to be 5·73 in. (± 0·01 in.). The distance between the exposure edges of the upper winter flange and the lower summer flange must not be less than 2·45 in., nor exceed 2·50 in. The distances from the middle line on the equinoctial card to the middle lines on the summer and winter cards are to be 0·70 in. (± 0·02 in.). The inclination of the summer card, in place, to the winter card, in place, is to be 32° ± ½°, symmetrically arranged with regard to the equinoctial card. The section of the supporting surface by a plane through the polar axis is to be as in fig. 3.

The Sphere.—The material for the sphere must be "crown" glass, colourless, or of a very pale yellow tint. The diameter 4 in. The weight between 2·92 and 3·02 ℔. The focal length from the centre of the sphere to the geometrical focus for parallel rays should be between 2·96 in. and 2·99 in.

Measurement of the Sunshine Record.—It was mentioned that the Campbell-Stokes recorder involves a conventional definition of sunshine. The recorded day of sunshine is less than the actual time during which the sun is above the horizon by about twenty minutes at sunrise and sunset on account of the want of burning power of a very low sun. Some further convention is necessary in order to obtain a tabulation of the records which will serve as the basis of a comparison of results for climatological purposes. The spot which is scorched on the card by the sun is not quite limited to the image of the sun, and a few seconds of really strong sunshine will produce a circular burn which is hardly distinguishable in size from that of a minute's record. (See fig. 4.) Consequently with intermittent sunshine exaggeration of the actual duration of burning is very probable. Strictly speaking measurements ought to be between the diameters of the circular ends of the burns, but the practice of measuring all the trace that can be distinctly recognized as scorched has become almost universal in Great Britain, and appears to give a working basis of comparisons.

FIG. 4.—Records obtained by exposing a Campbell-Stokes Sunshine Recorder for measured intervals varying from one second to thirty minutes. The duration of the exposure of the separate burns increases from right to left of the diagram.

Other Types of Sunshine Recorder.—There are, however, various other conventions as to sunshine which are used as the basis of recorders of quite different types. The Jordan recorder uses ferrocyanide paper and the sun keeps the time of its own record by the traverse of a spot of light over the sensitive paper, arranged as a cylinder about a line parallel to the polar axis. The effect thereby recorded is a photochemical one, and the composite character of the sun's radiation, modified by the elective absorption of the atmosphere makes the relation of the record to that of the sun's scorching power dependent upon atmospheric conditions and therefore on different occasions, so that the two records give different aspects of the solar influence. Other recorders use the thermal or photographic effect

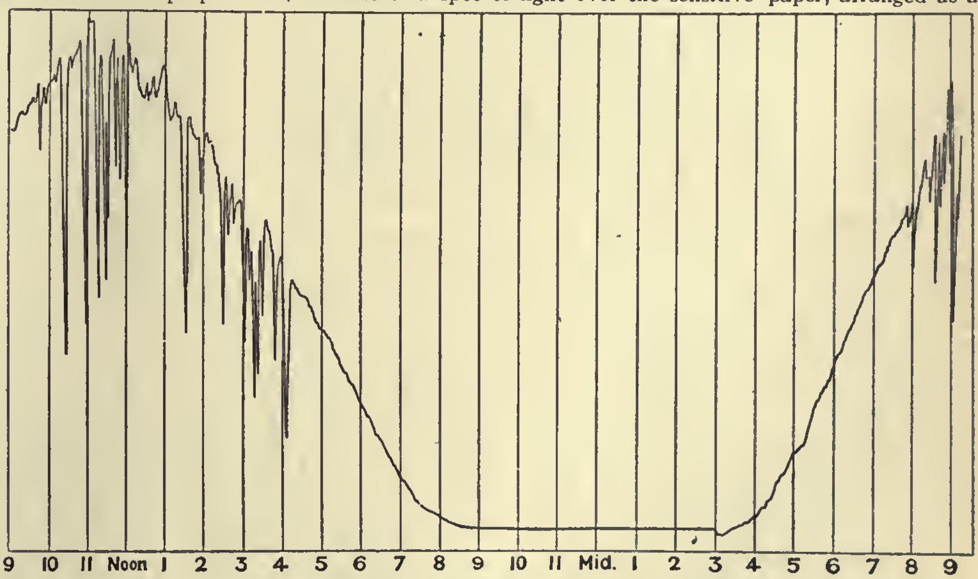


FIG. 5.—Sunshine Record (June 19 and 20, 1908).

of the sun's rays and record duration by a clock instead of allowing the sun to keep its own time. In the Marvin sunshine recorders of

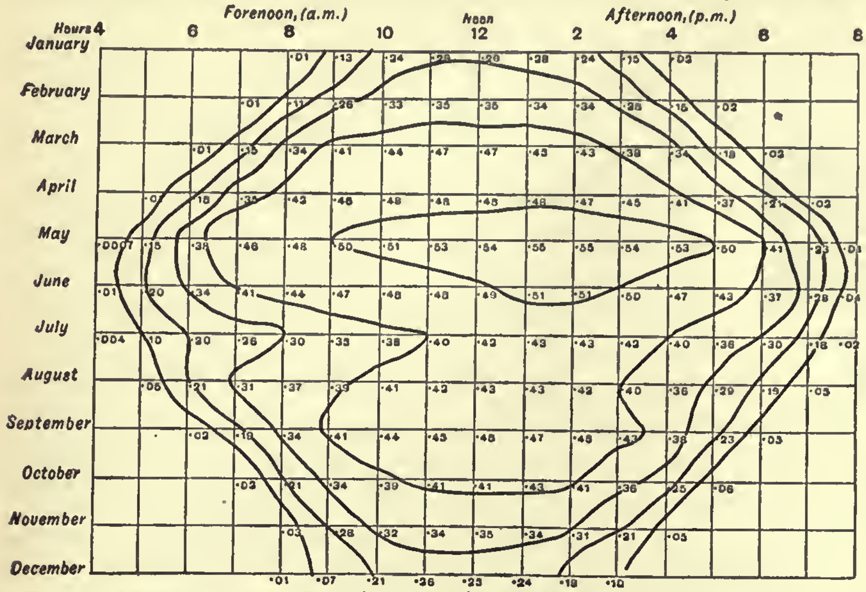


FIG. 6.—Monthly Average Duration of bright Sunshine for each hour of the day at Valencia (Ireland).

the United States weather bureau an electrical contact is made by the thermal effect of the sun and the duration of the contact is recorded. An instrument which gives a corresponding result is described by W. H. Dines (*Quart. Journ. Roy. Met. Soc.* xxvi. 243). These define sunshine by the effect necessary to produce or maintain a certain thermal effect, but the definition once accepted there is no uncertainty as to the record. The Callendar sunshine recorder[1] gives a record of the difference of temperature of two wires, one solarized and the other not, and it is therefore a continuous record of the thermal effect of solar and terrestrial radiation. It is vastly more detailed than that of other instruments (see fig. 5), but the interpretation of the record in terms suitable for meteorological or climatological purposes is a special study, which has not yet been attempted. In a somewhat similar way information about the duration and intensity of sunshine with an abundance of detail can be obtained from the record upon photographic paper passing under an aperture in a drum which revolves with the sun, as in the Lander recorder, but the study of such details has not been begun.

Sunshine Records for the British Isles.—The interest in the use of sunshine recorders is more widely extended in the British Isles than elsewhere, and it is, so far as the public are concerned, the most important meteorological element, but it is singular that up to the present a knowledge of the total amount of sunshine recorded during the day, the week, the month or the year is all that is apparently required. Except for the observatories in connexion with the meteorological office and a few others the distribution of sunshine during the day is not taken out, so that we are still some distance from attacking the problems presented by the finer details of solar records. Fig. 6 shows the average duration of bright sunshine for each hour of the day for each month at Valencia. The expectation of sunshine is greatest at 1 p.m. and 2 p.m. in May, while there is a well-marked secondary maximum in September.

Exposure.—We now consider what the daily sunshine record for a particular station means. An ideal exposure has an uninterrupted view of those parts of the horizon in which the sun rises or sets; and elsewhere the view of the sun must not be obstructed by the ground, buildings, trees or any other obstacle; but ideal exposures are not always to be obtained. In mountainous districts particularly it may be impossible to find a site in which the sun is not obstructed for an appreciable part of the day. In these circumstances it becomes a question whether the amount of sunshine recorded should be referred to the maximum possible for an uninterrupted horizon or the maximum possible for the particular exposure. The answer to the question really depends upon the purpose for which the information is wanted. As a climatological factor of the locality the shadow cast by the surrounding hills is of importance, it is part of the difference between the fertility of the southern and northern slopes of hill country. This importance is, of course, in many respects exclusively local, and indeed the possible duration of sunshine at any station is a local characteristic which it is desirable to know. Consequently as evidence of the peculiarity of the site the recorded sunshine might be referred to the total possible with a free horizon. On the other hand, taking the record of sunshine as an indication of the clearness of the sky for the purposes of general meteorology, the screening of the sun by hills must be regarded simply as limiting the time during which observation is possible and the duration of the sunshine recorded should be referred to the possible duration at the particular site. It would, therefore, be desirable in publishing records of the duration of sunshine recorded to note also the possible amount for the instrument as exposed (see *Hourly Means at Five Observatories under the Meteorological Council*, 1891, No. 113, p. 10). The table shows the number of hours the sun is above the horizon during each month in the latitude of the British Isles.

Possible Duration of Bright Sunshine in the Latitude of the British Isles.

Latitude.	Jan.	Feb.	Leap Year.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
50°	262	278	288	365	410	473	482	485	442	373	327	266	246
51°	257	276	286	365	411	477	487	489	444	373	325	262	241
52°	251	273	284	365	412	481	491	494	446	374	324	258	236
53°	247	271	281	364	414	486	498	499	450	375	323	254	231
54°	243	268	279	363	417	490	503	505	453	375	322	251	225
55°	237	265	276	363	418	494	510	511	456	376	319	245	218
56°	232	263	273	362	420	499	516	516	459	376	316	239	211
57°	226	260	270	362	423	504	524	523	463	377	314	236	205
58°	219	257	267	361	426	510	532	530	467	378	312	232	197
59°	211	253	263	361	429	517	541	538	471	379	309	225	187

By way of exhibiting the results obtained from sunshine records we reproduce (fig. 7) the sunshine map of the British Isles taken from the annual summary of the Monthly "Weather Report," 1908 (*British Meteorological Year-Book*, pt. ii.). Corresponding maps embodying data from over 130 stations are prepared each month; fig. 8 shows the variation in the distribution of sunshine that may take place in different months. Further, fig. 9 represents the average weekly distribution of sunshine in different sections of the British Isles according to the average of twenty-five years.

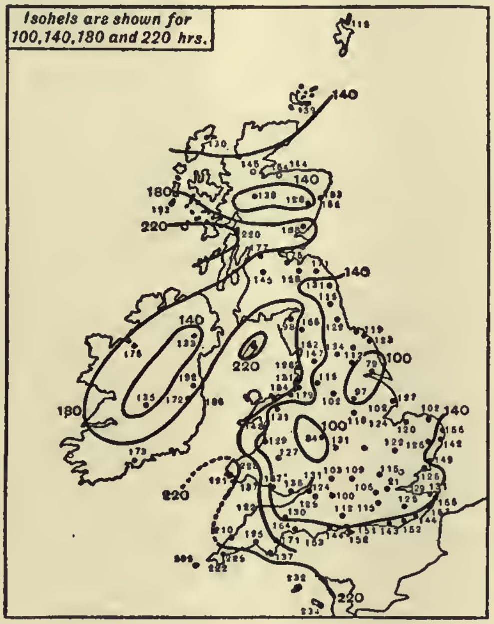
FIG. 7.—Sunshine in the British Isles in 1908.

Sunshine in the Antarctic Regions.—It is clear that so far as concerns the zone from 50° to 60° N. in this particular region, the annual amount of sunshine diminishes as one goes northward. It would, however, not be safe to conclude that this diminution in the aggregate duration of sunshine during the year goes on without interruption as one proceeds northward. At least the corresponding statement would not be true of the southern hemisphere. No doubt

[1] *Brit. Assoc. Report* (1900), p. 44.

the frequency of cloud and the consequent loss of duration of sunshine would increase for corresponding latitudes from the tropical anticyclone southward, but beyond the region of minimum pressure at the winter quarters of the "Discovery" in latitude 77° 51′ S., longitude 166° 45′ E., the amount of bright sunshine recorded during the two years 1902 and 1903 was remarkably large. The total for 1903 equalled that for Scilly, and in December of that year an average of 16 hours per day was registered.

May 1909.



June 1909.

FIG. 8.—Sunshine in the British Isles in May and June 1909.

Sunshine Results for Other Parts of the World.—Maps showing the average annual distribution of sunshine over Europe and North America are given in Bartholomew's *Physical Atlas*, vol. iii. *Atlas of Meteorology*. Over Europe the largest totals, over 2750 hours per annum, are shown over central Spain. In North America, values exceed 3250 hours per annum in the New Mexico region. For other parts of the world the information available is not sufficiently extensive for the construction of charts.

Effect upon Sunshine Records of the Smoke of Great Cities.—Much discussion has taken place from time to time as to whether the climate of a locality can be altered by artificial means. Questions have been raised as to the effect of forests upon rainfall, as to the indirect effect of irrigation or the converse process, the obliteration of natural irrigation by blown sand, and as to the possibility of producing, arresting or modifying rainfall by the discharge of explosives.

The one question of the kind to which the sunshine recorder gives an absolutely incontrovertible answer is as to the effect of the smoke of great cities in diminishing the sunshine in the immediate

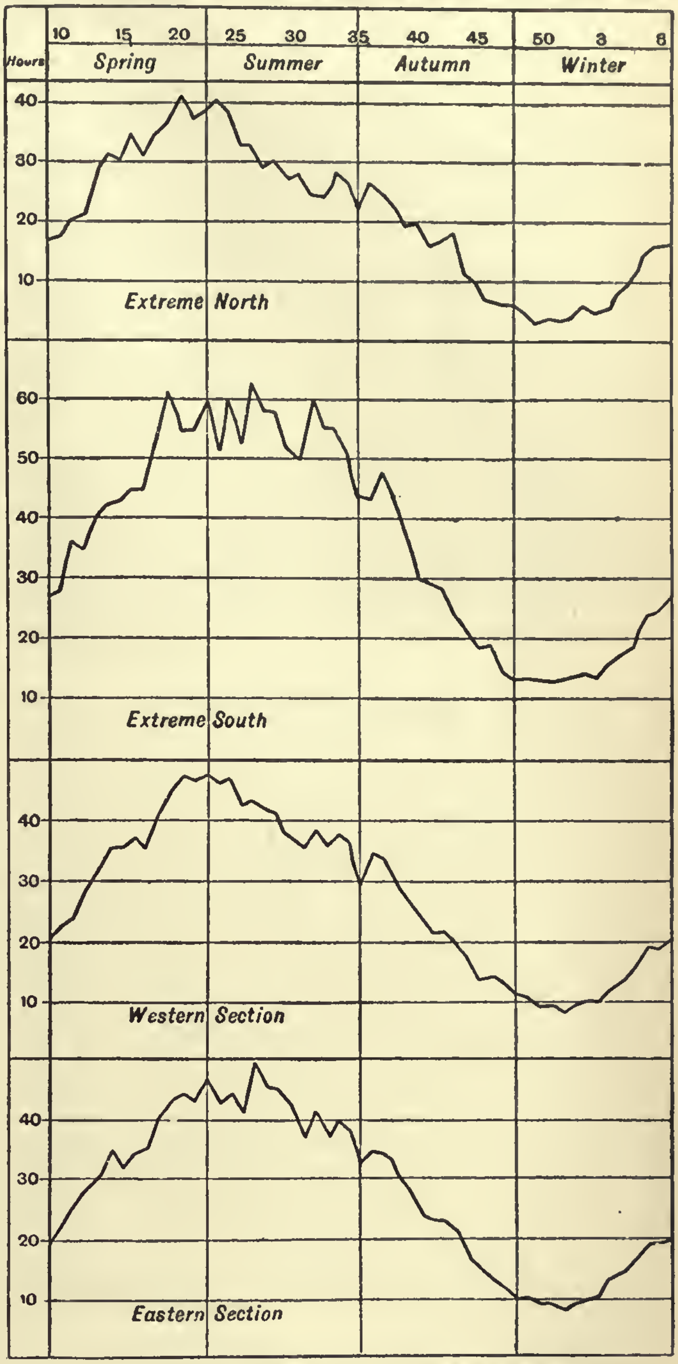


FIG. 9.—Average Duration of bright Sunshine in the British Isles for each week.

neighbourhood. This may be illustrated by the figures for sunshine during the winter months off Bunhill Row, E.C., in the middle of London, Westminster, Kew and Cambridge.

Monthly Average Duration of Bright Sunshine derived from Observations extending over Twenty Years.

Station.	November.	December.	January.	February.
Bunhill Row . .	22·8	7·5	14·1	30·6
Westminster . .	27·7	13·1	18·4	32·8
Kew	50·8	38·1	40·3	54·6
Cambridge . . .	61·0	40·6	48·9	73·8

This is not a question which comes out merely by taking averages. The answer can be seen directly by comparing the daily cards (see fig. 10, Sunshine Cards for Cambridge, Westminster and Bunhill Row for December 1904). Thus it appears that the direct effect of the local contamination of the London atmosphere results in the diminution of the recorded sunshine for the whole year by 37%, and it is clear that the contamination extends in some degree as far as Kew, where the loss amounts to about 10%. There is evidence of various kinds to show that the effect of the smoke cloud of cities

Cambridge. Westminster. Bunhill Row.

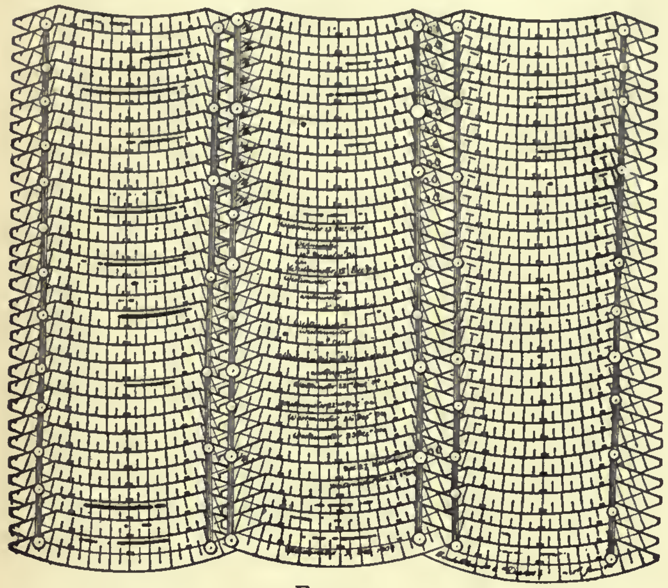


FIG. 10.

can be traced sometimes for great distances, and in special conditions of weather with easterly winds the effect is sometimes remarkably persistent. (W. N. S.)

SUNSTONE, a felspar exhibiting in certain directions a brilliant spangled appearance, which has led to its use as an ornamental stone. The effect appears to be due to reflections from enclosures of red haematite, in the form of minute scales, which are hexagonal, rhombic or irregular in shape, and are disposed parallel to the principal cleavage-plane. These enclosures give the stone an appearance something like that of aventurine (*q.v.*), whence sunstone is known also as "aventurine-felspar." It is not common, the best-known locality being Tvedestrand, near Arendal, in south Norway, where masses of the sunstone occur embedded in a vein of quartz running through gneiss. It is found also near Lake Baikal, in Siberia, and at several localities in the United States, notably at Middletown, Delaware county, Pennsylvania, and at Statesville in North Carolina. The felspar which usually displays the aventurine appearance is oligoclase (*q.v.*), but the effect is sometimes seen also in orthoclase (*q.v.*): hence two kinds of sunstone are distinguished as "oligoclase sunstone" and "orthoclase sunstone." The latter has been found near Crownpoint and at several other localities in the state of New York, as also at Glen Riddle in Delaware county, Pennsylvania, and at Amelia Court House, Amelia county, Virginia.

SUNSTROKE (*Heatstroke*; *Insolation*; *Thermic Fever*; *Siriasis*), a term applied to the effects produced upon the central nervous system, and through it upon other organs of the body, by exposure to the sun or to overheated air. Although most frequently observed in tropical regions, this disease occurs also in temperate climates during hot weather. A moist condition of the atmosphere, which interferes with cooling of the overheated body, greatly increases the liability to suffer from this ailment.

Sunstroke has been chiefly observed and investigated as occurring among soldiers in India, where formerly, both in active service and in the routine of ordinary duty, cases of this disease constituted a considerable item of sickness and mortality. The increased attention now paid by military authorities to the personal health and comfort of the soldier, particularly as regards barrack accommodation and dress, together with the care taken in adjusting the time and mode of movement of troops, has done much to lessen the mortality from this cause. It would appear that, while any one exposed to the influence of strong solar heat may suffer from the symptoms of sunstroke, there are certain conditions which greatly predispose to it in the case of individuals. Causes calculated to depress the health, such as previous disease, particularly affections of the nervous system—anxiety, worry or overwork, irregularities in food, and in a marked degree intemperance—have a powerful predisposing influence, while personal uncleanliness, which prevents among other things the healthy action of the skin, the wearing of tight garments, which impede the functions alike of heart and lungs; and living in overcrowded and insanitary dwellings have an equally hurtful tendency.

While attacks of sunstroke are frequently precipitated by exposure, especially during fatigue, to the direct rays of the sun, in a large number of instances they come on under other circumstances. Cases are of not infrequent occurrence among soldiers in hot climates when there is overcrowding or bad ventilation in their barracks, and sometimes several will be attacked in the course of a single night. The same remark applies to similar conditions existing on shipboard. Further, persons whose occupation exposes them to excessive heat, such as stokers, laundry workers, &c., are apt to suffer, particularly in hot seasons. In the tropics Europeans, especially those who have recently arrived, are more readily affected than natives. But natives are not exempt.

The symptoms of heatstroke, which obviously depend upon the disorganization of the normal heat-regulating mechanism, as well as of the functions of circulation and respiration, vary in their intensity and likewise to some extent in their form. Three chief types of the disease are usually described.

1. *Heat Syncope.*—In this form the symptoms are those of exhaustion, with a tendency towards fainting or its actual occurrence. A fully developed attack of this description is usually preceded by sickness, giddiness, some amount of mental excitement followed by drowsiness, and then the passage into the syncopal condition, in which there are pallor and coldness of the skin, a weak, quick and intermittent pulse, and gasping or sighing respiration. The pupils are often contracted. Death may quickly occur; but if timely treatment is available recovery may take place.

2. *Heat Apoplexy or Asphyxia.*—In this variety the attack, whether preceded or not by the premonitory symptoms already mentioned, is usually sudden, and occurs in the form of an apoplectic seizure, with great vascular engorgement, as seen in the flushed face, congested eyes, quick full pulse and stertorous breathing. There is usually insensibility, and convulsions are not infrequent. Death is often very sudden. This form, however, is also amenable to treatment.

3. *Thermic Fever.*—This variety is characterized chiefly by the excessive development of fever (hyperpyrexia), the temperature of the body rising at such times to 108° to 110° F. or more. Accompanying this are the other symptoms of high febrile disturbance, such as great thirst, quick full pulse, pains throughout the body, headache, nausea and vomiting, together with respiratory embarrassment. After the attack has lasted for a variable period, often one or two days, death may ensue from collapse or from the case assuming the apoplectic form already described. But here, too, treatment may be successful if it is promptly applied.

Besides these, other varieties depending on the prominence of certain symptoms are occasionally met with. The chief changes in the body after death from heatstroke are those of anaemia of the brain and congestion of the lungs, together with softness of the heart and of the muscular tissues generally. The blood is dark and fluid and the blood corpuscles are somewhat altered in shape. Attacks of sunstroke are apt to leave traces of their effects upon the constitution, especially upon the nervous system. A liability to severe headache, which in many cases would seem to depend upon a condition of chronic meningitis, epileptic fits, mental irritability and alterations in the disposition are among the more important. It is often observed that heat in any form is ever afterwards ill borne, while there also appears to be an abnormal susceptibility to the action of stimulants. The mortality from sunstroke is estimated at from 40 to 50%.

Treatment.—Means should be adopted to prevent attacks in the case of those who must necessarily be exposed to the sun. These consist in the wearing of loose clothing, with the exception of the head-dress, which ought to be worn close to the head, in due attention to the function of the skin, and in the avoidance of alcoholic and other excesses. Cold water may be drunk in small quantities at frequent intervals. Sleeping in the open air in very hot seasons is recommended. The treatment of a patient suffering from an attack necessarily depends upon the form it has assumed. In all cases he should if possible be at once removed into a shaded or cool place. Where the symptoms are mostly those of shock and there is a tendency to death from heart failure, rest in the recumbent position, the use of diffusible stimulants, such as ammonia or ether, &c., together with friction or warmth applied to the extremities, are the means to be adopted. Where, on the other hand, the symptoms are those of apoplexy or of hyperpyrexia, by far the most successful results are obtained by the use of cold (the cold affusion, rubbing the surface with ice, enemata of ice-cold water). The effect is a marked lowering of the temperature, while at the same time a stimulus is given to the respiratory function. Mustard or turpentine applied to the nape of the neck or chest is a useful adjuvant. Should the temperature be lowered in this way but unconsciousness still persist, removal of the hair and blistering the scalp are recommended. The subsequent treatment will depend upon the nature of the resulting symptoms, but change to a cool climate is often followed by marked benefit.

SUPERANNUATION (formed on the basis of "annual," "annuity," from the Late Lat. *superannatus*, one that has lived beyond the year, *super*, above, and *annus*, year, Fr. *suranner*, to grow very old), properly a disqualification or relief from office or service on account of old age, infirmity, or of passing the limit of age fixed for service, hence the pension or allowance granted in respect of service at the expiry of the term or the retirement (see PENSION). Educationally the term is specifically used of the removal of a backward pupil, who would otherwise remain in a class or form below that which his age demands.

SUPERCARGO, a term in maritime law (adapted from the Span. *sobrecargo*, one over or in charge of a cargo) for a person employed on board a vessel by the owners of the cargo to manage their trade, sell the merchandise at the ports to which the vessel is sailing, and buy and receive goods for shipment homewards. He has control of the cargo unless expressly or impliedly limited by his contract or agreement. He differs from a factor, who has a fixed place of residence at a port or trading place, by sailing from port to port with the vessel to which he is attached.

SUPEREROGATION (Late Lat. *supererogatio*, payment beyond what is due or asked, from *super*, beyond, *erogare*, to pay out, expend, *ex*, out, *rogare*, to ask), the performance of more than is asked for, the action of doing more than duty requires. In the theology of the Roman Church, "works of supererogation" are those which are performed beyond what is required by God, thus forming a reserve store of works of merit which can be drawn upon for the dispensation of those whose works fall short of the standard required.

SUPERINTENDENT, a term which, apart from its general use for an official in charge, has a distinct religious connotation, being applied, *e.g.* to the head of a Sunday school and to the chief minister in a Methodist circuit. In its most important historical sense it refers to certain ecclesiastical officers of reformed churches of the Lutheran model.

At the Reformation the question of the ordering and constitution of the churches was urgent. The greatest confusion prevailed: the priests were often dissolute, the people were ignorant, and meanwhile nobles were seizing the Church lands. Luther and Melanchthon would have preferred to retain the old episcopal control, and to have charged the bishops with the duty of making the necessary alterations in the ecclesiastical constitution. For, while they taught that in spiritual powers all ministers were equal, they recognized the propriety of allowing administrative distinctions. But the bishops were unwilling to come to any terms with the Reformers, and it became necessary to appoint officers of some new kind. The name of superintendent was then given to a class of men who discharged many of the functions of the older bishops, while bearing a character which in several respects was new. Only in Denmark was the name of bishops reserved for the new officers after the Lutheran model had been adopted and the older bishops had been deposed and imprisoned. It is still used there, though no claim is made that it is the sign of formal apostolical succession. In Scotland the *First Book of Discipline* provided not only for ministers, teachers, elders and deacons, but also for superintendents and readers. The superintendents (who were appointed because of the scarcity of Protestant pastors) took charge of districts corresponding in some degree with the episcopal dioceses, and made annual reports to the general assembly of the ecclesiastical and religious state of their provinces, in the churches of which they also preached.

The distinctive character borne by the new officers was determined by the cardinal principles which Luther had laid down in his work regarding the religious functions of the state. He conceived of the secular government as an ordinance of God, and as being set to direct and control the external fortunes of the Church. He hoped that righteous magistrates would at all times form a sound court of appeal in times of ecclesiastical disorder, and that they would guard the interests of truth and justice more securely than had been done under papal jurisdiction. The superintendents who now had to undertake large administrative responsibilities in the Church were therefore to be appointed by the civil power and to be answerable to it. They were to stand as intermediaries between the prince or magistrates on the one hand, and the ministers in their districts on the other.

In his earlier writings Luther had laid his main emphasis on the spiritual priesthood of all believers. Every sincere Christian was declared free, not only to preach, but also to administer the sacraments and to rebuke evil livers. The differences in office and function between the members implied no difference in rank, for the members of Christ's Church were all members of His body, and Luther believed that they would all be ruled into true order and charity by the Head. But he was shaken by the Peasants' War, and his faith in the virtues of the average man never recovered itself. The result was seen in his later writings, where he expresses his conviction that men need to be directed and restrained from without, and he looks to the state to undertake this duty. In the last resort the civil magistrates must take control of the Church. His vindication for thus subordinating the ecclesiastical to the civil lay in his assumption that the rulers of a Christian land would themselves be Christian, and that it was the Christian duty of the Church to render obedience to those who had been ordained of God to bear rule. He, and the rest of the Reformers, were as firm believers in a visible Catholic Church as were any of those of whom he speaks as "the adherents of the old religion," and Luther, always conservative in feeling, clung to an alliance with the state and denied that the repudiation by the Reformers of papal authority had severed them from the visible Church.

The character of the office and duties of the superintendent were not everywhere the same. Luther shrank from imposing any stereotyped forms and asked that the special circumstances of each separate district should be consulted. He hoped that as few changes as possible would be made, and trusted that the reformed doctrines would spread peacefully throughout the country. After the Diet of Speyer (1526) the civil authorities were invited to reorganize the Church in their respective dominions as they thought best. This was not felt to present any great difficulties in the free towns, for institutions of self-rule had there grown strong and schemes of ecclesiastical readjustment were speedily drawn up. Richter and Sehling[1] have published a number of these ordinances, and they show that as a rule one of the city clergy was appointed superintendent by the city fathers and set in a position of administrative authority over all the churches within their jurisdiction. They were answerable to those fathers for their good order. Greater difficulties presented themselves in the territories of the German princes, and in the case of Saxony Luther proposed to the elector that his first step should be to send out a commission of visitation which should report on the moral and spiritual condition of his principality, district by district. His proposal was carried out, and Luther himself became one of the visitors (1527–1528). He found the people in a state of such religious indifference and ignorance, and the clergy living often in such grossness, that his faith in their fitness to govern themselves ecclesiastically sank even lower than before, and he resisted all schemes for self-government such as had been proposed by Francis Lambert. The church organization which he devised for Saxony provided

[1] In their works on *Die evangelischen Kirchenordnung des 16ten Jahrhunderts* (Weimar, 1846; and Leipzig, 1902–1904).

no place for democratic or representative elements: the grasp of the state must at all times be felt. The superintendent must speak at all times as a minister of the state, and the state must be represented in the synod to which he makes his first report, for upon the synod there must sit not only the pastors but also a delegate from every parish. If any appeal should be made from the decisions of the synod it must be heard in the court of the electoral prince, for he, as supreme civil ruler, possessed the *jus episcopale*, the right of oversight of the churches. Luther proposed that he should exercise this right by appointing a consistorial court composed in part of theologians and in part of canon lawyers, and it was thus that in 1542 the Wittenberg ecclesiastical consistory was formed. Other principalities adopted the model, so that the institution became common throughout the Lutheran churches.

In this scheme the superintendent (or superattendant) was charged with such part of the duty of the older bishops as had been purely administrative. He must concern himself with the discharge of their duties by the pastors of the churches, as well as with their character and demeanour. He must supervise their conduct of public worship, as well as give them licence to preach. He must take cognizance of their ministry to the indigent in their parishes, and of their management of the schools. He must further direct the studies of candidates for the pastoral office. He was answerable to the civil authorities to report all evil-living and false teaching, and those authorities had final power in the matters referred to them. If those matters, however, presented technical difficulties, they could be referred to the consistorial courts.

The earliest occasion of the appointment of such a superintendent would seem to be found in the decisions of Prince John of Saxony about 1527. He assigns the duties of the office, and summons the newly appointed officer to give diligent heed to the conduct and teaching of the pastors under him, faithfully to warn them of all errors, and, in case they prove obstinate, to report them to the electoral court. He must further give close attention to the due observance of the marriage laws, for in this matter the previously appointed visitors to the principality had reported grave laxity. The title of this office was not new, but was taken over from the later Scholastics, who had employed it as a suitable translation of the word ἐπίσκοποι, but Prince John made it clear that his superintendents were not to be bishops in the old sense of the term. For every pastor was declared in the reformed doctrine to be truly a bishop and to have the spiritual functions and authority of a bishop; but the older bishops had also claimed a large number of administrative powers, and these for the future must be retained in the hands of the secular power, which would express itself in the first instance through the state-appointed superintendent. In the few cases in which the old bishoprics were retained in Lutheran communities their tenants held office directly from the state.

Some of the smaller principalities appointed but a single superintendent for their territory, who, instead of being answerable to a consistory, sat as spiritual member on the territorial council, whilst in towns the superintendent was summoned to the town council whenever Church matters arose for discussion. In larger states there were various classes of superintendents with their respective duties severally assigned.

In modern times the functions of the superintendent have been somewhat confused in consequence of the introduction into Lutheran Church theory of inconsistent elements of Presbyterian and synodal type.

See T. M. Lindsay, *History of the Reformation* (1906), i. 400–416; and the articles "Kirchenordnung" and "Superintendent" in Herzog-Hauck's *Realencyklopädie für protestantische Theologie und Kirche.* (E. Ar.*)

SUPERIOR, the most north-westerly of the Great Lakes of North America, and the largest body of fresh water in the world, lying between 46° 30′ and 48° N., and 84° 30′ and 92° W. It is bounded E. and N. by the province of Ontario, W. by the state of Minnesota, and S. by Wisconsin and Michigan. It has deep, extremely cold, clear water, and high and rocky shores along a large portion of its coast. Its general form is that of a wide crescent convex towards the north, but its shores are more irregular in outline than those of the other lakes. Following the curves of its axis from west to east the lake is about 383 m. long, and its greatest breadth is 160 m. Its maximum recorded depth is 1008 ft., and its height above mean sea level is 602 ft., or about 21 ft. above that of lakes Michigan and Huron, to which it is joined at its eastern extremity through the river St Mary. The lake receives the waters of 200 rivers, and drains a territory of 48,600 sq. m., the total area of its basin being 80,400 sq. m. The largest river which empties into it is the St Louis, at its western end. The principal rivers on the north shore are the Pigeon, which forms the international boundary line, the Kaministikwia, the Nipigon, which drains the lake of the same name and together with the lake is about 200 m. long, the Pic, the White and the Michipicoten. No large rivers empty into Lake Superior from the south. There are not many islands in the lake, the largest being Isle Royal, 44 m. long; Michipicoten Island in the eastern part; St Ignace, in the northern part, off the mouth of the Nipigon River; Grand Island between Pictured Rocks and Marquette; Manitou Island, east of Keweenaw Point, and the Apostle Group, to the north of Chequamegon Bay.

The boundary between the United States and Canada runs up the middle of the outlet of the lake and follows a median line approximately to about mid-lake; thence it sweeps northwestward, so as to include Isle Royal within the territory of the United States, and continues near the north shore, to the mouth of Pigeon River, which it follows westward, leaving the whole west end of the lake in United States territory.

Lake Superior lies in a deep rift in rocks principally of Archean and Cambrian age, of the Laurentian, Huronian and Keweenaw formations, rich in minerals that have been extensively worked. The lake is, as it were, surrounded by iron, which is the probable cause of very strong magnetic fields of influence. Native silver as well as silver ores exist around Thunder Bay, native copper was formerly worked on Isle Royal, and rich copper mines are worked on the south shore, while nickel abounds in the country north of the lake. The Archean rocks produce a picturesque coast-line, the north shore particularly being indented by deep bays surrounded by high cliffs, mostly burnt off and somewhat desolate; the islands also rise abruptly to considerable heights, the north shore furnishing the boldest scenery of the Great Lakes. On the south coast, opposite the broadest part of the lake, are precipitous walls of red sandstone, extending about 14 m., famous as the Pictured Rocks, so called from the effect of wave action on them. There are no appreciable tides and little current. A general set of the water towards the outlet exists, especially on the southern shore. From the Apostle Islands to the eastward of Keweenaw point this current has great width, and towards the eastern end of the lake spreads out in the shape of a fan, a branch passing to the northward and westward reaching the north coast. Autumn storms raise dangerous seas. The level varies with the season, and also from year to year, the maximum variation, covering a cycle of years, being about 5 ft. The discharge of the lake is computed to be 75,200 cubic ft. per second at mean stage of water.

The season of navigation, controlled by the opening and closing of the Sault Ste Marie canals, averages about eight months—from the middle of April to the middle of December. The season has been extended for a few days, in both spring and autumn, by the use of ice-breaking tugs at Fort William and Port Arthur, this service being organized by the government particularly to facilitate the movement of grain from the Canadian North-west. The lake never freezes over, though the temperature of the water does not, even in summer, rise far above freezing point. The bays freeze over and there is border ice, often gathered by wind into large fields in the bays and extremities of the lake.

Lake Superior is fairly well provided with natural harbours, and works of improvement have created additional harbours of refuge at various points. Marquette, Mich., Presque Ile Point, Mich., Agate Bay, Minn., Grand Marais, Minn., and Ashland, Wis., are on bays which have protective breakwaters across their mouths. Duluth, Superior, Port Wing, Wis., Ontonagon, Mich., and Grand Marais, Mich., are harbours with entrances formed by parallel jetties extending across obstructing bars. On the Canadian side Fort William, in the mouth of the Kaministikwia, and Port Arthur, four miles distant, an artificial harbour, are the only important shipping points, being the lake terminals of three great transcontinental railway systems, though the whole north shore is liberally supplied with natural harbours. The traffic on Lake Superior grows constantly in volume, the increase in tonnage of each year over that of the preceding year having, for 50 years past, averaged 20%. The freight carried into and out of the lake, as gauged by the statistics gathered at the Sault Canal offices, aggregated in 1907 over 58,000,000 (short) tons. The principal freight shipped eastward consists of flour, wheat and other grains, through Duluth–Superior from the United States, and through Fort William–Port Arthur from the Canadian prairies; copper ore from the mines on the south shore; iron ore in immense quantities from both shores, the principal ore shipping ports being Ashland, Two Harbors, Marquette, Superior and Michipicoten, and lumber produced on the tributary rivers. West-bound freight consists largely of coal for general distribution and for terminal railway points.

The fishing industry of Lake Superior is important, salmon-trout (*Salvelinus namaycush*, Walb), ranging from 10 to 50 lb in weight, being gathered from the individual fishermen by steam tenders and shipped by rail to city markets. The river Nipigon, on the north shore, is famous for speckled-trout (*Salvelinus fontinalis*, Mitchill) of unusual size; and all rivers and brooks falling into the lake are trout streams.

See Bulletin No. 17, *Survey of Northern and North-Western Lakes*, U.S. War Department, Lake Survey Office, Detroit (1907); *Sailing Directions for Lake Superior and the St Mary's River*, U.S. Hydrographic Office publication No. 108 A. (Washington, 1906), with supplements. (W. P. A.)

SUPERIOR, a city, a port of entry and the county-seat of Douglas county, Wisconsin, U.S.A., about 140 m. N. by E. of Minneapolis and St Paul, on Superior, St Louis and Allouez bays at the head of Lake Superior, and directly opposite Duluth, Minnesota, with which it is connected by ferry and by railway and road bridges. Pop. (1890), 11,983; (1900), 31,091, of whom 11,419 were foreign-born (2854 Swedish, 2404 English Canadians, 2026 Norwegian, and 801 German), and 186 were negroes; (1910, U.S. census), 40,384. Superior is served by the Northern Pacific, the Duluth, South Shore & Atlantic, the Wisconsin Central, the Great Northern, the Minneapolis, St Paul & Sault Ste Marie, and the Chicago & North-Western railways, and (for freight only) by the Chicago, Milwaukee & St Paul. A belt line railway connects the several systems. Superior shares with Duluth one of the finest natural inland harbours in the world. The harbour, which has been improved by the Federal government, is formed by two narrow strips of sandy land, known as Minnesota and Wisconsin Points, which extend several miles across the head of the lake from the Minnesota and Wisconsin shores respectively and almost meet in the centre. The body of water thus formed, Superior and Allouez bays, varies in width from 1 to $1\frac{1}{4}$ m., and is $9\frac{1}{2}$ m. long. St Louis Bay, on the west, is about $1\frac{1}{2}$ by 4 m. The city is situated on gently rising ground facing these bays, and has 29 m. of harbour frontage. The settlement of Superior at different times and in different places is responsible for the large area covered by the city (36·1 sq. m.) and its appearance is that of three distinct towns. The intervening portions have however been platted and are now largely settled. Superior is the seat of a state normal school (1896), which occupies a splendidly equipped building, and, in addition to the ordinary normal courses, has departments of kindergarten training, manual training and domestic science. The city is the see of a Roman Catholic bishop. Superior has a cheap fuel supply and power is furnished by electricity generated on the St Louis river. In 1905 the value of its factory products was $6,356,981. Flour is the principal product, and shipbuilding is important. Among steel ships, the type known as the "whaleback" originated here; and iron and wooden ships, launches and small pleasure craft are also made. Other manufactures are railway cars, casks, cooperage, saw and planing mill products, furniture, wooden ware, windmills, gas-engines, and mattresses and wire beds. Superior is an important grain market. Much iron and copper ore is shipped from the Duluth-Superior harbour; and large quantities of coal, brought by lake boats, are distributed from here throughout the American and Canadian North-west. The total tonnage of the Duluth–Superior Harbour was estimated in 1908 to be exceeded in the United States only by that of New York and that of Philadelphia.

Pierre Esprit Radisson and Medard Chouart des Groseilliers probably visited the site of Superior in 1661, and it is practically certain that other French *coureurs-des-bois* were here at different times before Daniel Greysolon, Sieur Du Lhut (Duluth), established a trading post in the neighbourhood about 1678. About 1820 the Hudson's Bay Company established a post here, but there was no permanent settlement until after the middle of the 19th century. Attention was directed to the site by a survey made by George R. Stuntz, a government surveyor, in 1852, and in 1853 a syndicate of capitalists, at the head of which was William Wilson Corcoran, the wealthy Washington banker, associated with whom were Senators Stephen A. Douglas (from whom the county was named), R. M. T. Hunter and J. B. Bright, Ex-Senator Robert J. Walker, Congressmen John C. Breckinridge and John L. Dawson, and others, largely Southern politicians and members of Congress, bought lands here and platted a town which was named Superior. The proprietors secured in 1856 the construction of a military road to St Paul, Minnesota, 160 m. long. The town grew rapidly, and in 1856–1857 had about 2500 inhabitants. The panic of 1857 interrupted its growth, and the population dwindled so that in 1860 there were only a few hundred settlers on the town-site. The Civil War increased the depression, and the lands of those who had taken part against the Union were confiscated. In 1862 a series of stockades was built as a protection from the Indians. Within the area under the government of the town of Superior, which was at first co-extensive with the county, West Superior was platted in 1883 and South Superior soon afterwards. A village government was established in September 1887, including the three settlements mentioned, and in April 1889 Superior was chartered as a city. The harbour was surveyed in 1823–1825 by Lieut. Henry Wolsey Bayfield (1795–1885) of the British Navy. In 1860–1861 it was resurveyed by Captain George G. Meade, who was engaged in the work at the outbreak of the Civil War. A branch of the Northern Pacific railway was built to Superior in 1881.

SUPPÉ, FRANZ VON (1820–1895), Austrian musical composer, whose real name was Francesco Ezechiele Ermenegildo Suppé-Demelli, was born at Spalato, in Dalmatia, in 1820, and died at Vienna in 1895. Originally he studied philosophy at the university of Padua, but on the death of his father devoted himself to music, studying at the Vienna conservatoire. He began his musical career as a conductor in one of the smaller Viennese theatres, and gradually worked his way up to be one of the most popular composers of ephemeral light opera of the day. Outside Vienna his works never won much success. Of his sixty comic operas *Fatinitza* (Vienna, 1876; London, 1878) was the most successful, while *Boccaccio* (Vienna, 1879; London, 1882) only enjoyed moderate favour. Suppé's overture to *Dichter und Bauer* is his most successful orchestral work. He also wrote some church music.

SUPPLY (through Fr. from Lat. *supplere*, to fill up), provision; more particularly the money granted by a legislature to carry on the work of government. In the United Kingdom the granting of supply is the exclusive right of the House of Commons, and is carried out by two committees of the House, one of supply and the other of ways and means (see PARLIAMENT). In the United States supply originates in the House of Representatives (see UNITED STATES: *Appropriation*).

In Scotland commissioners of supply were officers appointed to assess and collect the land tax offered as supply to the sovereign. Under the Lands Valuation (Scotland) Act 1854 all owners of property of a certain value were qualified as commissioners of supply. Their duties were also enlarged to comprise the general administration of the country, but by the Local Government (Scotland) Act 1889 all their powers and duties were transferred to and vested in the county council. They still meet annually, but transact only formal business.

SUPPLY AND TRANSPORT, MILITARY. In all ages the operations of armies have been influenced, and in many cases absolutely controlled, by the necessity of providing and distributing food, forage and stores for men and horses. In modern history these supplies have become more and more varied as weapons developed in complexity, power and accuracy of workmanship. In proportion, the branches of an army which are charged with the duties of "supply and transport" have become specialized as regards recruiting, training and organization.

The predatory armies of the middle ages not only lived upon the country they traversed, but enriched themselves with the plunder they obtained from it, and this method of subsisting and paying an army reached its utmost limits in the Thirty Years' War. During the last stages of this war Germany had been so thoroughly devastated that the armies marched hither and thither like packs of hungry wolves, every soldier accompanied by two or three non-combatants—camp followers of all sorts, mistresses, ragged children and miserable peasants who had lost all and now sought to live by robbing others under the protection of the army. An English traveller, as early as 1636, twelve years before the peace of Westphalia, reported that at Bacharach-on-Rhine he had found "the poor people dead with grass in their mouths," and that a village at which he stayed "hath been pillaged eight-and-twenty times in two years, and twice in one day."

From these horrors there followed a revulsion to the other extreme. Unless ordered by higher authority for political reasons to sack a particular town or to pillage a particular district, the soldiers were rigidly kept in hand, rationed by their own supply officers and hanged or flogged if at any moment an outbreak of the old vices made the example necessary. After 1648 there were very few districts in Middle Europe that could support an army for even a few days, and the burden of their sustenance had to be distributed over a larger area. Thus, at the mere rumour of an army's approach, the peasantry fled with all their belongings into the fortified places, armies soon came to be supplied from "magazines," which were filled either by contract from the home country or by inducing the peasantry—by means of good conduct and cash payments—to bring their produce to market. These magazines were placed in a strong place, and if one was not available, a siege had to be undertaken to meet the demand. Moreover, soldiers in Marlborough's time were not as easily obtained as in the Thirty Years' War, and they had to be housed and fed comfortably enough to make it worth their while to stay with the colours instead of deserting. From these and similar conditions there grew up a system of supply and transport usually called the "magazine system," under which an army was bound, under penalty of dissolution, to go no farther than seven marches from the nearest fortress, two days from the nearest field bakery, and so on. When an 18th-century army foraged for itself it was because the regular supply service was interrupted, *i.e.* when it was *in extremis*. But the relative rarity of wars in the 18th century, the habit of demanding nothing from the inhabitants of the country traversed by an army, and the virtual exclusion of the people from the prince's quarrels, gave Europe a century's respite in which to recover from the drain of the Thirty Years' War. And therefore, when the French Revolution came, the attempts of the armies of old Europe to suppress it without robbing a single Frenchman of a loaf of bread proved futile, and soon the national army created by the Revolution, unencumbered by tents, magazines and supply trains, swept over southern Germany and Italy. The Revolutionary armies differed indeed from those of the old wars in this, that they did not devastate wantonly, nor did they murder for the sake of loot. But they were merciless in their exactions, and, moreover, the tides of their invasions flowed in particular channels, so that the greater part of the invaded country escaped. This had a considerable, sometimes even a predominant, influence on the strategy pursued, a retreat along their own lines of communication being often in fact avoided by the French as being the worst fate that could befall them. Napoleon, however, systematized the wasteful and irregular requisitioning that his predecessors had introduced, and in his hands the supply service, like all else connected with the art of war, underwent a thorough reform. His strategy[1] in the offensive passed through two distinct stages—(*a*) the swift and sudden descent into the theatre of war, and (*b*) the close grouping of his armies in view of the decisive blow. The first stage was characterized by extraordinarily swift movement, complete independence of all trains (other than the reserves of ammunition) and thorough exploitation of the food resources of the traversed zone. If the troops suffered, as well as the inhabitants, this did not shake the emperor's purpose in the slightest. If all the disorders which are the natural consequence of ill-regulated requisitioning—that is, marauding—cost the army 50,000 men, he had foreseen the loss and taken 50,000 men more than he needed for the battle. But the second stage, which as a rule involved three or four days' occupation, without considerable movement, of a restricted area, required other measures of supply. In this the army lived upon magazines, which were filled from the captured supply trains from the available supplies in the area, and from the resources accumulated in requisitioned vehicles close to the head of the routes followed in the first period. These resources were collected in the towns within this concentration area, and placed "out of reach of an insult" (that is, made safe against raiders) with a garrison and field works to supplement the town walls and gates. From this *centre of operations* Napoleon never allowed himself to be severed, whereas to the preservation of the route between France and that centre of operations he gave very little thought and assigned few or no troops, and most of the confusion of strategical thought since his time has been due to the general failure to perceive the essential distinction, in Napoleonic practice, between a centre of operations and a "base."

In the 19th century, however, there came the inevitable reaction. Purely political wars, and the consequent indifference of the inhabitants to the operations of war, produced as before a return to the system of cash payments and convoy supply, especially in the Austrian army. As regards Europe the introduction of railways enormously facilitated the supply and transport service, and campaigns were neither as barren nor as prolonged as they had been under the old conditions. The French and British armies did not, at least to the same extent, wage political wars, but their ceaseless colonial warfare imposed upon them the magazine and convoy system, and habituated them to it. The French, in 1870, stood still in the midst of the rich fields of Lorraine, and as a prolonged halt is fatal to the system of living on the country, it would have failed, even had it been tried. The Germans, on the other hand, levied requisitions, civilian transport, and contributions in money in accordance with Napoleonic tradition, though (owing to the existence of railways) with much less than Napoleonic severity. Their system has been accepted as the best for European warfare by all the great powers, whose organizations and methods of transporting and issuing supplies are the same in principle.

This principle is based on the Napoleonic distinction between supplies required during an advance and those required during a concentrated halt. The British *Field Service Regulations* (1909), pt. ii., lay it down that "the system of subsistence should be elastic and readily adaptable to every situation as it arises," but that it must always be based on the rule that "all mobile supplies are to be regarded as a *reserve*" for use when neither local nor line-of-communication resources are available. As a general rule local resources should be used before the line of communication is called upon, and last of all the call is made on the mobile supplies in the hands of the fighting units. During a strategical concentration or a long halt "the resources of the immediate neighbourhood cannot be expected to support the troops. At such times they may be supplied from field dépôts established at convenient centres, and filled with supplies that are obtained by purchase or requisition and collected by requisitioned or hired (civilian) transport." During an advance, on the other hand, "by far the most advantageous method is for the troops to be rationed by the inhabitants on whom they are billeted . . . This method should be employed whenever possible."

The extent to which it can be employed varies considerably with the place and the season, but the British and all continental armies have their own "rules of thumb" or rough generalizations based on experience. General Lewal (*Stratégie de marche*, p. 47) says that in a country of ordinary fertility, with 70 inhabitants to the square kilometre, or 180 to the square mile, 10,000 men can be subsisted for one day on an area of 22 square

[1] H. Camon, *Guerre napoléonienne.*

kilometres or 8½ square miles, or 1200 per square mile. General Bonnal in his *Sadowa* gives 36 square miles as sufficient for the maintenance of an army corps (30,000–35,000) or about 1100 men to the square mile during the assembly period, but only on condition of helping out local resources by special supplies from the base. The British *Field Service Regulations* state that ordinary agricultural districts of Western Europe, not previously traversed by troops, will support a force of twice the strength of the population for a week at a maximum. This would mean exacting fourteen rations from each inhabitant, but the incidence of the burden is spread over several days. A practical rule therefore would seem to be, in a district of 200 inhabitants to the square mile, to allot 1400 men per square mile for a flying passage of one day and 400 for a stay of one week, the resources of the country being more thoroughly and systematically exploited in the latter case. A British division (combatant column only) closing up to half its marching depth at the end of the day would require 12 square miles, and as its depth would be about 5½ miles, its front or width would perhaps extend for only a mile on either side of the route. It is quite possible to move two divisions for several consecutive days on the same road, living on the country exclusively, subject to the condition that the second should halt on the areas which the first has passed through without stopping. In continental armies the rule is, in fact, "one army corps (=2 British divisions) on one road."

During the period of concentration, however, even if in movement, a modern army will necessarily be supplied in somewhat the same way as Napoleon's. The billets will be allotted "without subsistence," and the regimental reserve supplies will be called upon to ration their men, while all around the occupied towns and villages the supply officers and their mounted escorts will requisition food and vehicles to bring the food into the concentration area. In view of this, "supply officers will be sent on with cavalry or mounted brigades to investigate the resources of the country ahead of the main body, and if possible to collect supplies at suitable points." Only commissioned officers and, as a rule, only those officers to whom the power is expressly delegated are entitled to carry out requisitions, though in an emergency a commander of any rank may obtain from the inhabitants articles or services by requisition and on his own responsibility, which responsibility may mean answering to a charge of "plundering" before a court-martial. On purely requisitioning work direct contact between the troops and the inhabitants is to be avoided.

Generally, then, a British regiment operating in Europe would be fed, during an advance, (*a*) by the inhabitants who provide the billets, without the necessity of a supply officer's intervention, (*b*) by the regimental reserves, which would be filled up as they were emptied from the field dépôts, of food-stuffs requisitioned by the supply officers, or (*c*) on emergency by direct requisitioning. During a concentration it would be fed (*a*) in the first instance by "billets with subsistence," as in an advance, (*b*) in so far as this was insufficient, by regimental, brigade and divisional reserves, which would refill partly from the lines of communication and partly from the field dépôts created by the requisitioning supply officers. Thus, as regards food and forage, the British Regulations—though it was not until 1909 that they appeared—are based on the fundamental principles of Napoleon that strategy must be the master, not the servant of supply, and that this mastery is most complete when—by means of "billets with subsistence" or by means of field dépôts of requisitioned food-stuffs—an army makes itself practically independent, as regards food, of its lines of communication.

The general organization of the supply service in Great Britain, calculated for a campaign under European conditions, is as follows: There are dépôts of various kinds and "mobile supplies." The former are classified as (*a*) *base dépôt*, which is the great reserve magazine that collects all resources that come from outside the theatre of war; (*b*) *intermediate dépôts* (filled from the base or by local requisitioning) at intervals along the line of communication, which serve principally to feed the troops posted on the line of communication and those passing along it to the front, but can also be used as an "overflow" magazine if the base dépôt is full, and as a means of bringing reserves nearer to the front: (*c*) *advanced dépôts* at the head of the line of communication, which serve as the expense-magazine, issuing to the "mobile supplies" what these need to enable them to supplement local resources; (*d*) *field dépôts*, frequently alluded to above, which are small temporary dépôts (filled by requisitioning) in the immediate neighbourhood of the front, and from which, in preference to their own mobile reserves, the troops draw supplies if the inhabitants do not furnish them directly in the billets; field dépôts may also be utilized for storing local supplies surplus to the immediate wants of the army. The "mobile supplies" are classified as follows: (*a*) *Regimental*, which are carried partly by man and horse in the ranks and partly in "regimental transport" vehicles, and consist of the current day's ration and the "emergency ration" of compressed food (which is never to be used except in an extremity) on man or horse, and a complete ration for every man and horse on the ration strength of the unit, with an extra "grocery ration" and some compressed forage in the vehicles. (*b*) *Column*, which are carried in the Army Service Corps "supply columns" of the division and carry one day's complete ration[1] and one emergency ration per head of men and animals—these are in a sense mobile field dépôts and depend either on requisitioning or on the advanced dépôt of the line of communication. (*c*) *Park*, which are carried in "divisional parks" that move a day's march (often more) in rear of the divisions and comprise a last mobile reserve of three days' rations of food and forage for the troops.

In warfare in savage or undeveloped countries the conditions are far less favourable, and each case has to be dealt with on its merits. But, in general, such warfare always necessitates an almost complete dependence on magazine supply. There are few or no "billets with subsistence" or "field dépôts" which are the backbone of the supply system in European warfare, and the regimental and column supply vehicles have generally such difficulty in keeping touch with the advanced dépôt of the line of communication that the striking radius of the army is strictly limited to the position and output of the line of communications. Moreover, the difficulty—even the principal difficulty—is the transport of the supplies obtained from the line of communication. The alternative, which has often to be adopted by "punitive" expeditions, is to carry all supplies for the calculated duration of the movements with the troops, but the penalty for this freedom to move is either slowness of movement—the fighting troops regulating their pace by that of the supply vehicles or pack animals—or a disproportionate number of "useless mouths" or non-combatants who must be fed. Altogether, the supply difficulty in expeditions in the Sudan, or West Africa, or on the Indian frontier infinitely outweighs all difficulties of country or enemy. Moreover, paradoxical as it may be, the triumphant surmounting of these difficulties has its disadvantages as regards European warfare. Generals and supply officers who have always dealt with the maximum of difficulty find it almost impossible to bring themselves to deal with easier conditions. In 1805 Mack vainly sought to teach the Austrian soldier how to live on the country in the Napoleonic fashion. In 1806 the Prussians starved in the midst of riches, in 1870 the French moved as slowly and kept themselves as closely concentrated as desert columns in Algeria, and so deprived themselves of the resources of their own country.

Military transport—other than water and rail—may be classed in respect of the means employed as draught and pack, and in respect of its organization and functions as transport on the line of communications and transport in the field, the latter being subdivided into first line and second line. The British army, on account of its frequent expeditions into undeveloped countries, makes a large—in the view of many, far too large—use of pack transport, for which mules, camels and human carriers are employed. But in

[1] One day's supply of meat is usually taken with the column "on the hoof."

European, and to a large extent in other warfare, horsed transport is by far the most generally used. Mechanical transport (generally either traction engines with trucks or motor lorries) is, however, superseding horse draught to a considerable extent in second-line transport. The vehicle usually employed for military transport is the "General Service Wagon," a heavily-built springless four-wheeled vehicle drawn by six or four horses according to circumstances, which weighs empty about 18 cwt., and allows of a maximum load of 30 cwt. There are also four-horse "limbered wagons" consisting of body and limber, weighing 13 cwt. empty and 43 cwt. fully loaded, and lighter two-wheeled carts which can take 13–15 cwt. load.

As regards organization and functions, road transport is used on the line of communications to supplement the railway, and consists of locally hired or requisitioned vehicles worked by the Army Service Corps, or by civilian personnel under A.S.C. control. Transport with the field units is, as has been said, divided into first line, which accompanies the fighting troops, and second line, which follows them at a distance. Both lines are, as a rule, manned exclusively by the A.S.C. (or regimental details in the case of regimental transport) and composed of regulation-pattern carts and wagons. The first-line vehicles include ammunition wagons and carts, tool carts, engineer vehicles and medical vehicles. All baggage and store and supply wagons, as well as a proportion of medical, ammunition and engineer vehicles, form the second line.

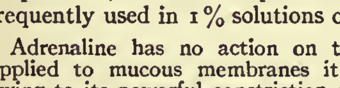
(C. F. A.)

SUPRA-RENAL EXTRACT. The extract of the supra-renal gland is one of the most valuable remedies recently introduced in medicine. Feeding with the fresh gland of sheep was at first practised, but the sterilized glycerin preparation known as supra-renal extract is now used, the dose being 5 to 15 minims. The active principle of the gland,. best known as adrenaline or epinephrine, occurs only in the medulla of the gland. It forms minute white crystals, soluble in weak solutions of hydrochloric acid. The U.S.P. contains a desiccated preparation, *Glandulae suprarenales siccae*. Adrenaline is most frequently used in 1% solutions of the chloride.

Adrenaline has no action on the unbroken skin, but locally applied to mucous membranes it causes blanching of the part owing to its powerful constriction of the capillaries by stimulating the muscular fibres of the vessel walls. It acts rapidly in a similar manner when hypodermically injected. The vessels of the uterus are strongly acted upon by it, but the effect on the cerebral vessels is slight, and the pulmonary vessels are unaffected. The heart is slowed and the systole increased. Adrenaline stimulates the salivary glands. It also produces a temporary glycosuria. In poisonous doses it causes haemorrhages into the viscera and oedema of the lungs.

In Addison's disease the use of supra-renal extract has been beneficial in some cases, but its chief use is in the control of haemorrhage. For this purpose it is given in conjunction with local anaesthetics such as cocaine in order to produce bloodless operations on the eye, nose and elsewhere. It is also useful in haemorrhage from small vessels, where it can be applied at the bleeding spot, as in epistaxis. In menorrhagia and metrorrhagia it is also of service. In surgical shock and in chloroform syncope an injection of adrenaline often saves life through the rise of blood pressure produced. An attack of bronchial asthma may be cut short by a hypodermic injection of adrenaline solution. It should never be used in the treatment of haemoptysis. Similar commercial products on the market are hemisine, renaglandine, suprarenine, adnephrine, paranephrine and renostyptine. Supra-renal snuff containing the dry extract with menthol and boric acid is of use in hay fever. Rhinodyne is of this type. Suppositories containing supra-renal extract are used to check bleeding piles.

The chemistry of adrenaline has been mainly elucidated by the investigations of Pauly, Jowett and Bertrand; Jowett proposing a constitution (see annexed formula) now accepted as correct.



Adrenaline.

Many substances having related constitutions have been synthesized, and it has been found that they resemble adrenaline in increasing the blood pressure. For example, the corresponding ketone, adrenalone (obtained in 1904 by Stolz) is active, and the methyl group can be replaced by hydrogen or another radical without destroying the activity. It seems that the para-hydroxyl group is essential. For instance, para-hydroxyphenylethylamine, $HO{\cdot}C_6H_4CH_2{\cdot}CH_2NH_2$, which is one of the active bases of ergot, closely resembles adrenaline (G. Barger, *Journ. Chem. Soc.*, 1909, 95, pp. 1123, 1720; K. W. Rosenmund, *Ber.*, 1909, 42, p. 4778); as does also its dimethyl derivative hordenine, an alkaloid found in barley (G. Barger, ibid., p. 2193). Adrenaline is optically active, the naturally occurring isomer being the laevo form; it is interesting to note that, like nicotine, the laevo base has a much greater physiological activity than the dextro.

SUPREME COURT OF JUDICATURE, in England, a court of law established by the Judicature Act 1873, by section 3 of which it was provided that the high court of chancery, the courts of king's bench, common pleas, and exchequer, the high court of admiralty, the court of probate and the divorce court, should be united under this name. By section 4, the Supreme Court was to consist of two divisions, one to be called the "high-court of justice" and the other the "court of appeal." See further under JUDICATURE ACTS, and also the articles under the headings of the different courts enumerated above.

The Supreme Court of the United States is the head of the national judiciary. Its establishment was authorized by article iii. of the Constitution, which states that "the judicial power of the United States shall be vested in one Supreme Court, and in such inferior courts as the Congress may from time to time ordain and establish" (s. i.). Section ii. states that "the judicial power shall extend to all cases in law and equity arising under this Constitution, the laws of the United States, and treaties made, or which shall be made, under their authority; to all cases affecting ambassadors, other public ministers and consuls; to all cases of admiralty and maritime jurisdiction; to controversies between two or more states, between a state and citizens of another state, between citizens of different states, between citizens of the same state claiming lands under grants of different states, and between a state, and the citizens thereof, and foreign states, citizens, or subjects. In all cases affecting ambassadors, other public ministers and consuls, and those in which a state shall be party, the Supreme Court shall have original jurisdiction. In all the other cases before mentioned the Supreme Court shall have appellate jurisdiction both as to law and fact, with such exceptions and under such regulations as the Congress shall make." The Supreme Court of the United States also occupies the unique position of being guardian of the Constitution. It has to decide whether a measure passed by the legislative powers is unconstitutional or not, and it may thus have to veto the deliberate resolutions of both houses of Congress and the president.

See UNITED STATES.

SURABAYA (Dutch *Soerabaja*), a seaport of Java, in the eastern division of the island, on the narrow Surabaya strait, which separates the island of Madura from Java, and at the mouth of the Kali Mas River. Pop. (1900), 146,944 (Europeans 8906; Chinese 13,035). Surabaya is the principal mercantile town in Java. Its roadstead is sheltered by Madura, and it has important dockyards. It is also the headquarters of the military authorities for East Java, and has artillery workshops. Railways running north-west, south-west and south give it connexions throughout the island. In the old town, with its partly demolished fortifications, houses, shops and warehouses are more closely packed and the streets are narrower than in most East Indian towns, and, although a considerable number of Europeans live in this quarter, the outlying quarters, such as Simpang (where is the government house) and Tuntungan, are preferable for residence.

SURAJ-UD-DOWLAH (d. 1757), ruler of Bengal. The date of his birth is uncertain, but is generally placed between 1729 and 1736. His name was Mirza Mahommed, and he succeeded his grandfather Aliverdi Khan as nawab of Bengal on the 9th of April 1756. He was a cruel and profligate fanatic. Being offended with the English for giving protection to a native official who had escaped with treasure from Dacca, he attacked and took Calcutta on the 20th of June 1756. He then permitted the massacre known in history as "The Black Hole of Calcutta" (see CALCUTTA). This atrocious act was soon avenged. Calcutta was retaken by Clive and Admiral Watson on the 2nd of January 1757, and on the 23rd of June, Suraj-ud-Dowlah, routed at Plassey, fled to Rajmahal, where he was captured. He was put to death on the 4th of July 1757 at Murshidabad, by order of Miran, son of Mir Jafar, who had conspired against Suraj-ud-Dowlah and had been present at Plassey without taking part in the battle.

SURAT, a city and district of British India in the northern division of Bombay. The city is on the site where the English first established a factory on the mainland, and so planted the seed of the British Empire in India. Local traditions fix the establishment of the modern city in the last year of the fifteenth century, and in 1514 the Portuguese traveller Barbosa described it as an important seaport, frequented by many ships from Malabar and all parts. During the reigns of Akbar, Jahangir and Shah Jahan it rose to be the chief commercial city of India. At the end of the 16th century the Portuguese were undisputed masters of the Surat seas. But in 1612 Captain Best, and after him Captain Downton, destroyed the Portuguese naval supremacy and obtained an imperial firman making Surat the seat of a presidency under the English East India Company, while the Dutch also founded a factory. In 1664 Sir George Oxenden defended the factory against Sivaji with a bravery that deserves to rank with Clive's defence of Arcot. The prosperity of the factory at Surat received a fatal blow when Bombay was ceded to the Company (1668) and shortly afterwards made the capital of the Company's possessions and the chief seat of their trade. From that date also the city began to decline. At one time its population was estimated at 800,000, by the middle of the 19th century the number had fallen to 80,000; but in 1901 it had risen again to 119,306. Surat was taken by the English in 1759, and the conquerors assumed the undivided government of the city in 1800. Since the introduction of British rule the district has remained comparatively tranquil; and even during the Mutiny peace was not disturbed, owing in great measure to the loyalty of the leading Mahommedan families.

The city is situated on the left bank of the river Tapti, 14 m. from its mouth, and has a station on the Bombay, Baroda & Central India railway, 167 m. north of Bombay. A moat indicates the dividing-line between the city, with its narrow streets and handsome houses, and the suburbs, mostly scattered among cultivated lands; but the city wall has almost disappeared. On the river frontage rises the irregular picturesque fortress built about 1540. A fire and a flood in 1837 destroyed a great number of buildings, but there remain several of interest, such as the mosque of Nav Saiyid Sahib, with its nine tombs, the Saiyid Edroos mosque (1634) and the ornate Mirza Sami mosque and tomb (1540). The most interesting monuments are the tombs of English and Dutch merchants of the 17th century, especially that of the Oxenden brothers. Surat is still a centre of trade and manufacture, though some of its former industries, such as ship-building, are extinct. There are cotton mills, factories for ginning and pressing cotton, rice-cleaning mills and paper mills. Fine cotton goods are woven in hand-looms, and there are special manufactures of silk brocade and embroidery. The chief trades are organized in gilds. There are many wealthy Parsee, Hindu and Mahommedan merchants.

The District of Surat has an area of 1653 sq. m., and the population in 1901 was 637,017, showing a decrease of 2% in the decade. The district has a coast-line of 80 m., consisting of a barren stretch of sand drift and salt marsh; behind this is a rich, highly-cultivated plain, nearly 60 m. in breadth, at the mouth of the Tapti, but narrowing to only 15 m. in the southern part, and on the north-east are the wild hills and jungle of the Dangs. The principal crops are millets, rice, pulses, cotton and a little wheat. After Surat city the chief centre of trade is Bulsar. The district is traversed by the main line of the Bombay & Baroda railway, with a branch along the Tapti valley to join the Great Indian Peninsula railway in Khandesh. Near the coast, under the influence of the sea breeze, an equable temperature prevails, but 8 to 11 m. inland the breeze ceases to blow. The coast also possesses a much lighter rainfall than the interior, the annual average ranging from 30 in. in Olpad to 72 in Chikhli, while at Surat city the average is 39½ in.

The Surat Agency consists of three native states: Dharampur (*q.v.*), Bansda (*q.v.*) and Sachin, together with the tract known as the Dangs. Total area, 1960 sq. m.; pop. (1901), 179,975. Sachin has a revenue of £17,000 and its chief is a Mahommedan.

SURBASE (Lat. *super*, whence the Fr. *sur*, above or upon, and base, *q.v.*), *i.e.* upper base, the term in architecture applied to what, in the fittings of a room, is called the chair-rail. It is also used to distinguish the cornice of a pedestal or podium and is separated from the base by the dado or die.

SURBITON, an urban district in the Kingston parliamentary division of Surrey, England, 13 m. S.W. of Charing Cross, London; on the London & South-Western railway. Pop. (1891), 12,178; (1901), 15,017. It has a frontage upon the right bank of the Thames, with a pleasant esplanade. The district is largely residential. Surbiton is the headquarters of the Kingston Rowing Club and the Thames Sailing Club.

SURETY, in law, the party liable under a contract of guarantee (*q.v.*). In criminal practice sureties bound by recognizance (*q.v.*) are a means of obtaining compliance with the order of a court of justice, whether to keep the peace or otherwise.

SURFACE, the bounding or limiting parts of a body. In the article Curve the mathematical question is treated from an historical point of view, for the purpose of showing how the leading ideas of the theory were successively arrived at. These leading ideas apply to surfaces, but the ideas peculiar to surfaces are scarcely of the like fundamental nature, being rather developments of the former set in their application to a more advanced portion of geometry; there is consequently less occasion for the historical mode of treatment. Curves in space are considered in the same article, and they will not be discussed here; but it is proper to refer to them in connexion with the other notions of solid geometry. In plane geometry the elementary figures are the point and the line; and we then have the curve, which may be regarded as a singly infinite system of points, and also as a singly infinite system of lines. In solid geometry the elementary figures are the point, the line and the plane; we have, moreover, first, that which under one aspect is the curve and under another aspect the developable (or torse), and which may be regarded as a singly infinite system of points, of lines or of planes; and secondly, the surface, which may be regarded as a doubly infinite system of points or of planes, and also as a special triply infinite system of lines. (The tangent lines of a surface are a special complex.) As distinct particular cases of the first figure we have the plane curve and the cone, and as a particular case of the second figure the ruled surface, regulus or singly infinite system of lines; we have, besides, the congruence or doubly infinite system of lines and the complex or triply infinite system of lines. And thus crowds of theories arise which have hardly any analogues in plane geometry; the relation of a curve to the various surfaces which can be drawn through it, and that of a surface to the various curves which can be drawn upon it, are different in kind from those which in plane geometry most nearly correspond to them—the relation of a system of points to the different curves through them and that of a curve to the systems of points upon it. In particular, there is nothing in plane geometry to correspond to the theory of the curves of curvature of a surface. Again, to the single theorem of plane geometry, that a line is the shortest distance between two points, there correspond in solid geometry two extensive and difficult theories—that of the geodesic lines on a surface and that of the minimal surface, or surface of minimum area, for a given boundary. And it would be easy to say more in illustration of the great extent and complexity of the subject.

In Part I. the subject will be treated by the ordinary methods of analytical geometry; Part II. will consider the Gaussian treatment by differentials, or the E, F, G analysis.

Part I.

Surfaces in General; Torses, &c.

1. A surface may be regarded as the locus of a doubly infinite system of points—that is, the locus of the system of points determined by a single equation $U=(*\between x, y, z, 1)^n, =0$, between the cartesian co-ordinates (to fix the ideas, say rectangular co-ordinates) x, y, z; or, if we please, by a single homogeneous relation $U=(*\between x, y, z, w)^n, =0$, between the quadriplanar co-ordinates x, y, z, w.

The degree n of the equation is the order of the surface; and this definition of the order agrees with the geometrical one, that the order of the surface is equal to the number of the intersections of the surface by an arbitrary line. Starting from the foregoing point definition of the surface, we might develop the notions of the tangent line and the tangent plane; but it will be more convenient to consider the surface *ab initio* from the more general point of view in its relation to the point, the line and the plane.

2. Mention has been made of the plane curve and the cone; it is proper to recall that the *order* of a plane curve is equal to the number of its intersections by an arbitrary line (in the plane of the curve), and that its *class* is equal to the number of tangents to the curve which pass through an arbitrary point (in the plane of the curve). The cone is a figure correlative to the plane curve: corresponding to the plane of the curve we have the vertex of the cone, to its tangents the generating lines of the cone, and to its points the tangent planes of the cone. But from a different point of view we may consider the generating lines of the cone as corresponding to the points of the curve and its tangent planes as corresponding to the tangents of the curve. From this point of view we define the order of the cone as equal to the number of its intersections (generating lines) by an arbitrary plane through the vertex, and its class as equal to the number of the tangent planes which pass through an arbitrary line through the vertex. And in the same way that a plane curve has singularities (singular points and singular tangents) so a cone has singularities (singular generating lines and singular tangent planes).

Order, Class and Rank.

3. Consider now a surface in connexion with an arbitrary line. The line meets the surface in a certain number of points, and, as already mentioned, the *order* of the surface is equal to the number of these intersections. We have through the line a certain number of tangent planes of the surface, and the *class* of the surface is equal to the number of these tangent planes.

But, further, through the line imagine a plane; this meets the surface in a curve the order of which is equal (as is at once seen) to the order of the surface. Again, on the line imagine a point; this is the vertex of a cone circumscribing the surface, and the class of this cone is equal (as is at once seen) to the class of the surface. The tangent lines of the surface which lie in the plane are nothing else than the tangents of the plane section, and thus form a singly infinite series of lines; similarly, the tangent lines of the surface which pass through the point are nothing else than the generating lines of the circumscribed cone, and thus form a singly infinite series of lines. But, if we consider those tangent lines of the surface which are at once in the plane and through the point, we see that they are finite in number; and we define the *rank* of a surface as equal to the number of tangent lines which lie in a given plane and pass through a given point in that plane. It at once follows that the class of the plane section and the order of the circumscribed cone are each equal to the rank of the surface, and are thus equal to each other. It may be noticed that for a general surface $(*\between x, y, z, w)^n, =0$, of order n without point singularities the rank is $a, =n(n-1)$, and the class is $n', =n(n-1)^2$; this implies (what is in fact the case) that the circumscribed cone has line singularities, for otherwise its class, that is the class of the surface, would be $a(a-1)$, which is not $=n(n-1)^2$.

4. The notions of the tangent line and the tangent plane have been assumed as known, but they require to be further explained in reference to the original point definition of the surface. Speaking generally, we may say that the points of the surface consecutive to a given point on it lie in a plane which is the tangent plane at the given point, and conversely the given point is the point of contact of this tangent plane, and that any line through the point of contact and in the tangent plane is a tangent line touching the surface at the point of contact. Hence we see at once that the tangent line is any line meeting the surface in two consecutive points, or—what is the same thing—a line meeting the surface in the point of contact counting as two intersections and in $n-2$ other points. But, from the foregoing notion of the tangent plane as a plane containing the point of contact and the consecutive points of the surface, the passage to the true definition of the tangent plane is not equally obvious. A plane in general meets the surface of the order n in a curve of that order without double points; but the plane may be such that the curve has a double point, and when this is so the plane is a tangent plane having the double point for its point of contact. The double point is either an acnode (isolated point), then the surface at the point in question is convex towards (that is, concave away from) the tangent plane; or else it is a crunode, and the surface at the point in question is then concavo-convex, that is, it has its two curvatures in opposite senses (see below, par. 16). Observe that in either case any line whatever in the plane and through the point meets the surface in the points in which it meets the plane curve, viz. in the point of contact, which *qua* double point counts as two intersections, and in $n-2$ other points; that is, we have the preceding definition of the tangent line.

Tangent Lines and Planes.

5. The complete enumeration and discussion of the singularities of a surface is a question of extreme difficulty which has not yet been solved.[1] A plane curve has point singularities and line singularities; corresponding to these we have for the surface isolated point singularities and isolated plane singularities, but there are besides continuous singularities applying to curves on or torses circumscribed to the surface, and it is among these that we have the non-special singularities which play the most important part in the theory. Thus the plane curve represented by the general equation $(*\between x, y, z)^n=0$, of any given order n, has the non-special line singularities of inflexions and double tangents; corresponding to this the surface represented by the general equation $(*\between x, y, z, w)^n=0$, of any given order n, has, not the isolated plane singularities, but the continuous singularities of the spinode curve or torse and the node-couple curve or torse. A plane may meet the surface in a curve having (1) a cusp (spinode) or (2) a pair of double points; in each case there is a singly infinite system of such singular tangent planes, and the locus of the points of contact is the curve, the envelope of the tangent planes the torse. The reciprocal singularities to these are the nodal curve and the cuspidal curve: the surface may intersect or touch itself along a curve in such wise that, cutting the surface by an arbitrary plane, the curve of intersection has at each intersection of the plane with the curve on the surface (1) a double point (node) or (2) a cusp. Observe that these are singularities not occurring in the surface represented by the general equation $(*\between x, y, z, w)^n=0$ of any order; observe further that in the case of both or either of these singularities the definition of the tangent plane must be modified. A tangent plane is a plane such that there is in the plane section a double point in addition to the nodes or cusps at the intersections with the singular lines on the surface.

Singularities.

6. As regards isolated singularities, it will be sufficient to mention the point singularity of the conical point (or cnicnode) and the corresponding plane singularity of the conic of contact (or cnictrope). In the former case we have a point such that the consecutive points, instead of lying in a tangent plane, lie on a quadric cone, having the point for its vertex; in the latter case we have a plane touching the surface along a conic; that is, the complete intersection of the surface by the plane is made up of the conic taken twice and of a residual curve of the order $n-4$.

7. We may, in the general theory of surfaces, consider either a surface and its reciprocal surface, the reciprocal surface being taken to be the surface enveloped by the polar planes (in regard to a given quadric surface) of the points of the original surface; or—what is better—we may consider a given surface in reference to the reciprocal relations of its order, rank, class and singularities. In either case we have a series of unaccented letters and a corresponding series of accented letters, and the relations between them are such that we may in any equation interchange the accented and the unaccented letters; in some cases an unaccented letter may be equal to the corresponding accented letter. Thus, let n, n' be as before the order and the class of the surface, but, instead of immediately defining the rank, let a be used to denote the class of the plane section and a' the order of the circumscribed cone; also let S, S' be numbers referring to the singularities. The form of the relations is $a=a'$ (=rank of surface); $a'=n\ (n-1)-S$; $n'=n\ (n-1)^2-S$; $a=n'\ (n'-1)-S'$; $n=n'\ (n'-1)^2-S'$. In these last equations S, S' are merely written down to denote proper corresponding combinations of the several numbers referring to the singularities collectively denoted by S, S' respectively. The theory, as already mentioned, is a complex and difficult one.

8. A torse or developable corresponds to a curve in space in the same manner as a cone corresponds to a plane curve: although capable of representation by an equation $U=(*\between x, y, z, w)^n=0$, and so of coming under the foregoing point definition of a surface, it is an entirely distinct geometrical conception. We may indeed, *qua* surface, regard it as a surface characterized by the property that each of its tangent planes touches it, not at a single point, but along a line; this is equivalent to saying that it is the envelope, not of a doubly infinite series of planes, as is a proper surface, but of a singly infinite system of planes. But it is perhaps easier to regard it as the locus of a singly infinite system of lines, each line meeting the consecutive line, or, what is the same thing, the lines being tangent lines of a curve in space. The tangent plane is then the plane through two consecutive lines, or, what is the same thing, an osculating plane of the curve, whence also the tangent plane intersects the surface in the generating line counting twice, and in a residual curve of the order $n-2$. The curve is said to be the edge of regression of the developable, and it is a cuspidal curve thereof; that is to say, any plane section of the developable has at each point of intersection with the edge of regression a cusp. A sheet of paper bent in any manner without crumpling gives a developable;

Torse or Developable.

[1] In a plane curve the only singularities which need to be considered are those that present themselves in Plücker's equations, for every higher singularity whatever is equivalent to a certain number of nodes, cusps, inflexions and double tangents. As regards a surface, no such reduction of the higher singularities has as yet been made.

but we cannot with a single sheet of paper properly exhibit the form in the neighbourhood of the edge of regression: we need two sheets connected along a plane curve, which, when the paper is bent, becomes the edge of regression and appears as a cuspidal curve on the surface.

It may be mentioned that the condition which must be satisfied in order that the equation $U=0$ shall represent a developable is $H(U)=0$; that is, the Hessian or functional determinant formed with the second differential coefficients of U must vanish in virtue of the equation $U=0$, or—what is the same thing—$H(U)$ must contain U as a factor. If in cartesian co-ordinates the equation is taken in the form $z-f(x, y)=0$, then the condition is $rt-s^2=0$ identically, where r, s, t denote as usual the second differential coefficients of z in regard to x, y respectively.

Regulus or Ruled Surface.

9. A regulus or ruled surface is the locus of a singly infinite system of lines, where the consecutive lines do not intersect; this is a true surface, for there is a doubly infinite series of tangent planes—in fact any plane through any one of the lines is a tangent plane of the surface, touching it at a point on the line, and in such wise that, as the tangent plane turns about the line, the point of contact moves along the line. The complete intersection of the surface by the tangent plane is made up of the line counting once and of a residual curve of the order $n-1$. A quadric surface is a regulus in a twofold manner, for there are on the surface two systems of lines each of which is a regulus. A cubic surface may be a regulus (see below, par. 11).

Surfaces of the Orders 2, 3 and 4.

Quadric Surfaces.

10. A surface of the second order or a quadric surface is a surface such that every line meets it in two points, or—what comes to the same thing—such that every plane section thereof is a conic or quadric curve. Such surfaces have been studied from every point of view. The only singular forms are when there is (1) a conical point (cnicnode), when the surface is a cone of the second order or quadricone; (2) a conic of contact (cnictrope), when the surface is this conic; from a different point of view it is a "surface aplatie" or flattened surface. Excluding these degenerate forms, the surface is of the order, rank and class each $=2$, and it has no singularities. Distinguishing the forms according to *reality*, we have the ellipsoid, the hyperboloid of two sheets, the hyperboloid of one sheet, the elliptic paraboloid and the hyperbolic paraboloid (see GEOMETRY: § *Analytical*). A particular case of the ellipsoid is the sphere; in abstract geometry this is a quadric surface passing through a given quadric curve, the circle at infinity. The tangent plane of a quadric surface meets it in a quadric curve having a node, that is, in a pair of lines; hence there are on the surface two singly infinite sets of lines. Two lines of the same set do not meet, but each line of the one set meets each line of the other set; the surface is thus a regulus in a twofold manner. The lines are real for the hyperboloid of one sheet and for the hyperbolic paraboloid; for the other forms of surface they are imaginary.

Cubic Surfaces.

11. We have next the surface of the third order or cubic surface, which has also been very completely studied. Such a surface may have isolated point singularities (cnicnodes or points of higher singularity), or it may have a nodal line; we have thus $21+2,=23$ cases. In the general case of a surface without any singularities, the order, rank and class are $=3$, 6, 12 respectively. The surface has upon it 27 lines, lying by threes in 45 planes, which are triple tangent planes. Observe that the tangent plane is a plane meeting the surface in a curve having a node. For a surface of any given order n there will be a certain number of planes each meeting the surface in a curve with 3 nodes, that is, triple tangent planes; and, in the particular case where $n=3$, the cubic curve with 3 nodes is of course a set of 3 lines; it is found that the number of triple tangent planes is, as just mentioned, $=45$. This would give 135 lines, but through each line we have 5 such planes, and the number of lines is thus $=27$. The theory of the 27 lines is an extensive and interesting one; in particular, it may be noticed that we can, in thirty-six ways, select a system of 6×6 lines, or "double sixer," such that no two lines of the same set intersect each other, but that each line of the one set intersects each line of the other set.

A cubic surface having a nodal line is a ruled surface or regulus; in fact any plane through the nodal line meets the surface in this line counting twice and in a residual line, and there is thus on the surface a singly infinite set of lines. There are two forms.

Quartic Surfaces.

12. As regards quartic surfaces, only particular forms have been much studied. A quartic surface can have at most 16 conical points (cnicnodes); an instance of such a surface is Fresnel's wave surface, which has 4 real cnicnodes in one of the principal planes, 4×2 imaginary ones in the other two principal planes, and 4 imaginary ones at infinity—in all 16 cnicnodes; the same surface has also 4 real+12 imaginary planes each touching the surface along a circle (cnictropes)—in all 16 cnictropes. It was easy by a mere homographic transformation to pass to the more general surface called the tetrahedroid; but this was itself only a particular form of the general surface with 16 cnicnodes and 16 cnictropes first studied by Kummer. Quartic surfaces with a smaller number of cnicnodes have also been considered.

Another very important form is the quartic surface having a nodal conic; the nodal conic may be the circle at infinity, and we have then the so-called anallagmatic surface, otherwise the cyclide (which includes the particular form called Dupin's cyclide). These correspond to the bicircular quartic curve of plane geometry. Other forms of quartic surface might be referred to.

Congruences and Complexes.

Congruences.

13. A congruence is a doubly infinite system of lines. A line depends on four parameters and can therefore be determined so as to satisfy four conditions; if only two conditions are imposed on the line we have a doubly infinite system of lines or a congruence. For instance, the lines meeting each of two given lines form a congruence. It is hardly necessary to remark that, imposing on the line one more condition, we have a ruled surface or regulus; thus we can in an infinity of ways separate the congruence into a singly infinite system of reguli or of torses (see below, par. 16).

Considering in connexion with the congruence two arbitrary lines, there will be in the congruence a determinate number of lines which meet each of these two lines; and the number of lines thus meeting the two lines is said to be the *order-class* of the congruence. If the two arbitrary lines are taken to intersect each other, the congruence lines which meet each of the two lines separate themselves into two sets—those which lie in the plane of the two lines and those which pass through their intersection. There will be in the former set a determinate number of congruence lines which is the *order* of the congruence, and in the latter set a determinate number of congruence lines which is the *class* of the congruence. In other words, the order of the congruence is equal to the number of congruence lines lying in an arbitrary plane, and its class to the number of congruence lines passing through an arbitrary point.

The following systems of lines form each of them a congruence: (A) lines meeting each of two given curves; (B) lines meeting a given curve twice; (C) lines meeting a given curve and touching a given surface; (D) lines touching each of two given surfaces; (E) lines touching a given surface twice, or, say, the bitangents of a given surface.

The last case is the most general one; and conversely for a given congruence there will be in general a surface having the congruence lines for bitangents. This surface is said to be the *focal surface* of the congruence; the general surface with 16 cnicnodes first presented itself in this manner as the focal surface of a congruence. But the focal surface may degenerate into the forms belonging to the other cases A, B, C, D.

Complexes.

14. A complex is a triply infinite system of lines—for instance, the tangent lines of a surface. Considering an arbitrary point in connexion with the complex, the complex lines which pass through the point form a cone; considering a plane in connexion with it, the complex lines which lie in the plane envelop a curve. It is easy to see that the class of the curve is equal to the order of the cone; in fact each of these numbers is equal to the number of complex lines which lie in an arbitrary plane and pass through an arbitrary point of that plane; and we then say *order* of complex = order of curve; *rank* of complex = class of curve = order of cone; *class* of complex = class of cone. It is to be observed that, while for a congruence there is in general a surface having the congruence lines for bitangents, for a complex there is not in general any surface having the complex lines for tangents; the tangent lines of a surface are thus only a special form of complex. The theory of complexes first presented itself in the researches of Malus on systems of rays of light in connexion with double refraction.

15. The analytical theory as well of congruences as of complexes is most easily carried out by means of the six co-ordinates of a line; viz. there are co-ordinates (a, b, c, f, g, h) connected by the equation $af+bg+ch=0$, and therefore such that the ratios $a:b:c:f:g:h$ constitute a system of four arbitrary parameters. We have thus a congruence of the order n represented by a single homogeneous equation of that order $(*\between a, b, c, f, g, h)^n=0$ between the six co-ordinates; two such relations determine a congruence. But we have in regard to congruences the same difficulty as that which presents itself in regard to curves in space: it is not every congruence which can be represented completely and precisely by *two* such equations (see GEOMETRY: § *Line*).

The linear equation $(*\between a, b, c, f, g, h)=0$ represents a congruence of the first order or linear congruence; such congruences are interesting both in geometry and in connexion with the theory of forces acting on a rigid body.

Curves of Curvature; Asymptotic Lines.

16. The normals of a surface form a congruence. In any congruence the lines consecutive to a given congruence line do not

in general meet this line; but there is a determinate number of consecutive lines which do meet it; or, attending for the moment to only one of these, say the congruence line is met by a consecutive congruence-line. In particular, each normal is met by a consecutive normal; this again is met by a consecutive normal, and so on. That is, we have a singly infinite system of normals each meeting the consecutive normal, and so forming a torse; starting from different normals successively, we obtain a singly infinite system of such torses. But each normal is in fact met by two consecutive normals, and, using in the construction first the one and then the other of these, we obtain two singly infinite systems of torses each intersecting the given surface at right angles. In other words, if in place of the normal we consider the point on the surface, we obtain on the surface two singly infinite systems of curves such that for any curve of either system the normals at consecutive points intersect each other; moreover, for each normal the torses of the two systems intersect each other at right angles; and therefore for each point of the surface the curves of the two systems intersect each other at right angles. The two systems of curves are said to be the curves of curvature of the surface.

The normal is met by the two consecutive normals in two points which are the centres of curvature for the point on the surface; these lie either on the same side of the point or on opposite sides, and the surface has at the point in question like curvatures or opposite curvatures in the two cases respectively (see above, par. 4).

17. In immediate connexion with the curves of curvature we have the so-called asymptotic curves (Haupt-tangentenlinien). The tangent plane at a point of the surface cuts the surface in a curve having at that point a node. Thus we have at the point of the surface two directions of passage to a consecutive point, or, say, two elements of arc; and, passing along one of these to the consecutive point, and thence to a consecutive point, and so on, we obtain on the surface a curve. Starting successively from different points of the surface we thus obtain a singly infinite system of curves; or, using first one and then the other of the two directions, we obtain two singly infinite systems of curves, which are the curves above referred to. The two curves at any point are equally inclined to the two curves of curvature at that point, or—what is the same thing—the supplementary angles formed by the two asymptotic lines are bisected by the two curves of curvature. In the case of a quadric surface the asymptotic curves are the two systems of lines on the surface.

Geodetic Lines.

18. A geodetic line (or curve) is a shortest curve on a surface; more accurately, the element of arc between two consecutive points of a geodetic line is a shortest arc on the surface. We are thus led to the fundamental property that at each point of the curve the osculating plane of the curve passes through the normal of the surface; in other words, any two consecutive arcs PP', $P'P''$ are *in plano* with the normal at P'. Starting from a given point P on the surface, we have a singly infinite system of geodetics proceeding along the surface in the direction of the several tangent lines at the point P; and, if the direction PP' is given, the property gives a construction by successive elements of arc for the required geodetic line.

Considering the geodetic lines which proceed from a given point P of the surface, any particular geodetic line is or is not again intersected by the consecutive generating line; if it is thus intersected, the generating line is a shortest line on the surface up to, but not beyond, the point at which it is first intersected by the consecutive generating line; if it is not intersected, it continues a shortest line for the whole course.

In the analytical theory both of geodetic lines and of the curves of curvature, and in other parts of the theory of surfaces, it is very convenient to consider the rectangular co-ordinates x, y, z of a point of the surface as given functions of two independent parameters p, q; the form of these functions of course determines the surface, since by the elimination of p, q from the three equations we obtain the equation in the co-ordinates x, y, z. We have for the geodetic lines a differential equation of the second order between p and q; the general solution contains two arbitrary constants, and is thus capable of representing the geodetic line which can be drawn from a given point in a given direction on the surface. In the case of a quadric surface the solution involves hyperelliptic integrals of the first kind, depending on the square root of a sextic function.

Curvilinear Co-ordinates.

19. The expressions of the co-ordinates x, y, z in terms of p, q may contain a parameter r, and, if this is regarded as a given constant, these expressions will as before refer to a point on a given surface. But, if p, q, r are regarded as three independent parameters x, y, z will be the co-ordinates of a point in space, determined by means of the three parameters p, q, r; these parameters are said to be the curvilinear co-ordinates, or (in a generalized sense of the term) simply the co-ordinates of the point. We arrive otherwise at the notion by taking p, q, r each as a given function of x, y, z; say we have $p=f_1(x, y, z)$, $q=f_2(x, y, z)$, $r=f_3(x, y, z)$, which equations of course lead to expressions for p, q, r each as a function of x, y, z. The first equation determines a singly infinite set of surfaces: for any given value of p we have a surface; and similarly the second and third equations determine each a singly infinite set of surfaces. If, to fix the ideas, f_1, f_2, f_3 are taken to denote each a rational and integral function of x, y, z, then two surfaces of the same set will not intersect each other, and through a given point of space there will pass one surface of each set; that is, the point will be determined as a point of intersection of three surfaces belonging to the three sets respectively; moreover, the whole of space will be divided by the three sets of surfaces into a triply infinite system of elements, each of them being a parallelepiped.

Orthotomic Surfaces; Parallel Surfaces.

20. The three sets of surfaces may be such that the three surfaces through any point of space whatever intersect each other at right angles; and they are in this case said to be orthotomic. The term curvilinear co-ordinates was almost appropriated by Lamé, to whom this theory is chiefly due, to the case in question: assuming that the equations $p=f_1(x, y, z)$, $q=f_2(x, y, z)$, $r=f_3(x, y, z)$ refer to a system of orthotomic surfaces, we have in the restricted sense p, q, r as the curvilinear co-ordinates of the point.

An interesting special case is that of confocal quadric surfaces. The general equation of a surface confocal with the ellipsoid $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ is $\frac{x^2}{a^2+\theta}+\frac{y^2}{b^2+\theta}+\frac{z^2}{c^2+\theta}=1$; and, if in this equation we consider x, y, z as given, we have for θ a cubic equation with three real roots p, q, r, and thus we have through the point three real surfaces, one an ellipsoid, one a hyperboloid of one sheet, and one a hyperboloid of two sheets.

21. The theory is connected with that of curves of curvature by Dupin's theorem. Thus in any system of orthotomic surfaces each surface of any one of the three sets is intersected by the surfaces of the other two sets in its curves of curvature.

22. No one of the three sets of surfaces is altogether arbitrary: in the equation $p=f_1(x, y, z)$, p is not an arbitrary function of x, y, z, but it must satisfy a certain partial differential equation of the third order. Assuming that p has this value, we have $q=f_2(x, y, z)$ and $r=f_3(x, y, z)$ determinate functions of x,y,z such that the three sets of surfaces form an orthotomic system.

23. Starting from a given surface, it has been seen (par. 16) that the normals along the curves of curvature form two systems of torses intersecting each other, and also the given surface, at right angles. But there are, intersecting the two systems of torses at right angles, not only the given surface, but a singly infinite system of surfaces. If at each point of the given surface we measure off along the normal one and the same distance at pleasure, then the locus of the points thus obtained is a surface cutting all the normals of the given surface at right angles, or, in other words, having the same normals as the given surface; and it is therefore a parallel surface to the given surface. Hence the singly infinite system of parallel surfaces and the two singly infinite systems of torses form together a set of orthotomic surfaces.

The Minimal Surface.

24. This is the surface of minimum area—more accurately, a surface such that, for any indefinitely small closed curve which can be drawn on it round any point, the area of the surface is less than it is for any other surface whatever through the closed curve. It at once follows that the surface at every point is concavo-convex; for, if at any point this was not the case, we could, by cutting the surface by a plane, describe round the point an indefinitely small closed plane curve, and the plane area within the closed curve would then be less than the area of the element of surface within the same curve. The condition leads to a partial differential equation of the second order for the determination of the minimal surface: considering z as a function of x, y, and writing as usual p, q, r, s, t for the first and the second differential coefficients of z in regard to x, y respectively, the equation (as first shown by Lagrange) is $(1+q^2)r-2pqs+(1+p^2)t=0$, or, as this may also be written, $\frac{d}{dy}\frac{q}{\sqrt{1+p^2+q^2}}+\frac{d}{dx}\frac{p}{\sqrt{1+p^2+q^2}}=0$. The general integral contains of course arbitrary functions, and, if we imagine these so determined that the surface may pass through a given closed curve, and if, moreover, there is but one minimal surface passing through that curve, we have the solution of the problem of finding the surface of minimum area within the same curve. The surface continued beyond the closed curve is a minimal surface, but it is not of necessity or in general a surface of minimum area for an arbitrary bounding curve not wholly included within the given closed curve. It is hardly necessary to remark that the plane is a minimal surface, and that, if the given closed curve is a plane curve, the plane is the proper solution; that is, the plane area within the given closed curve is less than the area for any other surface through the same curve. The given closed curve is not

of necessity a single curve: it may be, for instance, a skew polygon of four or more sides.

The partial differential equation was dealt with in a very remarkable manner by Riemann. From the second form given above it appears that we have $\frac{qdx-pdy}{\sqrt{1+p^2+q^2}}$ = a complete differential, or, putting this $=d\zeta$, we introduce into the solution a variable ζ, which combines with z in the forms $z\pm i\zeta$ $(i=\sqrt{-1})$. The boundary conditions have to be satisfied by the determination of the conjugate variables η, η' as functions of $z+i\zeta$, $z-i\zeta$, or, say, of Z, Z' respectively, and by writing S, S' to denote $x+iy$, $x-iy$ respectively. Riemann obtains finally two ordinary differential equations of the first order in S, S', η, η', Z, Z', and the results are completely worked out in some very interesting special cases. (A. CA.)

PART II.

We proceed to treat the differential geometry of surfaces, a study founded on the consideration of the expression of the lineal element in terms of two parameters, u, v,

$$ds^2=\mathrm{E}du^2+2\mathrm{F}dudv+\mathrm{G}dv^2,$$

u=const, v=const, being thus systems of curves traced on the surface. This method, which may be said to have been inaugurated by Gauss in his classical paper published in 1828, *Disquisitiones generales circa superficies curvas*, has the great advantage of dealing in the most natural way with all questions connected with geodetics, geodetic curvature, geodetic circles, &c.—in fact, all relations of lines on a surface which can be formulated without reference to anything external to the surface. All such relations when deduced for any particular surface can be at once generalized in their application, holding good for any other surface which has the same expression for its lineal element; *e.g.* relations involving great circles and small circles on a sphere furnish us with corresponding relations for geodetics and geodetic circles on any synclastic surface of constant specific curvature.

1. Gauss begins by introducing the conception of the integral curvature (*curvatura integra*) of any portion of a surface. This he defines to be the area of the corresponding portion of a sphere of unit radius, traced out by a radius drawn parallel to the normal at each point of the surface; *i.e.* it is $\iint ds/\mathrm{RR}'$ where R, R′ are the principal radii of curvature. The quotient obtained by dividing the integral curvature of a small portion of the surface round a point by the area of that portion, that is $1/\mathrm{RR}'$, he naturally calls the measure of curvature or the specific curvature at the point in question. He proceeds to establish his leading proposition, that this specific curvature at any point is expressible in terms of the E, F and G which enter into the equation for the lineal element, together with their differential coefficients with respect to the variables, u and v.

It is desirable to make clear the exact significance of this theorem. Of course, for any particular surface, the curvature can be expressed in an indefinite variety of ways. The speciality of the Gaussian expression is that it is deduced in such a manner as to hold good for all surfaces which have the same expression for the lineal element. The expression for the specific curvature, which is in general somewhat elaborate, assumes a very simple form when a system of geodetics and the system of their orthogonal trajectories are chosen for the parameter curves, the parameter u being made the length of the arc of the geodetic, measured from the curve, $u=0$ selected as the standard. If this be done the equation for the lineal element becomes $ds^2=du^2+\mathrm{P}^2dv^2$, and that for the specific curvature $(\mathrm{RR}^1)^{-1}=-\mathrm{P}^{-1}\,d^2\mathrm{P}/du^2$. By means of this last expression Gauss then proves that the integral curvature of a triangle formed by three geodetics on the surface can be expressed in terms of its angles, and is equal to $\mathrm{A}+\mathrm{B}+\mathrm{C}-\pi$.

This theorem may be more generally stated:—

The integral curvature of any portion of a surface $=2\pi-\Sigma di$ *round the contour of this portion*, where di denotes the angle of geodetic contingence of the boundary curve. The angle of geodetic contingence of a curve traced on a surface may be defined as the angle of intersection of two geodetic tangents drawn at the extremities of an element of arc, an angle which may be easily proved to be the same as the projection on the tangent plane of the ordinary angle of contingence. The geodetic curvature, ρ^{-1}, is thus equal to the ordinary curvature multiplied by cos ϕ, ϕ being the angle the osculating plane of the curve makes with the tangent plane.

Gauss's theorem may be established geometrically in the following simple manner: If we draw successive tangent planes along the curve, these will intersect in a system of lines, termed the *conjugate* tangents, forming a developable surface. If we unroll this developable then $di=d\theta-d\psi$, where di is the angle of geodetic contingence, $d\theta$ the angle between two consecutive conjugate tangents, ψ the angle the conjugate tangent makes with the curve. Therefore, as ψ returns to its original value when we integrate round the curve, we have $\Sigma di=\Sigma d\theta$. This equation holds for both the curve on the given surface and the representative curve on the sphere. But the tangent planes along these curves being always parallel, their successive intersections are so also; therefore $\Sigma d\theta$ is the same for both; consequently Σdi for the curve on the surface $=\Sigma di$ for the representative curve on the sphere. Hence integral curvature of curve of surface = area of representative curve on sphere,

$=2\pi-\Sigma di$ on sphere by spherical geometry,
$=2\pi-\Sigma di$ for curve on surface.

A useful expression for the geodetic curvature of one of the curves, v=const, can be obtained. If a curve receive a small displacement on any surface, so that the displacements of its two extremities are normal to the curve, it follows, from the calculus of variations, that the variation of the length of the curve $=\int\rho^{-1}\delta n ds$ where ρ^{-1} is the geodetic curvature, and δn the normal component of the displacement at each point. Applying this formula to one of the v curves, we find

$$\delta\int\mathrm{P}dv=\int(d\mathrm{P}/du)\delta u dv=\delta \text{ length of curve}=\int\rho^{-1}\,\delta u\mathrm{P}dv,$$

and as δu is the same for all points of the curve, $\rho^{-1}=\mathrm{P}^{-1}d\mathrm{P}/du$.

We can deduce immediately from this expression Gauss's value for the specific curvature. For applying his theorem to the quadrilateral formed by the curves u, u_1, v, v_1, and remembering that Σdi along a geodetic vanishes, we have

$$\begin{aligned}\iint(\mathrm{RR}')^{-1}\mathrm{P}dudv&=-\Sigma di \text{ for curve BC}-\Sigma di \text{ for curve DA},\\ &=-\Sigma\rho^{-1}ds \text{ for curve BC}+\Sigma\rho^{-1}ds \text{ for curve AD},\\ &=-\int\frac{1}{\mathrm{P}}\frac{d\mathrm{P}}{du}\mathrm{P}dv \text{ for curve BC}+\int\frac{1}{\mathrm{P}}\frac{d\mathrm{P}}{du}\mathrm{P}dv \text{ for curve AD},\\ &=-\int\left\{\left(\frac{d\mathrm{P}}{du}\right)_{u1}-\left(\frac{d\mathrm{P}}{du}\right)_{u}\right\}dv,\end{aligned}$$

therefore passing to the limit $\mathrm{P}/\mathrm{RR}'=-d^2\mathrm{P}/du^2$.

Gauss then proceeds to consider what the result will be if a surface be deformed in such a way that no lineal element is altered. It is easily seen that this involves that the angle at which two curves on the surface intersect is unaltered by this deformation; and since obviously geodetics remain geodetics, the angle of geodetic contingence and consequently the geodetic curvature are also unaltered. It therefore follows from his theorem that the integral curvature of any portion of a surface and the specific curvature at any point are unaltered by non-extensional deformation.

Geodetics and Geodetic Circles.

A geodetic and its fundamental properties are stated in part I., where it is also explained in that article within what range a geodetic possesses the property of being the shortest path between two of its points. The determination of the geodetics on a given surface depends upon the solution of a differential equation of the second order. The first integral of this equation, when it can be found for any given class of surfaces, gives us the characteristic property of the geodetics on such surfaces. The following are some of the well-known classes for which this integral has been obtained: (1) quadrics; (2) developable surfaces; (3) surfaces of revolution.

1. *Quadrics.*—Several mathematicians about the middle of the 19th century made a special study of the geometry of the lines of curvature and the geodetics on quadrics, and were rewarded by the discovery of many wonderfully simple and elegant analogies between their properties and those of a system of confocal conics and their tangents *in plano*. As explained above, the lines of curvature on a quadric are the systems of orthogonal curves formed by its intersection with the two systems of confocal quadrics. Joachimsthal showed that the interpretation of the first integral of the equation for geodetics on a central quadric is, that along a geodetic $p\mathrm{D}$=constant (C,) p denoting the perpendicular let fall from the centre on the tangent plane, and D the semidiameter drawn parallel to the element of the geodetic, the envelope of all geodetics having the same C being a line of curvature. In particular, all geodetics passing through one of the real umbilics (the four points where the indicatrix is a circle) have the same C.

Michael Roberts pointed out that it is an immediate consequence of the equation $p\mathrm{D}=\mathrm{C}$, that if two umbilics, A and B (selecting two not diametrically opposite), be joined by geodetics to any point P on a given line of curvature, they make equal angles with such line of curvature, and consequently that, as P moves along a line of curvature, either PA+PB or PA−PB remains constant. Or, conversely, that the locus of a point P on the surface, for which the sum or difference of the geodetic distances PA and PB is constant, is a line of curvature. It follows that if the ends of a string be fastened at the two umbilics of a central quadric, and a style move over the surface keeping the string always stretched, it will describe a line of curvature.

Another striking analogue is the following: As, *in plano*, if a variable point or an ellipse be joined to the two foci S and H, tan ½ PSH tan ½PHS=const, and for the hyperbola tan ½PSH/tan ½PHS=const, so for a line of curvature on a central quadric, if P be joined to two umbilics S and H by geodetics, either the product or the ratio of the tangents of ½PSH and ½PHS will be constant.

Chasles proved that if an ellipse be intersected in the point A by a confocal hyperbola, and from any point P on the hyperbola tangents PT, PT′ be drawn to the ellipse, then the difference of the arcs of the ellipse TA, T′A = the difference of the tangents PT, PT′; and subsequently Graves showed that if from any point P on the outer of two confocal ellipses tangents be drawn to the inner, then the excess of the sum of the tangents PT, PT′ over the intercepted arc TT′ is constant. Precisely the same theorems hold for a quadric replacing the confocals by lines of curvature and the rectilineal tangents by geodetic tangents. Hart still further developed the analogies with confocal conics, and established the following: If a geodetic polygon circumscribe a line of curvature, and all its vertices but one move on lines of curvature, this vertex will also describe a line of curvature, and when the lines of curvature all belong to the same system the perimeter of the polygon will be constant.

2. *Geodetics on Developable Surfaces.*—On these the geodetics are the curves which become right lines when the surface is unrolled into a plane. From this property a first integral can be immediately deduced.

3. *Geodetics on Surfaces of Revolution.*—In all such the geodetics are the curves given by the equation $r \sin \phi$=const, r being the perpendicular on the axis of revolution, ϕ the angle at which the curve crosses the meridian.

The general problem of the determination of geodetics on any surface may be advantageously treated in connexion with that of "parallel" curves. By "parallel" curves are meant curves whose geodetic distances from one another are constant—in other words, the orthogonal trajectories of a system of geodetics. In applying this method the determination of a system of parallel curves comes first, and the determination of the geodetics to which they are orthogonal follows as a deduction. If $\phi(u, v)$=const be a system of parallel curves, it is shown that ϕ must satisfy the partial differential equation

$$E\left(\frac{d\phi}{dv}\right)^2 - 2F\left(\frac{d\phi}{du}\right)\left(\frac{d\phi}{dv}\right) + G\left(\frac{d\phi}{dv}\right)^2 = EG - F^2.$$

If $\phi(u, v, a)$=const be a system of parallel curves satisfying this equation, then $d\phi/da$=const is proved to represent the orthogonal geodetics. The same method enables us to establish a result first arrived at by Jacobi, that whenever a first integral of the differential equation for geodetics can be found, the final integral is always reducible to quadratures. In this method ϕ corresponds to the characteristic function in the Hamiltonian dynamics, the geodetics being the paths of a particle confined to the surface when no extraneous forces are in action.

The expression for the lineal element on a quadric in elliptic co-ordinates suggested to Liouville the consideration of the class of surfaces for which this equation takes the more general form $ds^2 = (U-V)(U_1^2du^2 + V_1^2dv^2)$, where U, U_1 are functions of u, and V, V_1 functions of v, and shows that, for this class, the first integral of the equation of the parallels is immediately obtainable, and hence that of the corresponding geodetics. It is to be remarked that for this more general class of surfaces the theorems of Chasles and Graves given above will also hold good.

Geodetics on a surface corresponding to right lines on a plane, the question arises what curves on a surface should be considered to correspond to plane circles. There are two claimants for the position: first, the curves described by a point whose geodetic distance from a given point is constant; and, second, the curves of constant geodetic curvature.

On certain surfaces the curves which satisfy one of these conditions also satisfy the other, but in general the two curves must be carefully distinguished. The property involved in the second definition is more intrinsic, and we shall therefore, following Liouville, call the curves possessing it geodetic circles. It may be noted that geodetic circles, except on surfaces of constant specific curvature, do not return back upon themselves like circles *in plano*. As a particular instance, a geodetic on an ellipsoid (which is, of course, a geodetic circle of zero curvature), starting from an umbilic, when it returns again, as it does to that umbilic, makes a finite angle with its original starting position. As to the curve described by a point whose geodetic distance from a given centre is constant, Gauss showed from the fundamental property of a geodetic that this curve resembles the plane circle in being everywhere perpendicular to its radius. In the same way it holds that the curve described by a point the sum (or difference) of whose geodetic distances from two given points (foci) is constant, resembles the plane ellipse (or hyperbola) in the property that it bisects at every point the external (or internal) angle between the geodetic focal radii, and, as a consequence, that the curves on any surface answering to confocal ellipses and hyperbolas intersect at right angles. The equation for the lineal element enables us to discuss geodetic circles on surfaces of constant specific curvature; for we have seen that if we choose as parameters geodetics and their orthogonal trajectories, the equation becomes $ds^2 = du^2 + P^2du^2$; and since $(RR')^{-1} = -P^{-1}d^2P/du^2$, and here $(RR')^{-1} = \pm a^{-2}$, it follows $P = A \cos ua^{-1} + B \sin ua^{-1}$, or $P = A \cosh ua^{-1} + B \sinh ua^{-1}$, according as the surface is synclastic or anticlastic. If a geodetic circle (curvature k^{-1}) be chosen for the starting curve u=0, and if v be made the length of the arc OY, intercepted on this circle by the curve v=const (see fig. 1), then A and B can be proved to be independent of u and $P = \cos ua^{-1} + ak^{-1} \sin ua^{-1}$ for a synclastic surface, $P = \cosh ua^{-1} + ak^{-1} \sinh ua^{-1}$ for an anticlastic surface. It follows from the expression for the geodetic curvature $\rho^{-1} = P^{-1}dP/du$ that in both classes of surfaces all the other orthogonal curves u=const will be geodetic circles. It also appears that on a synclastic surface of constant specific curvature all the geodetics normal to a geodetic circle converge to a point on either side as on a sphere, and can be described with a stretched string taking either of these points as centre, the length of the string being $a \tan^{-1} ak^{-1}$ (see fig. 2). These normals will be all cut orthogonally by an equator, that is, by a geodetic circle of zero curvature.

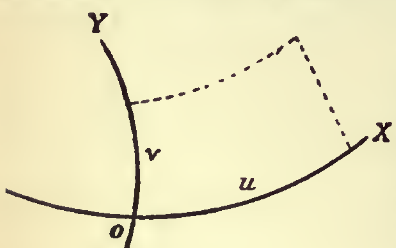


FIG. 1.

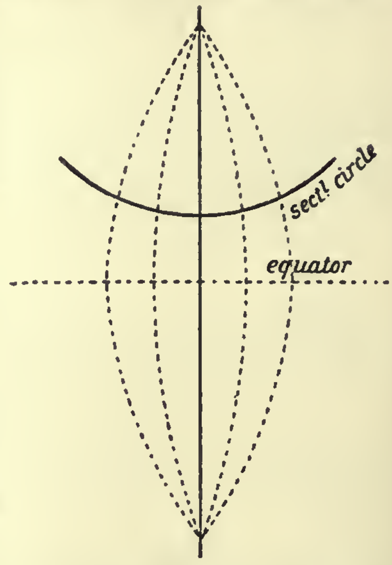


FIG. 2.

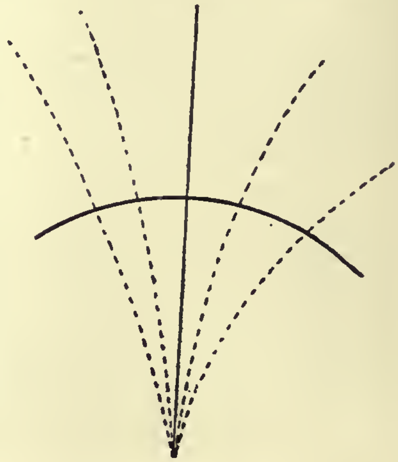


FIG. 3.

For anticlastic surfaces, however, we must distinguish two cases. If the curvature k^{-1} of the geodetic circle $> a^{-1}$ the geodetic normals meet in a point on the concave side of the geodetic circle, and can be described as on the synclastic by a stretched string, the length of the string being $a \tanh^{-1} ak^{-1}$, but in this case the geodetic normals have no equator (see fig. 3). If on the other hand the curvature of the geodetic circle be $< a^{-1}$ the normals do not meet on either side, but do possess an equator, and at this equator the geodetic normals come nearer together than they do anywhere else (see fig. 4).

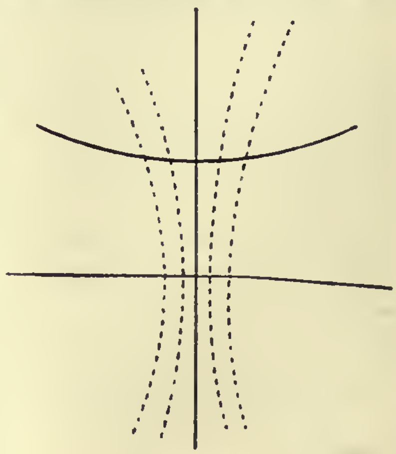


FIG. 4.

On a synclastic surface of constant specific curvature a^{-2} two near geodetics proceeding from a point always meet again at the geodetic distance πa; and more generally for any synclastic surface whose specific curvature at every point lies between the limits a^{-2} and b^{-2} two near geodetics proceeding from a point always meet again at a geodetic distance intermediate in value between πa and πb. On an anticlastic surface two near geodetics proceeding from a point never meet again.

Representation of Figures on a Surface by Corresponding Figures on a Plane; Theory of Maps.

The most valuable methods of effecting such representation are those in which small figures are identical in shape with the figures which they represent. This property is known to belong to the representation of a spherical surface by Mercator's method as well as to the representation by stereographic projection. The problem of effecting this "conformable" representation is easily seen to be equivalent to that of throwing the expression for the lineal element into what is known in the theory of heat conduction as the isothermal form $ds^2=\lambda(du^2+dv^2)$, for we have then only to choose for the representative point on the plane that whose rectangular co-ordinates are $x=u$, $y=v$. A curious investigation has been made by Beltrami—when is it possible to represent a surface on a plane in such a way that the geodetics on the surface shall correspond to the right lines on the plane (as, for example, holds true when a spherical surface is projected on a plane by lines through its centre)? He has proved that the only class of surface for which such representation is possible is the class of uniform specific curvature.

Just as the intrinsic properties of a synclastic surface of uniform specific curvature are reducible to those of a particular surface of this type, *i.e.* the sphere, so we can deal with an anticlastic surface of constant specific curvature, and reduce its properties to a particular anticlastic surface. A convenient surface to study for this purpose is that known as the *pseudosphere*, formed by the revolution of the tractrix (an involute of the catenary) round its base (see fig. 5). Its equations are $r=a\sin\phi$, $z=a(\cos\phi+\log\tan\frac{1}{2}\phi)$. This surface can be conformably represented as a plane map by choosing $x'=\omega$ where ω is the longitude of the point and $y'=a/\sin\phi$. It will then be found that $ds=ads'/y'$, where ds=lineal element on the surface, ds'=same on the map. It easily appears that geodetic circles on the surface are represented by circles on the map, the angle ψ at which these circles cut the base depending only upon the curvature of the geodetic circle, $\cos\psi$ being equal to ρ^{-1}. As a particular case it follows that the geodetics on the surface are represented by those special circles on the map whose centres lie on the base (see fig. 6). The geodetic distance between two points P and Q on the surface is represented by the logarithm of the anharmonic function AP'BQ', where P'Q' are the representing points on the map, A B the points in which the circle on the map which passes through P' and Q' and has its centre on the base cuts the base. The perimeter (l) of a geodetic circle of curvature ρ^{-1} turns out to be $2\pi a\rho/\sqrt{(a^2-\rho^2)}$, and its area $(l\rho^{-1}-2\pi)a^2$. The geometry of coaxal circles *in plano* accordingly enables us to demonstrate anew by means of the pseudosphere the properties which we have shown to hold good in all anticlastic surfaces of constant curvature. Thus the system of geodetics cutting orthogonally a geodetic circle C will be represented on the map by circles having their centres on the base, and cutting a given circle C' orthogonally, *i.e.* by a coaxal system of circles. We know that the other orthogonal trajectories of this last system are another coaxal system, and therefore, going back to the pseudosphere, we learn that if a system of geodetics be drawn normal to a geodetic circle, all the orthogonals to this system are geodetic circles. It is to be noted that while every point on the surface has its representative on the map, the converse does not hold. It is only points lying above the line $y'=a$ which have their prototypes on the surface, the portion of the plane below this line not answering to any real part of the surface. If we take any curve C' on the map crossing this line, the part of the curve above this line has as its prototype a curve on the surface. When C' reaches this line, C reaches the circular base of the pseudosphere, and there terminates abruptly. The distinction between the two cases of a geodetic circle with curvature greater and one with curvature less than a^{-1} also comes out clearly. For if curvature of C$>a^{-1}$ the map circle C' lies entirely above the base, and the coaxal system cutting C' orthogonally passes through a real point; therefore C has a centre. If curvature of C$<a^{-1}$ the map circle C' intersects the base, the coaxal system cutting C' orthogonally does not intersect in a real point, and C has accordingly no centre. It is of interest to examine in what way a pseudosphere differs from a plane as regards the behaviour of parallel lines. If on a plane a geodetic AB (*i.e.* a right line) be taken, and another geodetic constantly pass through a point P and revolve round P, it will always meet AB in the point except in the particular position. On the pseudosphere, if we carry out the corresponding construction, the position of the non-intersecting geodetic is not unique, but all geodetics drawn within a certain angle fail to meet the geodetic AB.

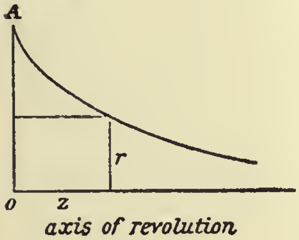


FIG. 5.

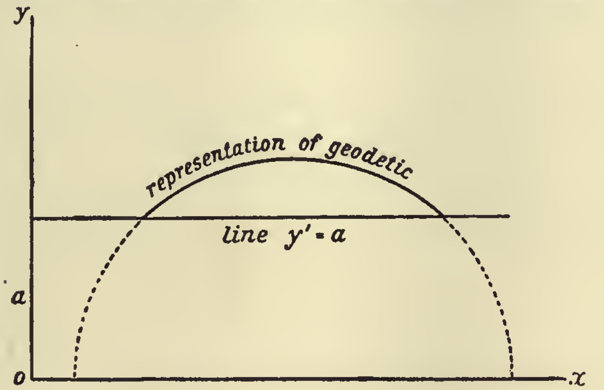


FIG. 6.

Minimal Surfaces.

From the definition given in part I. readily follows the well-known property of these surfaces—that the two principal curvatures are at every point of such a surface equal and opposite. For familiar instances of the class we have the surface formed by the revolution of a catenary round its base called by French mathematicians the alysséide, and the right conoid, $z=a\tan^{-1}(y/x)$, formed by the successive edges of the steps of a spiral staircase. Monge succeeded in expressing the co-ordinates of the most general minimal surface in two parameters, and in a form in which the variables are separated. The separation of the variables in the expression signifies that every minimal surface belongs to the class of surfaces which can be generated by a movement of translation of a curve. Enneper has thrown the expression for the co-ordinates into the following convenient forms:—

$$x=\tfrac{1}{2}\int(1-u^2)f(u)du+\tfrac{1}{2}\int(1-v^2)\phi(v)dv,$$
$$y=\tfrac{1}{2}i\int(1+u^2)f(u)du-\tfrac{1}{2}i\int(1+v^2)\phi(v)dv,$$
$$z=\int uf(u)du+\int v\phi(v)dv.$$

It is noteworthy that the expression for the lineal element on a minimal surface assumes the isothermal form $ds^2=\lambda(du^2+dv^2)$—(1) when the curves u=const, v=const are so chosen as to be the lines of curvature; and (2) when they are chosen to be the lines in which the surface is intersected by a system of parallel planes and the orthogonal trajectories of these lines. It is easily proved that a minimal surface possesses the property of being conformable to its spherical representation. For since the indicatrix at every point is a rectangular hyperbola, the angle between the elements of two intersecting curves=angle between their conjugate tangents; but this=angle between conjugate tangents to representative curves on sphere=angle between these curves themselves.

The problem of finding a minimal surface to pass through a given curve in space, known as Plateau's problem, possesses an exceptional interest from the circumstance that it can be always exhibited to the eye in the following way by an actual physical experiment. Dip a wire having the form of the given curve in a soap-bubble solution, and the film adhering to the wire when it is withdrawn is the surface required. This is evident, since from the theory of surface-tension we know that a very thin film must assume that form for which the area of its surface is the least possible. The same theory also furnishes us with an elementary proof of the characteristic property that the sum of the curvatures is everywhere zero, inasmuch as the normal pressure on the film, here zero, is known to be proportional to the surface-tension multiplied by the sum of the curvatures.

Riemann, adopting a method depending upon the use of the complex variable, has succeeded in solving Plateau's problem for several interesting cases, *e.g.* 1° when the contour consists of three infinite right lines; 2° when it consists of a gauche quadrilateral; and 3° when it consists of any two circles situated in parallel planes. (For Lie's investigations in this domain, see GROUPS, THEORY OF.)

Non-extensional Deformation.

We have already explained what is meant by this term. It is a subject to which much study has been devoted, connecting itself, as it does, with the work of Gauss in pure geometry on the one hand and with the theory of elasticity on the other. Several questions have been opened up: (1) What are the conditions which must be fulfilled by two surfaces such that one can be "deformed" so as to fit on the other? (2) What instances have we of known surfaces applicable to one another? (3) What surfaces are applicable to themselves? (4) In regard to infinitely small deformations, what are the differential equations which must be satisfied by the displacements? (5) Under what circumstances can a surface not be deformed? Can a closed surface ever be deformed?

1. Of course if two surfaces are applicable we must be able to get two systems of parameter curves u=const, v=const, on the first

surface, and two systems on the second, such that the equation for the lineal element, when referred to these, may have an identical form for the two surfaces. The problem is now to select these corresponding systems. We may conveniently take for the co-ordinate u the specific curvature on each surface, and choose for v the function du/dn which denotes the rate of increase of u along a direction normal to the curve u=const. Then, since at corresponding points both u and v will be the same for one surface as for the other, if the surfaces are applicable, E, F and G, in the equation $ds^2=\mathrm{E}du^2+2\mathrm{F}dudv+\mathrm{G}dv^2$, must be identical for the two surfaces. Clerk Maxwell has put the geometrical relation which exists between two applicable surfaces in the following way: If we take any two corresponding points P and P′ on two such surfaces, it is always possible to draw two elements through P parallel to conjugate semi-diameters of the indicatrix at P, such that the corresponding elements through P′ shall be parallel to conjugate semi-diameters of the indicatrix at P′. The curves made up of all these elements will divide the two surfaces into small parallelograms, the four parallelograms having P as common vertex being identical in size and shape with the four having P′ as vertex. Maxwell regards the surfaces as made up in the limit of these small parallelograms. Now, in order to render these surfaces ready for application, the first step would be to alter the angle between two of the planes of the parallelograms at P, so as to make it equal to that between the corresponding planes at P′. If this be done it is readily seen that all the angles between the other planes at P and P′, and at all other corresponding points, will become equal also. The curves which thus belong to the conjugate systems common to the two surfaces may be regarded as *lines of bending*.

2. Any surface of uniform specific curvature, whether positive or negative, is applicable to another surface of the same uniform specific curvature in an infinite variety of ways. For if we arbitrarily choose two points, O and O′, one on each surface, and two elements, one through each point, we can apply the surfaces, making O and O′ corresponding points and the elements corresponding elements. This follows from the form of the equation of the lineal element, which is for synclastic surfaces $ds^2=du^2+a^2\sin^2(ua^{-1})dv^2$, and for anticlastic, $ds^2=du^2+a^2\sinh^2(ua^{-1})dv^2$, and is therefore identical for the two surfaces in question. Again, a ruled surface may evidently be deformed by first rotating round a generator, the portion of the surface lying to one side of this generator, then round the consecutive generator, the portion of the surface lying beyond this again, and so on. It is clear that in such deformation the rectilinear generators in the old surface remain the rectilinear generators in the new; but it is interesting to note that two ruled surfaces can be constructed which shall be applicable, yet so that the generators will not correspond. For, deform a hyperboloid of one sheet in the manner described, turning the portions of the surface round the consecutive generators of one system, and then deform the hyperboloid, using the generators of the other system. The two surfaces so obtained are, of course, applicable to one another, yet so that their generators do not now correspond. Conversely Bonnet has shown that, whenever two ruled surfaces are thus applicable, without correspondence of generators, they must be both applicable to the same hyperboloid of one sheet. The alysséide is a good example of a surface of revolution applicable to a ruled surface, in this case the right circular conoid, the generators of the conoid coinciding with the meridians of the alysséide.

3. As instances of surfaces applicable to themselves, we may take surfaces of uniform specific curvature, as obviously follows from the reasoning already given; also surfaces of revolution, inasmuch as any such surface can be turned round its axis and still fit upon its old position. Again, helicoidal surfaces possess this property. A helicoidal surface means that traced out by a rigid wire, which is given a screw motion round a fixed axis, or, which comes to the same thing, the surface made up of a system of helices starting from the points of a given curve, all having the same axis and the same interval between the successive threads. The applicability of such a surface to itself, if given a screw motion round the axis, is evident from the law of its formation.

4. The possible small variations ξ, η, ζ of the points of a surface when it is subject to a small inextensional deformation are conditioned by the equation $dxd\xi+dyd\eta+dzd\zeta=0$, or making x and y the independent variables,

$$dx^2\left(\frac{d\xi}{dx}+p\frac{d\zeta}{dx}\right)+dxdy\left(\frac{d\xi}{dy}+\frac{d\eta}{dx}+p\frac{d\zeta}{dy}+q\frac{d\zeta}{dx}\right)+dy^2\left(\frac{d\eta}{dy}+q\frac{d\zeta}{dy}\right)=0.$$

From this it follows that the three equations must separately hold

$$\frac{d\xi}{dx}+p\frac{d\zeta}{dx}=0,\ \frac{d\xi}{dy}+\frac{d\eta}{dx}+p\frac{d\zeta}{dy}+q\frac{d\zeta}{dx}=0,\ \frac{d\eta}{dy}+q\frac{d\zeta}{dy}=0.$$

Accordingly, the determination of a possible small deformation of a given surface is reduced to the analytical problem of finding three functions ξ, η, ζ of the variables x and y to satisfy these equations. Changing the co-ordinates to α and β where α=const, β=const, are the curves of inflexion on the surface, the solution of the equations can be shown to depend upon that of the equation $d^2w/d\alpha d\beta=\lambda w$, where λ is a function of α and β depending on the form of the surface. The last equation can be integrated, and the possible deformation determined in the case of a spherical surface, or of any surface of uniform specific curvature. It is easily shown that if we have determined the displacements for any surface S we can do so for any surface obtained from S by a linear transformation of the variables.

For let

$$x'=a_1x=b_1y+c_1z+d_1,\ y=a_2x+b_2y+c_2z+d_2,$$
$$z'=a_3x+b_3y+c_3z+d_3,$$

then the displacements

$$\xi'=\mathrm{A}_1\xi+\mathrm{B}_1\eta+\mathrm{C}_1\zeta,\ \eta'=\mathrm{A}_2\xi+\mathrm{B}_2\eta+\mathrm{C}_2\zeta,\ \zeta'=\mathrm{A}_3\xi+\mathrm{B}_3\eta+\mathrm{C}_3\zeta,$$

where A_1 B_1, &c., are the minors of the determinant $[a_1\ b_2\ c_3]$, will evidently satisfy the equation

$$dx'd\xi'+dy'd\eta'+dz'd\zeta'=0.$$

Accordingly the known solution for a sphere furnishes us with a solution for any quadric. Moutard has pointed out a curious connexion between the problem of small deformation and that of the applicability of two finitely different surfaces.

For if $dxd\xi+dyd\eta+dzd\zeta=0$, it follows that if k be any constant,

$$\{d(x+k\xi)\}^2+\{d(y+k\eta)\}^2+\{d(z+k\zeta)\}^2$$
$$=\{d(x-k\xi)\}^2+\{d(y-k\eta)\}^2+\{d(z-k\zeta)\}^2.$$

Consequently, if we take two surfaces such that for the first

$$\mathrm{X}=x+k\xi,\ \mathrm{Y}=y+k\eta,\ \mathrm{Z}=z+k\zeta,$$

and for the second

$$\mathrm{X}'=x-k\xi,\ \mathrm{Y}'=y-k\eta,\ \mathrm{Z}'=z-k\zeta,$$

then

$$d\mathrm{X}^2+d\mathrm{Y}^2+d\mathrm{Z}^2=d\mathrm{X}'^2+d\mathrm{Y}'^2=d\mathrm{Z}'^2,$$

and therefore the new surfaces are applicable.

5. Jellett and Clerk Maxwell have shown by different methods that, if a curve on a surface be held fixed, there can be no small deformation, except this curve be a curve of inflexion. This may be also proved thus: There can be no displacement of the tangent planes along the fixed curve, for, at any point of the curve the geodetic curvature cannot alter; but in present case the ordinary curvature of the curve is also fixed, therefore their ratio is constant, so that $\delta\cos\theta=-\sin\theta\delta\theta=0$, where θ is the angle which the osculating plane makes with the tangent plane; therefore unless $\sin\theta=0$, as it is along a curve of inflexion, $\delta\theta=0$, and therefore the tangent plane at each point is unaltered. Hence it can be shown that along the given curve not only ξ, η, ζ vanish, but also their differential coefficients of all orders, and therefore no displacement is possible.

The question has been much discussed: Can a closed synclastic surface be deformed? There seems to be a prevalent opinion amongst mathematicians that such deformation is always impossible, but we do not think any unimpeachable demonstration of this has yet been given. It is certain that a complete spherical surface does not admit of inextensive deformation, for if it did it would follow from Gauss's theorem that the new surface would have a uniform specific curvature. Now, it is not difficult to prove that the only closed surface possessing this property is the sphere itself, provided that the surfaces in question be such that all their tangent planes lie entirely outside them. We can then, by the method of linear transformation already given, extend the theorem of the impossibility of deformation to any ellipsoid.

The theorem that a sphere is the only closed surface of constant specific curvature may, we suggest, be established by means of the following two propositions, which hold for integration on any closed surface, p being the perpendicular from the origin on the tangent plane:—

$$\iint(1/\mathrm{R}+1/\mathrm{R}')\,d\mathrm{S}=2\iint p\,d\mathrm{S}/\mathrm{RR}' \qquad (1)$$

$$2\iint d\mathrm{S}=\iint p(1/\mathrm{R}+1/\mathrm{R}')d\mathrm{S}. \qquad (2)$$

Now multiply both sides of the first equation by the constant $\sqrt{\mathrm{RR}'}$, and subtract the second, and we get:—

$$\iint\{(\mathrm{R}'/\mathrm{R})^{\frac{1}{2}}-(\mathrm{R}/\mathrm{R}')^{\frac{1}{2}}\}^2d\mathrm{S}+\iint p(1/\mathrm{R}^{\frac{1}{2}}-1/\mathrm{R}'^{\frac{1}{2}})^2d\mathrm{S}=0$$

which is impossible unless R′=R everywhere, since in accordance with the proviso p is everywhere positive.

Theorems (1) and (2) are deduced by Jellett by means of the calculus of variations in his treatise on that subject. They may also be very simply proved thus: Draw normals to the surface along the contours of the small squares formed by lines of curvature, and let these meet successive parallel surfaces at distances dn, then the volume bounded by two parallel surfaces

$$=\iint\left(d\mathrm{S}\int_0^n dn(1+n/\mathrm{R})(1+n/\mathrm{R}')\right)$$
$$=\iint d\mathrm{S}(n+\tfrac{1}{2}n^2(1/\mathrm{R}+1/\mathrm{R}')+\tfrac{1}{3}n^3/\mathrm{RR}');$$

but taking origin inside, the perpendiculars let fall from O on a tangent plane to the outer surface $=p+n$ on account of the parallelism of the surfaces. Also $d\mathrm{S}$ for outer surface $=d\mathrm{S}(1+n/\mathrm{R})(1+n/\mathrm{R}')$; therefore volume in question

$$=\tfrac{1}{3}\iint(p+n)(1+n/\mathrm{R})(1+n/\mathrm{R}')d\mathrm{S}-\tfrac{1}{3}\iint p\,d\mathrm{S}$$
$$=\tfrac{1}{3}n\iint\left(1+\frac{p}{\mathrm{R}}+\frac{p}{\mathrm{R}'}\right)d\mathrm{S}+\tfrac{1}{3}n^2\iint\left(\frac{p}{\mathrm{RR}'}+\frac{1}{\mathrm{R}}+\frac{1}{\mathrm{R}'}\right)d\mathrm{S}+\tfrac{1}{3}n^3\iint\frac{1}{\mathrm{RR}'}d\mathrm{S}.$$

Hence equating coefficients of the powers of n—

$$\iint p\,(1/R + 1/R')dS = 2\iint dS,$$

and $$\iint 2pdS/RR' = \iint (1/R + 1/R')dS.$$

References to the original memoirs will be found in Salmon's *Analytical Geometry of Three Dimensions*, Frost's *Solid Geometry* and, more completely, in Darboux's *Leçons sur la théorie générale des surfaces.* (J. Pu.; F. Pu.)

SURGE, in meteorology, an irregular fluctuation of the barometer, extending over a long period (*e.g.* a month), in contradistinction to the shorter fluctuations, covering two or three days, caused by alternating conditions of high and low pressure. The cause of surges is not understood.

SURGERY (Fr. *chirurgie*, from Gr. *χειρουργία*, *i.e.* handwork), the profession and art of the surgeon (*chirurgien*), connected specially with the cure of diseases or injuries by operative manual and instrumental treatment.

History.—Surgery in all countries is as old as human needs. A certain skill in the stanching of blood, the extraction of arrows, the binding up of wounds, the supporting of broken limbs by splints, and the like, together with an instinctive reliance on the healing power of the tissues, has been common to men everywhere. In both branches of the Indo-European stock surgical practice (as well as medical) reached a high degree of perfection at a very early period. It is a matter of controversy whether the Greeks got their medicine (or any of it) from the Hindus (through the medium of the Egyptian priesthood), or whether the Hindus owed that high degree of medical and surgical knowledge and skill which is reflected in Charaka (1st century A.D.) and Suśruta (2nd century) (commentators of uncertain date on the Yajur-Veda) to their contact with Western civilization after the campaigns of Alexander. The evidence in favour of the former view is ably stated by Wise in the Introduction to his *History of Medicine Among the Asiatics* (London, 1868). The correspondence between the *Suśruta* and the *Hippocratic Collection* is closest in the sections relating to the ethics of medical practice; the description, also, of lithotomy in the former agrees almost exactly with the account of the Alexandrian practice as given by Celsus. But there are certainly some dexterous operations described in Suśruta (such as the rhinoplastic) which were of native invention; the elaborate and lofty ethical code appears to be of pure Brahmanical origin; and the copious materia medica (which included arsenic, mercury, zinc, and many other substances of permanent value) does not contain a single article of foreign source. There is evidence also (in Arrian, Strabo and other writers) that the East enjoyed a proverbial reputation for medical and surgical wisdom at the time of Alexander's invasion. We may give the first place, then, to the Eastern branch of the Indo-European stock in a sketch of the rise of surgery, leaving as insoluble the question of the date of the Sanskrit compendiums or compilations which pass under the names of two representative persons, Charaka and Suśruta (the dates assigned to these ranging as widely as 500 years on each side of the Christian era).

Hindu.

The *Suśruta* speaks throughout of a single class of practitioners who undertook both surgical and medical cases. Nor were there any fixed degrees or orders of skill within the profession; even lithotomy, which at Alexandria was assigned to specialists, was to be undertaken by any one, the leave of the raja having been first obtained. The only distinction recognized between medicine and surgery was in the inferior order of barbers, nail-trimmers, ear-borers, tooth-drawers and phlebotomists, who were outside the Brahmanical caste.

Suśruta describes more than one hundred surgical instruments, made of steel. They should have good handles and firm joints, be well polished, and sharp enough to divide a hair; they should be perfectly clean, and kept in flannel in a wooden box. They included various shapes of scalpels, bistouries, lancets, scarifiers, saws, bone-nippers, scissors, trocars and needles. There were also blunt hooks, loops, probes (including a caustic-holder), directors, sounds, scoops and forceps (for polypi, &c.), as well as catheters, syringes, a rectal speculum and bougies. There were fourteen varieties of bandage. The favourite form of splint was made of thin slips of bamboo bound together with string and cut to the length required. Wise says that he had frequently used "this admirable splint," particularly for fractures of the thigh, humerus, radius and ulna, and it was subsequently adopted in the English army under the name of the "patent rattan-cane splint."

Fractures were diagnosed, among other signs, by crepitus. Dislocations were elaborately classified, and the differential diagnosis given; the treatment was by traction and countertraction, circumduction and other dexterous manipulation. Wounds were divided into incised, punctured, lacerated, contused, &c. Cuts of the head and face were sewed. Skill in extracting foreign bodies was carried to a great height, the magnet being used for iron particles under certain specified circumstances. Inflammations were treated by the usual antiphlogistic regimen and appliances; venesection was practised at several other points besides the bend of the elbow; leeches were more often resorted to than the lancet; cupping also was in general use. Poulticing, fomenting and the like were done as at present. Amputation was done now and then, notwithstanding the want of a good control over the haemorrhage; boiling oil was applied to the stump, with pressure by means of a cup-formed bandage, pitch being sometimes added. Tumours and enlarged lymphatic glands were cut out, and an arsenical salve applied to the raw surfaces to prevent recurrence. Abdominal dropsy and hydrocele were treated by tapping with a trocar; and varieties of hernia were understood, omental hernia being removed by operation on the scrotum. Aneurisms were known, but not treated; the use of the ligature on the continuity of an artery, as well as on the cut end of it in a flap, is the one thing that a modern surgeon will miss somewhat noticeably in the ancient surgery of the Hindus; and the reason of their backwardness in that matter was doubtless their want of familiarity with the course of the arteries and with the arterial circulation. Besides the operation already mentioned, the abdomen was opened by a short incision below the umbilicus slightly to the left of the middle line for the purpose of removing intestinal concretions or other obstruction (laparotomy). Only a small segment of the bowel was exposed at one time; the concretion when found was removed, the intestine stitched together again, anointed with ghee and honey, and returned into the cavity. Lithotomy was practised, without the staff. There was a plastic operation for the restoration of the nose, the skin being taken from the cheek adjoining, and the vascularity kept up by a bridge of tissue. The ophthalmic surgery included extraction of cataract. Obstetric operations were various, including caesarean section and crushing the foetus.

The medication and constitutional treatment in surgical cases were in keeping with the general care and elaborateness of their practice, and with the copiousness of their materia medica. Ointments and other external applications had usually a basis of ghee (or clarified butter), and contained, among other things, such metals as arsenic, zinc, copper, mercury and sulphate of iron. For every emergency and every known form of disease there were elaborate and minute directions in the śāstras, which were taught by the physician-priests to the young aspirants. Book learning was considered of no use without experience and manual skill in operations; the different surgical operations were shown to the student upon wax spread on a board, on gourds, cucumbers and other soft fruits; tapping and puncturing were practised on a leathern bag filled with water or soft mud; scarifications and bleeding on the fresh hides of animals from which the hair had been removed; puncturing and lancing upon the hollow stalks of water-lilies or the vessels of dead animals; bandaging was practised on flexible models of the human body; sutures on leather and cloth; the plastic operations on dead animals; and the application of caustics and cauteries on living animals. A knowledge of anatomy was held to be necessary, but it does not appear that it was systematically acquired by dissection. Superstitions and theurgic ideas were diligently kept up so as to impress the vulgar. The whole body of teaching, itself the slow growth of much close observation and profound thinking during the vigorous period of Indo-Aryan progress, was given out in later times as a revelation from heaven, and as resting upon an absolute authority. Pathological principles were not wanting, but they were derived from a purely arbitrary or conventional physiology (wind, bile and phlegm); and the whole elaborate fabric of rules and directions, great though its utility must have been for many generations, was without the quickening power of reason and freedom, and became inevitably stiff and decrepit.

Chinese.

The Chinese appear to have been far behind the Hindus in their knowledge of medicine and surgery, notwithstanding that China profited at the same time as Tibet by the missionary propagation of Buddhism. Surgery in particular had hardly developed among them beyond the merest rudiments, owing to their religious respect for dead bodies and their unwillingness to draw blood or otherwise interfere with the living structure. Their anatomy and physiology have been from the earliest times unusually fanciful, and their surgical practice has consisted almost entirely of external applications. Tumours and boils were treated by scarifications or incisions. The distinctive Chinese surgical invention is *acupuncture*, or the insertion of fine needles, of hardened silver or gold, for an inch or more (with a twisting motion) into the seats of pain or inflammation. Wise says that "the needle is allowed to remain in that part several minutes, or in some cases of neuralgia for days, with great advantage"; rheumatism and chronic gout were among the localized pains so treated. There are 367 points specified where needles may be inserted without injuring great vessels and vital organs.

Egyptian.

Cupping-vessels made of cow-horn have been found in ancient Egyptian tombs. On monuments and the walls of temples are figures of patients bandaged, or undergoing operation at the hands of surgeons. In museum collections of Egyptian antiquities there are lancets, forceps, knives, probes, scissors, &c. Ebers interprets a passage in the papyrus discovered by him as relating to the operation of cataract. Surgical instruments for the ear are figured, and artificial teeth have been found in mummies. Mummies have also been found with well-set fractures. Herodotus describes Egypt, notwithstanding its fine climate, as being full of medical practitioners, who were all "specialists." The ophthalmic surgeons were celebrated, and practised at the court of Cyrus.

Greek.

Greek Surgery.—As in the case of the Sanskrit medical writings, the earliest Greek compendiums on surgery bear witness to a long organic growth of knowledge and skill through many generations. In the Homeric picture of society the surgery is that of the battlefield, and it is of the most meagre kind. Achilles is concerned about the restoration to health of Machaon for the reason that his skill in cutting out darts and applying salves to wounds was not the least valuable service that a hero could render to the Greek host. Machaon probably represents an amateur, whose taste had led him, as it did Melampus, to converse with centaurs and to glean some of their traditional wisdom. Between that primitive state of civilization and the date of the first Greek treatises there had been a long interval of gradual progress.

Hippocratic Surgery.

The surgery of the *Hippocratic Collection* (age of Pericles) bears every evidence of finish and elaboration. The two treatises on fractures and on dislocations respectively are hardly surpassed in some ways by the writings of the present mechanical age. Of the four dislocations of the shoulder the displacement downwards into the axilla is given as the only one at all common. The two most usual dislocations of the femur were backwards on to the dorsum ilii and forwards on to the obturator region. Fractures of the spinous processes of the vertebrae are described, and caution advised against trusting those who would magnify that injury into fracture of the spine itself. Tubercles (φύματα) are given as one of the causes of spinal curvature, an anticipation of Pott's diagnosis. In all matters of treatment there was the same fertility of resource as in the Hindu practice; the most noteworthy point is that shortening was by many regarded as inevitable after simple fracture of the femur. Fractures and dislocations were the most complete chapters of the Hippocratic surgery; the whole doctrine and practical art of them had arisen (like sculpture) with no help from dissection, and obviously owed its excellence to the opportunities of the palaestra. The next most elaborate chapter is that on wounds and injuries of the head, which refers them to a minute subdivision, and includes the depressed fracture and the *contrecoup*. Trephining was the measure most commonly resorted to, even where there was no compression. Numerous forms of wounds and injuries of other parts are specified. Ruptures, piles, rectal polypi, fistula in ano and prolapsus ani were among the other conditions treated. The amputation or excision of tumours does not appear to have been undertaken so freely as in Hindu surgical practice; nor was lithotomy performed except by a specially expert person now and then. The diagnosis of empyema was known, and the treatment of it was by an incision in the intercostal space and evacuation of the pus. Among their instruments were forceps, probes, directors, syringes, rectal speculum, catheter and various kinds of cautery.

Alexandrian Period.

Between the Hippocratic era and the founding of the school of Alexandria (about 300 B.C.) there is nothing of surgical progress to dwell upon. The Alexandrian epoch stands out prominently by reason of the enthusiastic cultivation of human anatomy—there are allegations also of vivisection—at the hands of Herophilus (335–280 B.C.) and Erasistratus (280 B.C.). The substance of this movement appears to have been precision of diagnosis (not unattended with pedantic minuteness), boldness of operative procedure, subdivision of practice into a number of specialities, but hardly a single addition to the stock of physiological or pathological ideas, or even to the traditional wisdom of the Hippocratic time. "The surgeons of the Alexandrian school were all distinguished by the nicety and complexity of their dressings and bandagings, of which they invented a great variety." Herophilus boldly used the knife even on internal organs such as the liver and spleen, which latter he regarded "as of little consequence in the animal economy." He treated retention of urine by a particular kind of catheter, which long bore his name. Lithotomy was much practised by a few specialists, and one of them (Ammonius Lithotomos, 287 B.C.) is said to have used an instrument for breaking the stone in the bladder into several pieces when it was too large to remove whole. A sinister story of the time is that concerning Antiochus, son of Alexander, king of Syria (150 B.C.), who was done to death by the lithotomists when he was ten years old, under the pretence that he had stone in the bladder, the instigator of the crime being his guardian and supplanter Diodotus.

Celsus.

The treatise of Celsus, *De re medica* (reign of Augustus), reflects the state of surgery in the ancient world for a period of several centuries: it is the best record of the Alexandrian practice itself, and it may be taken to stand for the Roman practice of the period following. Great jealousy of Greek medicine and surgery was expressed by many of the Romans of the republic, notably by Cato the Elder (234–149 B.C.), who himself practised on his estate according to the native traditions. His medical observations are given in *De re rustica*. In reducing dislocations he made use of the following incantation: "Huat hanat ista pista sista damiato damnaustra." The first Greek surgeon who established himself in Rome is said to have been Archagathus, whose fondness for the knife and cautery at length led to his expulsion by the populace. It was in the person of Asclepiades, the contemporary and friend of Cicero, that the Hellenic medical practice acquired a permanent footing in Rome. He confined his practice mostly to medicine, but he is credited with practising the operation of tracheotomy. He is one of those whom Tertullian quotes as practising vivisections for the gratification of their curiosity (*De anima*, 15). The next figure in the surgical history is Celsus, who devotes the 7th and 8th books of his *De re medica* exclusively to surgery. There is not much in these beyond the precepts of the Brahmanical śāstras and the maxims and rules of Greek surgery. Plastic operations for the restoration of the nose, lips and ears are described at some length, as well as the treatment of hernia by taxis and operation; in the latter it was recommended to apply the actual cautery to the canal after the hernia had been returned. The celebrated description of lithotomy is that of the operation as practised long before in India and at Alexandria. The treatment of sinuses in various regions is dwelt upon, and in the case of sinuses of the thoracic wall resection of the rib is mentioned. Trephining has the same prominent place assigned to it as in the Greek surgery. The resources of contemporary surgery may be estimated by the fact that subcutaneous urethrotomy was practised when the urethra was blocked by a calculus. Amputation of an extremity is described in detail for the first time in surgical literature. Mention is made of a variety of ophthalmic operations, which were done by specialists after the Alexandrian fashion.

Galen.

Galen's practice of surgery was mostly in the early part of his career (b. A.D. 130), and there is little of special surgical interest in his writings, great as their importance is for anatomy, physiology and the general doctrines of disease. Among the operations credited to him are resection of a portion of the sternum for caries and ligature of the temporal artery. It may be assumed that surgical practice was in a flourishing condition all through the period of the empire from the accounts preserved by Oribasius of the great surgeons Antyllus, Leonides, Rufus and Heliodorus. Antyllus (A.D. 300) is claimed by Häser as one of the greatest of the world's surgeons; he had an operation for aneurism (tying the artery above and below the sac, and evacuating its contents), for cataract, for the cure of stammering; and he treated contractures by something like tenotomy. Rufus and Heliodorus are said to have practised torsion for the arrest of haemorrhage; but in later periods both that and the ligature appear to have given way to the actual cautery. Häser speaks of the operation for scrotal hernia attributed to Heliodorus as "a brilliant example of the surgical skill during the empire." The same surgeon treated stricture

Roman Empire.

of the urethra by internal section. Both Leonides and Antyllus removed glandular swellings of the neck (*strumae*); the latter ligatured vessels before cutting them, and gives directions for avoiding the carotid artery and jugular vein. Flap-amputations were practised by Leonides and Heliodorus. But perhaps the most striking illustration of the advanced surgery of the period is the freedom with which bones were resected, including the long bones, the lower jaw and the upper jaw.

Byzantine. Whatever progress or decadence surgery may have experienced during the next three centuries is summed up in the authoritative treatise of Paulus of Aegina (A.D. 650). Of his seven books the sixth is entirely devoted to operative surgery, and the fourth is largely occupied with surgical diseases. The importance of Paulus for surgical history during several centuries on each side of his own period will appear from the following remarks of Francis Adams (1796–1861) in his translation and commentary (ii. 247):—

"This book (bk. vi.) contains the most complete system of operative surgery which has come down to us from ancient times. . . . Haly Abbas (d. A.D. 994) in the 9th book of his *Practica* copies almost everything from Paulus. Albucasis [Abulcasis] (10th century A.D.) gives more original matter on surgery than any other Arabian author, and yet, as will be seen from our commentary, he is indebted for whole chapters to Paulus. In the *Continens* of Rhases, that precious repository of ancient opinions on medical subjects, if there be any surgical information not to be found in our author it is mostly derived from Antyllus and Archigenes. As to the other authorities, although we will occasionally have to explain their opinions upon particular subjects, no one has treated of surgery in a systematical manner; for even Avicenna, who treats so fully of everything else connected with medicine, is defective in his accounts of surgical operations; and the descriptions which he does give of them are almost all borrowed from our author. The accounts of fractures and dislocations given by Hippocrates and his commentator Galen may be pronounced almost complete; but the information which they supply upon most other surgical subjects is scanty."

Paulus' sixth book, with the valuable commentary of Adams, brings the whole surgery of the ancient world to a focus. Paulus is credited with the principle of local depletion as against general, with the lateral operation for stone instead of the mesial and with understanding the merits of a free external incision and a limited internal, with the diagnosis of aneurism by anastomosis, with an operation for aneurism like that of Antyllus, with amputation of the cancerous breast by crucial incision, and with the treatment of fractured patella.

Arabian. The Arabians have hardly any greater merit in medicine than that of preserving intact the bequest of the ancient world. To surgery in particular their services are small—first, because their religion proscribed the practice of anatomy, and, secondly, because it was a characteristic of their race to accept with equanimity the sufferings that fell to them, and to decline the means of alleviation. The great names of the Arabian school, Avicenna (980–1037) and Averroes (1126–1198), are altogether unimportant for surgery. Their one distinctively surgical writer was Abulcasim (d. 1122), who is chiefly celebrated for his free use of the actual cautery and of caustics. He showed a good deal of character in declining to operate on goitre, in resorting to tracheotomy but sparingly, in refusing to meddle with cancer, and in evacuating large abscesses by degrees.

Medieval. For the five hundred years following the work of Paulus of Aegina there is nothing to record but the names of a few practitioners at the court and of imitators or compilers. Meanwhile in western Europe (apart from the Saracen civilization) a medical school had grown up at Salerno, which in the 10th century had already become famous. From it issued the *Regimen salernitanum*, a work used by the laity for several centuries, and the *Compendium salernitanum*, which circulated among the profession. The decline of the school dates from the founding of a university at Naples in 1224. In its best period princes and nobles resorted to it for treatment from all parts of Europe. The hôtel dieu of Lyons had been founded in 560, and that of Paris a century later. The school of Montpellier was founded in 1025, and became the rallying point of Arabian and Jewish learning. A good deal of the medical and surgical practice was in the hands of the religious orders, particularly of the Benedictines. The practice of surgery by the clergy was at length forbidden by the Council of Tours (1163). The surgical writings of the time were mere reproductions of the classical or Arabian authors. One of the first to go back to independent observation and reflection was William of Saliceto, who belonged to the school of Bologna; his work (1275) advocates the use of the knife in many places where the actual cautery was used by ancient prescription. A greater name in the history of medieval surgery is that of his pupil Lanfranchi of Milan, who migrated (owing to political troubles) first to Lyons and then to Paris. He distinguished between arterial and venous haemorrhage, and is said to have used the ligature for the former. Contemporary with him in France was Henri de Mondeville (Hermondaville) of the school of Montpellier, whose teaching is best known through that of his more famous pupil Guy de Chauliac; the *Chirurgie* of the latter bears the date of 1363, and marks the advance in precision which the revival of anatomy by Mondino had made possible. Eighteen years before Lanfranchi came to Paris a college of surgeons was founded there (1279) by Pitard, who had accompanied St Louis to Palestine as his surgeon. The college was under the protection of St Cosmas and St Damianus, two practitioners of medicine who suffered martyrdom in the reign of Diocletian, and it became known as the Collège de St Côme. From the time that Lanfranchi joined it it attracted many pupils. It maintained its independent existence for several centuries, alongside the medical faculty of the university; the corporations of surgeons in other capitals, such as those of London and Edinburgh, were modelled upon it.

The 14th and 15th centuries are almost entirely without interest for surgical history. The dead level of tradition is broken first by two men of originality and genius—P. Paracelsus (1493–1541) and Paré, and by the revival of anatomy at the hands of Andreas Vesalius (1514–1564) and Gabriel Fallopius (1523–1562), professors at Padua. Apart from the mystical form in which much of his teaching was cast, Paracelsus has great merits as a reformer of surgical practice. *Paracelsus.* "The high value of his surgical writings," says Häser, "has been recognized at all times, even by his opponents." It is not, however, as an innovator in operative surgery, but rather as a direct observer of natural processes, that Paracelsus is distinguished. His description of "hospital gangrene," for example, is perfectly true to nature; his numerous observations on syphilis are also sound and sensible; and he was the first to point out the connexion between cretinism of the offspring and goitre of the parents. He gives most prominence to the healing of wounds. His special surgical treatises are *Die kleine Chirurgie* (1528) and *Die grosse Wund-Arznei* (1536–1537) —the latter being the best known of his works. Somewhat later in date, and of much greater concrete importance for surgery than Paracelsus, is Ambroise Paré (1510–1590). *Paré.* He began life as apprentice to a barber-surgeon in Paris and as a pupil at the hôtel dieu. His earliest opportunities were in military surgery during the campaign of Francis I. in Piedmont. Instead of treating gunshot wounds with hot oil, according to the practice of the day, he had the temerity to trust to a simple bandage; and from that beginning he proceeded to many other developments of rational surgery. In 1545 he published at Paris *La Méthode de traicter les playes faictes par hacquebutes et aultres bastons à feu*. The same year he began to attend the lectures of Sylvius, the Paris teacher of anatomy, to whom he became prosector; and his next book was an *Anatomy* (1550). His most memorable service was to get the use of the ligature for large arteries generally adopted, a method of controlling the haemorrhage which made amputation on a large scale possible for the first time. Like Paracelsus, he writes in the language of the people, while he is free from the encumbrance of mystical theories, which detract from the merits of his fellow reformer in Germany. It is only in his book on monsters, written towards the end of his career, that he shows himself to have been by no means free from superstition. Paré was adored by the army and greatly esteemed by successive

French kings; but his innovations were opposed, as usual, by the faculty, and he had to justify the use of the ligature as well as he could by quotations from Galen and other ancients.

16th Century.

Surgery in the 16th century recovered much of the dexterity and resource that had distinguished it in the best periods of antiquity, while it underwent the developments opened up to it by new forms of wounds inflicted by new weapons of warfare. The use of the staff and other instruments of the "apparatus major" was the chief improvement in lithotomy. A "radical cure" of hernia by sutures superseded the old application of the actual cautery. The earlier modes of treating stricture of the urethra were tried; plastic operations were once more done with something like the skill of Brahmanical and classical times; and ophthalmic surgery was to some extent rescued from the hands of ignorant pretenders. It is noteworthy that even in the legitimate profession dexterous special operations were kept secret; thus the use of the "apparatus major" in lithotomy was handed down as a secret in the family of Laurence Colot, a contemporary of Paré's.

17th Century.

The 17th century was distinguished rather for the rapid progress of anatomy and physiology, for the Baconian and Cartesian philosophies, and the keen interest taken in complete systems of medicine, than for a high standard of surgical practice. The teaching of Paré that gunshot wounds were merely contused and not poisoned, and that simple treatment was the best for them, was enforced anew by Magati (1579–1647), Wiseman and others. Trephining was freely resorted to, even for inveterate migraine; Philip William, prince of Orange, is said to have been trephined seventeen times. Flap-amputations, which had been practised in the best period of Roman surgery by Leonides and Heliodorus, were reintroduced by Lowdham, an Oxford surgeon, in 1679, and probably used by Wiseman, who was the first to practise the primary major amputations. Fabriz von Hilden (1560–1634) introduced a form of tourniquet, made by placing a piece of wood under the bandage encircling the limb; out of that there grew the block-tourniquet of Morel, first used at the siege of Besançon in 1674; and this, again, was superseded by Jean Louis Petit's (1674–1750) screw-tourniquet in 1718. Strangulated hernia, which was for long avoided, became a subject of operation. Lithotomy by the lateral method came to great perfection in the hands of Jacques Beaulieu. To this century also belong the first indications (not to mention the Alexandrian practice of Ammonius) of crushing the stone in the bladder. The theory and practice of transfusion of blood occupied much attention, especially among the busy spirits of the Royal Society, such as Boyle, Lower and others. The seat of cataract in the substance of the lens was first made out by two French surgeons, Quarré and Lasnier. Perhaps the most important figure in the surgical history of the century is Richard Wiseman (1622?–1676) the father of English surgery.

Wiseman.

Wiseman took the Royalist side in the wars of the Commonwealth, and was surgeon to James I. and Charles I., and accompanied Charles II. in his exile in France and the Low Countries. After serving for a time in the Spanish fleet, he joined the Royalist cause in England and was taken prisoner at the battle of Worcester. At the Restoration he became serjeant-surgeon to Charles II., and held the same office under James II. His *Seven Chirurgical Treatises* were first published in 1676, and went through several editions; they relate to tumours, ulcers, diseases of the anus, king's evil (scrofula), wounds, fractures, luxations and lues venerea. Wiseman was the first to advocate primary amputation (or operation before the onset of fever) in cases of gunshot wounds and other injuries of the limbs. He introduced also the practice of treating aneurisms by compression, gave an accurate account of fungus articulorum, and improved the operative procedure for hernia.

The 18th century marks the establishment of surgery on a broader basis than the skill of individual surgeons of the court and army, and on a more scientific basis than the rule of thumb of the multitude of barber-surgeons and other inferior orders of practitioners. In Paris the Collège de St Côme gave way to the Academy of Surgery in 1731, with Petit as director, to which was added at a later date the École Pratique de Chirurgie, with François Chopart (1743–1795) and Pierre Desault (1744–1795) among its first professors.

18th Century.

The Academy of Surgery set up a very high standard from the first, and exercised great exclusiveness in its publications and its honorary membership. In London and Edinburgh the development of surgery proceeded on less academical lines, and with greater scope for individual effort. Private dissecting rooms and anatomical theatres were started, of which perhaps the most notable was Dr William Hunter's (1718–1783) school in Great Windmill Street, London, inasmuch as it was the first perch of his more famous brother John Hunter (1728–1793). In Edinburgh, Alexander Monro (1697–1767), first of the name, became professor of anatomy to the company of surgeons in 1719, transferring his title and services to the university the year after; as he was the first systematic teacher of medicine or surgery in Edinburgh, he is regarded as the founder of the famous medical school of that city. In both London and Edinburgh a company of barbers and surgeons had been in existence for many years before; but it was not until the association of these companies with the study of anatomy, comparative anatomy, physiology and pathology that the surgical profession began to take rank with the older order of physicians. Hence the significance of the eulogy of a living surgeon on John Hunter: "More than any other man he helped to make us gentlemen" (*Hunterian Oration*, 1877). The state of surgery in Germany may be inferred from the fact that the teaching of it at the new university of Göttingen was for long in the hands of Albrecht von Haller (1708–1777), whose office was "professor of theoretical medicine." In the Prussian army it fell to the regimental surgeon to shave the officers. At Berlin a medico-chirurgical college was founded by Surgeon-General Ernst von Holtzendorff (1688–1751) in 1714, to which was joined in 1726 a school of clinical surgery at the Charité. Military surgery was the original purpose of the school, which still exists, side by side with the surgical cliniques of the faculty, as the Friedrich Wilhelm's Institut. In Vienna, in like manner, a school for the training of army surgeons was founded in 1785—Joseph's Academy or the Josephinum. The first systematic teaching of surgery in the United States was by Dr Shippen at Philadelphia, where the medical college towards the end of the century was largely officered by pupils of the Edinburgh school. A great part of the advance during the 18th century was in surgical pathology, including Petit's observations on the formation of thrombi in severed vessels, Hunter's account of the reparative process, Benjamin Bell's classification of ulcers, the observations of Duhamel and others on the formation of callus and on bone-repair in general, Pott's distinction between spinal curvature from caries or abscess of the vertebrae and kyphosis from other causes, observations by various surgeons on chronic disease of the hip, knee, and other joints, and Cheselden's description of neuroma. Among the great improvements in surgical procedure we have Cheselden's operation of lithotomy (six deaths in eighty cases), Sir Caesar Hawkins's (1711–1786) cutting gorget for the same (1753), Hunter's operation (1785) for popliteal aneurism by tying the femoral artery in the canal of the triceps where its walls were sound ("excited the greatest wonder," Assalini), Petit's, Desault's and Percival Pott's (1714–1788) treatment of fractures, Gimbernat's (Barcelona) operation for strangulated femoral hernia, Pott's bistoury for fistula, Charles White's (1728–1813, Manchester) and Henry Park's (1745–1831, Liverpool) excision of joints, Petit's invention of the screw-tourniquet, the same surgeon's operation for lacrymal fistula, Chopart's partial amputation of the foot, Desault's bandage for fractured clavicle, William Bromfield's (1712–1792) artery hook, and William Cheselden's (1688–1752) operation of iridectomy. Other surgeons of great versatility and general merit were Sharp of London, Benjamin Gooch (*fl.* 1775) of Norwich, William Hey (1736–1819) of Leeds, David and Claude Nicolas Le Cat (1705–1768) of Rouen, Raphaël Sabatier (1732–1811), Georges de La

Faye (1701–1781), Ledran, Antoine Louis (1723–1792), Sauveur Morand (1697–1773) and Pierre Percy (1754–1825) of Paris, Bertrandi of Turin, Troja of Naples, Palleta of Milan, Schmucker of the Prussian army, August Richter of Göttingen, Siebold of Würzburg, Olaf Acrel of Stockholm and Callisen of Copenhagen.

19th Century.

Two things gave surgical knowledge and skill in the 19th century a character of scientific or positive cumulativeness and a wide diffusion through all ranks of the profession.[1] The one was the founding of museums of anatomy and surgical pathology by the Hunters, Guillaume Dupuytren (1777–1835), Jules Cloquet (1790–1843), J. F. Blumenbach (1752–1840), John Barclay (1758–1826), and a great number of more modern anatomists and surgeons; the other was the method of clinical teaching, exemplified in its highest form of constant reference to principles by Thomas Lawrence (1711–1783) and James Syme (1799–1870). In surgical procedure the discovery of the anaesthetic properties of ether, chloroform, methylene, &c., was of incalculable service; while the conservative principle in operations upon diseased or injured parts, and especially what may be called the hygienic idea (or, more narrowly, the antiseptic and aseptic principles) in the conditions governing surgery, were strikingly beneficial.

The following were among the more important additions to the resources of the surgical art: the thin thread ligature for arteries, introduced by Jones of Jersey (1805); the revival of torsion of arteries by Jean Amussat (1796–1856). [1829]; the practice of drainage by Pierre Marie Chassaignac (1805–1879) [1859]; aspiration by Philippe Pelletan (1747–1829) and recent improvers; the plaster-of-Paris bandage or other immovable application for simple fractures, club-foot, &c. (an old Eastern practice recommended in Europe about 1814 by the English consul at Basra); the re-breaking of badly set fractures; galvano-caustics and écraseurs; the general introduction of resection of joints (Sir William Fergusson (1808–1877), Syme and others); tenotomy by Jacques Delpech (1777–1832) and Louis Stromeyer (1804–1876) [1831]; operation for squint by Johann Dieffenbach (1795–1847) [1842]; successful ligature of the external iliac for aneurism of the femoral by John Abernethy (1764–1831) [1806]; ligature of the subclavian in the third portion by Astley Cooper (1768–1841) [1806], and in its first portion by Colles; crushing of stone in the bladder by Gruithuisen of Munich (1819) and Jean Civiale (1792–1867) of Paris [1826]; cure of ovarian dropsy by removing the cyst (since greatly perfected); discovery of the ophthalmoscope, and many improvements in ophthalmic surgery by Alfred von Gräfe (1830–1899) and others; application of the laryngoscope in operations on the larynx by Jean Czermak (1828–1873) [1860] and others; together with additions to the resources of aural surgery and dentistry. The great names in the surgery of the first half of the century besides those mentioned are: Antonio Scarpa of Italy (1747–1832); Alexis Boyer (1757–1833), Félix Larrey (1766–1842)—to whom Napoleon left a legacy of a hundred thousand francs, with the eulogy: "C'est l'homme le plus vertueux que j'aie connu," Philibert Roux (1780–1854), Jacques Lisfranc (1790–1847), Alfred Louis Velpeau (1795–1868), Joseph Malgaigne (1806–1865), Auguste Nélaton (1807–1873)—all of the French school; of the British school, John Bell (1763–1820), Charles Bell (1774–1842), Allan Burns (1781–1813), Robert Liston (1794–1847), James Wardrop (1782–1869), Astley Cooper, Henry Cline (1750–1827), Benjamin Travers (1783–1858), Benjamin Brodie (1783–1862), Edward Stanley (1793–1862) and George Guthrie (1785–1856); in the United States, V. Mott, S. D. Gross and others; in Germany, Kern and Schuh of Vienna, Von Walther and Textor of Würzburg, Chelius, Hesselbach and the two Langenbecks—Konrad (1776–1851) and Bernhard (1810–1887).

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Modern Practice of Surgery.[2]—A great change has taken place in the practice of surgery since the middle of the 19th century, in consequence of the new science of bacteriology, and the introduction of aseptic methods, due to the teaching of Lord Lister.

It had long been known that subcutaneous injuries followed a far more satisfactory course than those with wounds, and the history of surgery gives evidence that surgeons endeavoured, by the use of various dressings, empirically to prevent the evils which were matters of common observation during the healing of open wounds. Various means were also adopted to prevent the entrance of air, as, for instance, in the opening of abscesses by the "valvular method" of Abernethy, and by the subcutaneous division of tendons in "club-foot." Balsams and turpentine and various forms of spirit were the basis of many varieties of dressing. These different dressings were frequently cumbersome and difficult of application, and they did not attain the object aimed at, while, at the same time, they shut in the discharges and gave rise to other evils which prevented rapid and painless healing. In the beginning of the 19th century these complicated dressings began to lose favour, and operating surgeons went to the opposite extreme and applied a simple dressing, the main object of which was to allow a free escape of discharge. Others applied no dressing at all, laying the stump of a limb after amputation on a piece of dry lint, avoiding thereby any unnecessary movement of the parts. Others, again, left the wound open for some hours after an operation, preventing in this way any accumulation, and brought its edges and surfaces together after all oozing of blood had ceased, and after the effusion, the result of injury to the tissues in the operation had to a great extent subsided. As a result of these measures many wounds healed kindly. But in other cases inflammation occurred, accompanied by pain and swelling, and the formation of pus. High fever also, due to the unhealthy state of the wound, was observed. These conditions often proved fatal, and surgeons attributed them to the constitution of the patient, or else thought that some poison had entered the wound, and, passing from it into the veins, had contaminated the blood and poisoned the patient. The close association between the formation of pus in wounds and the fatal "intoxication" of many of those cases encouraged the belief that the pus cells from the wound entered the circulation. Hence came the word "pyaemia." It was also observed that a septic condition of the wound was usually associated with constitutional fever, and it was supposed that the septic matter passed into the blood—whence the term "septicaemia." It was further observed that the crowding together of patients with open wounds increased the liability to these constitutional disasters, so every endeavour was made to separate the patients and to improve ventilation. In building hospitals the pavilion and other systems, with windows on both sides, with cross-ventilation in the wards, were adopted in order to give the utmost amount of fresh air. Hospital buildings were spread over as large an area as possible, and were restricted in height, if practicable, to two storeys. The term "hospitalism" was coined by Sir J. Y. Simpson, who collected statistics comparing hospital and private practice, by which he endeavoured to show that private patients were far less liable to such catastrophes than were those who were treated in hospitals.

Antiseptic Surgery.

This was the condition of affairs when Lister in 1860, from a study of the experimental researches of Pasteur into the causes of putrefaction, stated that the evils observed in open wounds were due to the admission into them of organisms which exist in the air, in water, on instruments, on sponges, and on the hands of the surgeon or the skin of the patient. Having accepted the germ theory of putrefaction, Lister applied himself to discover the best way of preventing all harmful organisms from reaching the wound from the moment that it was made until it was healed. In the germ he had to deal with a microscopic plant, and he desired to render its growth impossible. This, he thought, could be done either by destroying the plant itself before it had the chance of entering the wound or after it had entered, or by facilitating the removal of the discharges and preventing their accumulation in the wound, and by doing everything to prevent the lowering of the vitality of the wounded tissues, because unhealthy tissues are the most liable to attack. Several substances were then known as possessing properties antagonistic to sepsis or putrefaction, and hence called "antiseptic." Acting on a suggestion of Lemaire, Lister chose for his experiments carbolic acid, which he used at first in a crude form. He had many difficulties to contend with—the impurity of the substance.

[1] The Royal College of Surgeons in London was established in 1800, the title being changed in 1843 to Royal College of Surgeons of England.

[2] For the surgery of any particular region or organ, reference should be made to the article on that region or organ.

its irritating properties and the difficulty of finding the exact strength in which to use it: he feared to use it too strong, lest it should impair the vitality of the tissues and thus prevent healing; and he feared to use it too weak, lest its antiseptic qualities should be insufficient for the object in view. As dressings for wounds he used various chemical substances, which, being mixed with carbolic acid, were intended to give off a certain quantity of carbolic acid in the form of vapour, so that the wound might be constantly surrounded by an antiseptic which would destroy any organisms approaching it, and, at the same time, not interfere with its healing. At first, although he prevented pyaemia in a marked degree, he, to a certain extent, irritated the wounds and prevented rapid healing. He began his historic experiments in Glasgow and continued them on his removal to the chair of clinical surgery in Edinburgh. After many disappointments, he gradually perfected his method of performing operations and dressing wounds, which was somewhat as follows.

A patient was suffering, for instance, from disease of the foot necessitating amputation at the ankle joint. The part to be operated on was enveloped in a towel soaked with a 5% solution of carbolic acid. The towel was applied two hours before the operation, with the object of destroying the putrefactive organisms present in the skin. The patient was placed on the operating table, and brought under the influence of chloroform; the limb was then elevated to empty it of blood, and a tourniquet was applied round the limb below the knee. The instruments to be used during the operation had been previously purified by lying for half an hour in a flat porcelain dish containing carbolic acid (1 in 20). The sponges lay in a similar carbolic lotion. Towels soaked in the same solution were laid over the table and blankets near the part to be operated upon. The hands of the operator, as well as those of his assistants, were thoroughly cleansed by washing them in carbolic lotion, free use being made of a nail brush for this purpose. The operation was performed under a cloud of carbolized watery vapour (1 in 30) from a steam spray-producer. The visible bleeding points were first ligated; the tourniquet was removed; and any vessels that had escaped notice were secured. The wound was stitched, a drainage-tube made of red rubber being introduced at one corner to prevent accumulation of discharge; a strip of "protective"—oiled silk coated with carbolized dextrin—was washed in carbolic lotion and applied over the wound. A double ply of carbolic gauze was soaked in the lotion laid over the protective, overlapping it freely. A dressing consisting of eight layers of dry gauze was placed over all, covering the stump and passing up the leg for about six inches. Over that a piece of thin mackintosh cloth was placed, and the whole arrangement was fixed with a gauze bandage. The mackintosh cloth prevented the carbolic acid from escaping and at the same time caused the discharge from the wound to spread through the gauze. The wound itself was shielded by the protective from the vapour given off by the carbolic gauze, whilst the surrounding parts, being constantly exposed to its activity, were protected from the intrusion of septic contamination. And these conditions were maintained until sound healing took place. Whenever the discharge reached the edge of the mackintosh the case required to be dressed, and a new supply of gauze was applied round the stump. Whenever the wound was exposed for dressing the stump was enveloped in the vapour of carbolic acid by means of the steam spray-producer. At first a syringe was used to keep the surface constantly wet with lotion and then a hand-spray. These dressings were repeated at intervals until the wound was healed. The drainage-tube was gradually shortened, and was ultimately removed altogether.

The object Lister had in view from the beginning of his experiments was to place the open wound in a condition as regards the entrance of organisms as nearly as possible like a truly subcutaneous wound, such as a contusion or a simple fracture, in which the unbroken skin acted as a protection to the wounded tissues beneath. The introduction of this practice by Lister effected a complete change in operative surgery. The dark times of suppurating wounds, of foul discharges, of secondary haemorrhage, of pyaemic abscesses and hospital gangrene constitute what is now spoken of in surgery as the pre-Listerian era.

As years went on, surgeons tried to simplify and improve the somewhat complicated and expensive measures and dressings and chemists were at pains to supply carbolic acid in a pure form and to discover new antiseptics, the great object being to get a non-irritating antiseptic which should at the same time be a powerful germicide. Iodoform, oil of eucalyptus, salicylic acid, boracic acid, mercuric iodide, and corrosive sublimate were used.

For some years Lister irrigated a wound with carbolic lotion during the operation and at the dressings when it was exposed, but the introduction of the spray displaced the irrigation method. All these different procedures, however, as regards both the antiseptic used and the best method of its application in oily and watery solutions and in dressings, were subsidiary to the great principle involved—namely, that putrefaction in a wound is an evil which can be prevented, and that, if it is prevented, local irritation, in so far as it is due to putrefaction, is obviated and septicaemia and pyaemia cannot occur. Alongside of this great improvement the immense advantage of free drainage was universally acknowledged. Moreover, surgeons at once began to take greater care in securing the cleanliness of wounds, and some of them, Lawson Tait and Bantock, for example, produced such excellent results by the adoption merely of methods of strict cleanliness, and became so aggressive in their championship of them, that many of the older practitioners were bewildered and unable to decide as to where truth began and where it ended in the new doctrine. But though the actual methods, as taught and practised by Lister, have, with the spray-producers, passed away and given place to new, still the great light which he shed in the surgical world burns as brightly as ever it did; and all the methods which are practised to-day are the direct results of his teaching.

By 1885 the carbolic acid spray, which to some practitioners had apparently been the embodiment of the Listerian theory and practice, was beginning to pass into desuetude, though for a good many years after that time certain surgeons continued to employ it during operation, and during the subsequent dressings of the wound. Surgeons who, having had practical experience of the unhappy course which their operation-cases had been apt to run in the pre-Listerian days, and of the vast improvements which ensued on their adoption of the spray-and-gauze method in its entirety, were, not unnaturally, reluctant to operate except in a cloud of carbolic vapour. So, even after Lister himself had given up the spray, its use was continued by many of his disciples. It was in the course of 1888 that operating surgeons began to neglect the letter of the antiseptic treatment and to bring themselves more under the broadening influence of its spirit. Certain adventurous and partially unconvinced surgeons began to give up the carbolic spray gradually, by imparting a smaller percentage of carbolic acid to the vapour, until at last the antiseptic disappeared altogether, apparently without detriment to the excellence of the results obtained. But while some surgeons were thus ceasing to apply the antiseptic spray to the wound during operation, others were pouring mild carbolic lotion, or a very weak solution of corrosive sublimate (an extremely potent germicide) over the freshly-cut surfaces. These measures were in turn given up, to the advantage of the patient; for it was hardly to be expected that a chemical agent which was strong enough to destroy or render inert septic micro-organisms in and about a wound would fail to injure exposed and living tissues. Eventually it became generally admitted that if a surgeon was going to operate upon the depths of an open abdomen for an hour or more, the chilling and the chemical influences of the spray must certainly lower the vitality of the parts exposed, as well as interfere with the prompt healing of the wounded surfaces. With the spray went also the "protective," the paraffin gauze, and the mackintosh sheeting which enveloped the bulky dressing.

Years before this happened, in the address on surgery given at the Cork meeting of the British Medical Association, Sir William (then Mr) Savory had somewhat severely criticized the rigid exclusiveness of the members of the spray-and-gauze school: the sum and substance of the address was that every careful surgeon was an antiseptic surgeon, and that the success of the Listerian surgeon did not depend upon the spray or the gauze, or the two together, but upon *cleanliness*—that the surgeon's fingers and instruments and the area operated on must be *surgically clean*. Though precise experiments show that it is impossible for the surgeon to remove every trace of septicity from his own hands and from the skin of his patient, still with nail-brush, soap and water, and alcohol or turpentine, with possibly the help of some mercuric germicide, he can, for all practical purposes, render his hands safe. Recognizing this difficulty many surgeons prefer to operate in thin rubber gloves which can, for certain, by boiling, be rendered free of all germs; others, in addition, put on a mask, sterile overalls, and india-rubber shoes. But these excessive refinements do not seem to be generally acceptable, whilst the results of practice show that they are by no means necessary. The careful, the antiseptic surgeon of 1885 is to-day represented by the careful, the *aseptic* surgeon. The *antiseptic* surgeon was waging a constant warfare against germs which his creed told him were on his hands, in the wound, in the air, everywhere—and these he attacked with potent chemicals which beyond question often did real damage to the healthy tissues laid bare during the operation. If, as was frequently the case, his own hands became sore and rough from contact with the antiseptics he employed, it was not to be wondered at if a peritoneal surface or an incised tissue became more seriously affected. The surgeon of to-day has much less commerce with antiseptics: he operates with hands which, for all practical purposes, may be considered as germless; he uses instruments which are certainly germless, for they have just been boiled for twenty minutes in water (to which a little common soda has been added to prevent tarnishing of the steel), and he operates on tissues which have been duly made clean in a surgical sense. If he were asked what he considers the chief essentials for securing success in his operative practice, he would probably reply, "Soap and water and a nail-brush." He uses no antiseptics during the operations, he keeps the wound dry by gently swabbing it with aseptic, absorbent cotton-wool, and he dresses it with a pad of aseptic gauze. This is the simple aseptic method which has been gradually evolved from the Listerian antiseptic system. But though the pendulum has swung so far in the direction of *aseptic* surgery, a very large proportion of operators still adhere to the *antiseptic* measures which had proved so highly beneficial. The judicious employment of weak solutions of carbolic acid, or of mercuric salts, and the application of unirritating dressings of an antiseptic nature cannot do any harm, and, on the other hand, they may be of great service in the case of there having been some flaw in the carrying out of what should have been an absolutely aseptic operation.

Aseptic Surgery.

A great change has taken place in connexion with the use of soft india-rubber drainage-tubes. In former years most surgeons placed one or more of these in the dependent parts of the area of operation, so that the blood or serum oozing from the injured tissues might find a ready escape. But to-day, except in dealing with a large abscess or other septic cavity, many surgeons make no provision for drainage, but, bandaging the part beneath a pad of aseptic wool, put on so much pressure that any little leakage into the tissues is quickly absorbed. If a drainage-tube can be dispensed with, so much the better, for if it is not actually needed its presence keeps up irritation and delays prompt healing. But inasmuch as a tube if rightly placed in a deep wound is an insurance against the occurrence of "tension," and as it can easily be withdrawn at the end of twenty-four hours (even if it has served no useful purpose), it is improbable that the practice of drainage of freshly made cavities will ever be entirely given up. If the tube is removed after twenty-four hours its presence can have done no harm and sometimes the large amount of fluid which it has drained from the wound affords clear evidence that its use has saved the patient discomfort and has probably expedited his recovery. For septic cavities drainage-tubes are still used, but it must be remembered that the tube cannot remain long in position without causing and keeping up irritation; hence, even in septic cases, the modern surgeon discards the tube at the earliest possible moment. If after he has taken it out septic fluids collect, and the patient's temperature rises, it can easily be reinserted. But it is better to take out the tube too soon than to leave it in too long; this remark applies with special force to the treatment of abscess of the pleural cavity (empyema), in the treatment of which a drainage-tube has almost certainly to be employed.

Drainage-tubes.

Poultices are now never used: they were apt to be foul and offensive, and were certainly septic and dangerous. If moisture and warmth are needed for a wound they can be obtained by the use of a fold of clean lint, or by some aseptic wool which has been wrung out in a hot solution of boracic or carbolic acid, and applied under some waterproof material, which effectually prevents evaporation and chilling. There was no special virtue in poultices made of linseed meal or even of scraped carrot: they simply stored up the moisture and heat. They possessed no possible advantage over the modern fomentation under oil-silk.

Much less is heard now of so-called "bloodless" operations. The bloodlessness was secured by the part to be operated on—an arm, for instance—being raised and compressed from the fingers to the shoulder by successive turns of an india-rubber roller-bandage (Esmarch's), the main artery of the limb being then compressed by the application of an elastic cord above the highest turn of the bandage. The bandage being removed, the operation was performed through bloodless tissues. But when it was completed and the elastic cord removed from around the upper part of the limb, a reactionary flow of blood took place into every small vessel which had been previously squeezed empty, so that though the operation itself had actually been bloodless, the wound could not be closed because of the occurrence of unusually free haemorrhage or troublesome oozing. A further objection to the application of such an elastic roller-bandage was that septic or tuberculous material might by chance be squeezed from the tissues in which it was perhaps harmlessly lying, forced into the blood vessels, and so widely disseminated through the body. Esmarch's bandage is therefore but little used now in operative surgery. Instead, each bleeding point at an operation is promptly secured by a small pair of nickel-plated clip-forceps, which generally have the effect, after being left on for a few minutes, of completely and permanently arresting the bleeding. These clips were specially introduced into practice by Sir Spencer Wells, and it is no unusual thing for a surgeon to have twenty or thirty pairs of them at hand during an extensive operation. Seeing how convenient, not to say indispensable, they are in such circumstances, the surgeon of to-day wonders how he formerly managed to get on at all without them.

Bloodless Operations.

Biers's treatment by passive congestion is carried out by gently assisting the return of venous blood from a part of the body without in any way checking the arterial flow. In the case of tuberculous disease of the knee-joint, for instance, an elastic band is gently placed round the thigh for several hours a day, and in disease of the wrist or elbow the girth is applied round the arm. The skin below becomes flushed, and the arterial blood which, as shown by the pulse, is still flowing into the affected part, is compelled to linger in the affected tissues, giving the serum and the white corpuscles time to exert their beneficial influence upon the disease.

In the case of tuberculous, or septic, affections of the lymphatic glands of the neck, or of other parts where the constriction cannot be conveniently obtained, effective congestion can be secured by the use of cupping glasses. And if so be that suppuration is taking place in the interior of an inflamed gland, the cupping-glasses can be applied after a small puncture has been made into the softened part of the gland. In this way the whole of the broken-down material can be got away without the necessity of making an actual *incision* or of resorting to scraping. The method of inducing hyperaemia should be so conducted as to give the patient no pain whatever: it must not be carried out with excessive energy.

Röntgen Rays.

By means of the Röntgen or X-rays (see X-Ray Treatment) the surgeon is able to procure a distinct shadow-portrait of deeply-placed bones, so that he can be assured as to the presence or absence of fracture or dislocation, or of outgrowth of bone, or of bone-containing tumours. By this means also he is able to locate with absolute precision the situation of a foreign body in the tissues—of a coin in the windpipe or gullet, of a broken piece of a needle in the hand, of a splinter of glass in the foot, or of a bullet deeply embedded in soft tissues or bone. This effect may be obtained upon a fluorescent screen or printed in a permanent form upon glass or paper. The shadow is cast by a 10- or 12-in. spark from a Crookes vacuum tube. The rays of Röntgen find their way through dead and living tissues which are far beyond the reach of the rays of ordinary light, and they are thus able even to reveal changes in the deeply placed hip-joint which have been produced by tuberculous disease. In examining an injured limb it is not necessary to take off wooden splints or bandages except in cases where the latter have been treated with plaster of paris, lime-salts obstructing the rays and throwing a shadow. Thus the rays may pass through an ordinary uric acid calculus in the kidney or bladder; but if it contains salts of lime, as does the mulberry calculus (oxalate of lime), a definite shadow is cast upon the screen. The value of the X-rays is not limited to the elucidation of obscure problems such as those just indicated: they are also of therapeutic value; for example, in the treatment of certain forms of skin disease, as well as of cancer.

Too much, however, must not be expected from them. For the treatment of a patch of tuberculous ulceration (lupus), or for a superficial cancerous sore (epithelioma), they may be of service, but in the treatment of a deeply-seated malignant growth—as a cancer of the breast—they have not proved of value. Moreover, the X-rays sometimes cause serious burns of the skin; and although this happens less often now than was previously the case, still the frequent application of the rays is apt to be followed by cutaneous warty growths which are apt in turn to develop into cancer. In many cases in which the X-rays are used a more prompt and efficient means of treatment would probably be by excision. One great advantage which operative treatment by the knife must always have over the treatment by X-rays is that the secondary implication of the lymphatic glands can be dealt with at the same time. And this, in many cases, is a matter of almost equal importance to that of removal of the cancer itself.

Radium.

The employment of radium in surgery is still in its infancy. Doubtless radium is a very powerful agent, but even if it were found of peculiar value in treatment its cost would, for the present, put it out of the reach of most practitioners. Probably it will be found useful in the treatment of naevus, rodent ulcers and superficial malignant growths. As to what influence radium may have in the treatment of deeply-seated cancers it is as yet impossible even to guess. For those sad cases, however, which the practical surgeon is reluctantly compelled to admit as being beyond the reach of his operative skill, the influence of radium should be tried with determination and thoroughness. The therapeutic influence of radium may eventually be found to be great, or it may be disappointing. The fact that under direct royal patronage an institution has been established in London for the investigation of the physical and therapeutic value of this newly discovered agent should satisfy every one that its properties will be duly inquired into and made known without mystery or charlatanism and absolutely in the interest of the people. But in the meanwhile too much must not be expected from it as a surgical agent. (E. O.*)

SURGICAL INSTRUMENTS AND APPLIANCES. The purpose of this article is to give an account of the more important surgical instruments that are now in general use, and to show by what modifications, and from what discoveries in science, the present methods of an operation have come to be what they are. The good surgeon is careful to use the right sort and pattern of instrument, and the chief fact about the surgery of the present day, that it is aseptic or antiseptic, is recorded in the make of surgical instruments and in all the installation of an operating-theatre. Take, for instance, a scalpel and a saw that are figured in Ambroise Paré's (1510–1590) surgical writings. The scalpel folds into a handle like an ordinary pocket-knife, which alone was enough in those days to keep it from being aseptic. The handle is most elegantly adorned with a little winged female figure, but it does not commend itself as likely to be surgically

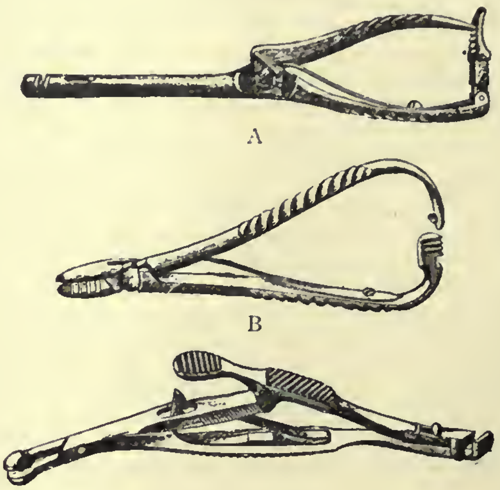

Fig. 1.—Needle-holders.
A, Hagedorn's; B, Macphail's; C, Allen and Hanbury's, for Hagedorn or ordinary needles.

clean. The saw, after the same fashion, has a richly chased metal frame, and, at the end of the handle, a lion's head in bold relief, with a ring through its mouth to hang it up by. It may be admirable art, but it would harbour all sorts of germs. If one contrasts with these artistic weapons the

Fig. 2.—Tenotomy Knives forged in one piece.

instruments of 1850, one finds no such adornment, and for general finish Savigny's instruments would be hard to beat; but the wooden or ivory handles, cut with finely scored lines like the cross-hatching of an engraving, are not more likely to be aseptic than the handles of Paré's instruments. At the present time, instead of such handles as these, with blades riveted into them, scalpels are forged out of one piece of steel, their handles are nickel-plated and perfectly smooth, that they may afford no crevices, and may be boiled and immersed in carbolic lotion without tarnishing or rusting; the scalpel has become just a single, smooth, plain piece of metal, having this one purpose that it shall make an aseptic wound. In the same way the saw is made in one piece, if this be possible; anyhow, it must be, so far as possible, a simple, smooth, unrusting metal instrument, that can be boiled and laid in lotion; it is a foreign body that must be introduced into tissues susceptible of infection, and it must not carry infection with it.

Or we may take, at different periods of surgery, the various kinds of ligature for the arrest of bleeding from a divided blood-vessel. In Paré's time (he was the first to use the ligature in amputation, but the existence of some sort of ligature is as old as Galen) the ligature was a double thread, *bon fil qui soit en double*; and he employed a forceps to draw forward the cut end of the vessel to be ligatured. From the time of Ambroise Paré to the time of Lord Lister no great improvement was made. In the middle of last century it was no uncommon thing for the house-surgeon at an operation to hang a leash of waxed threads, silk or flax, through his button-hole, that they might

FIG. 3.—Amputating Saws.

be handy during the operation. Then came Lord Lister's work on the absorbable ligature; and out of this and much other experimental work has come the present use of the ligature in its utmost perfection—a thread that can be tied, cut short, and left in the depth of the wound, with absolute certainty that the wound may at once be closed from end to end and nothing more will ever be heard of the ligatures left buried in the tissues. The choice of materials for the ligature is wide. Some surgeons prefer catgut, variously prepared; others prefer silk; for certain purposes, as for the obliteration of a vessel not divided but tied in its course for the cure of aneurism, use is made of kangaroo-tendon, or some other animal substance. But whatever is chosen is made aseptic by boiling, and is guarded vigilantly from contamination on its way from the sterilizer into the body of the patient. The old ligatures were a common cause of suppuration. Therefore the wound was not closed along its whole length, but the ligatures were left long, hanging out of one end of the wound, and from day to day were gently pulled until they came away. Certainly they served thus to drain the wound, but they were themselves a chief cause of the suppuration that required drainage.

Sutures, like ligatures, were a common cause of suppuration in or around the edges of the wound. Therefore, in the hope of avoiding this trouble, they were made of silver wire, which was inconvenient to handle, and gave pain at the time of removal of the sutures. At the present time they are of silkworm-gut, catgut, silk or horsehair; they are made aseptic by boiling, and can be left any number of days without causing suppuration and can then be removed without pain.

Next may come the consideration of surgical dressings. In the days when inflammation and suppuration were almost inevitable, the dressings were usually something very simple, that could be easily and frequently changed—ointment, or wet compresses, to begin with, and poultices when suppuration was established. It is reported of the great Sir William Fergusson that he once told his students, "You may say what you like, gentlemen, but after all, there's no better dressing than cold water." This is not the place to try to tell the long history of the quest after a perfect surgical dressing, and the advance that was begun when Lord Lister invented his carbolic paste. The work was done slowly in the international unity of science during many years. The perfect antiseptic dressing must fulfil many requirements: it must be absorbent, yet not let its medicament be too quickly soaked out of it; and it must be antiseptic, yet not virulent or poisonous. Of the many gauzes now available, that which is chiefly used is one impregnated with a double cyanide of zinc and mercury. Its pleasant amethystine tint has no healing virtue, but is used to distinguish it from other gauzes—carbolized gauze, tinted straw-colour; iodoform gauze, tinted yellow; sublimate, blue; chinosol, green. The chinosol gauze is especially used in ophthalmic surgery; for general surgery the cyanide gauze is chiefly employed. The various preparations of absorbent wool (*i.e.* wool that has been freed of its grease, so that it readily takes up moisture) are used not only for outside dressings, but also as sponges at the time of operation, and have to a great extent done away with the use of real sponges. The gauzes in most cases are used not dry, but just wrung out of carbolic lotion, that their antiseptic influence may act at once.

The whole subject of surgical instruments may be considered in more ways than one. It may be well, for the sake of clearing the ground, to take first some of the more common instruments of general

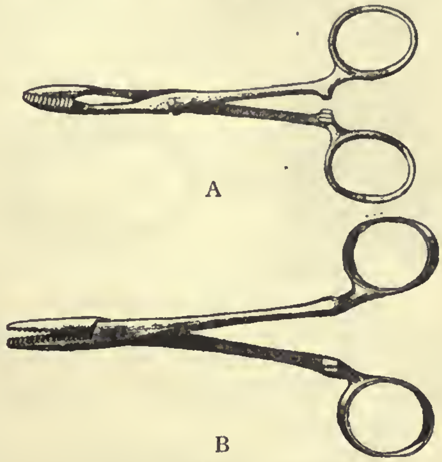

FIG. 4.—Artery Forceps.
A, Péan's; B, Spencer Wells's.

surgery, and then to note the working out, in the operations of surgery, of the three great principles—the use of anaesthetics, the use of antiseptic or aseptic methods, and the surgical uses of electricity.

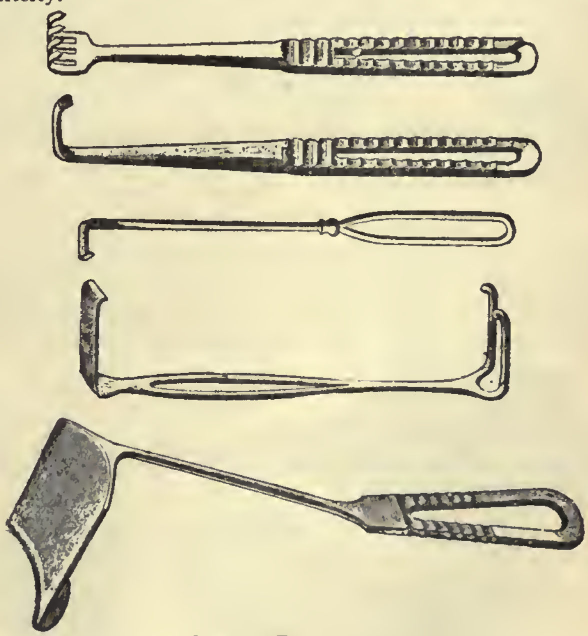

FIG. 5.—Retractors.

Of the essential instruments that are common to all operations, we may well believe that they have now become, by gradual development, perfect. Take, for instance, the ordinary surgical needle. In the older forms the eye was slit-shaped, not easily threaded, and the needle was often made of a triangular outline, like a miniature bayonet. At the present time the needles used in general surgery are mostly Hagedorn's, which have a full-sized round eye, easy for threading, are flat for their whole length and have a fine cutting edge on one side, near the point. Thus they enter the skin very easily, like a miniature knife, and the minute wound they make is not a hole, but a tiny slit that is at once drawn together and, as it were, obliterated by the tying of the suture. Or, for another simple instrument in universal use, take the catch-forceps that is used for taking hold of a bleeding point till it is ligatured. This forceps is as old as the time of Paré, but he made use of a very heavy and clumsy pattern. Up to the last few years the artery-forceps was made with broad, curved, fenestrated blades, with the catch set close to the blades. At the present time the forceps in general use, named after Dr Péan in France and after Sir Spencer Wells in England, is made with very narrow grooved blades, and the catch is placed not near the blades, but near the handles: thus it takes a surer hold, and can be set free when the ligature is tied by a moment's extra pressure on the handles.

Among other instruments in universal use are divers forms of retractors, for holding gently the edges of a wound: the larger patterns are made with broad, slightly-concave, highly-polished surfaces, that they may, so far as possible, reflect light into the wound. Among tourniquets, the old and elaborate Petit's tourniquet, which was a band carrying a pad screwed down over the main artery of the limb, has given place to the elastic tourniquet with Esmarch's bandage. For example, in an amputation, or in an operation on a joint or on a vessel or a nerve in a limb, the limb is

Fig. 6.—Tourniquet (Esmarch's).

raised, and the Esmarch's elastic bandage is applied from below upward till it has reached a point well above the site of the operation; then an elastic tourniquet is wound round the limb at this point, the bandage is removed, and the limb is thus kept almost bloodless during the operation.

Fig. 7.—Lithotrite (Bigelow's).

It is not possible to describe here the many forms of other ordinary instruments of general surgery—probes, directors, scissors, forceps, and many more—nor those that are used in operations on the bones. Nor again can the numerous instruments used in special departments of surgery be discussed in detail. But, with regard to the special

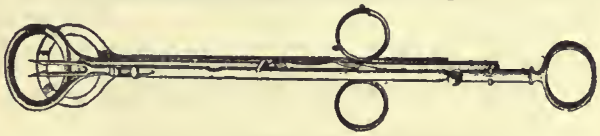

Fig. 8.—Tonsillotome (Mathieu's).

surgery of the eye, and of the throat and ear, it is to be noted that the chief advance in treatment arose from the invention of the present instruments of diagnosis, and that these are of comparatively recent date. The *opthalmoscope* was the work of Helmholtz. The *laryngoscope* was invented by Manuel Garcia in the middle of the

Fig. 9.—Ophthalmoscope (Landolt's).

19th century; and the use of a *frontal mirror*, for focussing a strong light on the membrana tympani, in the examination of the ear, was in use somewhat earlier. Before the ophthalmoscope it was impossible to study the internal diseases of the eye; before the laryngoscope the diseases of the larynx were invisible, and were mainly a matter of guess-work, and of vague and often futile treatment. Before the use of the frontal mirror the diseases of the ear were hardly studied, in that sense in which they are studied now. The wonderful advance of the special departments of surgery was, of course, the result of many forces, but one of the chief of these

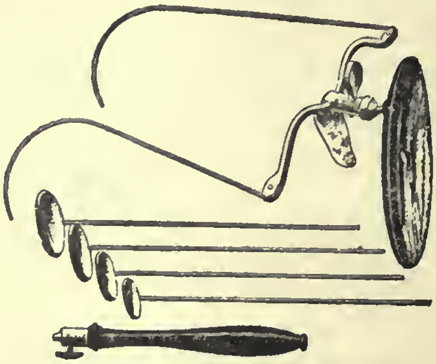

Fig. 10.—Laryngoscope (Lennox Browne's).

forces was the invention of proper instruments of diagnosis. The textbooks that were written immediately before those instruments became available were not far in advance of Ambroise Paré, so far as these special departments are concerned.

It may be well next to consider in what ways the conduct of an operation is influenced by those two great discoveries of anaesthetics, and the more gradual development of the principles of antiseptic and aseptic surgery; with special reference to the use of the instruments of surgery. The jubilee year of anaesthesia was 1896; the first use of nitrous oxide was on the 11th of December 1844; the first operation under ether was on the 30th of September 1846; the first use of chloroform was on the 4th of November 1847. The choice of the anaesthetic, or of some combination of anaesthetics, that is best suited to each particular case, is a matter of careful consideration; but, on the whole, the tendency in England is to keep to the *via media* between the more general use of chloroform in Scotland and the more general use of ether in the United States. Of the methods of administering chloroform there is no need to say much; by some

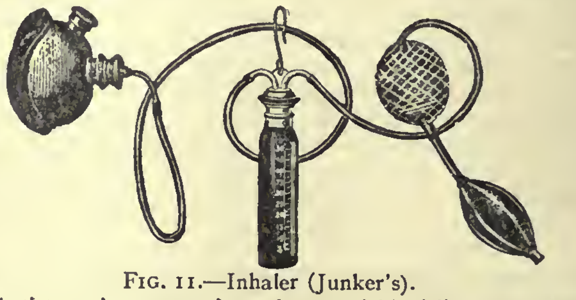

Fig. 11.—Inhaler (Junker's).

anaesthetists no instrument is used save a fold of lint or some such stuff, or a piece of flannel made into a sort of cone or mask. Use is generally made of a modification of "Junker's inhaler," whereby the vapour of chloroform is administered by means of a hand-ball. For the administration of ether some form of Clover's inhaler is generally used, whereby the ether in a small metal chamber passes as vapour into an indiarubber bag, and there is combined with the patient's breath in proportions determined by the anaesthetist throughout the operation. The metal chamber is so designed that by turning it the exact proportion of ether to air is fixed in accordance with the requirements of the case. Of late years, by the use of an iron cylinder of nitrous oxide, connected by a tube with a Clover's inhaler, it is possible to begin with nitrous oxide, and to go on, without interruption, with ether. More recently an admirable method has been devised of administering nitrous oxide with the admixture of air or of oxygen in such a way that the anaesthesia produced by the gas may be maintained for time enough to allow of an operation of some length.

Fig. 12.—Gas and Ether Apparatus (Hewitt's).

The series of discoveries which, in its application to surgery, has brought about the present antiseptic and aseptic methods of operation, is concerned both with the shape or use of the instruments of surgery and with their preparation for use. The mere sterilization, by boiling or by steaming, of all instruments and dressings, is enough to ensure their freedom from the ordinary micro-organisms of suppuration; but the surgeon cannot boil or steam either himself or his patient. The preparation, therefore, of the surgeon's hands, and of the skin over the area of operation, is made not only by scrubbing with soap and hot water, but by careful use of antiseptic lotions. Again, ligatures and sutures, which must be kept in stock ready for use, are kept, after careful sterilization, in antiseptic lotion, or are again sterilized immediately before an operation. Again, all towels used at an operation must be prepared, either by sterilization or by immersion in antiseptic lotion.

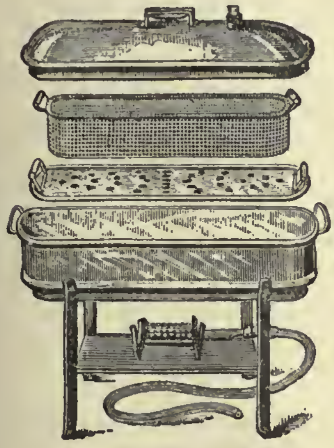

Fig. 13—Instrument Sterilizer.

The sterilization of all instruments and dressings is a simple matter: the usual sterilizer is a vessel like a fish-kettle, with a perforated metal tray in it, so that the instruments can be immersed in boiling water, and can be lifted on the tray and transferred straight from the sterilizer into vessels containing sterilized water or antiseptic lotion. For the sterilization of dressings an upper vessel is fitted to the sterilizer, so that the steam may permeate the dressings placed in it. In hospital practice it is used also to sterilize all towels, aprons and the like in a large cylindrical vessel. Sterilization by boiling or steaming, together with the use of antiseptic lotions, or of water that has been boiled, for all such things as cannot be boiled or steamed, is the essential principle of the surgery of the present day; and practically the antiseptic method and the aseptic method have become one, varying a little this way or that according to the nature and circumstances of the case.

Beside anaesthetics and antiseptics, there is a third series of discoveries that has profoundly influenced surgery—the use of the forces of electricity. The uses of electricity are fivefold.

1. *The Galvano-Cautery.*—The original form of the cautery, the *fer ardent* of Paré's time, for the arrest of haemorrhage after amputation, was a terrible affair. Happily for mankind, his invention of the ligature put an end to this use of the cautery, but it was still used in a small number of other cases. Subsequently Claude André Paquelin (b. 1836) invented a very ingenious form of cautery, a series of metal blades or points of different shapes and sizes, that could be fitted to a handle: these points were hollow inside, and were filled with fine platinum gauze, and, by means of a bottle and hand-bellows, they could be kept heated with benzene-vapour. Thus, when they had once been raised to a glowing heat by holding them over a spirit-lamp, they could be kept at any desired heat. This instrument is still in use for a few cases where very rapid and extensive cauterization is necessary. But for all finer use of actual heat the galvano-cautery alone is used—a series of very minute points of platinum, with a suitable trigger-handle, connected with a battery or (by means of a converter) with the ordinary house supply of electricity. In this way it is possible to apply a glowing point with a fineness and accuracy of adjustment that were wholly impossible with Paquelin's cautery.

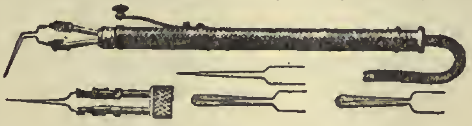

Fig. 14.—Galvano-cautery Set.

2. *Electrolysis.*—This method is of great value, in suitable cases, for the arrest or obliteration of small growths. The passage of the electric current between needles introduced into or under the skin brings about a gradual shrinking or cicatrization of the tissues subjected to it, without the production of any unsightly scar.

Fig. 15.—Electrolysis Needle-holders.

3. *Electro-Motor Power.*—During recent years the use of a small electro-motor machine has come into the practice of surgery for certain operations on the bones; especially for the operation for disease involving the mastoid bone. It is, of course, a better method for the use of a fine drill or burr, for example, than the "dental engine," where the power is generated by a pedal turning a wheel, and it will probably come into wide use both for dental surgery and for those operations of general surgery that require very gradual and delicate removal of small circumscribed areas of bone, especially of the cranial bones.

4. *The X-Rays.*—This, the most unexpected and, as it were, the most sensational discovery that has been bestowed on physicians and surgeons since the discovery of anaesthetics, is now used over a very wide and varied field of practice. Its value does not stop at the detection and localization of foreign bodies; indeed, this is but a small part of its work. It is used constantly for cases of actual or suspected fracture or dislocation; for cases of congenital or acquired

Fig. 16.—Cystoscope (Nitze's).

deformity; for cases involving difficulties of diagnosis between a swelling of the bone due to inflammation and a swelling due to a tumour; and for obscure cases of spinal disease, hip disease and the like. Moreover, it has been found possible, by Dr Hugh Walsham, and others to obtain pictures of the thoracic organs that are a very valuable guide in many obscure cases of disease of the lungs or of the pleura, and in many cases of thoracic aneurism or of intra-thoracic tumour. Every year the number and the range of the cases where the X-rays are helpful for diagnosis and for treatment become greater; and it is impossible to say at what point the surgical value of this discovery will find its limits. Beyond these uses, it is probable that the X-rays will maintain and extend the importance that they already have in the direct treatment of certain cases of disease of the skin (see X-Ray Treatment).

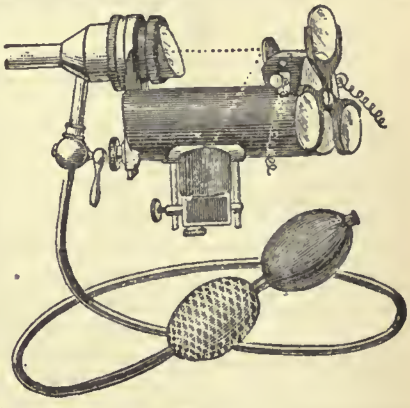

Fig. 17.—Urethroscope (Fenwick's), also used for ear, nose, throat, &c.

5. *The Electric Light.*—Beside the general superiority of this light to other lights for the routine work of surgery, there are several special uses for it. Of these, the most important is the *cystoscope*, a long narrow tube, shaped and curved somewhat like a catheter, and having at its end a very minute glow-lamp and reflector, and a small window. Its other end is fitted with a lens, and is connected by a switch with the main current. With this instrument, in skilled hands, it is possible to inspect the interior of the bladder, and in many cases to make an exact diagnosis under circumstances where otherwise it would be impossible. Another instance of the value of the electric lamp in diagnosis is given by the trans-illumination of the facial bones in cases of suspected disease of the central cavity of the superior maxillary bone. A small glow-lamp is held in the closed mouth, in a darkened room, and by a comparison of the shadows on the two sides of the face, thus trans-illuminated, an exact diagnosis can often be obtained as to the presence or absence of pus in this central cavity. Again, a small glow-lamp, duly sterilized, is often of great value in deep operations on the abdominal cavity.

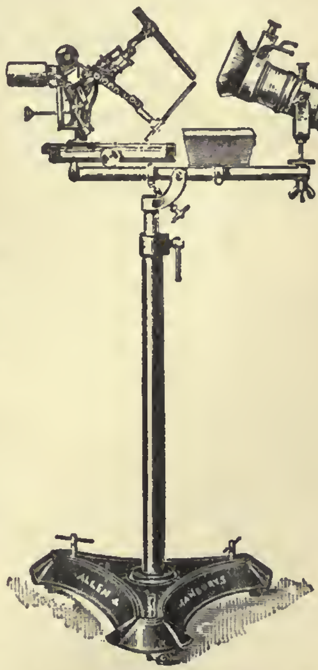

Fig. 18.—Finsen-Reyn Lamp.

The bactericidal properties of light have long been demonstrated by Bie and others. Professor Niels Finsen of Copenhagen first used the ultra-violet rays of solar light in the treatment of skin diseases.

notably of lupus. He later invented the lamp which bears his name. The original Finsen lamp comprised a voltaic arc of 60 to 80 amperes round which four tubes collected the light by quartz lenses, the light being cooled by passing through water and the tubes being surrounded by a water-jacket. The usual exposure was one hour. In the Finsen-Reyn modification now used, a single collecting tube fitted on an adjustable stand is placed in front of a scissors arc lamp consuming 20 amperes. The rays are cooled and water-jacketed as in the original. A suitable quartz compressor with a chamber containing circulating water is pressed upon the skin of the part to be treated and held at right angles to the impinging rays. The time of exposure is now reduced to forty-five minutes.

Radium when used in surgery is applied by means of applicators, either having the fixed salts on square or oblong metallic plates or cloths or by applicators having free radium in sealed metal tubes. These tubes are sometimes buried in the tissues. Sometimes a method of "screening" is adopted in order to modify the intensity of the radiation. This is done by enveloping the tubes containing

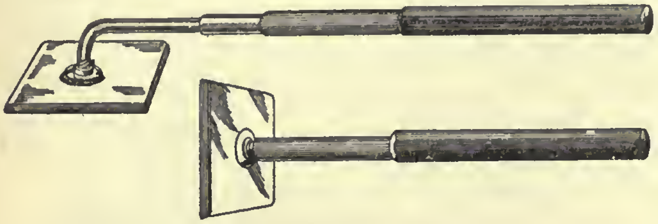

Fig. 19.—Radium Applicators.

the radium in cases of silver, lead or nickel of various thicknesses. In this, known as the method of Dr Dominici, the α and β rays are intercepted by the metal screens and the highly penetrative rays only applied to the morbid tissues.

The illustrations in this article are by permission of Messrs Allen & Hanbury, London, and that of the radium applicators by permission of Messrs Siemens Brothers, London.

SURICATE, or Meerkat (*Suricata tetradactyla*), a small South African mammal of the civet family, ranging from Cape Colony to Algoa Bay. The head and body are about 14 in. long, and the tail half as much; the fur is long and soft, light grizzled grey in colour, and banded with black on the lower part of the back. Meerkats are sociable animals, living in holes in the rocks on the mountains, and burrowing in the sandy soil of the plains. They form amusing pets, and in a wild state, writes Mrs A. Martin, they feed chiefly on "succulent bulbs, which they scratch up with the long, curved, black claws on their fore-feet. They are devoted sun-worshippers and in the early morning, before it is daylight, they emerge from their burrows and wait in rows till their divinity appears, when they bask joyfully in his beams."

SURINAM TOAD (*Pipa americana*), an aglossal tailless Batrachian, rendered famous by its mode of reproduction, first observed in 1710 by the Dutch anatomist F. Ruisch. It inhabits South America east of the Andes and north of the Amazons, and is thoroughly aquatic. In its extremely flattened head it is paralleled by two other vertebrates only, which, curiously, inhabit the same parts of South America, viz. the Silurid fish *Aspredo batrachus* and the Chelonian *Chelys matamata*; the end of the snout and the angles of the jaws bear several lappets, the fingers terminate in a star-shaped appendage, the toes are very broadly webbed and the eyes are minute and without lids.

The eggs are carried on the back by the mother, and the skin thickens and grows round the eggs until each is enclosed in a dermal cell, which is finally covered by a horny lid, believed to be formed by a secretion of the skin or else to represent the remains of the gelatinous capsule which at first surrounded the eggs. These, which may number about one hundred and measure five to seven millimetres in diameter, develop entirely within these pouches, and the young hop out in the perfect condition, without a vestige of a tail. Pairing takes place in the water, the male clasping the female round the waist. The way in which the eggs reach the back of the female has been observed in specimens kept in the London Zoological Gardens. During oviposition the cloaca projects from the vent as a bladder-like pouch, which is inverted forwards, between the back of the female and the breast of the male, and by means of this ovipositor the eggs are evenly distributed over the whole back How the eggs are fertilized has not been ascertained.

Authorities.—G. Grönberg and A. von Klinckowström, "Zur Anatomie der Pipa americana," *Zool. Jahrb. Anat.* vii. 609; A. D. Bartlett, "Note on the Breeding of the Surinam Water Toad," *Proc. Zool. Soc.* (1896), p. 595.

SURMA, or Barak, a river of Assam, India. It is one of the two chief rivers of the province, watering the southern valley as the Brahmaputra waters the northern and larger valley. It rises in the Barail range to the north of Manipur, its sources being among the southern spurs of Japvo. Thence its course is south with a slight westerly bearing, through the Manipur hills to British territory. The name of Barak is given to the upper part of the river, in Manipur and Cachar. A short distance below Badarpur in Cachar it divides into two branches. One of these, which passes Sylhet, is called Surma. The other is called Kusiara till it subdivides into (*a*) a branch called Bibiana or Kalni, which joins the Surma near Ajmiriganj, and (*b*) a branch which resumes the name of Barak and joins the Surma near Habiganj. At Bhairab Bazar in Mymensingh the Surma unites with the old Brahmaputra and becomes known as the Meghna. The river is navigable by steamers as far as Silchar in the rains. Total length about 560 m.

The Surma Valley and Hill Districts Division is a division of the province of Eastern Bengal and Assam. It includes the five districts of Sylhet Cachar, Lushai hills, Naga hills, and Khasi and Jaintia hills, with a total area of 25,481 sq. m. and a population in 1901 of 3,084,527.

SURPLICE (Late Lat. *superpelliceum*; Fr. *super*, over, and *pellis*, fur; Span. *sobrepellice*; Fr. *surplis*; in Ital. *cotta* and Ger. *Chorrock*, choir coat), a liturgical vestment of the Christian Church. It is a tunic of white linen or cotton material, with wide or moderately wide sleeves, reaching—according to the Roman use—barely to the hips and elsewhere in the churches of the Roman communion to the knee. It is usually decorated with lace, but in modern times—in Germany at least—also with embroidered bordures. The surplice originally reached to the feet, but as early as the 13th century it began to be shortened, though as late as the 15th century it still fell to the middle of the shin, and it was not till the 17th and 18th centuries that it was considerably shortened. More drastic were other modifications which it underwent in course of time in several localities, which led to the appearance of various subsidiary forms alongside of the original type. Such were the sleeveless surplice, which was provided at the sides with holes to put the arms through; the surplice with slit-up arms or lappels (so-called "wings") instead of sleeves; the surplice of which not only the sleeves but the body of the garment itself were slit up the sides, precisely like the modern dalmatic; and, finally, a sort of surplice in the form of a bell-shaped mantle, with a hole for the head, which necessitated the arms being stuck out under the hem. The first two of these forms were very early developed; and, in spite of their prohibition by synods here and there (*e.g.* that of Liége in 1287), they survive in various places to the present day. The latter two only appeared after the close of the middle ages: the first of them in South Germany, the second more especially in Venetia, where its use is attested by numerous pictorial records. As a rule, however, these subsidiary forms of surplice were worn mostly by the lower clergy. They were the result partly of the influence of the secular fashions, but more particularly of considerations of convenience.

The surplice belongs to the *vestes sacrae*, though it requires no benediction. It is proper to all clerics, even to those who have only received the tonsure, the bishop himself vesting with it those who have been newly tonsured by him. Its use in divine service is very varied. It is worn in choir at the solemn offices; it is the official sacral dress of the lower clergy in their liturgical functions; it is worn by the priest when administering the sacraments, undertaking benedictions, and the like; the use of the alb being nowadays almost exclusively confined to the mass and functions connected with this. In general it may be said that this was, in all main particulars, the custom so early as the 14th century.

The older history of the surplice is obscured by lack of exact information. Its name is derived, as Durandus and Gerland also affirm, from the fact that it was formerly put on over the fur garments which used to be worn in church and at divine service as a protection against the cold. It has been maintained that the surplice was known in the 5th century, the evidence being the garments worn by the two clerics in attendance on Bishop Maximian represented in the mosaics of S. Vitale at Ravenna; in this case, however, the dalmatic has been confused with the surplice. In all probability the surplice is no more than an expansion of the ordinary liturgical alb, due to the necessity for wearing it over thick furs. It is first mentioned in the 11th century, in a canon of the synod of Coyaca in Spain (1050) and in an ordinance of King Edward the Confessor. In Rome it was known at least as early as the 12th century. It probably originated outside Rome, and was imported thence into the Roman use. Originally only a choir vestment and peculiar to lower clergy, it gradually—certainly no later than the 13th century—replaced the alb as the vestment proper to the administering of the sacraments and other sacerdotal functions.

In the Oriental rites there is no surplice, nor any analogous vestment. Of the non-Roman Churches in the West the surplice has continued in regular use only in the Lutheran churches of Denmark, Norway and Sweden, and in the Church of England (see below). (J. Bra.)

Church of England.—The surplice was prescribed by the second Prayer-Book of Edward VI., as, with the tippet or the academical hood, the sole vestment of the minister of the church at "all times of their ministration," the rochet being practically regarded as the episcopal surplice. Its use was furiously assailed by the extremer Reformers but, in spite of their efforts, was retained by Elizabeth's Act of Uniformity, and enforced by the advertisements and injunctions issued under her authority, which ordered the "massing vestments"—chasubles, albs, stoles and the like—to be destroyed. It has since remained, with the exception of the cope (*q.v.*), the sole vestment authorized by law for the ministers, other than bishops, of the Church of England (for the question of the vestments prescribed by the "Ornaments Rubric" see Vestments). Its use has never been confined to clerks in holy orders, and it has been worn since the Reformation by all the "ministers" (including vicars-choral and choristers) of cathedral and collegiate churches, as well as by the fellows and scholars of colleges in chapel. The distinctive mark of the clergy (at least of the more dignified) has been the tippet or scarf above mentioned, a broad band of black silk worn stole-wise, but not to be confused with the stole, since it has no liturgical significance and was originally no more than part of the clerical outdoor dress (see Stole). The surplice was formerly only worn by the clergy when conducting the service, being exchanged during the sermon for the "black gown," *i.e.* either a Geneva gown or the gown of an academical degree. This custom has, however, as a result of the High Church movement, fallen almost completely obsolete. The "black gown," considered wrongly as the ensign of Low Church views, survives in comparatively few of even "evangelical" churches; it is still, however, the custom for preachers of university sermons to wear the gown of their degree.

The traditional form of the surplice in the Church of England is that which survived from pre-Reformation times, viz. a wide-sleeved, very full, plain, white linen tunic, pleated from the yoke, and reaching almost, or quite, to the feet. Towards the end of the 17th century, when large wigs came into fashion, it came for convenience to be constructed gown-wise, open down the front and buttoned at the neck, a fashion which still partially survives, notably at the universities. In general, however, the tendency has been, under continental influence, to curtail its proportions. The ample vestment with beautiful falling folds has thus in many churches given place to a scanty, unpleated garment scarce reaching to the knee. In the more "extreme" churches the surplices are frank imitations of the Roman *cotta.* (W. A. P.)

SURRENDER, in law, a mode of alienation of real estate. It is defined by Lord Coke to be "the yielding up of an estate for life or years to him that hath an immediate estate in reversion or remainder" (Coke upon Littleton, 337 b). It is the converse of release, which is a conveyance by the reversioner or remainderman to the tenant of the particular estate. A surrender is the usual means of effecting the alienation of copyholds. The surrender is made to the lord, who grants admittance to the purchaser, an entry of the surrender and admittance being made upon the court rolls. Formerly a devise of copyholds could only have been made by surrender to the use of the testator's will followed by admittance of the devisee. The Wills Act of 1837 now allows the devisee of copyholds without surrender, though admittance of the devisee is still necessary. A surrender must, since the Real Property Act 1845, be by deed, except in the case of copyholds and of surrender by operation of law. Surrender of the latter kind generally takes place by merger, that is, the combination of the greater and less estate by descent or other means without the act of the party (see Remainder). In Scots law surrender in the case of a lease is represented by renunciation. The nearest approach to surrender of a copyhold is resignation *in remanentiam* (to the lord) or resignation *in favorem* (to a purchaser). These modes of conveyance were practically superseded by the simpler forms introduced by the Conveyancing Act 1874.

SURRENTUM (mod. *Sorrento*, *q.v.*), an ancient town of Campania, Italy, situated on the N. side of the promontory which forms the S.E. extremity of the Bay of Naples. The legends indicate a close connexion between Lipara and Surrentum, as though the latter had been a colony of the former; and even through the Imperial period Surrentum remained largely Greek. Before the Roman supremacy it was one of the towns subject to Nuceria, and shared its fortunes up to the Social War; it seems to have joined in the revolt of 90 B.C. like Stabiae; and was reduced to obedience in the following year, when it seems to have received a colony. Its prosperity dates from the imperial period, when Capreae was a favourite residence of Augustus and Tiberius. Numerous sepulchral inscriptions of Imperial slaves and freedmen have been found at Surrentum. An inscription shows that Titus in the year after the earthquake of A.D. 79 restored the *horologium* of the town and its architectural decoration. A similar restoration of an unknown building in Naples in the same year is recorded in an inscription from the last-named town (cf. A. Sogliano in *Notizie degli Scavi*, 1901, p. 363). The most important temples of Surrentum were those of Athena and of the Sirens (the latter the only one in the Greek world in historic times); the former gave its name to the promontory. In antiquity Surrentum was famous for its wine (oranges and lemons which are now so much cultivated there not having been introduced into Italy in antiquity), its fish, and its red Campanian vases; the discovery of coins of Massilia, Gaul and the Balearic Islands here indicates the extensive trade which it carried on. The position of Surrentum was very secure, it being protected by deep gorges, except for a distance of 300 yds. on the south-west where it was defended by walls, the line of which is necessarily followed by those of the modern town. The arrangement of the modern streets preserves that of the ancient town, and the disposition of the walled paths which divide the plain to the east seems to date in like manner from Roman times. No ruins are now preserved in the town itself, but there are many remains in the villa quarter to the east of the town on the road to Stabiae, of which traces still exist, running much higher than the modern road, across the mountain; the site of one of the largest (possibly belonging to the Imperial house) is now occupied by the Hotel Victoria, under the terrace of which a small theatre was found in 1855; an ancient rock-cut tunnel descends hence to the shore. Remains of other villas may be seen, but the most important ruin is the reservoir of the (subterranean) aqueducts just outside the town on the east, which had no less than twenty-seven chambers each about 90 ft. by 20 ft. Greek and Oscan tombs have also been found. Another suburb lay below the town and on the promontory on the west of it; under the Hotel Sirena are substructions and a rock-hewn tunnel. To the north-west on the Capo di Sorrento is another villa, the so-called Bagni della Regina Giovanna, with baths, and in the bay to the south-west was the villa of Pollius Felix, the friend of Statius, which he describes in *Silvae* ii. 2, of which remains still exist. Farther west again are villas, as far as the temple of Athena on the promontory named after her at the extremity of the peninsula (now Punta Campanella). Neither of this nor of the famous temple of the Sirens are any traces existing.

See J. Beloch, *Campanien*, p. 252 sqq. (2nd ed., Breslau, 1890). (T. As.)

SURREY, EARLDOM OF. There is some doubt as to when this earldom was created, but it is unquestionably of early origin. A Norman count, William de Warenne (*c.* 1030–1088), is generally regarded as its first holder and is thought to have been made an earl by William II. about 1088. William and his successors were styled earls of Surrey or Earls Warenne indifferently, and the family became extinct when William, the 3rd earl, died in 1148. The second family to hold the earldom of Surrey was descended from Isabel de Warenne (d. 1199), daughter and heiress of Earl William, and her second husband Hamelin Plantagenet (d. 1202), an illegitimate half-brother of King Henry II. Hamelin took the name of Warenne and was recognized as earl of Surrey or Earl Warenne, and his descendants held the earldom until Earl John died without legitimate issue in 1347.

The earldom and estates of the Warennes now passed to John's nephew, Richard Fitzalan, earl of Arundel (*c.* 1307–1376), being forfeited when Richard's son, Richard, was beheaded for treason in 1397. Then for about two years there was a duke of Surrey, the title being borne by Thomas Holand, earl of Kent (1374–1400), from 1397 until his degradation in 1399. In 1400 Richard Fitzalan's son, Sir Thomas Fitzalan (1381–1415), was restored to his father's honours and became earl of Arundel and earl of Surrey, but the latter earldom reverted to the Crown when he died. In 1451 John Mowbray (1444–1476), afterwards duke of Norfolk, was created earl of Surrey, but the title became extinct on his death.

The long connexion of the Howards with the earldom of Surrey began in 1483 when Thomas Howard, afterwards duke of Norfolk, was created earl of Surrey. Since that time, with the exception of brief periods when some of its holders were under attainder, the title has been borne by the duke of Norfolk. The courtesy title of the duke's eldest son is earl of Surrey.

See the articles WARENNE, EARLS; and ARUNDEL, EARLS OF; also G. E. C.(okayne), *Complete Peerage*, vol. vii. (1896).

SURREY, HENRY HOWARD, EARL OF (1518?–1547), English poet, son of Lord Thomas Howard, afterwards 3rd duke of Norfolk, and his wife Elizabeth Stafford, daughter of the duke of Buckingham, was born probably in 1518.[1] He succeeded to the courtesy title of earl of Surrey in 1524, when his father became duke of Norfolk. His early years were spent in the various houses belonging to the Howards, chiefly at Kenninghall, Norfolk. He had as tutor John Clerke, who, beside instructing him in the classics, inculcated a great admiration for Italian literature. The duke of Norfolk was proud of his son's attainments (Chapuys to the emperor, December 9, 1529). The duke was governor of Henry Fitzroy, duke of Richmond, the natural son of Henry VIII. and Elizabeth Blount. Surrey was a little more than a year older than Fitzroy, and became his companion and friend. Fitzroy was at Windsor from 1530 to 1532, and it must be to these years that Surrey refers in the lines written in prison at Windsor, "where I, in lust and joy, with a king's son, my childish years did pass." Anne Boleyn tried to arrange a marriage between the princess Mary and her kinsman, Surrey. The Spanish ambassador, in the hope of detaching the duke of Norfolk's interest from Anne Boleyn in favour of Catherine of Aragon, seems to have been inclined to favour the project; but Anne changed her mind, and as early as October 1530 arranged a marriage for Surrey with Lady Frances de Vere, daughter of the 15th earl of Oxford. This was concluded at the earliest possible date, in February 1532, but in consequence of the extreme youth of the contracting parties, Frances did not join her husband until 1535. In October Surrey accompanied Henry VIII. to Boulogne to meet Francis I., and, rejoining the duke of Richmond at Calais, he proceeded with him to the French court, where the two Englishmen were lodged with the French royal princes. Surrey created for himself a reputation for wisdom, soberness and good learning, which seems curious in view of the events of his later life. Meanwhile in spite of his marriage with Frances de Vere, the project of a contract between him and the princess Mary was revived in a correspondence between Pope Clement VII. and the emperor Charles V., but definitely rejected by the latter. Surrey only returned to England in the autumn of 1533, when the duke of Richmond was recalled to marry his friend's sister, Mary Howard. Surrey made his home at his father's house of Kenninghall, and here was a witness of the final separation between his parents, due to the duke's relations with Elizabeth Holland, who had been employed in the Howards' nursery. Surrey took his father's side in the family disputes, and remained at Kenninghall, where his wife joined him in 1535. In May 1536 he filled his father's functions of earl marshal at the trial of his cousins Anne Boleyn and Lord Rochford. In the autumn of that year he took part with his father in the bloodless campaign against the rebels in Yorkshire and Lincolnshire, in the "Pilgrimage of Grace." Although he had supported the royal cause, insinuations were made that he secretly favoured the insurgents. Hasty in temper, and by no means friendly to the Seymour faction at court, he struck a man who repeated the accusation in the park at Hampton Court. For breaking the peace in the king's domain he was arrested (1537), but thanks to Cromwell, who had yielded to the petition of the young man's father, he was not compelled to appear before the privy council, but was merely sent to reside for a time at Windsor. During this imprisonment and the subsequent retirement at Kenninghall, he had leisure to devote himself to poetry. In 1539 he was again received into favour. In May 1540 he was one of the champions in the jousts celebrated at court. The fall of Thomas Cromwell a month later increased the power of the Howards, and in August Henry VIII. married Surrey's cousin, Catherine Howard. Surrey was knighted early in 1541, and soon after he received the order of the Garter, was made chancellor of the duchy of Lancaster, and, in conjunction with his father, grand seneschal of the university of Cambridge. He apparently preserved the royal favour after the execution of Catherine Howard (at which he was present), for in December 1541 he received the grant of certain manors in Norfolk and Suffolk. In 1542 he was imprisoned in the Fleet for a quarrel with a certain John Leigh, but on appeal to the privy council he was sent to Windsor Castle, and, after being bound over to keep the peace with John Leigh under a penalty of 10,000 marks, he was soon liberated. Shortly after his release he joined his father on the Scottish expedition. They laid waste the country, but retreated before the earl of Huntly, taking no part in the victorious operations that led up to Solway Moss. To this year no doubt belong the poems in memory of Sir Thomas Wyat. His ties with Wyat, who was fifteen years his elder and of opposite politics, seem to have been rather literary than personal. He appears to have entered into closer relations with the younger Wyat. In company with "Mr Wyat," he amused himself by breaking the windows of the citizens of London on the 2nd of February 1543. For this he was accused by the privy council, a second charge being that he had eaten meat in Lent. In prison probably he wrote the satire on the city of London, in which he explains his escapade by a desire to rouse Londoners to a sense of their wickedness. In October he joined the English army co-operating with the imperial forces in Flanders, and on his return in the next month brought with him a letter of high commendation from Charles V. In the campaign of the next year he served as field marshal under his

[1] The only authority for the date of his birth is the legend *Sat. superest. Aetatis XXIX.* on a portrait of Henry Howard at Arundel Castle.

father, and took part in the unsuccessful siege of Montreuil. In August 1545 he was sent to the relief of Edward Poynings, then in command of Boulogne, and was made lieutenant-general of the English possessions on the Continent and governor of Boulogne. Here he gained considerable successes, and insisted on the retention of the town in spite of the desire of the privy council that it should be surrendered to France. A reverse on the 7th of January at St Étienne was followed by a period of inaction, and in March Surrey was recalled.

Surrey had always been an enemy to the Seymours, whom he regarded as upstarts, and when his sister, the duchess of Richmond, seemed disposed to accept a marriage with Sir Thomas Seymour, he wrote to her insinuating that this was a step towards becoming the mistress of Henry VIII. By his action in thwarting this plan he increased the enmity of the Seymours and added his sister to the already long list of the enemies which he had made by his haughty manner and brutal frankness. He was now accused of quartering with his own the arms of Edward the Confessor, a proceeding which, it was alleged, was only permissible for the heir to the crown. The details of this accusation were false; moreover, Surrey had long quartered the royal arms with his own without offence. The charge was a pretext covering graver suspicions. Surrey had asserted in the presence of a certain George Blage, who was inclined to the reforming movement, that on Henry's death, his father, the duke of Norfolk, as the premier duke in England, had the obvious right of acting as regent to Prince Edward. He also boasted of what he would do when his father had attained that position. All of this was construed into a plot on the part of his father and himself to murder the king and the prince. The duke of Norfolk and his son were sent to the Tower on the 12th of December 1546. Every effort was made to secure evidence. The duchess of Richmond was one of the witnesses (see her depositions in Herbert of Cherbury, *Life and Reign of Henry VIII.*, 1649) against her brother, but her statements were too doubtful to add anything to the formal indictment. On the 13th of January 1547 Surrey defended himself at the guildhall on the charge of high treason for having illegally made use of the arms of Edward the Confessor, before judges selected for their known hatred of himself. He was condemned by a jury, packed for the occasion, to be hanged, drawn and quartered at Tyburn. This sentence was not carried out. Surrey was beheaded on Tower Hill on the 19th of the month, and was buried in the church of All Saints, Barking. His remains were afterwards removed by his son the earl of Northampton to Framlingham, Suffolk. His father, who was charged with complicity in his son's crime, was, as a peer of the realm, not amenable to a common jury. The consequent delay saved his life. He was imprisoned during the whole of the reign of Edward VI., but on Mary's accession he was set free, by an act which also assured the right of the Howards, as descendants of the Mowbray family, to bear the arms of the Confessor.

Surrey's name has been long connected with the "Fair Geraldine," to whom his love poems were supposed to be addressed. The story is founded on the romantic fiction of Thomas Nashe, *The Unfortunate Traveller, or Life of Jack Wilton* (1594), according to which Surrey saw in a magic glass in the Netherlands the face of Geraldine, and then travelled throughout Europe challenging all comers to deny in full field the charms of the lady. At Florence he held a tournament in her honour, and was to do the same in other Italian cities when he was recalled by order of Henry VIII. The legend, deprived of its more glaring discrepancies with Surrey's life, was revived in Michael Drayton's *Englands Heroicall Epistles* (1598). Geraldine was the daughter of the earl of Kildare, Lady Elizabeth Fitzgerald, who was brought up at the English court in company with the princess Elizabeth (see James Graves, a *Brief Memoir of Lady Elizabeth Fitzgerald*, 1874). She was ten years old when in 1537 Surrey addressed to her the sonnet "From Tuskane came my ladies worthy race," and nothing more than a passing admiration of the child and an imaginative anticipation of her beauty can be attributed to Surrey. "A Song . . . to a ladie that refused to daunce with him," is addressed to Lady Hertford, wife of his bitter enemy, and the two poems, "O happy dames" and "Good ladies, ye that have your pleasures in exile," are addressed to his wife, to whom, at any rate in his later years, he seems to have been sincerely attached.

His poems, which were the occupation of the leisure moments of his short and crowded life, were first printed in *Songs and Sonettes written by the ryght honorable Lorde Henry Howard late Earle of Surrey, and other* (apud Richardum Tottel, 1557). A second edition followed in July 1557, and others in 1559, 1565, 1567, 1574, 1585 and 1587. Although Surrey's name, probably because of his rank, stands first on the title-page, Wyat was the earlier in point of time of Henry's "courtly makers." Surrey, indeed, expressly acknowledges Wyat as his master in poetry. As their poems appeared in one volume, long after the death of both, their names will always be closely associated. Wyat possessed strong individuality, which found expression in rugged, forceful verse. Surrey's contributions are distinguished by their impetuous eloquence and sweetness. He revived the principles of Chaucer's versification, which his predecessors had failed to grasp, perhaps because the value of the final *e* was lost. He introduced new smoothness and fluency into English verse. He never allowed the accent to fall on a weak syllable, nor did he permit weak syllables as rhymes. His chief innovation as a metrician lies outside the *Miscellany*. His translation of the second and fourth books of the *Aeneid* into blank verse—the first attempt at blank verse in English—was published separately by Tottel in the same year with the title of *Certain Bokes of Virgiles Aeneis turned into English meter*. It has been suggested that in this matter Surrey was influenced by the translation of Virgil published at Venice by Ippolito de' Medici in 1541, but there is no direct evidence that such was the case. His sonnets are in various schemes of verse, and are less correct in form and more loosely constructed than those of Wyat. They commonly consist of three quatrains with independent rhymes, terminating with a rhyming couplet. But his sonnets, his elegy on the death of Wyat, his lover's complaint cast in pastoral form, and his lyrics in various measures, served as models to more than one generation of court poets. Both in form and substance Surrey and his fellow poets were largely indebted to Italian predecessors; most of his poems are in fact adaptations from Italian originals. The tone of the love sentiment was new in English poetry, very different in its earnestness, passion and fantastic extravagance from the lightness and gaiety of the Chaucerian school.

See Professor E. Arber's reprint of *Songs and Sonettes* (*English Reprints*, 1870); the Roxburghe Club reprint of *Certain Bokes of Virgiles Aeneis* (1814); Dr G. F. Nott, *The Works of Henry Howard, Earl of Surrey* (1815); and *The Poetical Works of Henry Howard, Earl of Surrey* (Aldine edition, 1866). The best account of Surrey's life is in Edmond Bapst's *Deux Gentilhommes-poètes de la cour de Henry VIII.* (1891), which rectifies Dr Nott's memoir in many points. See also Brewer and Gairdner, *Letters and State Papers of Henry VIII.*; Lord Herbert of Cherbury, *Life and Raigne of Kinge Henry the Eighth* (1649); J. A. Froude, *History of England* (chs. xxi. and xxii.); W. J. Courthope, *History of English Poetry* (1897), vol. ii. ch. iii., where the extent and value of Surrey's innovations in English poetry are estimated; F. M. Padelford, *The MS. Poems of Henry Howard, Earl of Surrey* (1906); O. Fest, "Über Surreys Virgilübersetzung," in *Palästra*, vol. xxxiv. (Berlin, 1903).

SURREY, a south-eastern county of England bounded N. by the Thames, separating it from Buckinghamshire and Middlesex, E. by Kent, S. by Sussex, and W. by Hampshire and Berkshire. The administrative county of London bounds that of Surrey (south of the Thames) on the north-east. The area is 758 sq. m. The north Downs are a picturesque line of hills running east and west through the county somewhat south of the centre (see Downs). Leith Hill, south-west of Dorking (965 ft.), is the highest summit, and commands a prospect unrivalled in the south of England; Holmbury Hill close by reaches 857 ft., and the detached summit of Hindhead above Haslemere in the south-west reaches 895 ft. At Guildford the Wey breaches the hills; and at Dorking the Mole. These are the chief rivers of the county; they reach the Thames near Weybridge and at East Molesey respectively. The Wandle is a smaller tributary in the north-east of the county. Surrey is thus almost entirely in the Thames basin. In the south-east it includes headstreams of the Eden, a tributary of the Medway; and in the south a small area drains to the English channel. Three types of scenery appear—that of the hilly southern district; that of the Thames, with its richly-wooded banks; and, in the north-west, that of the sandy heath-covered district, abundant in conifers, which includes the healthy open tracts of Bagshot Heath and other commons, extending into Berkshire and Hampshire. Possessing these varied attractions, Surrey has become practically a great residential district for those who must live in the neighbourhood of London.

Geology.—The northern portion of the county, in the London basin, belongs to the Eocene formation: the lower ground is occupied chiefly by the London Clay of the Lower Eocene, stretching (with interruptions) from London to Farnham; this is fringed on its southern edge by the underlying Woolwich beds of the same group, which also appear in isolated patches at Headley near Leatherhead; and the Thanet Sands at the base crop out between Beddington, Banstead and Leatherhead. The north-western portion of the county, covered chiefly by heath and Scotch fir, belongs to the Upper Eocene, Bagshot Sands: the Fox hills and the bleak Chobham Ridges are formed of the upper series of the group, which rests upon the middle beds occupying the greater part of Bagshot Heath and Bisley and Pirbright commons, while eastwards the commons of Chobham, Woking and Esher belong to the lower division of the group. To the south of the Eocene formations the smooth rounded outlines of the chalk hills extend through the centre of the county from Farnham to Westerham (Kent). From Farnham to Guildford they form a narrow ridge called the Hog's Back, about half a mile in breadth with a higher northern dip, the greatest elevation reached in this section being 505 ft. East of Guildford the northern dip decreases and the outcrop widens, throwing out picturesque summits, frequently partly wooded, and commanding wide and beautiful views over the Weald. The Upper Greensand, locally known as firestone, and quarried and mined for this purpose and for hearthstone near Godstone, crops out underneath the Chalk along the southern escarpment of the Downs. The Gault, a dark blue sandy clay, rests beneath the Upper Greensand in the bottom of the long narrow valley which separates the chalk Downs from the well-marked Lower Greensand hills. The Lower Greensand includes the subordinate divisions known as the Folkestone Sands, exploited near Godstone for commercial purposes; the Sandgate beds, to which the well-known fuller's earth of Nutfield belongs, and the Hythe beds, which contain the Kentish Rag, a sandy glauconitic limestone used for road repairs and building; also a hard, conglomeratic phase of this series locally called Bargate stone. To this formation belong the heights of Leith Hill, Hindhead and the Devil's Punchbowl, Holmbury Hill. Between the Lower Greensand and the Weald Clay is a narrow inconspicuous belt of Atherfield Clay. The Weald Clay itself consists of a blue or brown shaly clay, amid which are deposited river shells, plants of tropical origin and reptilian remains. The lower portion of the Wealden series, the Hastings Sands, occupy a small area in the south-eastern corner of the county. Bordering the Thames there are terraced deposits of gravel and loam.

Agriculture.—Between one-half and three-fifths of the area of the county, a low proportion, is under cultivation, and of this about five-ninths is in permanent pasture. There are considerable varieties of soil, ranging from plastic clay to calcareous earth and bare rocky heath. The plastic clay is well adapted for wheat, but oats are the most largely grown of the decreasing grain crops. A considerable area is occupied by market gardens on the alluvial soil along the banks of the Thames, especially in the vicinity of London. In early times the market gardeners were Flemings, who introduced the culture of asparagus at Battersea and of carrots at Chertsey. Rhododendrons and azaleas are largely grown in the north-western district of the county. In the neighbourhood of Mitcham various medicinal plants are cultivated, such as lavender, mint, camomile, anise, rosemary, liquorice, hyssop, &c. The calcareous soil in the neighbourhood of Farnham is well adapted for hops, but this crop in Surrey is of minor importance. There is a large area under wood. Oak, chestnut, walnut, ash and elm are extensively planted; alder and willow plantations are common; and the Scotch fir propagates naturally from seed on the commons in the north-west. The extent of pasture land is not great, with the exception of the Downs, which are chiefly occupied as sheep-runs. Dairy-farming is a more important industry than cattle-feeding, large quantities of milk being sent to London.

Manufactures and Communications.—The more important manufactures are chiefly confined to London and its immediate neighbourhood. The rivers Mole and Wandle, however, supply power for a variety of manufactures, such as oil, paper and sheet-iron mills. Communications include the navigation of the Thames and Wey, and the Basingstoke canal, communicating with the Wey from Frimley and Woking. Owing to its proximity to London the county is served by many lines of railway, the companies being the London & South-Western, the London Brighton & South Coast and the South-Eastern & Chatham.

Population and Administration.—The area of the ancient county is 485,122 acres, with a population in 1901 of 2,012,744. The population in 1801 was 268,233, and in 1851, 683,082; and it nearly doubled between 1871 and 1901. Under the provisions of the Local Government Act 1888, part of the county was transferred to the county of London. Thus the area of the ancient county, extra-metropolitan, is 461,999 acres, with a population in 1901 of 675,774. The area of the administrative county is 461,807 acres. The county contains 14 hundreds. Croydon (pop. 133,895) is a county borough, and the other municipal boroughs are Godalming (8748), Guildford (15,938), Kingston (34,375), Reigate (25,993), Richmond (31,672), Wimbledon (41,652). The following are urban districts: Barnes (17,821), Carshalton (6746), Caterham (9486), Chertsey (12,762), Dorking (7670), East and West Molesey (6034), Egham (10,187), Epsom (10,915), Esher and The Dittons (9489), Farnham (6124), Frimley (8409), Ham (1460), Leatherhead (4964), The Maldens and Coombe (6233), Surbiton (15,017), Sutton (17,223), Walton-on-Thames (10,329), Weybridge (5329), Woking (16,244). There are six parliamentary divisions—North Western or Chertsey, Mid or Epsom, Kingston, North Eastern or Wimbledon, South Eastern or Reigate, South Western or Guildford; each returning one member. The borough of Croydon returns one member. Surrey is in the south-eastern circuit, and assizes are held at Guildford and Kingston alternately. The administrative county has one court of quarter sessions, and is divided into eleven petty sessional divisions. The boroughs of Croydon, Godalming, Guildford, Kingston, Reigate and Richmond have separate commissions of the peace, and Croydon and Guildford have in addition separate courts of quarter sessions. The central criminal court has jurisdiction over certain parishes adjacent to London. All those civil parishes within the county of Surrey, of which any part is within 12 m. of, or of which no part is more than 15 m. from, Charing Cross, are in the metropolitan police district. The total number of civil parishes is 144. The ancient county contains 230 ecclesiastical parishes or districts, wholly or in part situated in the dioceses of Rochester, Winchester, Canterbury, Oxford and Chichester.

History.—The early history of this district is somewhat uncertain. Ethelwerd, in the Anglo-Saxon Chronicle for 823, places it in the "Medii Angli" or "Medii Saxones." Its position between the Weald and the Thames decided its northern and southern borders, and the Kentish boundary probably dates from the battle of Wibbandune between Ethelbert of Kent and Ceawlin of Wessex, which traditionally took place at Wimbledon, though this is disputed. The western border, like the southern, was a wild uncultivated district; no settled boundary probably existing at the time of the Domesday Survey. The number of hundreds at that time was fourteen as now, but the hundred of Farnham was not so called, the lands of the bishop of Winchester being placed in no hundred, but coinciding with the present hundred of that name. There is no record of Surrey ever having been in any diocese but Winchester, of which it was an archdeaconry in the 12th century. At the time of the Domesday Survey there were four deaneries: Croydon, Southwark, Guildford and Ewell. Croydon was a peculiar of Canterbury, in which diocese it was included in 1291. In the time of Henry VIII., Croydon was comprehended in the deanery of Ewell, some of its rectories being included in the deanery of Southwark. The old deanery of Guildford was included in the modern one of Stoke. In 1877, Southwark, with some parishes, was transferred to the diocese of Rochester. In the 7th century Surrey was under the overlordship of Wulfhere, king of Mercia, who founded Chertsey abbey, but in 823, when the Mercians were defeated by Egbert of Wessex, it was included in the kingdom of Wessex, as the Anglo-Saxon Chronicle relates.

Surrey was constantly overrun by Danish hordes in the 9th century and until peace was established by the accession of Canute. In 857 a great national victory over the Danes took place at Ockley near Leith Hill. Surrey is not of great historical importance, except its northern border, the southern part having been forest and waste land, long uninhabited and almost impassable for an army. Guildford, though the county town, and often the seat of the court under John and Henry III., was of little importance beside Southwark, the centre of trade and commerce, the residence of many ecclesiastical dignitaries, a frequent point of attack on London, and a centre for rebellions and riots. The Norman army traversed and ravaged the county in their march on London, a large portion of the county having been in the hands of Edward and Harold, fell to the share of William himself; his most important tenants in chief being Odo of Bayeux and Richard de Tonebridge, son of Count Gilbert, afterwards "de Clare." The church also had large possessions in the county, the abbey of Chertsey being the largest monastic house. Besides these private jurisdictions, there were the large royal parks and forests, with their special jurisdiction. The shire court was almost certainly held at Guildford, where the gaol for both Sussex and Surrey was from as early as 1202 until 1487, when Sussex had its own gaol at Lewes. The houses of Warenne and de Clare were long the two great rival influences in the county; their seats at Reigate and Blechingley being represented in parliament from the time of Edward I. till the Reform bills of the 19th century. At the time of the Barons' Wars their influence was divided—de Clare marching with Montfort, and de Warenne supporting the king. In the Peasants' Rising of 1381, and during Jack Cade's Rebellion in the next century, Southwark was invaded, the prisons broken open and the bridge into London crossed. London was unsuccessfully attacked from the Surrey side in the Wars of the Roses; and was held for three days and pillaged during a rising of the southern counties under Mary. During the fears of invasions from Spain, levies were held in readiness in Surrey to protect London; and it was an even more important bulwark of London in the Civil War, on account of the powder mills at Chilworth and the cannon foundries of the Weald. In common with the south-eastern district generally, Surrey was parliamentarian in its sympathies. Sir Richard Onslow and Sir Poynings More were the most prominent local leaders. Farnham Castle and Kingston, with its bridge, were several times taken and held during the war by the opposing parties, and in the later part of the war, when the parliament and army were treating, three of the line of forts defending London were on the Surrey side, from which the army entered London.

The last serious skirmish south of the Thames took place near Ewell and Kingston, where the earl of Holland and a body of the Royalists were routed. This was the last real fighting in the county, though it was often a centre of riots; the most serious being those of 1830, and of the Chartists in 1848, who chose Kennington Common as their meeting-place. The Mores of Loseley and the Onslows were among the most famous county families under the Tudors, as at the time of the Civil War; the Onslows being even better known later in the person of Sir Arthur Onslow, Speaker of the House under George I.

The earliest industries in Surrey were agricultural. The stone quarries of Limpsfield and the chalk of the Downs were early used, the latter chiefly for lime-making. Fuller's earth was obtained from Reigate and Nutfield; and the facilities afforded by many small streams, and the excellent sheep pasture, made it of importance in the manufacture of cloth, of which Guildford was a centre. Glass and iron were made in the Weald district, whose forests produced the necessary charcoal for smelting. Chiddingfold is mentioned in 1266 for its glass-making, and was one of the chief glass-producing districts in late Tudor times. The ironworks of Surrey were of less importance, and much later in development than those of Kent and Sussex, owing to the want of good roads or waterways, but the increasing demand for ordnance in the 16th century led to the spread of the industry northward; the most considerable works in Surrey being those of Viscount Montague at Haslemere. Chilworth, which was famous for its powder mills in the 16th century, remains a seat of the industry. Southwark and its neighbourhood early became a suburb of London and a centre of trades which were crowded out of London. The earliest Delft ware manufactory in England was at Lambeth, which maintains its fame as a centre of earthenware manufacture. The beautiful encaustic tiles of Chertsey Abbey are thought to have been made in English monasteries and date from the 13th century. Although the county was doubtless represented in the representative councils of the reign of Henry III., the first extant returns of two knights of the shire are for the parliament of 1290. The Reform Bill of 1832 gave Surrey four members; dividing the county into east and west divisions. Several boroughs were disfranchized then and in 1867, when East Surrey was again divided into east and mid divisions, on account of the growth of London suburbs, two more members being added at the same time. In 1855 all old boroughs and divisions were superseded; the county being divided into the electoral divisions of Chertsey, Guildford, Reigate, Epsom, Kingston and Wimbledon, each returning one member. Finally, in 1888, the new county of London annexed large portions of Surrey along the northern border.

Antiquities.—The only ecclesiastical ruins worthy of special mention are the picturesque walls of Newark Priory, near Woking, founded for Augustinians in the time of Richard Cœur de Lion; and the Early English crypt and part of the refectory of Waverley Abbey, the earliest house of the Cistercians in England, founded in 1128. The church architecture is of a very varied kind, and has no peculiarly special features. Among the more interesting churches are Albury (the old church), near Guildford, the tower of which is of Saxon or very early Norman date; Beddington, a fine example of Perpendicular, containing monuments of the Carew family; Chaldon, remarkable for its fresco wall-paintings of the 12th century, discovered during restoration in 1870; Compton, which, though mentioned in Domesday, possesses little of its original architecture, but is worthy of notice for its two-storeyed chancel and its carved wooden balustrade surmounting the pointed transitional Norman arch which separates the nave from the chancel; Leigh, Perpendicular, possessing some very fine brasses of the 15th century; Lingfield, Perpendicular, containing ancient tombs and brasses of the Cobhams, and some fine stalls (the church was formerly collegiate); Ockham, chiefly Decorated, with a lofty embattled tower, containing the mausoleum of Lord Chancellor King (d. 1734), with full-length statue of the chancellor by Rysbrack; Stoke d'Abernon, Early English, with the earliest extant English brass, that of Sir John d'Abernon, 1277, and other fine examples. Churches at Guildford, Reigate and Woking are also noteworthy. Of old castles the only examples are Farnham, occupied as a palace by the bishops of Winchester, originally built by Henry of Blois, and restored by Henry III.; and Guildford, with a strong quadrangular Norman keep. Of ancient domestic architecture examples include Beddington Hall (now a female orphan asylum), the ancient mansion of the Carews, rebuilt in the reign of Queen Anne, and in modern times, but retaining the hall of the Elizabethan building; Crowhurst Place, built in the time of Henry VII., the ancient seat of the Gaynesfords, and frequently visited by Henry VIII.; portions of Croydon Palace, an ancient seat of the archbishops of Canterbury; the gate tower of Esher Place, built by William of Waynflete, bishop of Winchester, and repaired by Cardinal Wolsey; Archbishop Abbot's hospital, Guildford, in the Tudor style; the fine Elizabethan house of Loseley near Guildford; Smallfield Place near Reigate, now a farmhouse, once the seat of Sir Edward Bysshe (*c.* 1615–1679), garter king-at-arms; Sutton Place near Woking, dating from the time of Henry VIII., possessing curious mouldings and ornaments in terra-cotta; and Ham House, of red brick, dating from 1610.

See Topley's *Geology of the Weald* and Whitaker's *Geology of London Basin*, forming part of the *Memoirs of Geological Survey of United Kingdom* (London, 1875); J. Aubrey, *Natural History and Antiquities of Surrey* (5 vols., London, 1718–1719); D. Lysons, *Environs of London* (5 vols., London, 1800–1811); Baxter, *Domesday Book of Surrey* (1876); O. Manning and W. Bray, *History and Antiquities of Surrey* (3 vols., London, 1804–1814); E. W. Brayley, *Topographical History of Surrey* (5 vols., London, 1841–1848); another edition, revised by E. Walford (London, 1878); *Archaeological Collections* (Surrey Archaeological Society; London, from 1858); Eric Parker, *Highways and Byways in Surrey* (London, 1908).

SURROGATE (from Lat. *surrogare*, to substitute for), a deputy of a bishop or an ecclesiastical judge, acting in the absence of his principal and strictly bound by the authority of the latter. Canon 128 of the canons of 1603 lays down the qualifications necessary for the office of surrogate and canon 123 the regulations for the appointment to the office. At present the chief duty of a surrogate in England is the granting of marriage licences, but judgments of the arches court of Canterbury have been delivered by a surrogate in the absence of the official principal. The office is unknown in Scotland, but is of some importance in the United States as denoting the judge to whom the jurisdiction of the probate of wills, the grant of administration and of guardianship is confided. In some states he is termed surrogate, in others judge of probate, register, judge of the orphans' court, &c. His jurisdiction is local, being limited to his county.

SURTEES, ROBERT (1779–1834), English antiquary and topographical historian, was the son of Robert Surtees of Mainsforth, Durham. He was educated at Christ Church, Oxford, and after studying law without being called to the bar he settled on the family estate at Mainsforth, which he inherited on his father's death in 1802, and where he lived in retirement for the rest of his life, devoting himself to the study of local antiquities and collecting materials for his *History of Durham*. This book was published in four volumes, the first of which appeared in 1816, and the last in 1840, after the author's death. The work contains a large amount of genealogical and antiquarian information; it is written in a readable style, and its learning is enlivened by humour. Surtees had also a gift for ballad writing, and he was so successful in imitating the style of old ballads that he managed to deceive Sir Walter Scott himself, who gave a place in his *Minstrelsy of the Scottish Border* to a piece by Surtees called "The Death of Featherstonehaugh," under the impression that it was ancient. Surtees, who in 1807 married Anne Robinson, died at Mainsforth on the 11th of February 1834. As a memorial of him the "Surtees Society" was founded in 1834 for the purpose of publishing ancient unedited manuscripts bearing on the history of the border country.

See G. Taylor, *Memoir of Robert Surtees*, with additions by J. Raine (Surtees Society, London, 1852).

SURTEES, ROBERT SMITH (1803–1864), English novelist and sporting writer, was the second son of Anthony Surtees of Hamsterley Hall, a member of an old Durham family. Educated to be a solicitor, Surtees soon began to contribute to the *Sporting Magazine*, and in 1831 he published a treatise on the law relating to horses and particularly the law of warranty, entitled *The Horseman's Manual*. In the following year he helped to found the *New Sporting Magazine*, of which he was the editor for the next five years. To this periodical he contributed between 1832 and 1834 the papers which were afterwards collected and published in 1838 as *Jorrocks's Jaunts and Jollities*. This humorous narrative of the sporting experiences of a cockney grocer, which suggested the more famous *Pickwick Papers* of Charles Dickens, is the work by which Surtees is chiefly remembered, though his novel *Handley Cross*, published in 1843, in which the character of "Jorrocks" is reintroduced as a master of fox-hounds, also enjoyed a wide popularity. The former of these two books was illustrated by "Phiz" (H. K. Browne), and the latter, as well as most of Surtees's subsequent novels, by John Leech, whose pictures of "Jorrocks" are everywhere familiar and were the chief means of ensuring the lasting popularity of that humorous creation. In 1838, on the death of his father, Surtees, whose elder brother had died in 1831, inherited the family property of Hamsterley Hall, where he lived for the rest of his life. The later novels by Surtees included *Hillingdon Hall* (1845), in which "Jorrocks" again appears; *Hawbuck Grange* (1847); *Mr Sponge's Sporting Tour* (1853); *Ask Mamma* (1858); *Plain or Ringlets?* (1860); *Mr Facey Romford's Hounds* (1865). The last of these novels appeared after the author's death, which occurred on the 16th of March 1864. In 1841 he married Elizabeth Jane, daughter of Addison Fenwick of Bishopwearmouth, by whom he had one son and two daughters, the younger of whom, Eleanor, in 1885 married John Prendergast Vereker, afterwards 5th Viscount Gort.

See R. S. Surtees, *Jorrocks's Jaunts and Jollities* (London, 1869), containing a biographical memoir of the author; W. P. Frith, *John Leech, His Life and Work* (2 vols., London, 1891); Samuel Halkett and J. Laing, *Dictionary of Anonymous and Pseudonymous Literature of Great Britain* (4 vols., Edinburgh, 1882–1888).

SURVEYING, the technical term for the art of determining the position of prominent points and other objects on the surface of the ground, for the purpose of making therefrom a graphic representation of the area surveyed. The general principles on which surveys are conducted and maps computed from such data are in all instances the same; certain measures are made on the ground, and corresponding measures are protracted on paper on whatever scale may be a convenient fraction of the natural scale. The method of surveying varies with the magnitude of the survey, which may embrace an empire or represent a small plot of land. All surveys rest primarily on linear measurements for the direct determination of distances; but linear measurement is often supplemented by angular measurement which enables distances to be determined by principles of geometry over areas which cannot be conveniently measured directly, such, for instance, as hilly or broken ground. The nature of the survey depends on the proportion which the linear and angular measures bear to one another and is almost always a combination of both.

History.—The art of surveying, *i.e.* the primary art of map-making from linear measurements, has no historical beginning. The first rude attempts at the representation of natural and artificial features on a ground plan based on actual measurements of which any record is obtainable were those of the Romans, who certainly made use of an instrument not unlike the plane-table for determining the alignment of their roads. Instruments adapted to surveying purposes were in use many centuries earlier than the Roman period. The Greeks used a form of log line for recording the distances run from point to point along the coast whilst making their slow voyage from the Indus to the Persian Gulf three centuries B.C.; and it is improbable that the adaptation of this form of linear measurement was confined to the sea alone. Still earlier (as early as 1600 B.C.) it is said that the Chinese knew the value of the loadstone and possessed some form of magnetic compass. But there is no record of their methods of linear measurements, or that the distances and angles measured were applied to the purpose of map-making (see COMPASS and MAP). The earliest maps of which we have any record were based on inaccurate astronomical determinations, and it was not till medieval times, when the Arabs made use of the Astrolabe (*q.v.*), that nautical surveying (the earliest form of the art) could really be said to begin. In 1450 the Arabs were acquainted with the use of the compass, and could make charts of the coast-line of those countries which they visited. In 1498 Vasco da Gama saw a chart of the coast-line of India, which was shown him by a Gujarati, and there can be little doubt that he benefited largely by information obtained from charts which were of the nature of practical coast surveys. The beginning of land surveying (apart from small plan-making) was probably coincident with the earliest attempts to discover the size and figure of the earth by means of exact measurements, *i.e.* with the inauguration of geodesy (see GEODESY and EARTH, FIGURE OF THE), which is the fundamental basis of all scientific surveying.

Classification.—For convenience of reference surveying may be considered under the following heads—involving very distinct branches of the art dependent on different methods and instruments[1]:—

1. Geodetic triangulation.
2. Levelling.
3. Topographical surveys.
4. Geographical surveys.
5. Traversing, and fiscal or revenue surveys.
6. Nautical surveys.

1. GEODETIC TRIANGULATION

Geodesy, as an abstract science dealing primarily with the dimensions and figure of the earth, may be found fully discussed in the articles GEODESY and EARTH, FIGURE OF THE; but, as furnishing the basis for the construction of the first framework of triangulation on which all further surveys depend (which may be described as its second but most important function), geodesy is an integral part of the art of surveying, and its relation to subsequent processes requires separate consideration. The part which geodetic triangulation plays in the general surveys of civilized countries which require closely accurate and various forms of mapping to illustrate their physical features for military, political or fiscal purposes is best exemplified by reference to some completed system which has already served its purpose over a large area. That of India will serve as an example.

The great triangulation of India was, at its inception, calculated to satisfy the requirements of geodesy as well as geography, because the latitudes and longitudes of the points of the triangulation had to be determined for future reference by process of calculation combining the results of the triangulation with the elements of the earth's figure. The latter were not then known with much accuracy, for so far geodetic operations had been mainly carried on in Europe, and additional operations nearer the equator were much wanted; the survey was conducted with a view to supply this want. Thus high accuracy was aimed at from the first.

Primarily a network was thrown over the southern peninsula. The triangles on the central meridian were measured with extra care and checked by base-lines at distances of about 2° apart in

[1] The subject of tacheometry is treated under its own heading.

latitude in order to form a geodetic arc, with the addition of astronomically determined latitudes at certain of the stations. The base-lines were measured with chains and the principal angles with a 3-ft. theodolite. The signals were cairns of stones or poles. The chains were somewhat rude and their units of length had not been determined originally, and could not be afterwards ascertained. The results were good of their kind and sufficient for geographical purposes; but the central meridional arc—the "great arc"—was eventually deemed inadequate for geodetic requirements. A superior instrumental equipment was introduced, with an improved

Trigonometrical Survey of India.

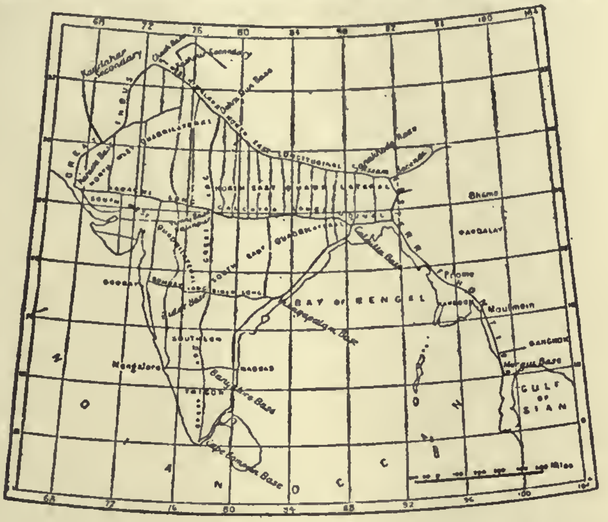

FIG. 1.

modus operandi, under the direction of Colonel Sir G. Everest in 1832. The network system of triangulation was superseded by meridional and longitudinal chains taking the form of gridirons and resting on base-lines at the angles of the gridirons, as represented in fig. 1. For convenience of reduction and nomenclature the triangulation west of meridian 92° E. has been divided into five sections—the lowest a trigon, the other four quadrilaterals distinguished by cardinal points which have reference to an observatory in Central India, the adopted origin of latitudes. In the north-east quadrilateral, which was first measured, the meridional chains are about one degree apart; this distance was latterly much increased and eventually certain chains—as on the Malabar coast and on meridian 84° in the south-east quadrilateral—were dispensed with because good secondary triangulation for topography had been accomplished before they could be begun.

All *base-lines* were measured with the Colby apparatus of compensation bars and microscopes. The bars, 10 ft. long, were set up horizontally on tripod stands; the microscopes, 6 in. apart, were mounted in pairs revolving round a vertical axis and were set up on tribrachs fitted to the ends of the bars. Six bars and five central and two end pairs of microscopes—the latter with their vertical axes perforated for a look-down telescope—constituted a complete apparatus, measuring 63 ft. between the ground pins or registers. Compound bars are more liable to accidental changes of length than simple bars; they were therefore tested from time to time by comparison with a standard simple bar; the microscopes were also tested by comparison with a standard 6-in. scale. At the first base-line the compensated bars were found to be liable to sensible variations of length with the diurnal variations of temperature; these were supposed to be due to the different thermal conductivities of the brass and the iron components. It became necessary, therefore, to determine the mean daily length of the bars precisely, for which reason they were systematically compared with the standard before and after, and sometimes at the middle of, the base-line measurement throughout the entire day for a space of three days, and under conditions as nearly similar as possible to those obtaining during the measurement. Eventually thermometers were applied experimentally to both components of a compound bar, when it was found that the diurnal variations in length were principally due to difference of position relatively to the sun, not to difference of conductivity—the component nearest the sun acquiring heat most rapidly or parting with it most slowly, notwithstanding that both were in the same box, which was always sheltered from the sun's rays. Happily the systematic comparisons of the compound bars with the standard were found to give a sufficiently exact determination of the mean daily length. An elaborate investigation of theoretical probable errors (*p.e.*) at the Cape Comorin base showed that, for any base-line measured as usual without thermometers in the compound bars, the *p.e.* may be taken as $\pm 1 \cdot 5$ millionth parts of the length, excluding unascertainable constant errors, and that on introducing thermometers into these bars the *p.e.* was diminished to $\pm 0 \cdot 55$ millionths.

In all base-line measurements the weak point is the determination of the temperature of the bars when that of the atmosphere is rapidly rising or falling; the thermometers acquire and lose heat more rapidly than the bar if their bulbs are outside, and more slowly if inside the bar. Thus there is always more or less lagging, and its effects are only eliminated when the rises and falls are of equal amount and duration; but as a rule the rise generally predominates greatly during the usual hours of work, and whenever this happens lagging may cause more error in a base-line measured with simple bars than all other sources of error combined. In India the probable average lagging of the standard-bar thermometer was estimated as not less than 0·3° F., corresponding to an error of − 2 millionths in the length of a base-line measured with iron bars. With compound bars lagging would be much the same for both components and its influence would consequently be eliminated. Thus the most perfect base-line apparatus would seem to be one of compensation bars with thermometers attached to each component; then the comparisons with the standard need only be taken at the times when the temperature is constant, and there is no lagging.

The *plan of triangulation* was broadly a system of internal meridional and longitudinal chains with an external border of oblique chains following the course of the frontier and the coast lines. The design of each chain was necessarily much influenced by the physical features of the country over which it was carried. The most difficult tracts were plains, devoid of any commanding points of view, in some parts covered with forest and jungle, malarious and almost uninhabited, in other parts covered with towns and villages and umbrageous trees. In such tracts triangulation was impossible except by constructing towers as stations of observation, raising them to a sufficient height to overtop at least the earth's curvature, and then either increasing the height to surmount all obstacles to mutual vision, or clearing the lines. Thus in hilly and open country the chains of triangles were generally made "double" throughout, *i.e.* formed of polygonal and quadrilateral figures to give greater breadth and accuracy; but in forest and close country they were carried out as series of single triangles, to give a minimum of labour and expense. Symmetry was secured by restricting the angles between the limits of 30° and 90°. The average side length was 30 m. in hill country and 11 in the plains; the longest principal side was 62·7 m., though in the secondary triangulation to the Himalayan peaks there were sides exceeding 200 m. Long sides were at first considered desirable, on the principle that the fewer the links the greater the accuracy of a chain of triangles; but it was eventually found that good observations on long sides could only be obtained under exceptionally favourable atmospheric conditions. In plains the length was governed by the height to which towers could be conveniently raised to surmount the curvature, under the well-known condition, height in feet = $\frac{2}{3} \times$ square of the distance in miles; thus 24 ft. of height was needed at each end of a side to overtop the curvature in 12 m., and to this had to be added whatever was required to surmount obstacles on the ground. In Indian plains refraction is more frequently negative than positive during sunshine; no reduction could therefore be made for it.

The *selection of sites for stations*, a simple matter in hills and open country, is often difficult in plains and close country. In the early operations, when the great arc was being carried across the wide plains of the Gangetic valley, which are covered with villages and trees and other obstacles to distant vision, masts 35 ft. high were carried about for the support of the small reconnoitring theodolites, with a sufficiency of poles and bamboos to form a scaffolding of the same height for the observer. Other masts 70 ft. high, with arrangements for displaying blue lights by night at 90 ft., were erected at the spots where station sites were wanted. But the cost of transport was great, the rate of progress was slow, and the results were unsatisfactory. Eventually a method of touch rather than sight was adopted, feeling the ground to search for the obstacles to be avoided, rather than attempting to look over them: the "rays" were traced either by a minor triangulation, or by a traverse with theodolite and perambulator, or by a simple alignment of flags. The first method gives the direction of the new station most accurately; the second searches the ground most closely; the third is best suited for tracts of uninhabited forest in which there is no choice of either line or site, and the required station may be built at the intersection of the two trial rays leading up to it. As a rule it has been found most economical and expeditious to raise the towers only to the height necessary for surmounting the curvature, and to remove the trees and other obstacles on the lines.

Each *principal station* has a central masonry pillar, circular and 3 to 4 ft. in diameter, for the support of a large theodolite, and around it a platform 14 to 16 ft. square for the observatory tent, observer and signallers. The pillar is isolated from the platform, and when solid carries the station mark—a dot surrounded by a circle—engraved on a stone at its surface, and on additional stones or the rock *in situ*, in the normal of the upper mark; but, if the height is considerable and there is a liability to deflection, the pillar is constructed with a central vertical shaft to enable the theodolite to be plumbed over the ground-level mark, to which access is obtained through a passage in the basement. In early years this precaution against deflection was neglected and the pillars were built solid throughout, whatever their height; the surrounding platforms, being usually constructed of sun-dried bricks or stones and earth, were liable to fall and press against the pillars, some of which thus became deflected during the rainy seasons that intervened between the periods during which operations were arrested or the beginning and close of the successive circuits of triangles. Large theodolites were invariably employed. Repeating circles were highly thought of by French geodesists at the time when the operations in India were begun; but they were not used in the survey, and have now been generally discarded. The principal theodolites were somewhat similar to the astronomer's alt-azimuth instrument, but with larger azimuthal and smaller vertical circles, also with a greater base to give the firmness and stability which are required in measuring horizontal angles. The azimuthal circles had mostly diameters of either 36 or 24 in., the vertical circles having a diameter of 18 in. In all the theodolites the base was a tribrach resting on three levelling foot-screws, and the circles are read by microscopes; but in different instruments the fixed and the rotatory parts of the body varied. In some the vertical axis was fixed on the tribrach and projected upwards; in others it revolved in the tribrach and projected downwards. In the former the azimuthal circle was fixed to the tribrach, while the telescope pillars, the microscopes, the clamps and the tangent screws were attached to a drum revolving round the vertical axis; in the latter the microscopes, clamps and tangent screws were fixed to the tribrach, while the telescope pillars and the azimuthal circle were attached to a plate fixed at the head of the rotary vertical axis.

Cairns of stones, poles or other opaque signals were primarily employed, the angles being measured by day only; eventually it was found that the atmosphere was often more favourable for observing by night than by day, and that distant points were raised well into view by refraction by night which might be invisible or only seen with difficulty by day. Lamps were then introduced of the simple form of a cup, 6 in. in diameter, filled with cotton seeds steeped in oil and resin, to burn under an inverted earthen jar, 30 in. in diameter, with an aperture in the side towards the observer. Subsequently this contrivance gave place to the Argand lamp with parabolic reflector; the opague day signals were discarded for heliotropes reflecting the sun's rays to the observer. The introduction of luminous signals not only rendered the night as well as the day available for the observations but changed the character of the operations, enabling work to be done during the dry and healthy season of the year, when the atmosphere is generally hazy and dust-laden, instead of being restricted as formerly to the rainy and unhealthy seasons, when distant opaque objects are best seen. A higher degree of accuracy was also secured, for the luminous signals were invariably displayed through diaphragms of appropriate aperture, truly centred over the station mark; and, looking like stars, they could be observed with greater precision, whereas opaque signals are always dim in comparison and are liable to be seen excentrically when the light falls on one side. A signalling party of three men was usually found sufficient to manipulate a pair of heliotropes—one for single, two for double reflection, according to the sun's position—and a lamp, throughout the night and day. Heliotropers were also employed at the observing stations to flash instructions to the signallers.

Measuring Horizontal Angles.

The theodolites were invariably set up under tents for protection against sun, wind and rain, and centred, levelled and adjusted for the runs of the microscopes. Then the signals were observed in regular rotation round the horizon, alternately from right to left and vice versa; after the prescribed minimum number of rounds, either two or three, had been thus measured, the telescope was turned through 180°, both in altitude and azimuth, changing the position of the face of the vertical circle relatively to the observer, and further rounds were measured; additional measures of single angles were taken if the prescribed observations were not sufficiently accordant. As the microscopes were invariably equidistant and their number was always odd, either three or five, the readings taken on the azimuthal circle during the telescope pointings to any object in the two positions of the vertical circle, "face right" and "face left," were made on twice as many equidistant graduations as the number of microscopes. The theodolite was then shifted bodily in azimuth, by being turned on the ring on the head of the stand, which brought new graduations under the microscopes at the telescope pointings; then further rounds were measured in the new positions, face right and face left. This process was repeated as often as had been previously prescribed, the successive angular shifts of position being made by equal arcs bringing equidistant graduations under the microscopes during the successive telescope pointings to one and the same object. By these arrangements all periodic errors of graduation were eliminated, the numerous graduations that were read tended to cancel accidental errors of division, and the numerous rounds of measures to minimize the errors of observation arising from atmospheric and personal causes.

Under this system of procedure the instrumental and ordinary errors are practically cancelled and any remaining error is most probably due to lateral refraction, more especially when the rays of light graze the surface of the ground. The three angles of every triangle were always measured.

Vertical Angles.

The apparent altitude of a distant point is liable to considerable variations during the twenty-four hours, under the influence of changes in the density of the lower strata of the atmosphere. Terrestrial refraction is capricious, more particularly when the rays of light graze the surface of the ground, passing through a medium which is liable to extremes of rarefaction and condensation, under the alternate influence of the sun's heat radiated from the surface of the ground and of chilled atmospheric vapour. When the back and forward verticals at a pair of stations are equally refracted, their difference gives an exact measure of the difference of height. But the atmospheric conditions are not always identical at the same moment everywhere on long rays which graze the surface of the ground, and the ray between two reciprocating stations is liable to be differently refracted at its extremities, each end being influenced in a greater degree by the conditions prevailing around it than by those at a distance; thus instances are on record of a station A being invisible from another B, while B was visible from A.

Refraction.

When the great arc entered the plains of the Gangetic valley, simultaneous reciprocal verticals were at first adopted with the hope of eliminating refraction; but it was soon found that they did not do so sufficiently to justify the expense of the additional instruments and observers. Afterwards the back and forward verticals were observed as the stations were visited in succession, the back angles at as nearly as possible the same time of the day as the forward angles, and always during the so-called "time of minimum refraction," which ordinarily begins about an hour after apparent noon and lasts from two to three hours. The apparent zenith distance is always greatest then, but the refraction is a minimum only at stations which are well elevated above the surface of the ground; at stations on plains the refraction is liable to pass through zero and attain a considerable negative magnitude during the heat of the day, for the lower strata of the atmosphere are then less dense than the strata immediately above and the rays are refracted downwards. On plains the greatest positive refractions are also obtained—maximum values, both positive and negative, usually occurring, the former by night, the latter by day, when the sky is most free from clouds. The values actually met with were found to range from + 1·21 down to −0·09 parts of the contained arc on plains; the normal "coefficient of refraction" for free rays between hill stations below 6000 ft. was about 0·07, which diminished to 0·04 above 18,000 ft., broadly varying inversely as the temperature and directly as the pressure, but much influenced also by local climatic conditions.

In measuring the vertical angles with the great theodolites, graduation errors were regarded as insignificant compared with errors arising from uncertain refraction; thus no arrangement was made for effecting changes of zero in the circle settings. The observations were always taken in pairs, face right and left, to eliminate index errors, only a few daily, but some on as many days as possible, for the variations from day to day were found to be greater than the diurnal variations during the hours of minimum refraction.

Weights.

In the ordnance and other surveys the bearings of the surrounding stations are deduced from the actual observations, but from the "included angles" in the Indian survey. The observations of every angle are tabulated vertically in as many columns as the number of circle settings face left and face right, and the mean for each setting is taken. For several years the general mean of these was adopted as the final result; but subsequently a "concluded angle" was obtained by combining the single means with weights inversely proportional to $g^2 + o^2 \div n$—g, being a value of the *e.m.s.*[1] of graduation derived empirically from the differences between the general mean and the mean for each setting, o the *e.m.s.* of observation deduced from the differences between the individual measures and their respective means, and n the number of measures at each setting. Thus, putting $w_1, w_2, \dots$ for the weights of the single means, w for the weight of the concluded angle, M for the general mean, C for the concluded angle, and $d_1, d_2, \dots$ for the differences between M and the single means, we have

$$C = M + \frac{w_1 d_1 + w_2 d_2 +}{w_1 + w_2 +} \tag{1}$$

and

$$w = w_1 + w_2 + \tag{2}$$

$C - M$ vanishes when n is constant; it is inappreciable when g is much larger than o; it is significant only when the graduation errors are more minute than the errors of observation; but it was always small, not exceeding 0·14″ with the system of two rounds of measures and 0·05″ with the system of three rounds.

The weights of the concluded angles thus obtained were employed in the primary reductions of the angles of single triangles and polygons which were made to satisfy the geometrical conditions

[1] The theoretical "error of mean square" = 1·48 × "probable error."

of each figure, because they were strictly relative for all angles measured with the same instrument and under similar circumstances and conditions, as was almost always the case for each single figure. But in the final reductions, when numerous chains of triangles composed of figures executed with different instruments and under different circumstances came to be adjusted simultaneously, it was necessary to modify the original weights, on such evidence of the precision of the angles as might be obtained from other and more reliable sources than the actual measures of the angles. This treatment will now be described.

Theoretical Errors of Angles.

Values of theoretical error for groups of angles measured with the same instrument and under similar conditions may be obtained in three ways—(i.) from the squares of the reciprocals of the weight w deduced as above from the measures of such angle, (ii.) from the magnitudes of the excess of the sum of the angles of each triangle above 180°+ the spherical excess, and (iii.) from the magnitudes of the corrections which it is necessary to apply to the angles of polygonal figures and networks to satisfy the several geometrical conditions.

Harmonizing Angles.

Every figure, whether a single triangle or a polygonal network, was made consistent by the application of corrections to the observed angles to satisfy its geometrical conditions. The three angles of every triangle having been observed, their sum had to be made = 180° + the spherical excess; in networks it was also necessary that the sum of the angles measured round the horizon at any station should be exactly = 360°, that the sum of the parts of an angle measured at different times should equal the whole and that the ratio of any two sides should be identical, whatever the route through which it was computed. These are called the *triangular, central, toto-partial* and *side* conditions; they present n geometrical equations, which contain t unknown quantities, the errors of the observed angles, t being always $>n$. When these equations are satisfied and the deduced values of errors are applied as corrections to the observed angles, the figure becomes consistent. Primarily the equations were treated by a method of successive approximations; but afterwards they were all solved simultaneously by the so-called method of minimum squares, which leads to the most probable of any system of corrections.

Sides of Triangles.

The angles having been made geometrically consistent *inter se* in each figure, the side-lengths are computed from the base-line onwards by Legendre's theorem, each angle being diminished by one-third of the spherical excess of the triangle to which it appertains. The theorem is applicable without sensible error to triangles of a much larger size than any that are ever measured.

Latitude and Longitude of Stations; Azimuth of Sides.

A station of origin being chosen of which the latitude and longitude are known astronomically, and also the azimuth of one of the surrounding stations, the differences of latitude and longitude and the reverse azimuths are calculated in succession, for all the stations of the triangulation, by Puissant's formulae (*Traité de géodésie*, 3rd ed., Paris, 1842).

Problem.—Assuming the earth to be spheroidal, let A and B be two stations on its surface, and let the latitude and longitude of A be known, also the azimuth of B at A, and the distance between A and B at the mean sea-level; we have to find the latitude and longitude of B and the azimuth of A at B.

The following symbols are employed: a the major and b the minor semi-axis; e the excentricity, $=\left\{\frac{a^2-b^2}{a^2}\right\}^{\frac{1}{2}}$; ρ the radius of curvature to the meridian in latitude λ, $=\frac{a(1-e^2)}{\{1-e^2\sin^2\lambda\}^{\frac{3}{2}}}$; ν the normal to the meridian in latitude λ, $=\frac{a}{\{1-e^2\sin^2\lambda\}^{\frac{1}{2}}}$; λ and L the given latitude and longitude of A; $\lambda+\Delta\lambda$ and $L+\Delta L$ the required latitude and longitude of B; A the azimuth of B at A; B the azimuth of A at B; $\Delta A=B-(\pi+A)$; c the distance between A and B. Then, all azimuths being measured from the south, we have

$$\Delta\lambda''=\left\{\begin{aligned}&-\frac{c}{\rho}\cos A\ \text{cosec}\ 1''\\&-\frac{1}{2}\frac{c^2}{\rho.\nu}\sin^2 A\tan\lambda\ \text{cosec}\ 1''\\&-\frac{3}{4}\frac{c^2}{\rho.\nu}\frac{e^2}{1-e^2}\cos^2 A\sin 2\lambda\ \text{cosec}\ 1''\\&+\frac{1}{6}\frac{c^3}{\rho.\nu^2}\sin^2 A\cos A(1+3\tan^2\lambda)\ \text{cosec}\ 1''\end{aligned}\right\}\quad(3)$$

$$\Delta L''=\left\{\begin{aligned}&-\frac{c}{\nu}\frac{\sin A}{\cos\lambda}\text{cosec}\ 1''\\&+\frac{1}{2}\frac{c^2}{\nu^2}\frac{\sin 2A\tan\lambda}{\cos\lambda}\text{cosec}\ 1''\\&-\frac{1}{6}\frac{c^3}{\nu^3}\frac{(1+3\tan^2\lambda)\sin 2A\cos A}{\cos\lambda}\text{cosec}\ 1''\\&+\frac{1}{3}\frac{c^3}{\nu^3}\frac{\sin^3 A\tan^2\lambda}{\cos\lambda}\text{cosec}\ 1''\end{aligned}\right\}\quad(4)$$

$$\begin{aligned}&\Delta A''\ \text{or}\\&B-(\pi+A)\end{aligned}=\left\{\begin{aligned}&-\frac{c}{\nu}\sin A\tan\lambda\ \text{cosec}\ 1''\\&+\frac{1}{4}\frac{c^2}{\nu^2}\left\{1+2\tan^2\lambda+\frac{e^2\cos^2\lambda}{1-e^2}\right\}\sin 2A\ \text{cosec}\ 1''\\&-\frac{c^3}{\nu^3}\left(\frac{5}{6}+\tan^2\lambda\right)\frac{\tan\lambda}{2}\sin 2A\cos A\ \text{cosec}\ 1''\\&+\frac{1}{6}\frac{c^3}{\nu^3}\sin^3 A\tan\lambda(1+2\tan^2\lambda)\ \text{cosec}\ 1''\end{aligned}\right\}\quad(5)$$

Each Δ is the sum of four terms symbolized by δ_1, δ_2, δ_3 and δ_4; the calculations are so arranged as to produce these terms in the order $\delta\lambda$, δL, and δA, each term entering as a factor in calculating the following term. The arrangement is shown below in equations in which the symbols $P, Q, \ldots Z$ represent the factors which depend on the adopted geodetic constants, and vary with the latitude; the logarithms of their numerical values are tabulated in the *Auxiliary Tables to Facilitate the Calculations of the Indian Survey.*

$$\left.\begin{aligned}&\delta_1\lambda=-P.\cos A.c && \delta_1 L=+\delta_1\lambda.Q.\sec\lambda.\tan A && \delta_1 A=+\delta_1 L.\sin\lambda\\&\delta_2\lambda=+\delta_1 A.R.\sin A.c && \delta_2 L=-\delta_2\lambda.S.\cot A && \delta_2 A=+\delta_2 L.T\\&\delta_3\lambda=-\delta_2 A.V.\cot A && \delta_3 L=+\delta_3\lambda.U.\sin A.c && \delta_3 A=+\delta_3 L.W\\&\delta_4\lambda=-\delta_3 A.X.\tan A && \delta_4 L=+\delta_4\lambda.Y.\tan A && \delta_4 A=+\delta_4 L.Z\end{aligned}\right\}\quad(6)$$

Reduction of Principal Triangulation.

The calculations described so far suffice to make the angles of the several trigonometrical figures consistent *inter se*, and to give preliminary values of the lengths and azimuths of the sides and the latitudes and longitudes of the stations. The results are amply sufficient for the requirements of the topographer and land surveyor, and they are published in preliminary charts, which give full numerical details of latitude, longitude, azimuth and side-length, and of height also, for each portion of the triangulation—secondary as well as principal—as executed year by year. But on the completion of the several chains of triangles further reductions became necessary, to make the triangulation everywhere consistent *inter se* and with the verificatory base-lines, so that the lengths and azimuths of common sides and the latitudes and longitudes of common stations should be identical at the junctions of chains and that the measured and computed lengths of the base-lines should also be identical.

As an illustration of the problem for treatment, suppose a combination of three meridional and two longitudinal chains comprising seventy-two single triangles with a base-line at each corner as shown in the accompanying diagram (fig. 2); suppose the three angles of every triangle to have been measured and made consistent. Let A be the origin, with its latitude and longitude given, and also the length and azimuth of the adjoining base-line. With these data processes of calculation are carried through the triangulation to obtain the lengths and azimuths of the sides and the latitudes and longitudes of the stations, say in the following order: from A through B to E, through F to E, through F to D, through F and E to C, and through F and D to C. Then there are two values of side, azimuth, latitude and longitude at E—one from the right-hand chains via B, the other from the left-hand chains via F; similarly there are two sets of values at C; and each of the base-lines at B, C and D has a calculated as well as a measured value. Thus eleven absolute errors are presented for dispersion over the triangulation by the application of the most appropriate correction to each angle, and, as a preliminary to the determination of these corrections, equations must be constructed between each of the absolute errors and the unknown errors of the angles from which they originated. For this purpose assume X to be the angle opposite the flank side of any triangle, and Y and Z the angles opposite the sides of continuation; also let x, y and z be the most probable values of the errors of the angles which will satisfy the given equations of condition. Then each equation may be expressed in the form $[ax+by+cz]=E$, the brackets indicating a summation for all the triangles involved. We have first to ascertain the values of the coefficients a, b and c of the unknown quantities. They are readily found for the side equations on the circuits and between the base-lines, for x does not enter them, but only y and z, with coefficients which are the cotangents of Y and Z, so that these equations are simply $[\cot Y.y-\cot Z.z]=E$. But three out of four of the circuit equations are geodetic, corresponding to the closing errors in latitude, longitude and azimuth, and in them the coefficients are very complicated. They are obtained as follows. The first term of each of the three expressions for $\Delta\lambda$, ΔL, and B is differentiated in terms of c and A, giving

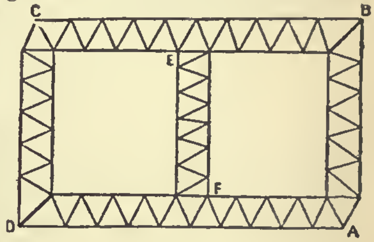

FIG. 2.

$$\left.\begin{aligned}d.\Delta\lambda&=\Delta\lambda\left\{\frac{dc}{c}-dA\tan A\sin 1''\right\}\\d.\Delta L&=\Delta L\left\{\frac{dc}{c}+dA\cot A\sin 1''\right\}\\dB=dA+\Delta A&\left\{\frac{dc}{c}+dA\cot A\sin 1''\right\}\end{aligned}\right\}\quad(7)$$

in which dc and dA represent the errors in the length and azimuth of any side c which have been generated in the course of the triangulation up to it from the base-line and the azimuth station at the origin. The errors in the latitude and longitude of any station which are due to the triangulation are $d\lambda$, $=[d.\Delta\lambda]$, and dL, $=[d.\Delta L]$. Let station 1 be the origin, and let 2, 3, ... be the succeeding stations taken along a predetermined line of traverse, which may either run from vertex to vertex of the successive triangles, zigzagging between the flanks of the chain, as in fig. 3 (1), or be carried directly along one of the flanks, as in fig. 3 (2). For the general symbols of the differential equations substitute $\Delta\lambda_n$, ΔL_n, ΔA_n, c_n, A_n, and B_n, for the side between stations n and $n+1$ of the traverse; and let δc_n and δA_n be the errors generated between the sides c_{n-1} and c_n; then

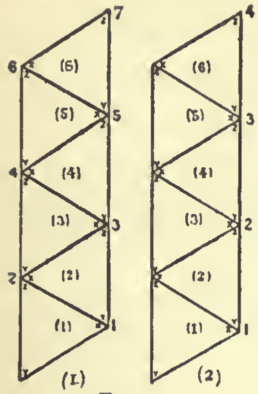

FIG. 3.

$$\frac{dc_1}{c_1}=\frac{\delta c_1}{c_1};\quad \frac{dc_2}{c_2}=\frac{\delta c_1}{c_1}+\frac{\delta c_2}{c_2};\dots\quad \frac{dc_n}{c_n}=\sideset{_1^n}{}{\left[\frac{\delta c}{c}\right]};$$
$$dA_1=\delta A_1;\ dA_2=dB_1+\delta A_2;\ \dots\ dA_n=dB_{n-1}+\delta A_n.$$

Performing the necessary substitutions and summations, we get

$$dB_n=\begin{cases}{}_1^n[\Delta A]\frac{\delta c_1}{c_1}+{}_2^n[\Delta A]\frac{\delta c_2}{c_2}+\dots+\Delta A_n\frac{\delta c_n}{c_n}\\ +(1+{}_1^n[\Delta A\cot A]\sin 1'')\delta A_1+(1+{}_2^n[\Delta A\cot A]\sin 1'')\delta A_2\\ \quad+\dots+(1+\Delta A_n\cot A_n\sin 1'')\delta A_n.\end{cases}$$

$$d\lambda_{n+1}=\begin{cases}{}_1^n[\Delta\lambda]\frac{\delta c_1}{c_1}+{}_2^n[\Delta\lambda]\frac{\delta c_2}{c_2}+\dots+\Delta\lambda_n\frac{\delta c_n}{c_n}\\ -\{{}_1^n[\Delta\lambda\tan A]\delta A_1+{}_2^n[\Delta\lambda\tan A]\delta A_2+\dots\\ \quad+\Delta\lambda_n\tan A_n\delta A_n\}\sin 1''\end{cases}$$

$$dL_{n+1}=\begin{cases}{}_1^n[\Delta L]\frac{\delta c_1}{c_1}+{}_2^n[\Delta L]\frac{\delta c_2}{c_2}+\dots+\Delta L_n\frac{\delta c_n}{c_n}\\ +\{{}_1^n[\Delta L\cot A]\delta A_1+{}_2^n[\Delta L\cot A]\delta A_2+\dots\\ \quad+\Delta L_n\cot A_n\delta A_n\}\sin 1''.\end{cases}$$

Thus we have the following expression for any geodetic error:—

$$\mu_1\frac{\delta c_1}{c_1}+\dots+\mu_n\frac{\delta c_n}{c_n}+\phi_1\delta A_1+\dots+\phi_n\delta A_n=E, \qquad (8)$$

where μ and ϕ represent the respective summations which are the coefficients of δc and δA in each instance but the first, in which 1 is added to the summation in forming the coefficient of δA.

The angular errors x, y and z must now be introduced, in place of δc and δA, into the general expression, which will then take different forms, according as the route adopted for the line of traverse was the zigzag or the direct. In the former, the number of stations on the traverse is ordinarily the same as the number of triangles, and, whether or no, a common numerical notation may be adopted for both the traverse stations and the collateral triangles; thus the angular errors of every triangle enter the general expression in the form $\qquad \pm\phi x+\cot Y.\mu' y-\cot Z.\mu' z,$

in which $\mu'=\mu\sin 1''$, and the upper sign of ϕ is taken if the triangle lies to the left, the lower if to the right, of the line of traverse. When the direct traverse is adopted, there are only half as many traverse stations as triangles, and therefore only half the number of μ's and ϕ's to determine; but it becomes necessary to adopt different numberings for the stations and the triangles, and the form of the coefficients of the angular errors alternates in successive triangles. Thus, if the pth triangle has no side on the line of the traverse but only an angle at the lth station, the form is

$$+\phi_l.x_p+\cot Y_p.\mu_l'.y_p-\cot Z_p.\mu_l'.z_p.$$

If the qth triangle has a side between the lth and the $(l+1)$th stations of the traverse, the form is

$$\cot X_q(\mu_l'-\mu'_{l+1})x_q+(\phi_l+\mu'_{l+1}\cot Y_q)y_q-(\phi_{l+1}-\mu_l'\cot Z_q)z_q.$$

As each circuit has a right-hand and a left-hand branch, the errors of the angles are finally arranged so as to present equations of the general form

$$[ax+by+cz]_r-[ax+by+cz]_l=E.$$

The eleven circuit and base-line equations of condition having been duly constructed, the next step is to find values of the angular errors which will satisfy these equations, and be the most probable of any system of values that will do so, and at the same time will not disturb the existing harmony of the angles in each of the seventy-two triangles. Harmony is maintained by introducing the equation of condition $x+y+z=0$ for every triangle. The most probable results are obtained by the method of minimum squares, which may be applied in two ways.

i. A factor λ may be obtained for each of the eighty-three equations under the condition that $\left[\frac{x^2}{u}+\frac{y^2}{v}+\frac{z^2}{w}\right]$ is made a minimum, u, v and w being the *reciprocals* of the weights of the observed angles. This necessitates the simultaneous solution of eighty-three equations to obtain as many values of λ. The resulting values of the errors of the angles in any, the pth, triangle, are

$$x_p=u_p[a_p\lambda];\ y_p=v_p[b_p\lambda];\ z_p=w_p[c_p\lambda]. \qquad (9)$$

ii. One of the unknown quantities in every triangle, as x, may be eliminated from each of the eleven circuit and base-line equations by substituting its equivalent $-(y+z)$ for it, a similar substitution being made in the minimum. Then the equations take the form $[(b-a)y+(c-a)z]=E$, while the minimum becomes

$$\left[\frac{(y+z)^2}{u}+\frac{y^2}{v}+\frac{z^2}{w}\right].$$

Thus we have now to find only eleven values of λ by a simultaneous solution of as many equations, instead of eighty-three values from eighty-three equations; but we arrive at more complex expressions for the angular errors as follows:—

$$\left.\begin{aligned}y_p&=\frac{v_p}{u_p+v_p+w_p}\{(u_p+w_p)[(b_p-a_p)\lambda]-w_p[(c_p-a_p)\lambda]\}\\ z_p&=\frac{w_p}{u_p+v_p+w_p}\{(u_p+v_p)[(c_p-a_p)\lambda]-v_p[(b_p-a_p)\lambda]\}\end{aligned}\right\}. \qquad (10)$$

The second method has invariably been adopted, originally because it was supposed that, the number of the factors λ being reduced from the total number of equations to that of the circuit and base-line equations, a great saving of labour would be effected. But subsequently it was ascertained that in this respect there is little to choose between the two methods; for, when x is not eliminated, and as many factors are introduced as there are equations, the factors for the triangular equations may be readily eliminated at the outset. Then the really severe calculations will be restricted to the solution of the equations containing the factors for the circuit and base-line equations as in the second method.

In the preceding illustration it is assumed that the base-lines are errorless as compared with the triangulation. Strictly speaking, however, as base-lines are fallible quantities, presumably of different weight, their errors should be introduced as unknown quantities of which the most probable values are to be determined in a simultaneous investigation of the errors of all the facts of observation, whether linear or angular. When they are connected together by so few triangles that their ratios may be deduced as accurately, or nearly so, from the triangulation as from the measured lengths, this ought to be done; but, when the connecting triangles are so numerous that the direct ratios are of much greater weight than the trigonometrical, the errors of the base-lines may be neglected. In the reduction of the Indian triangulation it was decided, after examining the relative magnitudes of the probable errors of the linear and the angular measures and ratios, to assume the base-lines to be errorless.

The chains of triangles being largely composed of polygons or other networks, and not merely of single triangles, as has been assumed for simplicity in the illustration, the geometrical harmony to be maintained involved the introduction of a large number of "side," "central" and "toto-partial" equations of condition, as well as the triangular. Thus the problem for attack was the simultaneous solution of a number of equations of condition = that of all the geometrical conditions of every figure + four times the number of circuits formed by the chains of triangles + the number of base-lines − 1, the number of unknown quantities contained in the equations being that of the whole of the observed angles; the method of procedure, if rigorous, would be precisely similar to that already indicated for "harmonizing the angles of trigonometrical figures," of which it is merely an expansion from single figures to great groups.

The rigorous treatment would, however, have involved the simultaneous solution of about 4000 equations between 9230 unknown quantities, which was impracticable. The triangulation was therefore divided into sections for separate reduction, of which the most important were the five between the meridians of 67° and 92° (see fig. 1), consisting of four quadrilateral figures and a trigon, each comprising several chains of triangles and some base-lines. This arrangement had the advantage of enabling the final reductions to be taken in hand as soon as convenient after the completion of any section, instead of being postponed until all were completed. It was subject, however, to the condition that the sections containing the best chains of triangles were to be first reduced; for, as all chains bordering contiguous sections would necessarily be "fixed" as a part of the section first reduced, it was obviously desirable to run no risk of impairing the best chains by forcing them into adjustment with others of inferior quality. It happened that both the north-east and the south-west quadrilaterals contained several of the older chains; their reduction was therefore made to follow that of the collateral sections containing the modern chains.

But the reduction of each of these great sections was in itself a very formidable undertaking, necessitating some departure from a purely rigorous treatment. For the chains were largely composed of polygonal networks and not of single triangles only as assumed in the illustration, and therefore cognizance had to be taken of a number of "side" and other geometrical equations of condition, which entered irregularly and caused great entanglement. Equations 9 and 10 of the illustration are of a simple form because they have a single geometrical condition to maintain, the triangular, which is not only expressed by the simple and symmetrical equation $x+y+z=0$, but—what is of much greater importance—recurs in a regular order of sequence that materially facilitates the general solution. Thus, though the calculations must in all cases be very numerous and laborious, rules can be formulated under which they can be well controlled at every stage and eventually brought to a successful issue. The other geometrical conditions of networks are expressed by equations which are not merely of a more complex form but have no regular order of sequence, for the networks present a variety of forms; thus their introduction would cause much entanglement and complication, and greatly increase the labour of the calculations and the chances of failure. Wherever, therefore, any compound figure occurred, only so much of it as was required to form a chain of single triangles was employed. The figure having previously been made consistent, it was immaterial what part was employed, but the selection was usually made so as to introduce the fewest triangles. The triangulation for final simultaneous reduction was thus made to consist of chains of single triangles only; but all the included angles were "fixed" simultaneously. The excluded angles of compound figures were subsequently harmonized with the fixed angles, which was readily done for each figure *per se*.

This departure from rigorous accuracy was not of material importance, for the angles of the compound figures excluded from the simultaneous reduction had already, in the course of the several independent figural adjustments, been made to exert their full influence on the included angles. The figural adjustments had, however, introduced new relations between the angles of different figures, causing their weights to increase *caeteris paribus* with the number of geometrical conditions satisfied in each instance. Thus, suppose w to be the average weight of the t observed angles of any figure, and n the number of geometrical conditions presented for satisfaction; then the average weight of the angles after adjustment may be taken as $w.\frac{t}{t-n}$, the factor thus being 1·5 for a triangle, 1·8 for a hexagon, 2 for a quadrilateral, 2·5 for the network around the Sironj base-line, &c.

In framing the normal equations between the indeterminate factors λ for the final simultaneous reduction, it would have greatly added to the labour of the subsequent calculations if a separate weight had been given to each angle, as was done in the primary figural reductions; this was obviously unnecessary, for theoretical requirements would now be amply satisfied by giving equal weights to all the angles of each independent figure. The mean weight that was finally adopted for the angles of each group was therefore taken as

$$w.\rho\frac{t}{t-n},$$

ρ being the modulus.

The second of the two processes for applying the method of minimum squares having been adopted, the values of the errors y and z of the angles appertaining to any, the pth, triangle were finally expressed by the following equations, which are derived from (10) by substituting u for the reciprocal final mean weight as above determined:—

$$\left.\begin{aligned} y_p &= \frac{u_p}{3}[(2b_p - a_p - c_p)\lambda] \\ z_p &= \frac{u_p}{3}[(2c_p - a_p - b_p)\lambda] \end{aligned}\right\} \qquad (11)$$

The following table gives the number of equations of condition and unknown quantities—the angular errors—in the five great sections of the triangulation, which were respectively included in the simultaneous general reductions and relegated to the subsequent adjustments of each figure *per se*:—

Section.	Simultaneous.			External Figural.					
	Equations.		Angular errors.	Equations.				Angular errors.	No. of figures.
	Circuit and base-line.	Tri-angular.		Tri-angular.	Central.	Side.	Toto-partial.		
1. N.W. Quad.	23	550	1650	267	104	152	6	761	110
2. S.E. Quad.	15	277	831	164	64	92	2	476	68
3. N.E. Quad.	49	573	1719	112	56	69	0	341	50
4. Trigon.	22	303	909	192	79	101	2	547	77
5. S.W. Quad.	24	172	516	83	32	52	1	237	40

The corrections to the angles were generally minute, rarely exceeding the theoretical probable errors of the angles, and therefore applicable without taking any liberties with the facts of observation.

Azimuth Observations.

Azimuth observations in connexion with the principal triangulation were determined by measuring the horizontal angle between a referring mark and a circumpolar star, shortly before and after elongation, and usually at both elongations in order to eliminate the error of the star's place. Systematic changes of "face" and of the zero settings of the azimuthal circle were made as in the measurement of the principal angles; but the repetitions on each zero were more numerous; the azimuthal levels were read and corrections applied to the star observations for dislevelment. The triangulation was not adjusted, in the course of the final simultaneous reduction, to the astronomically determined azimuths, because they are liable to be vitiated by local attractions; but the azimuths observed at about fifty stations around the primary azimuthal station, which was adopted as the origin of the geodetic calculations, were referred to that station, through the triangulation, for comparison with the primary azimuth. A table was prepared of the differences (observed at the origin—computed from a distance) between the primary and the geodetic azimuths; the differences were assumed to be mainly due to the local deflexions of the plumb-line and only partially to error in the triangulation, and each was multiplied by the factor

$$p = \frac{\text{tangent of latitude of origin,}}{\text{tangent of latitude of comparing station}}$$

in order that the effect of the local attraction on the azimuth observed at the distant station—which varies with the latitude and is = the deflexion in the prime vertical $\times$ the tangent of the latitude—might be converted to what it would have been had the station been situated in the same latitude as the origin. Each deduction was given a weight, w, inversely proportional to the number of triangles connecting the station with the origin, and the most probable value of the error of the observed azimuth at the origin was taken as

$$x = \frac{[(\text{observed} - \text{computed})\ p\ w]}{[w]} \qquad (12);$$

the value of x thus obtained was $-1{\cdot}1''$.

The formulae employed in the reduction of the azimuth observations were as follows. In the spherical triangle PZS, in which P is the pole, Z the zenith and S the star, the co-latitude PZ and the polar distance PS are known, and, as the angle at S is a right angle at the elongation, the hour angle and the azimuth at that time are found from the equations

$$\cos P = \tan PS \cot PZ,$$
$$\cos Z = \cos PS \sin P.$$

The interval, δP, between the time of any observation and that of the elongation being known, the corresponding azimuthal angle, δZ, between the two positions of the star at the times of observation and elongation is given rigorously by the following expression —$\tan\delta Z$

$$= -\frac{2\sin^2\frac{1}{2}\delta P}{\cot PS\sin PZ\sin P\{1+\tan^2 PS\cos\delta P+\sec^2 PS\cot P\sin\delta P\}} \qquad (13),$$

which is expressed as follows for logarithmic computation—

$$\delta Z = -\frac{m\tan Z\cos^2 PS}{1-n+l},$$

where $m = 2\sin^2\frac{\delta P}{2}\operatorname{cosec} 1''$, $n = 2\sin^2 PS\sin^2\frac{\delta P}{2}$, and $l = \cot P\sin\delta P$; l, m, and n are tabulated.

Height and Refraction.

Let A and B (fig. 4) be any two points the normals at which meet at C, cutting the sea-level at p and q; take $Dq = Ap$, then BD is the difference of height; draw the tangents Aa and Bb at A and B, then aAB is the depression of B at A and bBA that of A at B; join AD, then BD is determined from the triangle ABD. The triangulation gives the distance between A and B at the sea-level, whence $pq = c$; thus, putting Ap, the height of A above the sea-level, $= H$, and $pC = r$,

$$AD = c\left(1 + \frac{H}{r} - \frac{c^2}{24r^2}\right) \qquad (14).$$

Putting D_a and D_b for the actual depressions at A and B, S for the angle at A, usually called the "subtended angle," and h for BD—

$$S = \tfrac{1}{2}(D_b - D_a) \qquad (15),$$

and

$$h = AD\frac{\sin S}{\cos D_b} \qquad (16).$$

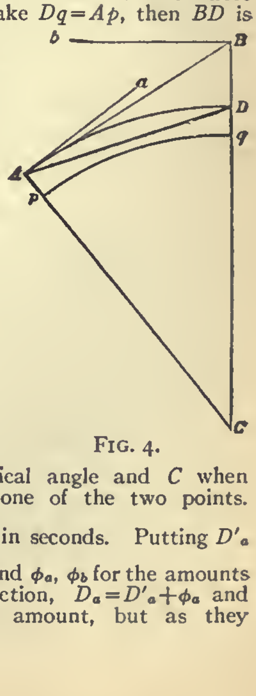

FIG. 4.

The angle at C being $= D_b + D_a$, S may be expressed in terms of a single vertical angle and C when observations have been taken at only one of the two points. C, the "contained arc," $= c\frac{\rho+\nu}{2\rho\nu}\operatorname{cosec} 1''$ in seconds. Putting D'_a and D'_b for the observed vertical angles, and ϕ_a, ϕ_b for the amounts by which they are affected by refraction, $D_a = D'_a + \phi_a$ and $D_b = D'_b + \phi_b$; ϕ_a and ϕ_b may differ in amount, but as they cannot be separately ascertained they are always assumed to be equal; the hypothesis is sufficiently exact for practical purposes when both verticals have been measured under similar atmospheric conditions. The refractions being taken equal, the observed verticals are substituted for the true in (15) to find S, and the difference of height is calculated by (16); the third term within the brackets of (14) is usually omitted. The mean value of the refraction is deduced from the formula

$$\phi=\tfrac{1}{2}\{C-D'_a+D'_b\} \qquad (17).$$

An approximate value is thus obtained from the observations between the pairs of reciprocating stations in each district, and the corresponding mean "coefficient of refraction," $\phi \div C$, is computed for the district, and is employed when heights have to be determined from observations at a single station only. When either of the vertical angles is an elevation $-E$ must be substituted for D in the above expressions.[1]

2. Levelling

Levelling is the art of determining the relative heights of points on the surface of the ground as referred to a hypothetical surface which cuts the direction of gravity everywhere at right angles. When a line of instrumental levels is begun at the sea-level, a series of heights is determined corresponding to what would be found by perpendicular measurements upwards from the surface of water communicating freely with the sea in underground channels; thus the line traced indicates a hypothetical prolongation of the surface of the sea inland, which is everywhere conformable to the earth's curvature.

The trigonometrical determination of the relative heights of points at known distances apart, by the measurements of their mutual vertical angles—is a method of levelling. But the method to which the term "levelling" is always applied is that of the direct determination of the differences of height from the readings of the lines at which graduated staves, held vertically over the points, are cut by the horizontal plane which passes through the eye of the observer. Each method has its own advantages. The former is less accurate, but best suited for the requirements of a general geographical survey, to obtain the heights of all the more prominent objects on the surface of the ground, whether accessible or not. The latter may be conducted with extreme precision, and is specially valuable for the determination of the relative levels, however minute, of easily accessible points, however numerous, which succeed each other at short intervals apart; thus it is very generally undertaken *pari passu* with geographical surveys to furnish lines of level for ready reference as a check on the accuracy of the trigonometrical heights. In levelling with staves the measurements are always taken from the horizontal plane which passes through the eye of the observer; but the line of levels which it is the object of the operations to trace is a curved line, everywhere conforming to the normal curvature of the earth's surface, and deviating more and more from the plane of reference as the distance from the station of observation increases. Thus, either a correction for curvature must be applied to every staff reading, or the instrument must be set up at equal distances from the staves; the curvature correction, being the same for each staff, will then be eliminated from the difference of the readings, which will thus give the true difference of level of the points on which the staves are set up.

Levelling has to be repeated frequently in executing a long line of levels—say seven times on an average in every mile—and must be conducted with precaution against various errors. Instrumental errors arise when the visual axis of the telescope is not perpendicular to the axis of rotation, and when the focusing tube does not move truly parallel to the visual axis on a change of focus. The first error is eliminated, and the second avoided, by placing the instrument at equal distances from the staves; and as this procedure has also the advantage of eliminating the corrections for both curvature and refraction, it should invariably be adopted.

[1] In topographical and levelling operations it is sometimes convenient to apply small corrections to observations of the height for curvature and refraction simultaneously. Putting d for the distance, r for the earth's radius, and κ for the coefficient of refraction, and expressing the distance and radius in miles and the correction to height in feet, then correction for curvature $=\tfrac{2}{3}d^2$; correction for refraction $= -\tfrac{4}{3}\kappa d^2$; correction for both $=\dfrac{2-4\kappa}{3}.d^2$.

Errors of staff readings should be guarded against by having the staves graduated on both faces, but differently figured, so that the observer may not be biased to repeat an error of the first reading in the second. The staves of the Indian survey have one face painted white with black divisions—feet, tenths and hundredths—from 0 to 10, the other black with white divisions from 5·55 to 15·55. Deflexion from horizontality may either be measured and allowed for by taking the readings of the ends of the bubble of the spirit-level and applying corresponding corrections to the staff readings, or be eliminated by setting the bubble to the same position on its scale at the reading of the second staff as at that of the first, both being equidistant from the observer.

Certain errors are liable to recur in a constant order and to accumulate to a considerable magnitude, though they may be too minute to attract notice at any single station, as when the work is carried on under a uniformly sinking or rising refraction—from morning to midday or from midday to evening—or when the instrument takes some time to settle down on its bearings after being set up for observation. They may be eliminated (i.) by alternating the order of observation of the staves, taking the back staff first at one station and the forward first at the next; (ii.) by working in a circuit, or returning over the same line back to the origin; (iii.) by dividing a line into sections and reversing the direction of operation in alternate sections. Cumulative error, not eliminable by working in a circuit, may be caused when there is much northing or southing in the direction of the line, for then the sun's light will often fall endwise on the bubble of the level, illuminating the outer edge of the rim at the nearer end and the inner edge at the farther end, and so biasing the observer to take scale readings of edges which are not equidistant from the centre of the bubble; this introduces a tendency to raise the south or depress the north ends of lines of level in the northern hemisphere. On long lines, the employment of a second observer, working independently over the same ground as the first, station by station, is very desirable. The great lines are usually carried over the main roads of the country, a number of "bench marks" being fixed for future reference. In the ordnance survey of Great Britain lines have been carried across from coast to coast in such a manner that the level of any common crossing point may be found by several independent lines. Of these points there are 166 in England, Scotland and Wales; the discrepancies met with at them were adjusted simultaneously by the method of minimum squares.

Sea-level.

The sea-level is the natural datum plane for levelling operations, more particularly in countries bordering on the ocean. The earliest surveys of coasts were made for the use of navigators and, as it was considered very important that the charts should everywhere show the minimum depth of water which a vessel would meet with, low water of spring-tides was adopted as the datum. But this does not answer the requirements of a land survey, because the tidal range between extreme high and low water differs greatly at different points on coast-lines. Thus the generally adopted datum plane for land surveys is the mean sea-level, which, if not absolutely uniform all the world over, is much more nearly so than low water. Tidal observations have been taken at nearly fifty points on the coasts of Great Britain, which were connected by levelling operations; the local levels of mean sea were found to differ by larger magnitudes than could fairly be attributed to errors in the lines of level, having a range of 12 to 15 in. above or below the mean of all at points on the open coast, and more in tidal rivers.[2] But the general mean of the coast stations for England and Wales was practically identical with that for Scotland. The observations, however, were seldom of longer duration than a fortnight, which is insufficient for an exact determination of even the short period components of the tides, and ignores the annual and semi-annual components, which occasionally attain considerable magnitudes. The mean sea-levels at Port Said in the Mediterranean and at Suez in the Red Sea have been found to be identical, and a similar identity is said to exist in the levels of the Atlantic and the Pacific oceans on the opposite coasts of the Isthmus of Panama. This is in favour of a uniform level all the world over; but, on the other hand, lines of level carried across the continent of Europe make the mean sea-level of the Mediterranean at Marseilles and Trieste from 2 to 5 ft. below that of the North Sea and the Atlantic at Amsterdam and Brest—a result which

[2] In tidal estuaries and rivers the mean water-level rises above the mean sea-level as the distance from the open coast-line increases; for instance, in the Hooghly river, passing Calcutta, there is a rise of 10 in. in 42 m. between Sagar (Saugor) Island at the mouth of the river and Diamond Harbour, and a further rise of 20 in. in 43 m. between Diamond Harbour and Kidderpur.

it is not easy to explain on mechanical principles. In India various tidal stations on the east and west coasts, at which the mean sea-level has been determined from several years' observations, have been connected by lines of level run along the coasts and across the continent; the differences between the results were in all cases due with greater probability to error generated in levelling over lines of great length than to actual differences of sea-level in different localities.

The sea-level, however, may not coincide everywhere with the geometrical figure which most closely represents the earth's surface, but may be raised or lowered, here and there, under the influence of local and abnormal attractions, presenting an equipotential surface—an ellipsoid or spheroid of revolution slightly deformed by bumps and hollows—which H. Bruns calls a "geoid." Archdeacon Pratt has shown that, under the combined influence of the positive attraction of the Himalayan Mountains and the negative attraction of the Indian Ocean, the sea-level may be some 560 ft. higher at Karachi than at Cape Comorin; but, on the other hand, the Indian pendulum operations have shown that there is a deficiency of density under the Himalayas and an increase under the bed of the ocean, which may wholly compensate for the excess of the mountain masses and deficiency of the ocean, and leave the surface undisturbed. If any bumps and hollows exist, they cannot be measured, instrumentally; for the instrumental levels will be affected by the local attractions precisely as the sea-level is, and will thus invariably show level surfaces even should there be considerable deviations from the geometrical figure.

Geoid or Deformed Surface.

3. Topographical Surveys

The skeleton framework of a survey over a large area should be triangulation, although it is frequently combined with traversing. The method of filling in the details is necessarily influenced to some extent by the nature of the framework, but it depends mainly on the magnitude of the scale and the requisite degree of minutiae. In all instances the principal triangles and circuit traverses have to be broken down into smaller ones to furnish a sufficient number of fixed points and lines for the subsequent operations. The filling in may be performed wholly by linear measurements or wholly by direction intersections, but is most frequently effected by both linear and angular measures, the former taken with chains and tapes and offset poles, the latter with small theodolites, sextants, optical squares or other reflecting instruments, magnetized needles, prismatic compasses and plane tables. When the scale of a survey is large, the linear and angular measures are usually recorded on the spot in a field-book and afterwards plotted in office; when small they are sometimes drawn on the spot on a plane table and the field-book is dispensed with.

In every country the scale is generally expressed by the ratio of some fraction or multiple of the smallest to the largest national units of length, but sometimes by the fraction which indicates the ratio of the length of a line on the paper to that of the corresponding line on the ground. The latter form is obviously preferable, being international and independent of the various units of length adopted by different nations (see Map). In the ordnance survey of Great Britain and Ireland and the Indian survey the double unit of the foot and the Gunter's link ($=\frac{66}{100}$ of a foot) are employed, the former invariably in the triangulation, the latter generally in the traversing and filling in, because of its convenience in calculations and measurements of area, a square chain of 100 Gunter's links being exactly one-tenth of an acre.

In the ordnance survey all linear measures are made with the Gunter's chain, all angular with small theodolites only; neither magnetized nor reflecting instruments nor plane tables are ever employed, except in hill sketching. As a rule the filling in is done by triangle-chaining only; traverses with theodolite and chain are occasionally resorted to, but only when it is necessary to work round woods and hill tracts across which right lines cannot be carried.

Detail surveying by triangles is based on the points of the minor triangulation. The sides are first chained perfectly straight, all the points where the lines of interior detail cross the sides being fixed; the alignment is effected with a small theodolite, and marks are established at the crossing points and at any other points on the sides where they may be of use in the subsequent operations. The surveyor is given a diagram of the triangulation, but no side lengths, as the accuracy of his chaining is tested by comparison with the trigonometrical values. Then straight lines are carried across the intermediate detail between the points established on the sides; they constitute the principal "cutting up or split lines"; their crossings of detail are marked in turn and straight lines are run between them. The process is continued until a sufficient number of lines and marks have been established on the ground to enable all houses, roads, fences, streams, railways, canals, rivers, boundaries and other details to be conveniently measured up to and fixed. Perpendicular offsets are limited to eighty and twenty links for the respective scales of 6 in. to a mile and $\frac{1}{2500}$.

When a considerable area has to be treated by traverses it is divided into a number of blocks of convenient size, bounded by roads, rivers or parish boundaries, and a "traverse on the meridian of the origin" is carried round the periphery of each block. Beginning at a trigonometrical station, the theodolite is set to circle reading 0° 0′ with the telescope pointing to the north, and at every "forward" station of the traverse the circle is set to the same reading when the telescope is pointed at the "back" station as was obtained at the back station when the telescope was pointing to the forward one. When the circuit is completed and the theodolite again put up at the origin and set on the last back station with the appropriate circle reading, the circle reading, with the telescope again pointed to the first forward station, will be the same as at first, if no error has been committed. This system establishes a convenient check on the accuracy of the operations and enables the angles to be readily protracted on a system of lines parallel to the meridian of the origin. As a further check the traverse is connected with all contiguous trigonometrical stations by measured angles and distances. Traverses are frequently carried between the points already fixed on the sides of the minor triangles; the initial side is then adopted, instead of the meridian, as the axis of co-ordinates for the plotting, the telescope being pointed with circle reading 0° 0′ to either of the trigonometrical stations at the extremities of the side.

The plotting is done from the field-books of the surveyors by a separate agency. Its accuracy is tested by examination on the ground, when all necessary addenda are made. The examiner —who should be surveyor, plotter and draughtsman—verifies the accuracy of the detail by intersections and productions and occasional direct measurements, and generally endeavours to cause the details under examination to prove the accuracy of each other rather than to obtain direct proof by remeasurement. He fixes conspicuous trees and delineates the woods, footpaths, rocks, precipices, steep slopes, embankments, &c., and supplies the requisite information regarding minor objects to enable a draughtsman to make a perfect representation according to the scale of the map. In examining a coast-line he delineates the foreshore and sketches the strike and dip of the stratified rocks. In tidal rivers he ascertains and marks the highest points to which the ordinary tides flow. The examiner on the 25·344 in. scale ($=\frac{1}{2500}$) is required to give all necessary information regarding the parcels of ground of different character—whether arable, pasture, wood, moor, moss, sandy—defining the limits of each on a separate tracing if necessary. He has also to distinguish between turnpike, parish and occupation roads, to collect all names, and to furnish notes of military, baronial and ecclesiastical antiquities to enable them to be appropriately represented in the final maps. The latter are subjected to a double examination—first in the office, secondly on the ground; they are then handed over to the officer in charge of the levelling to have the levels and contour lines inserted, and finally to the hill sketchers, whose duty it is to make an artistic representation of the features of the ground.

In the Indian survey all filling in is done by plane-tabling on a basis of points previously fixed; the methods differ simply in the extent to which linear measures are introduced to supplement the direction rays of the plane-table. When the scale of the survey is small, direct measurements of distance are rarely made and the filling is usually done wholly by direction intersections, which fix all the principal points, and by eye-sketching; but as the scale is increased linear measures with chains and offset poles are introduced to the extent that may be desirable. A sheet of drawing paper is mounted on cloth over the face of the plane-table; the points, previously fixed by triangulation or otherwise, are projected on it—the collateral meridians and parallels, or the rectangular co-ordinates, when these are more convenient for employment than the spherical, having first been drawn; the plane-table is then ready for use. Operations are begun at a fixed point by aligning with the sight rule on another fixed point, which brings the meridian line of the table on that of the station. The magnetic needle may now be placed on the table and a position assigned to it for future reference. Rays are drawn from the station point on the table to all conspicuous objects around with the aid of the sight rule. The table is then taken to other fixed points, and the process of ray-drawing is repeated at each; thus a number of objects, some of which may become available as stations of observation, are fixed. Additional stations may be established by setting up the table on a ray, adjusting it on the back station—that from which the ray was drawn—and then obtaining a cross intersection with the sight rule laid on some other fixed point, also by interpolating between three fixed points situated around the observer. The magnetic needle may not be relied on for correct orientation, but is of service in enabling the table to be set so nearly true at the outset that it has to be very slightly altered afterwards. The error in the setting is indicated by the rays from the surrounding fixed points intersecting in a small triangle instead of a point, and a slight change in azimuth suffices to reduce the triangle to a point, which will indicate the position of the station exactly. Azimuthal error being less apparent on short than on long lines, interpolation is best performed by rays drawn from near points, and checked by rays drawn to distant points, as the latter show most strongly the magnitude of any error of the primary magnetic setting. In this way, and by self-verificatory traverses "on the back ray" between fixed points, plane-table stations are established over the ground at appropriate intervals, depending on the scale of the survey; and from these stations all surrounding objects which the scale permits of being shown are laid down on the table, sometimes by rays only, sometimes by a single ray and a measured distance. The general configuration of the ground is delineated simultaneously. In *checking and examination* various methods are followed. For large scale work in plains it is customary to run arbitrary lines across it and make an independent survey of the belt of ground to a distance of a few chains on either side for comparison with the original survey; the smaller scale hill topography is checked by examination from commanding points, and also by traverses run across the finished work on the table.

4. Geographical Surveying

The introduction by mechanical means of superior graduation in instruments of the smaller class has enabled surveyors to effect good results more rapidly, and with less expenditure on equipment and on the staff necessary for transport in the field, than was formerly possible. The 12-in. theodolite of the present day, with micrometer adjustments to assist in the reading of minute subdivisions of angular graduation, is found to be equal to the old 24-in. or even 36-in. instruments. New Methods for the measurement of bases have largely superseded the laborious process of measurement by the alignment of "compensation" bars, though not entirely independent of them. The Jäderin apparatus, which consists of a wire 25 metres in length stretched along a series of cradles or supports, is the simplest means of measuring a base yet devised; and experiments with it at the Pulkova observatory show it to be capable of producing most accurate results. But there is a measurable defect in the apparatus, owing to the liability of the wires to change in length under variable conditions of temperature. It is therefore considered necessary, where base measurements for geodetic purposes are to be made with scientific exactness, that the Jäderin wires should be compared before and after use with a standard measurement, and this standard is best attained by the use of the Brunner, or Colby, bars. The direct process of measurement is not extended to such lengths as formerly, but from the ends of a shorter line, the length of which has been exactly determined, the base is extended by a process of triangulation.

Base Measurements.

There are vast areas in which, while it is impossible to apply the elaborate processes of first-class or "geodetic" triangulation, it is nevertheless desirable that we should rapidly acquire such geographical knowledge as will enable us to lay down political boundaries, to project roads and railways, and to attain such exact knowledge of special localities as will further military ends. Such surveys are called by various names—military surveys, first surveys, geographical surveys, &c.; but, inasmuch as they are all undertaken with the same end in view, *i.e.* the acquisition of a sound topographical map on various scales, and as that end serves civil purposes as much as military, it seems appropriate to designate them geographical surveys only.

Secondary Triangulation.

The governing principles of geographical surveys are rapidity and economy. Accuracy is, of course, a recognized necessity, but the term must admit of a certain elasticity in geographical work which is inadmissible in geodetic or cadastral functions. It is obviously foolish to expend as much money over the elaboration of topography in the unpeopled sand wastes which border the Nile valley, for instance (albeit those deserts may be full of topographical detail), as in the valley itself—the great centre of Egyptian cultivation, the great military highway of northern Africa. On the other hand, the most careful accuracy attainable in the art of topographical delineation is requisite in illustrating the nature of a district which immediately surrounds what may prove hereafter to be an important military position. And this, again, implies a class of technical accuracy which is quite apart from the rigid attention to detail of a cadastral survey, and demands a much higher intelligence to compass.

Principles which govern Geographical Surveys.

The technical principles of procedure, however, are the same in geographical as in other surveys. A geographical survey must equally start from a base and be supported by triangulation, or at least by some process analogous to triangulation, which will furnish the necessary skeleton on which to adjust the topography so as to ensure a complete and homogeneous map.

Methods of Survey.

This base may be found in a variety of ways. If geodetic triangulation exists in the country, that triangulation should of course include a wide extent of secondary determinations, the fixing of peaks and points in the landscape far away to either flank, which will either give the data for further extension of geographical triangulation, or which may even serve the purposes of the map-maker without any such extension at all. In this manner the Indus valley series of the triangulation of India has furnished the basis for surveys across Afghanistan and Baluchistan to the Oxus and Persia.

The Base.

Should no such preliminary determinations of the value of one or two starting-points be available, and it becomes necessary to measure a base and to work *ab initio*, the Jäderin wire apparatus may be adopted. It is cheap (cost about £50), and far more accurate than the process of measuring either by any known "subtense" system (in which the distance is computed from the angle subtended by a bar of given length) or by measurement with a steel chain. This latter method may, however, be adopted so long as the base can be levelled, repeated measurements obtained, and the chain compared with a standard steel tape before and after use.

The initial data on which to start a comprehensive scheme of triangulation for a geographical survey are: (1) latitude; (2) longitude; (3) azimuth; and (4) altitude, and this data should, if possible, be obtained *pari passu* with the measurement of the base.

Initial Data.

A 6-in. transit theodolite, fitted with a micrometer eyepiece and extra vertical wires, is the instrument *par excellence* for work of this nature; and it possesses the advantages of portability and comparative cheapness.

The method of using it for the purposes of determining values for (1) and (3), *i.e.* for ascertaining the latitude of one end of the base and the azimuth of the other end from it, are fully explained in Major Talbot's paper on *Military Surveying in the Field* (J. Mackay & Co., Chatham, 1889), which is not a theoretical treatise, but a practical illustration of methods employed successfully in the geographical survey of a very large area of the Indian transfrontier districts. It should be noted that these observations are not merely of an initial character. They should be constantly repeated as the survey advances, and under certain circumstances (referred to subsequently) they require daily repetition.

Latitude and Azimuth.

The problems connected with the determination of (2) longitude have of late years occupied much of the attention of scientific surveyors. No system of absolute determination is accurate enough for combination with triangulation, as affording a check on the accuracy of the latter, and the spaces in the world across which geographical surveying has yet to be carried are rapidly becoming too restricted to admit of any liability to error so great as is invariably involved in such determinations. It is true that absolute values derived from the observation of lunar distances, or occultations, have often proved to be of the highest value; but there remains a degree of uncertainty (possibly due to the want of *exact* knowledge of the moon's position at any instant of time), even when observations have been taken with all the advantages of the most elaborate arrangements and the most scientific manipulation, which renders the roughest form of triangulation more trustworthy for ascertaining differential longitude than any comparison between the absolute determination of any two points. Consequently, if an absolute determination is necessary it should be made *once*, with all possible care, and the value obtained should be carried through the whole scheme of triangulation. It rests with the surveyor to decide at what point of the general survey this value can best be introduced, provided he

Longitude.

can estimate the probable longitudinal value of his initial base within a few minutes of the truth. A final correction in longitude is constant, and can easily be applied. With reference to such absolute determinations of longitude, Major S. Grant's "Diagram for determining the parallaxes in declination and right ascension of a heavenly body and its application to the prediction of occultations" (*Roy. Geog. Soc. Journ.* for June 1896) will afford the observer valuable assistance.

Telegraph Determinations. But the recognized method of obtaining a longitude value in recent geographical fields is by means of the telegraph—a method so simple and so accurate that it may be applied with advantage even to the checking of long lines of triangulation. No effort should be spared to introduce a telegraphic longitude value into any scheme of geographical survey. It involves a clear line and an instructed observer at each end, but, given these desiderata, the interchange of time signals sufficient for an accurate record only requires a night or two of clear weather. But inasmuch as rigorous accuracy in the observations for time is necessary, it would be well for the surveyor in the field to be provided with a sidereal chronometer. Under all other circumstances demanding time observations (and they are an essential supplement to every class of astronomical determination) an ordinary mean time watch is sufficient.

Altitude. With reference to altitude determinations, there has lately been observable amongst surveyors a growing distrust of barometric results and a reaction in favour of direct levelling, or of differential results derived from direct observation with the theodolite (or clinometer) rather than from comparison of those determined by aneroid or hypsometer. It is indeed impossible to eliminate the uncertainties due to the variable atmospheric pressure introduced by "weather" changes from any barometric record. A mercurial barometer advantageously placed and carefully observed at fixed diurnal intervals throughout a comparatively long period may give fairly trustworthy results if a constant comparison can be maintained throughout that period with similar records at sea-level, or at any fixed altitude. Yet observations extending over several months have been found to yield results which compare most unfavourably with those attained during the process of triangulation by continued lines of vertical observations from point to point, even when the uncertainties of the correction for refraction are taken into account. Errors introduced into vertical observations by refraction are readily ascertainable and comparatively unimportant in their effect. Those due to variable atmospheric conditions on barometric records are still indefinite, and are likely to remain so. The result has been that the latter have been relegated to purely local conditions of survey, and that whenever practicable the former are combined with the general process of triangulation.

Conditions under which Geographical Surveys are carried out. The conditions under which geographical surveys can be carried out are of infinite variety, but those conditions are rare which absolutely preclude the possibility of any such surveys at all. Perfect freedom of action, and the recognition of such work as a public benefit, are not often attainable. Far more frequently the opportunity offers itself to the surveyor with the progress of a political mission or the advance of an army in the field. It cannot be too strongly insisted on that geographical surveys are functions of both civil and military operations. Very much of such work is also possible where a country lies open to exploration, not actively hostile, but yet unsettled and adverse to strangers. The geographical surveyor has to fit himself to all such conditions, and it may happen that a continuous, comprehensive scheme of triangulation as a map basis is impossible. Under such circumstances other expedients must be adopted to ensure that accuracy of position which cannot be attained by the topographer unaided.

Route Surveying. During a long-continued march extending through a line of country generally favourable for survey purposes—a condition which frequently occurs—when forward movement is a necessity, and an average of 10 to 15 m. of daily progress is maintained, one officer and an assistant can measure a daily base, obtain the necessary astronomical determinations, triangulate from both ends so as to fix the azimuth and distance from the base of points passed yesterday and those to be passed to-morrow; project those points on to the topographer's plane-table to be ready for the next day's work, and check each day's record by latitude; whilst a second assistant runs the topography through the route, basing his work on points so fixed, on the scale of 2 or 4 m. to the inch, according to the amount of detail. Occasionally a hill can be reached in the course of the day's march, or during a day's halt, which will materially assist to consolidate and strengthen the series.

Triangulation or Control. It may, however, frequently be impossible to maintain a consistent series of triangulation for the "control" (to use an American expression) of the topography, even when the configuration of the land surface is favourable. In such circumstances the method of observing azimuths to points situated approximately near to the probable route in advance, and of determining the exact position of those points in latitude as one by one they are passed by the moving force, has been found to yield results which are quite sufficiently accurate to ensure the final adjustment of the entire route geography to any subsequent system of triangulation which may be extended through the country traversed, without serious discrepancies in compilation. It is, however, obvious that as accuracy depends greatly on the exact determination of absolute latitude values, this method is best adapted to a route running approximately parallel to a meridian, and is at complete disadvantage in one running east and west. Where the conditions are favourable to its application, it has been adopted with most satisfactory results; as, for instance, on the route between Seistan and Herat, where the initial data for the Russo-Afghan boundary delimitation was secured by this means, and more recently on the boundary surveys of western Abyssinia.

Military Geography. When an active enemy is in the field, and topographical operations are consequently restricted, it is usually possible to obtain the necessary "control" (*i.e.* a few well-fixed points determined by triangulation) for topography in advance of a position securely held. With a very little assistance from the triangulator an experienced topographer will be able to sketch a field of action with far more certainty and rapidity than can be attained by the ordinary so-called "military surveyor," and he may, in favourable circumstances, combine his work with that of the military balloonist in such a way as to represent every feature of importance, even in a widely extended position held by the enemy. The application of the camera and of telephotography to the evolution of a map of the enemy's position is well understood in France (*vide* Colonel Laussedat's treatise on "The History of Topography"), as it is in Russia, and we must in future expect that all advantages of an expert and professional map of the whole theatre of a campaign will lie in the hands of the general who is best supplied with professional experts to compass them. Geographical surveying and military surveying are convertible terms, and it is important to note that both equally require the services of a highly trained staff of professional topographers. During the war between Russia and Turkey (1877–78) upwards of a hundred professional geographical surveyors were pressed into military service, besides the regular survey staff which is attached to every army corps. Triangulation was carried across the Balkans by eight different series; every pass and every notable feature of the Balkans and Rhodope Mountains was accurately surveyed, as well as the plains intervening between the Balkans and Constantinople. Surveys on a scale which averaged about 1 m. = 1 in. were carried up to the very gates of the city.

Photo-topography. The use of the camera as an accessory to the plane table (*i.e.* the art of photo-topography) has been applied almost exclusively to geographical or exploratory surveys. The camera is specially prepared, resting on a graduated horizontal plate which is read with verniers, and with a small telescope and vertical arc attached. Cross wires are fixed in the focal plane of the camera, which is also fitted with a magnetic needle and a scale so placed that the magnetic declination, the scale, and the intersection of the cross wires are all photographed on the plate containing the view. A panoramic group of views (slightly overlapping each other) is taken at each station, and the angular distance between each is measured on the horizontal circle. The process of constructing the horizontal projection from these perspective views involves plotting the skeleton triangulation, as obtained from the primary triangulation, with the theodolite (which precedes the photo-topographical survey), or from the horizontal plate of the camera. With several stations so plotted, the view from each of them of a certain portion of the country may be projected on the plane of the map, and salient points seen in perspective may be fixed by intersection.

The field work of a photo-topographic party consists primarily in execution of a triangulation by the usual methods which would be adapted to any ordinary topographical survey. To this is added a secondary triangulation, which is executed *pari passu* with the photography for the purpose of fixing the position of the camera stations. From such stations alone the topographical details are finally secured with the aid of the photographs. Great care is necessary in the selection of stations that will be suitable both for the extension of triangulation and the purposes of closely overlooking topographical details. In order to obtain means for correctly orienting the photographic views when plotting the map from them, it is usual, whilst making the exposures, to observe two or three points in each view with the alt-azimuth attached to the camera, in order to ascertain the horizontal and vertical angles between them. It is also advisable to keep an outline sketch of the landscape for the purpose of recording names of roads, buildings, &c.

The process of projecting the map from the photographs involves the use of two drawing-boards, on one of which the graphical determination of the points is made, and on the other the details of the final topography are drawn. The principal trigonometrical points are plotted on both these boards by their co-ordinates, and the camera stations either by their co-ordinate values or by intersection. Intermediate points, selected as appearing on two or more negatives, are then projected by intersection. The horizontal projection of a panorama consisting of any given number of plates is a regular geometrical figure of as many sides as there are plates, enclosing an inscribed circle whose radius is the focal length of the camera. Having correctly plotted the position of one plate, or view, with reference to the projected camera station by means of the angle observed to some known point within it, it is possible to plot the position of the rest of the series, with reference to the camera station and the orienting triangulation point, by the angular differences which are dependent on the number of photographs forming the sides of the geometrical figure. Having secured the correct orientation of the horizontal plan, direction lines are drawn from the plotted camera station to points photographed, and the position of topographical features is fixed by intersection from two or more camera stations.

Plane-table. The plane-table is the instrument, *par excellence*, on which the geographical surveyor must depend for the final mapping of the physical features of the country under survey. The methods of adapting the plane-table to geographical requirements differ with those varying climatic conditions which affect its construction. In the comparatively dry climate of Asiatic Russia or of the United States, where errors arising from the unequal expansion of the plane-table board are insignificant, the plane-table is largely made use of as a triangulating instrument, and is fitted with slow-motion screws and with other appliances for increasing the certainty and the accuracy of observations. Such an adaptation of the plane-table is found to be impossible in India, where the great alternations of temperature, no less than of atmospheric humidity, tend to vitiate the accuracy of the projections on the surface of the board by the unequal effects of expansion in the material of which it is composed. The Indian plane-table is of the simplest possible construction, and it is never used in connexion with the stadia for ascertaining the distances of points and features of the ground (as is the case in America); and in place of the complicated American alidade, with its telescope and vertical arc, a simple sight rule is used, and a chirometer for the measurement of vertical angles. The Indian plane-table approximates closely in general construction to the "Gannett" pattern of America, which is specially constructed for exploratory surveys.

Scale. The scale on which geographical surveys are conducted is necessarily small. It may be reckoned at from 1 : 500000 to 1 : 125000, or from 1 in. = 8 m. to 1 in. = 2 m. The 1 in. = 1 m. scale is the normal scale for rigorous topography, and although it is impossible to fix a definite line beyond which geographical scales merge into topographical (for instance, the 1-in. scale is classed as geographical in America whenever the continuous line contour system of ground representation gives place to hachuring), it is convenient to assume generally that geographical scales of mapping are smaller than the 1-in. scale.

Out-turn. On the smaller scales of 1 : 500000 or 1 : 250000 an experienced geographical surveyor, in favourable country, will complete an area of mapping from day to day which will practically cover nearly all that falls within his range of vision; and he will, in the course of five or six months of continuous travelling (especially if provided with the necessary "control") cover an area of geographical mapping illustrating all important topographical features representable on the small scale of his survey, which may be reckoned at tens of thousands of square miles. But inasmuch as everything depends upon his range of vision, and the constant occurrence of suitable features from which to extend it, there is obviously no guiding rule by which to reckon his probable out-turn.

Cost. The same uncertainty which exists about "out-turn" manifestly exists about "cost." The normal cost of the 1-in. rigorous topographical survey in India, when carried over districts which present an average of hills, plains and forests, may be estimated as between 35 to 40 shillings a square mile. This compares favourably with the rates which obtain in America over districts which probably present far more facilities for surveying than India does, but where cheap native labour is unknown. The geographical surveyor is simply a topographer employed on a smaller scale survey. His equipment and staff are somewhat less, but, on the other hand, his travelling expenses are greater. It is found that, on the whole, a fair average for the cost of geographical work may be struck by applying the square of the unit of scale as a factor to 1-in. survey rates; thus a quarter-inch scale survey (*i.e.* 4 m. to the in.), should be one-sixteenth of the cost per mile of the 1-in. survey over similar ground. A geographical reconnaissance on the scale of 1 : 500000 (8 m. = 1 in.) should be one-sixty-fourth of the square-mile cost of the 1-in. survey, &c. This is, indeed, a close approximation to the results obtained on the Indian transfrontier, and would probably be found to hold good for British colonial possessions.

Map Reproduction. In processes of map reproduction an invention for the reproduction of drawings by a method of direct printing on zinc without the intervention of a negative has proved of great value. By this method a considerable quantity of work has been turned out in much less time and at a much lower cost than would be involved by any process of photo-zincography or lithography. A large number of cadastral maps have been reproduced at about one-ninth of the ordinary cadastral rate.

For the rapid reproduction of geographical maps in the field in order to meet the requirements of a general conducting a campaign, or of a political officer on a boundary mission, no better method has been evolved than the ferrotype process, by which blue prints can be secured in a few hours from a drawing of the original on tracing-cloth. The sensitized paper and printing-frame are far more portable than any photo-lithographic apparatus. Sketches illustrative of a field of action may be placed in the hands of the general commanding on the day following the action, if the weather conditions are favourable for their development. The necessity for darkness whilst dealing with the sensitized material is a drawback, but it may usually be arranged with blankets and waterproof sheets when a tent is not available.

5. Traversing and Fiscal, or Revenue, Surveys

Traversing is a combination of linear and angular measures in equal proportions; the surveyor proceeds from point to point, measuring the lines between them and at each point the angle between the back and forward lines; he runs his lines as much as possible over level and open ground, avoiding obstacles by working round them. The system is well suited for laying down roads, boundary lines, and circuitous features of the ground, and is very generally resorted to for filling in the interior details of surveys based on triangulation. It has been largely employed in certain districts of British India, which had to be surveyed in a manner to satisfy fiscal as well as topographical requirements; for, the village being the administrative unit of the district, the boundary of every village had to be laid down, and this necessitated the survey of an enormous number of circuits. Moreover, the traverse system was better adapted for the country than a network of triangulation, as the ground was generally very flat and covered with trees, villages, and other obstacles to distant vision, and was also devoid of hills and other commanding points of view. The principal triangulation had been carried across it, but by chains executed with great difficulty and expense, and therefore at wide intervals apart, with the intention that the intermediate spaces should be provided with points as a basis for the general topography in some other way. A system of traverses was obviously the best that could be adopted under the circumstances, as it not only gave all the village boundaries, but was practically easier to execute than a network of minor triangulation.

In the Indian survey the traverses are executed in minor circuits following the periphery of each village and in major circuits comprising groups of several villages; the former are done with 4″ to 6″ theodolites and a single chain, the latter with 7″ to 10″ theodolites and a pair of chains, which are compared frequently with a standard. The main circuits are connected with every station of the principal triangulation within reach. The meridian of the origin is determined by astronomical observations; the angle at the origin between the meridian and the next station is measured, and then at each of the successive stations the angle between the immediately preceding and following stations; summing these together, the "inclinations" of the lines between the stations to the meridian of the origin are successively determined. The distances between the stations, multiplied by the cosines and sines of the inclinations, give the distance of each station from the one preceding it, resolved in the directions parallel and perpendicular respectively to the meridian of the origin; and the algebraical sums of these quantities give the corresponding rectangular co-ordinates of the successive stations relatively to the origin and its meridian. The area included in any circuit is expressed by the formula

area = half algebraical sum of products $(x_1+x_2)\ (y_2-y_1)$ (18),

x_1, y_1 being the co-ordinates of the first, and x_2, y_2 those of the second station, of every line of the traverse in succession round the circuit.

Of geometrical tests there are two, both applicable at the close of a circuit: the first is angular, viz. the sum of all the interior angles of the described polygon should be equal to twice as many right angles as the figure has sides, less four; the second is linear, viz. the algebraical sum of the x co-ordinates and that of the y co-ordinates should each be $=0$. The astronomical test is this: at any station of the traverse the azimuth of a referring mark may be determined by astronomical observations; the inclination of the line between the station and the referring mark to the meridian of the origin is given by the traverse; the two should differ by the convergency of the meridians of the station and the origin. In practice the angles of the traverse are usually adjusted to satisfy their special geometrical and astronomical tests in the first instance, and then the co-ordinates of the stations are calculated and adjusted by corrections applied to the longest, that the angles may be least disturbed, as no further corrections are given them.

Convergency of Meridians.

The exact value of the convergence, when the distance and azimuth of the second astronomical station from the first are known, is that of $B-(\pi+A)$ of equation (5); but, as the first term is sufficient for a traverse, we have

$$\text{convergency} = x \tan \lambda \frac{\operatorname{cosec} 1''}{\nu},$$

substituting x, the co-ordinate of the second station perpendicular to the meridian of the origin, for $c \sin A$.

Adjustment of Traverses to Triangulation.

The co-ordinates of the principal stations of a trigonometrical survey are usually the spherical co-ordinates of latitude and longitude; those of a traverse survey are always rectangular, plane for a small area but spherical for a large one. It is often necessary, therefore, for purposes of comparison and check at stations common to surveys of both descriptions, to convert either rectangular co-ordinates into latitudes and longitudes, or vice versa, in order that the errors of traverses may be dispersed by proportion over the co-ordinates of the traverse stations, if desired, or adjusted in the final mapping. The latter is generally all that is necessary, more particularly when the traverses are referred to successive trigonometrical stations as origins, as the operations are being extended, in order to prevent any large accumulation of error. Similar conversions are also frequently necessary in map projections. The method of effecting them will now be indicated.

Transformation of Co-ordinates.

Let A and B be any two points, Aa the meridian of A, Bb the parallel of latitude of B; then Ab, Bb will be their differences in latitude and longitude; from B draw BP perpendicular to Aa; then AP, BP will be the rectangular spherical co-ordinates of B relatively to A. Put $BP=x$, $AP=y$, the arc $Pb=\eta$, and the arc Bb, the difference of longitude, $=\omega$; also let λ_a, λ_b and λ_p be the latitudes of A, B, and the point P, ρ_p the radius of curvature of the meridian, and ν_p the normal terminating in the axis minor for the latitude λ_p; and let ρ_0 be the radius of curvature for the latitude $\frac{1}{2}(\lambda_a+\lambda_p)$. Then, when the rectangular co-ordinates are given, we have, taking A as the origin, the latitude of which is known,

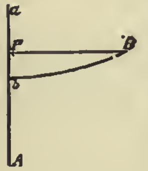

FIG. 5.

$$\left.\begin{aligned} \lambda_p &= \lambda_a + \frac{y}{\rho_0}\operatorname{cosec} 1''; \quad \eta = \frac{x^2}{2\rho_p\nu_p}\tan \lambda_p \operatorname{cosec} 1''; \\ \lambda_b - \lambda_a &= \frac{y}{\rho_0}\operatorname{cosec} 1'' - \eta; \quad \omega = \frac{x}{\nu_p}\sec(\lambda_b + \tfrac{1}{3}\eta) \operatorname{cosec} 1'' \end{aligned}\right\} \quad (19).$$

And, when the latitude and longitude are given, we have [1]

$$\left.\begin{aligned} \eta &= \left(\frac{\omega}{2}\right)^2 \frac{\nu_b}{\rho_b} \sin 2\lambda_b \sin 1'' \\ y &= \rho_0\{\lambda_b - \lambda_a + \eta\} \sin 1'' \\ x &= \omega\nu_p \cos(\lambda_b + \tfrac{1}{3}\eta) \sin 1'' \end{aligned}\right\} \quad (20).$$

Co-ordinates of Unvisited Point.

When a hill peak or other prominent object has been observed from a number of stations whose co-ordinates are already fixed, the converging rays may be projected graphically, and from an examination of their several intersections the most probable position of the object may be obtained almost as accurately as by calculations by the method of least squares, which are very laborious and out of place for the determination of a secondary point. The following is a description of the application of this method to points on a plane surface in the calculations of the ordnance survey. Let s_1, s_2, . . . be stations whose rectangular co-ordinates, x_1, x_2, . . . perpendicular, and y_1, y_2, . . . parallel, to the meridian of the origin are given; let a_1, a_2, . . . be the bearings—here the direction-inclinations with the meridian of the origin—of any point P, as observed at the several stations; and let p be an approximate position of P, with co-ordinates x_p, y_p, as determined by graphical projection on a district map or by rough calculation. Construct a diagram of the rays converging around p, by taking a point to represent p and drawing two lines through it at right angles to each other to indicate the directions of north, south, east and west. Calculate accurately $(y_p-y_1)\tan a_1$, and compare with (x_p-x_1); the difference will show how far the direction of the ray from s_1 falls to the east or west of p. Or calculate $(x_p-x_1)\cot a_1$, and compare with (y_p-y_1) to find how far the direction falls to the north or south of p. Set off the distance on the corresponding axis of p, and through

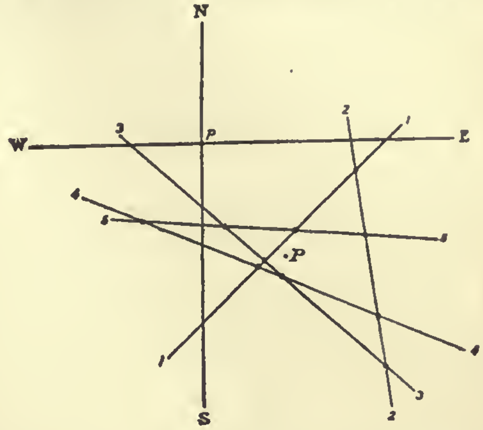

FIG. 6.

the point thus fixed draw the direction a_1 with a common protractor. All the other rays around p may be drawn in like manner; they will intersect each other in a number of points, the centre of which may be adopted as the most probable position of P. The co-ordinates of P will then be readily obtained from those of $p\pm$the distances on the meridian and perpendicular. In the annexed diagram (fig. 6) P is supposed to have been observed from five stations, giving as many intersecting rays, (1, 1), (2, 2), . . . ; there are ten points of intersection, the mean position of which gives the true position of P, the assumed position being p. The advantages claimed for the method are that, the bearings being independent, an erroneous bearing may be redrawn without disturbing those that are correct; similarly new bearings may be introduced without disturbing previous work, and observations from a large number of stations may be readily utilized, whereas, when calculation is resorted to, observations in excess of the minimum number required are frequently rejected because of the labour of computing them.

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(T. H. H.*)

6. NAUTICAL SURVEYING

The great majority of nautical surveys are carried out by H.M. surveying vessels under the orders of the hydrographer of the admiralty. Plans of harbours and anchorages are also received from H.M. ships in commission on foreign stations, but surveys of an extended nature can hardly be executed except by a ship specially fitted and carrying a trained staff of officers. The introduction of steam placed means at the disposal of nautical surveyors which largely modified the conditions under which they had to work in the earlier days of sailing vessels, and it has enabled the ship to be used in various ways previously impracticable. The heavy draught of ships in the present day, the growing increase of ocean and coasting traffic all over the world, coupled with the desire to save distance by rounding points of land and other dangers as closely as possible, demand surveys on larger scales and in greater detail than was formerly necessary; and to meet these modern requirements resurveys of many parts of the world are continually being called for. Nautical surveys vary much in character according to the nature of the work, its importance to navigation, and the time available. The elaborate methods and rigid accuracy of a triangulation for geodetic purposes on shore are unnecessary,

[1] In the Indian survey, tables are employed for these calculations which give the value of 1″ of arc in feet on the meridian, and on each parallel of latitude, at intervals of 5′ apart; also a corresponding table of arc-versines (Pb) of spheroidal arcs of parallel (Bb) 1° in length, from which the arc-versines for shorter or longer arcs are obtained proportionally to the squares of the arcs; x is taken as the difference of longitude converted into linear measure.

and are not attempted; astronomical observations at intervals in an extended survey prevent any serious accumulation of errors consequent upon a triangulation which is usually carried out with instruments, of which an 8-in. theodolite is the largest size used, whilst 5-in. theodolites generally suffice, and the sextant is largely employed for the minor triangulation. The scales upon which nautical surveys are plotted range from ½ in. to 2 or 3 in. to the sea-mile in coast surveys for the ordinary purposes of navigation, according to the requirements; for detailed surveys of harbours or anchorages a scale of from 6 to 12 in. is usually adopted, but in special cases scales as large as 60 in. to the mile are used.

Instruments.

The following are the principal instruments required for use in the field: *Theodolite*, 5 in., fitted with large telescope of high power, with coloured shades to the eye-piece for observing the sun for true bearings. *Sextant*, 8 in. observing, stand and artificial horizon. *Chronometers*, eight box, and two or three pocket, are usually supplied to surveying vessels. *Sounding sextants*, differing from ordinary sextants in being lighter and handier. The arc is cut only to minutes, reading to large angles of as much as 140°, and fitted with a tube of bell shape so as to include a large field in the telescope, which is of high power. *Measuring chain* 100 ft. in length. *Ten-foot pole* for coast-lining, is a light pole carrying two oblong frames, 18 in. by 24 in., covered with canvas painted white, with a broad vertical black stripe in the centre and fixed on the pole 10 ft. apart. *Station-pointer*, an instrument in constant requisition either for sounding, coast-lining, or topographical plotting, which enables an observer's position to be fixed by taking two angles between three objects suitably situated. The movable legs being set to the observed angles, and placed on the plotting sheet, the chamfered edges of the three legs are brought to pass through the points observed. The centre of the instrument then indicates the observer's position. *Heliostats*, for reflecting the rays of the sun from distant stations to indicate their position, are invaluable. The most convenient form is Galton's sun signal; but an ordinary swing mirror, mounted to turn horizontally, will answer the purpose, the flash being directed from a hole in the centre of the mirror. *Pocket aneroid barometer*, required for topographical purposes. *Prismatic compass*, *patent logs* (taffrail and harpoon), *Lucas wire sounding machine* (large and small size), and *James's submarine sentry* are also required. For chart-room use are provided a graduated brass scale, steel straight-edges and beam compasses of different lengths, rectangular vulcanite or ivory protractors of 6-in. and 12-in. length, and semicircular brass protractors of 10-in. radius, a box of good mathematical drawing instruments, lead weights, drawing boards and mounted paper.

Marks and Beacons.

Every survey must have fixed objects which are first plotted on the sheet, and technically known as "points." A keen eye is required for natural marks of all kinds, but these must often be supplemented by whitewash marks, cairns, tripods or bushes covered with white canvas or calico, and flags, white or black according to background. On low coasts, flagstaffs upwards of 80 ft. high must sometimes be erected in order to get the necessary range of vision, and thereby avoid the evil of small triangles, in working through which errors accumulate so rapidly. A barling spar 35 ft. in length, securely stayed and carrying as a topmast (with proper guys) a somewhat lighter spar, lengthened by a long bamboo, will give the required height. A *fixed beacon* can be erected in shallow water, 2 to 3 fathoms in depth, by constructing a tripod of spars about 45 ft. long. The heads of two of them are lashed together, and the heels kept open at a fixed distance by a plank about 27 ft. long, nailed on at about 5 ft. above the heels of the spars. These are taken out by three boats, and the third tripod leg lashed in position on the boats, the heel in the opposite direction to the other two. The first two legs, weighted, are let go together; using the third leg as a prop, the tripod is hauled into position and secured by guys to anchors, and by additional weights slipped down the legs. A vertical pole with bamboo can now be added, its weighted heel being on the ground and lashed to the fork. On this a flag 14 ft. square may be hoisted. *Floating beacons* can be made by filling up flush the heads of two 27-gallon casks, connected by nailing a piece of thick plank at top and bottom. A barling spar passing through holes cut in the planks between the casks, projecting at least 20 ft. below and about 10 ft. above them, is toggled securely by iron pins above the upper and below the lower plank. To the upper part of the spar is lashed a bamboo, 30 to 35 ft. long, carrying a black flag 12 to 16 ft. square, which will be visible from the ship 10 m. in clear weather. The ends of a span of ½-in. chain are secured round the spar above and below the casks with a long link travelling upon it, to which the cable is attached by a slip, the end being carried up and lightly stopped to the bamboo below the flag. A wire strop, kept open by its own stiffness, is fitted to the casks for convenience in slipping and picking up. The beacon is moored with chain and rope half as long again as the depth of water. Beacons have been moored by sounding line in as great depth as 3000 fathoms with a weight of 100 lb.

"Fixing."

There is nothing in a nautical survey which requires more attention than the "fix"; a knowledge of the principles involved is essential in order to select properly situated objects. The method of fixing by two angles between three fixed points is generally known as the "two-circle method," but there are really three circles involved. The "station-pointer" is the instrument used for plotting fixes. Its contruction depends upon the fact that angles subtended by the chord of a segment of a circle measured from any point in its circumference are equal. The lines joining three fixed points form the chords of segments of three circles, each of which passes through the observer's position and two of the fixed points. The more rectangular the angle at which the circles intersect each other, and the more sensitive they are, the better will be the fix; one condition is useless without the other. A circle is "sensitive" when the angle between the two objects responds readily to any small movement of the observer towards or away from the centre of the circle passing through the observer's position and the objects. This is most markedly the case when one object is very close to the observer and the other very distant, but not so when *both* objects are distant. Speaking generally, the sensibility of angles depends upon the relative distance of the two objects from the observer, as well as the absolute distance of the nearer of the two. In the accompanying diagram A, B, C are the objects, and X the observer. Fig. 7 shows the circle passing through C, B and X, cutting the circle ABX at a good angle, and therefore fixing X independently of the circle CAX, which is less sensitive than either of the other two. In fig. 8 the two first circles are very sensitive, but being nearly tangential

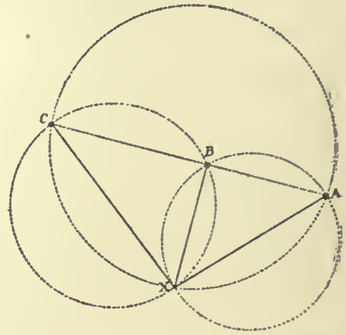

FIG. 7.

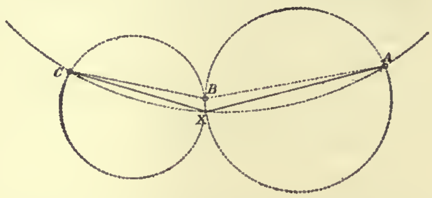

FIG. 8.

they give no cut with each other. The third circle cuts both at right angles; it is, however, far less sensitive, and for that reason if the right and left hand objects are both distant the fix must be bad. In such a case as this, because the angles CXB, BXA are both so sensitive, and the accuracy of the fix depends on the precision with which the angle CXA is measured, that angle should be observed direct, together with one of the other angles composing it. Fig. 9 represents a case where the points are badly disposed, approaching the condition known as "on the circle," passing through the three points. All three circles cut one another at such a fine angle as to give a very poor fix. The centre of the station-pointer could be moved considerably without materially affecting the coincidence of the legs with the three points. To avoid a bad fix the following rules are safe:—

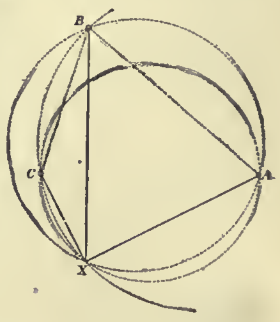

FIG. 9.

1. Never observe objects of which the central is the furthest unless it is *very* distant relatively to the other two, in which case the fix is admissible, but must be used with caution.

2. Choose objects disposed as follows: (*a*) One outside object distant and the other two near, the angle between the two near

objects being not less than 30° or more than 140°. The amount of the angle between the middle and distant object is immaterial. (*b*) The three objects nearly in a straight line, the angle between any two being not less than 30°. (*c*) The observer's position being inside the triangle formed by the objects.

A fix on the line of two points in transit, with an angle to a third point, becomes more sensitive as the distance between the transit points increases relatively to the distance between the front transit point and the observer; the more nearly the angle to the third point approaches a right angle, and the nearer it is situated to the observer, the better the fix. If the third point is at a long distance, small errors either of observation or plotting affect the result largely. A good practical test for a fix is afforded by noticing whether a very slight movement of the centre of the station-pointer will throw one or more of the points away from the leg. If it can be moved without appreciably disturbing the coincidence of the leg and all three points, the fix is bad.

Tracing-paper answers exactly the same purpose as the station-pointer. The angles are laid off from a centre representing the position, and the lines brought to pass through the points as before. This entails more time, and the angles are not so accurately measured with a small protractor. Nevertheless this has often to be used, as when points are close together on a small scale the central part of the station-pointer will often hide them and prevent the use of the instrument. The use of tracing-paper permits any number of angles to different points to be laid down on it, which under certain conditions of fixing is sometimes a great advantage.

Bases. Although marine surveys are in reality founded upon triangulation and measured bases of some description, yet when plotted irregularly the system of triangles is not always apparent. The triangulation ranges from the rough triangle of a running survey to the carefully formed triangles of detailed surveys. The measured base for an extended survey is provisional only, the scale resting ultimately mainly upon the astronomical positions observed at its extremes. In the case of a plan the base is absolute. The main triangulation, of which the first triangle contains the measured base as its known side, establishes a series of points known as main stations, from which and to which angles are taken to fix other stations. A sufficiency of secondary stations and marks enables the detail of the chart to be filled in between them. The points embracing the area to be worked on, having been plotted, are transferred to field boards, upon which the detail of the work in the field is plotted; when complete the work is traced and re-transferred to the plotting-sheet, which is then inked in as the finished chart, and if of large extent it is graduated on the gnomonic projection on the astronomical positions of two points situated near opposite corners of the chart.

The kind of base ordinarily used is one measured by chain on flat ground, of ½ to 1½ m. in length, between two points visible from one another, and so situated that a triangulation can be readily extended from them to embrace other points in the survey forming well-conditioned triangles. The error of the chain is noted before leaving the ship, and again on returning, by comparing its length with the standard length of 100 ft. marked on the ship's deck. The correction so found is applied to obtain the final result. If by reason of water intervening between the base stations it is impossible to measure the direct distance between them, it is permissible to deduce it by traversing.

A Masthead Angle Base is useful for small plans of harbours, &c., when circumstances do not permit of a base being measured on shore. The ship at anchor nearly midway between two base stations is the most favourable condition for employing this method. Theodolite reading of the masthead with its elevation by sextant observed simultaneously at each base station (the mean of several observations being employed) give the necessary data to calculate the distance between the base stations from the two distances resulting from the elevation of the masthead and the simultaneous theodolite-angles between the masthead and the base stations. The height of the masthead may be temporarily increased by securing a spar to extend 30 ft. or so above it, and the exact height from truck to netting is found by tricing up the end of the measuring chain. The angle of elevation should not be diminished below about 1° from either station.

Base by Sound.—The interval in seconds between the flash and report of a gun, carefully noted by counting the beats of a watch or pocket chronometer, multiplied by the rate per second at which sound travels (corrected for temperature) supplies a means of obtaining a base which is sometimes of great use when other methods are not available. Three miles is a suitable distance for such a base, and guns or small brass Cohorn mortars are fired alternately from either end, and repeated several times. The arithmetical mean is not strictly correct, owing to the retardation of the sound against the wind exceeding the acceleration when travelling with it; the formula used is therefore $T = \frac{2tt'}{t+t'}$ where T is the mean interval required, t the interval observed one way, t' the interval the other way. The method is not a very accurate one, but is sufficiently so when the scale is finally determined by astronomical observations, or for sketch surveys. The measurement should be across the wind if possible, especially if guns can only be fired from one end of the base. Sound travels about 1090 ft. per second at a temperature of 32° F., and increases at the rate of 1·15 ft. for each degree above that temperature, decreasing in the same proportion for temperatures below 32°.

Base by Angle of Short Measured Length.—An angle measured by sextant between two well-defined marks at a carefully measured distance apart, placed at right angles to the required base, will give a base for a small plan.

Astronomical Base.—The difference of latitude between two stations visible from each other and nearly in the same meridian, combined with their true bearings, gives an excellent base for an extended triangulation; the only drawback to it is the effect of local attraction of masses of land in the vicinity on the pendulum, or, in other words, on the mercury in the artificial horizon. The base stations should be as far apart as possible, in order to minimize the effect of any error in the astronomical observations. The observation spots would not necessarily be actually at the base stations, which would probably be situated on summits at some little distance in order to command distant views. In such cases each observation spot would be connected with its corresponding base station by a subsidiary triangulation, a short base being measured for the purpose. The ship at anchor off the observation spot frequently affords a convenient means of effecting the connexion by a masthead angle base and simultaneous angles. If possible, the observation spots should be east or west of the mountain stations from which the true bearings are observed.

If the base stations A and B are so situated that by reason of distance or of high land intervening they are invisible from one another, but both visible from some main station C between them, when the main triangulation is completed, the ratio of the sides AC, BC can be determined. From this ratio and the observed angle ACB, the angles ABC, BAC can be found. The true bearing of the lines AC or BC being known, the true bearing of the base stations A and B can be deduced.

Extension of Base.—A base of any description is seldom long enough to plot from directly, and in order to diminish errors of plotting it is necessary to begin on the longest side possible so as to work *inwards*. A short base measured on flat ground will give a better result than a longer one measured over inequalities, provided that the triangulation is carefully extended by means of judiciously selected triangles, great care being taken to plumb the centre of each station. To facilitate the extension of the base in as few triangles as possible, the base should be placed so that there are two stations, one on each side of it, subtending angles at them of from 30° to 40°, and the distances between which, on being calculated in the triangles of the quadrilateral so formed, will constitute the first extension of the base. Similarly, two other stations placed one on each side of the last two will form another quadrilateral, giving a yet longer side, and so on.

Main Triangulation. The angles to be used in the main triangulation scheme must be very carefully observed and the theodolite placed exactly over the centre of the station. Main angles are usually repeated several times by resetting the vernier at intervals equidistant along the arc, in order to eliminate instrumental errors as well as errors of observation. The selection of an object suitable for a zero is important. It should, if possible, be another main station at some distance, but not so far or so high as to be easily obscured, well defined, and likely to be permanent. Angles to secondary stations and other marks need not be repeated so many times as the more important angles, but it is well to check all angles once at least. Rough sketches from all stations are of great assistance in identifying objects from different points of view, the angles being entered against each in the sketch.

False Station.—When the theodolite cannot for any reason be placed over the centre of a station, if the distance be measured and the theodolite reading of it be noted, the observed angles may be reduced to what they would be at the centre of the station. False stations have frequently to be made in practice; a simple rule to meet all cases is of great assistance to avoid the possibility of error in applying the correction with its proper sign. This may very easily be found as follows, without having to bestow a moment's thought beyond applying the rule, which is a matter of no small gain in time when a large number of angles have to be corrected.

Rule.—Put down the theodolite reading which it is required to correct (increased if necessary by 360°), and from it subtract the theodolite reading of the centre of the station. Call this remainder θ. With θ as a "course" and the number of feet from the theodolite to the station as a "distance," enter the traverse table and take out the greater increment if θ lies between 45° and 135°, or between 225° and 315°, and the lesser increment for other angles. The accompanying diagram (fig. 10) will assist the memory. Refer this increment to the "table of subtended angles by various lengths at different distances" (using the distance of the object observed) and find the corresponding correction in arc, which mark + or − according as θ is under or over 180°. Apply this correction to the observed theodolite angle. A "table of subtended angles" is unnecessary if the formula

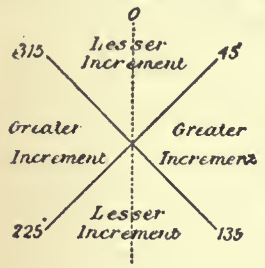

Fig. 10.

$$\text{Angle in seconds} = \frac{\text{number of feet subtended} \times 34}{\text{distance of object in sea-miles}}$$ be used instead.

Convergency of Meridians.—The difference of the reciprocal true bearings between two stations is called the "convergency." The formula for calculating it is: Conv. in minutes = dist. in sea-miles × sin. Merc. bearing × tan. mid. lat. Whenever true bearings are used in triangulation, the effect of convergency must be considered and applied. In north latitudes the southerly bearing is the greater of the two, and in south latitudes the northerly bearing. The Mercatorial bearing between two stations is the mean of their reciprocal true bearings.

Triangulated Coast Survey.

After a preliminary run over the ground to note suitable positions for main and secondary stations on prominent headlands, islands and summits not too far back from the coast, and, if no former survey exists, to make at the same time a rough plot of them by compass and patent log, a scheme must be formed for the main triangulation with the object of enclosing the whole survey in as few triangles as possible, regard being paid to the limit of vision of each station due to its height, to the existing meteorological conditions, to the limitations imposed by higher land intervening, and to its accessibility. The triangles decided upon should be well-conditioned, taking care not to introduce an angle of less than 30° to 35°, which is only permissible when the two longer sides of such a triangle are of nearly equal length, and when in the calculation that will follow one of these sides shall be derived from the other and not from the short side. In open country the selection of stations is comparatively an easy matter, but in country densely wooded the time occupied by a triangulation is mainly governed by the judicious selection of stations quickly reached, sufficiently elevated to command distant views, and situated on summits capable of being readily cleared of trees in the required direction, an all-round view being, of course, desirable but not always attainable. The positions of secondary stations will also generally be decided upon during the preliminary reconnaissance. The object of these stations is to break up the large primary triangles into triangles of smaller size, dividing up the distances between the primary stations into suitable lengths; they are selected with a view to greater accessibility than the latter, and should therefore usually be near the coast and at no great elevation. Upon shots from these will depend the position of the greater number of the coast-line marks, to be erected and fixed as the detailed survey of each section of the coast is taken in hand in regular order. The nature of the base to be used, and its position in order to fulfil the conditions specified under the head of *Bases* must be considered, the base when extended forming a side of one of the main triangles. It is immaterial at what part of the survey the base is situated, but if it is near one end, a satisfactory check on the accuracy of the triangulation is obtained by comparing the length of a side at the other extreme of the survey, derived by calculation through the whole system of triangles, with its length deduced from a check base measured in its vicinity. It is generally a saving of time to measure the base at some anchorage or harbour that requires a large scale plan. The triangulation involved in extending the base to connect it with the main triangulation scheme can thus be utilized for both purposes, and while the triangulation is being calculated and plotted the survey of the plan can be proceeded with. True bearings are observed at both ends of the survey and the results subsequently compared. Astronomical observations for latitude are obtained at observation spots near the extremes of the survey and the meridian distance run between them, the observation spots being connected with the primary triangulation; they are usually disposed at intervals of from 100 to 150 m., and thus errors due to a triangulation carried out with theodolites of moderate diameter do not accumulate to any serious extent. If the survey is greatly extended, intermediate observation spots afford a satisfactory check, by comparing the positions as calculated in the triangulation with those obtained by direct observation.

Calculating the Triangulation.—The triangles as observed being tabulated, the angles of each triangle are corrected to bring their sum to exactly 180°. We must expect to find errors in the triangles of as much as one minute, but under favourable conditions they may be much less. In distributing the errors we must consider the general skill of the observer, the size of his theodolite relatively to the others, and the conditions under which his angles were observed; failing any particular reason to assign a larger error to one angle than to another, the error must be divided equally, bearing in mind that an alteration in the small angle will make more difference in the resulting position than in either of the other two, and as it approaches 30° (the limit of a receiving angle) it is well to change it but very slightly in the absence of any strong reason to the contrary. The length of base being determined, the sides of all the triangles involved are calculated by the ordinary rules of trigonometry. Starting from the true bearing observed at one end of the survey, the bearing of the side of each triangle that forms the immediate line of junction from one to the other is found by applying the angles necessary for the purpose in the respective triangles, not forgetting to apply the convergency between each pair of stations when reversing the bearings. The bearing of the final side is then compared with the bearing obtained by direct observation at that end of the survey. The difference is principally due to accumulated errors in the triangulation; half of the difference is then applied to the bearing of each side. Convert these true bearings into Mercatorial bearings by applying half the convergency between each pair of stations. With the lengths of the connecting sides found from the measured base and their Mercatorial bearing, the Mercatorial bearing of one observation spot from the other is found by middle latitude sailing. Taking the observed astronomical positions of the observation spots and first reducing their true difference longitude to departure, as measured on a spheroid from the formula Dep. = T. D. long. $\frac{\text{no. ft. in 1 m. of long.}}{\text{no. ft. in 1 m. of lat.}}$, then with the d. lat. and dep. the Mercatorial true bearing and distance between the observation spots is calculated by middle latitude sailing, and compared with that by triangulation and measured base. To adjust any discrepancy, it is necessary to consider the probable error of the observations for latitude and meridian distance; within those limits the astronomical positions may safely be altered in order to harmonize the results; it is more important to bring the bearings into close agreement than the distance. From the amended astronomical positions the Mercatorial true bearings and distance between them are re-calculated. The difference between this Mercatorial bearing and that found from the triangulation and measured base must be applied to the bearing of each side to get the final corrected bearings, and to the logarithm of each side of the triangulation as originally calculated must be added or subtracted the difference between the logarithms of the distance of the amended positions of the observation spots and the same distance by triangulation.

Calculating Intermediate Astronomical Positions.—The latitude and longitude of any intermediate main station may now be calculated from the finally corrected Mercatorial true bearings and lengths of sides. The difference longitude so found is what it would be if measured on a true sphere, whereas we require it as measured on a spheroid, which is slightly less. The correction = d. long. $\frac{\cos^2 \text{mid. lat.}}{150}$ must therefore be subtracted; or the true difference longitude may be found direct from the formula dep. $\frac{\text{no. ft. in 1 m. of lat.}}{\text{no. ft. in 1 m. of long.}}$. From the foregoing it is seen that in a triangulation for hydrographical purposes both the bearings of the sides and their lengths ultimately depend almost entirely upon the astronomical observations at the extremes of the survey; the observed true bearings and measured base are consequently more in the nature of checks than anything else. It is obvious, therefore, that the nearer together the observation spots, the greater effect will a given error in the astronomical positions have upon the length and direction of the sides of the triangulation, and in such cases the bearings as actually observed must not be altered to any large extent when a trifling change in the astronomical positions might perhaps effect the required harmony. For the reasons given under *Astronomical Base*, high land near observation spots may cause very false results, which may often account for discrepancies when situated on opposite sides of a mountainous country.

Plotting.

Great care is requisite in projecting on paper the points of a survey. The paper should be allowed to stretch and shrink as it pleases until it comes to a stand, being exposed to the air for four or five hours daily, and finally well flattened out by being placed on a table with drawing boards placed over it heavily weighted. If the triangulation has been calculated beforehand throughout, and the lengths of all the different sides have been found, it is more advantageous to begin plotting by distances rather than by chords. The main stations are thus got down in less time and with less trouble, but these are only a small proportion of the points to be plotted, and long lines must be ruled between the stations as zeros for plotting other points by chords. In ruling these lines care must be taken to draw them exactly through the centre of the pricks denoting the stations, but, however carefully drawn, there is liability to slight error in any line projected to a point lying beyond the distance of the stations between which the zero line is drawn. In plotting by distances, therefore, all points that will subsequently have to be plotted by chords should lie well within the area covered by the main triangulation. Three distances must be measured to obtain an intersection of the arcs cutting each other at a sufficiently broad angle; the plotting of the main stations once begun must be completed before distortion of the paper can occur from change in the humidity of the atmosphere. Plotting, whether by distance or by chords, must be begun on as long a side as possible, so as to plot *inwards*, or with decreasing distances. In plotting by chords it is important to remember in the selection of lines of reference (or zero lines), that that should be preferred which makes the smallest angle with the line to be projected from it, and of the angular points those nearest to the object to be projected from them.

Irregular Methods of Plotting.—In surveys for the ordinary purposes of navigation, it frequently happens that a regular system of triangulation cannot be carried out, and recourse must be had to a variety of devices; the judicious use of the ship in such cases is often essential, and with proper care excellent results may be obtained. A few examples will best illustrate some of the methods used, but circumstances vary so much in every survey that it is only possible to meet them properly by studying each case as it arises, and to improvise methods. Fixing a position by means of the "back-angle" is one of the most ordinary expedients. Angles having been observed at A, to the station B, and certain other fixed points of the survey, C and D for instance; if A is shot up from B, at which station angles to the same fixed points have been observed, then it is not necessary to visit those points to fix A. For instance, in the triangle ABC, two of the angles have been observed, and therefore the third angle at C is known (the three angles of a triangle being equal to 180°), and it is called the "calculated or back-angle from C." A necessary condition is that the receiving angle at A, between any two lines (direct or calculated), must be sufficiently broad to give a good cut; also the points from which the "back-angles" are calculated should not be situated at too great distances from A, relatively to the distance between A and B. A station may be plotted by laying down the line to it from some other station, and then placing on tracing-paper a number of the angles taken at it, including the angle to the station from which it has been shot up. If the points to which angles are taken are well situated, a good position is obtained, its accuracy being much strengthened by being able to plot on a line to it, which, moreover, forms a good zero line for laying off other angles from the station when plotted. Sometimes the main stations must be carried on with a point plotted by only two angles. An effort must be made to check this subsequently by getting an "angle back" from stations dependent upon it to some old well-fixed point; failing this, two stations being plotted with two angles, pricking one and laying down the line to the other will afford a check. A well-defined mountain peak, far inland and never visited, when once it is well fixed is often invaluable in carrying on an irregular triangulation, as it may remain visible when all other original points of the survey have disappeared, and "back-angles" from it may be continually obtained, or it may be used for plotting on true bearing lines of it. In plotting the true bearing of such a peak, the convergency must be found and applied to get the reversed bearing, which is then laid down from a meridian drawn through it; or the reversed bearing of any other line already drawn through the peak being known, it may simply be laid down with that as a zero. A rough position of the spot from which the true bearing was taken must be assumed in order to calculate the convergency. Fig. 11 will illustrate the foregoing remarks. A and B are astronomical observation spots at the extremes of a survey, from both of which the high, inaccessible peak C is visible. D, E, F are intermediate stations; A and D, D and E, E and F, F and B being respectively visible from each other. G is visible from A and D, and C is visible from all stations. The latitudes of A and B and meridian distance between them being determined, and the true bearing of C being observed from both observation spots, angles are observed at all the stations. Calculating the spheroidal correction (from the formula, correction $= \text{d. long.}\ \dfrac{\cos^2 \text{mid. lat.}}{150}$) and adding it to the true (or chronometric) difference longitude between A and B to obtain the spherical d. long.; with this spherical d. long. and the d. lat., the Mercatorial true bearing and distance is found by middle latitude sailing (which is an equally correct but shorter method than by spherical trigonometry, and may be safely used when dealing with the distances usual between observation spots in nautical surveys). The convergency is also calculated, and the true bearing of A from B and B from A are thus determined. In the plane triangle ABC the angle A is the difference between the calculated bearing of B and the observed bearing of C from A; similarly angle B is the difference between calculated bearing of A and observed bearing of C from B. The distance AB having been also calculated, the side AC is found. Laying down AC on the paper on the required scale, D is plotted on its direct shot from A, and on the angle back from C, calculated in the triangle ACD. G is plotted on the direct shots from A and D, and on the angle back from C, calculated either in the triangle ACG or GCD. The perfect intersection of the three lines at G assures these four points being correct. E, F and B are plotted in a similar manner. The points are now all plotted, but they depend on calculated angles, and except for the first four points we have no check whatever either on the accuracy of the angles observed in the field or on the plotting. Another well-defined object in such a position, for instance as Z, visible from three or more stations, would afford the necessary check, if lines laid off to it from as many stations as possible gave a good intersection. If no such point, however, exists, a certain degree of check on the angles observed is derived by applying the sum of all the calculated angles at C to the true bearing of A from C (found by reversing observed bearing of C from A with convergency applied), which will give the bearing of B from C. Reverse this bearing with convergency applied, and compare it with the observed bearing of C from B. If the discrepancy is but small, it will be a strong presumption in favour of the substantial accuracy of the work. If the calculated true bearing of B from A be now laid down, it is very unlikely that the line will pass through B, but this is due to the discrepancy which must always be expected between astronomical positions and triangulation. If some of the stations between A and B require to be placed somewhat closely to one another, it may be desirable to obtain fresh true bearings of C instead of carrying on the original bearing by means of the calculated angle.

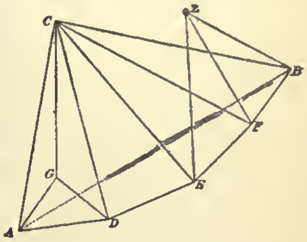

Fig. 11.

In all cases of irregular plotting the ship is very useful, especially if she is moored taut without the swivel, and angles are observed from the bow. Floating beacons may also assist an irregular triangulation.

Sketch Surveys.

Surveys of various degrees of accuracy are included among sketch surveys. The roughest description is the ordinary running survey, when the work is done by the ship steaming along the coast, fixing points, and sketching in the coast-line by bearings and angles, relying for her position upon her courses and distances as registered by patent log, necessarily regardless of the effect of wind and current and errors of steerage. At the other extreme comes the modified running survey, which in point of practical accuracy falls little short of that attained by irregular triangulation. Some of these modifications will be briefly noticed. A running survey of a coast-line between two harbours, that have been surveyed independently and astronomically fixed, may often be carried out by fixing the ship on the points already laid down on the harbour surveys and shooting up prominent intermediate natural objects, assisted possibly by theodolite lines from the shore stations. Theodolite lines to the ship at any of her positions are particularly valuable, and floating beacons suitably placed materially increase the value of any such work. A sketch survey of a coast upon which it is impossible to land may be well carried out by dropping beacons at intervals of about 10 m., well out from the land and placed abreast prominent natural objects called the "breastmarks," which must be capable of recognition from the beacons anchored off the next "breastmark" on either side. The distance between the beacons is found by running a patent log both ways, noting the time occupied by each run; if the current has remained constant, a tolerably good result can be obtained. At the first beacon, angles are observed between the second beacon and the two "breastmarks," an "intermediate" mark, and any other natural object which will serve as "points." At the second beacon, angles are observed between the first beacon and the same objects as before. Plotting on the line of the two beacons as a base, all the points observed can be pricked in on two shots. At a position about midway between the beacons, simultaneous angles are observed to all the points and laid off on tracing-paper, which will afford the necessary check, and the foundation is thus laid for filling in the detail of coast-line, topography, and soundings off this particular stretch of coast in any detail desired. Each section of coast is complete in itself on its own base; the weak point lies in the junction of the different sections, as the patent log bases can hardly be expected to agree precisely, and the scales of adjacent sections may thus be slightly different. This is obviated, as far as possible, by fixing on the points of one section and shooting up those of another, which will check any great irregularity of scale creeping in. The bearing is preserved by getting occasional true bearing lines at the beacons of the most distant point visible. Space does not here permit of dwelling upon the details of the various precautions that are necessary to secure the best results the method is capable of; it can only be stated generally that in all cases of using angles from the ship under weigh, several assistants are necessary, so that the principal angles may be taken simultaneously, the remainder being connected immediately afterwards with zeros involving the smallest possible error due to the ship not being absolutely stationary, these zeros being included amongst the primary angles. When close to a beacon, if its bearing is noted and the distance in feet obtained from its elevation, the angles are readily reduced to the beacon itself. Astronomical positions by twilight stars keep a check upon the work.

Sketch Surveys by Compass Bearings and Vertical Angles.—In the case of an island culminating in a high, well-defined summit visible from all directions, a useful and accurate method is to steam round it at a sufficient distance to obtain a true horizon, stopping to make as many stations as may be desirable, and fixing by compass bearing of the summit and its vertical angle. The height is roughly obtained by shooting in the summit, from two positions on a patent log base whilst approaching it. With this approximate height and Lecky's vertical danger angle tables, each station may be plotted on its bearing of the summit. From these stations the island is shot in by angles between its tangents and the summit, and angles to any other natural features, plotting the work as we go on any convenient scale which must be considered only as provisional. On completing the circuit of the island, the true scale is found by measuring the total distance in inches on the plotting-sheet from the first to the last station, and dividing it by the distance in miles between them as shown by patent log. The final height of the summit bears to the rough height used in plotting the direct proportion of the provisional scale to the true scale. This method may be utilized for the sketch survey of a coast where there are well-defined peaks of sufficient height at convenient intervals, and would be superior to an ordinary running survey. From positions of the ship fixed by bearings and elevations of one peak, another farther along the coast is shot in and its height determined; this second peak is then used in its turn to fix a third, and so on. The smaller the vertical angle the more liability there is to error, but a glance at Lecky's tables will show what effect an error of say 1′ in altitude will produce for any given height and distance, and the limits of distance must depend upon this consideration.

Surveys of Banks out of Sight of Land.—On striking shoal soundings unexpectedly, the ship may either be anchored at once and the shoal sounded by boats starring round her, using prismatic compass and masthead angle; or if the shoal is of large extent and may be prudently crossed in the ship, it is a good plan to get two beacons laid down on a bearing from one another and patent log distance of 4 or 5 m. With another beacon (or mark-boat, carrying a large black flag on a bamboo 30 ft. high) fixed on this base, forming an equilateral triangle, and the ship anchored as a fourth point, soundings may be carried out by the boats fixing by station-pointer. The ship's position is determined by observations of twilight stars.

Coast-lining. In a detailed survey the coast is sketched in by walking along it, fixing by theodolite or sextant angles, and plotting by tracing-paper or station-pointer. A sufficient number of fixed marks along the shore afford a constant check on the minor coast-line stations, which should be plotted on, or checked by, lines from one to the other wherever possible to do so. When impracticable to fix in the ordinary way, the ten-foot pole may be used to traverse from one fixed point to another. With a coast fronted by broad drying, coral reef or flats over which it is possible to walk, the distance between any two coast-line stations may be found by measuring at one of them the angle subtended by a known length placed at right angles to the line joining the stations. There is far less liability to error if the work is plotted at once on the spot on field board with the fixed points pricked through and circled in upon it; but if circumstances render it necessary, the angles being registered and sketches made of the bits of coast between the fixes on a scale larger than that of the chart, they may be plotted afterwards; to do this satisfactorily, however, requires the surveyor to appreciate instinctively exactly what angles are necessary at the time. It is with the high-water line that the coast-liner is concerned, delineating its character according to the admiralty symbols. The officer sounding off the coast is responsible for the position of the dry line at low-water, and on large scales this would be sketched in from a small boat at low-water springs. Heights of cliffs, rocks, islets, &c., must be inserted, either from measurement or from the formula,

$$\text{height in feet} = \frac{\text{angle of elevation in seconds} \times \text{distance in miles,}}{34}$$

and details of topography close to the coast, including roads, houses and enclosures, must be shown by the coast-liner. Rocks above water or breaking should be fixed on passing them. Coast-line may be sketched from a boat pulling along the shore, fixing and shooting up any natural objects on the beach from positions at anchor.

Sounding. The most important feature of a chart is the completeness with which it is sounded. Small scale surveys on anything less than one inch to the mile are apt to be very misleading; such a survey may appear to have been closely sounded, but in reality the lines are so far apart that they often fail to disclose indications of shoal-water. The work of sounding may be proceeded with as soon as sufficient points for fixing are plotted; but off an intricate coast it is better to get the coast-line done first. The lines of soundings are run by the boats parallel to one another and perpendicular to the coast at a distance apart which is governed by the scale; five lines to the inch is about as close as they can be run without overcrowding; if closer lines are required the scale must generally be increased. The distance apart will vary with the depth of water and the nature of the coast; a rocky coast with shallow water off it and projecting points will need much closer examination than a steep-to coast, for instance. The line of prolongation of a point under water will require special care to ensure the fathom lines being drawn correctly. If the soundings begin to decrease when pulling off-shore it is evidence of something suspicious, and intermediate lines of soundings or lines at right angles to those previously run should be obtained. Whenever possible lines of soundings should be run on transit lines; these may often be picked up by fixing when on the required line, noting the angle on the protractor between the line and some fixed mark on the field board, and then placing the angle on the sextant, reflecting the mark and noting what objects are in line at that angle. On large scale surveys whitewash marks or flags should mark the ends of the lines, and for the back transit marks natural objects may perhaps be picked up; if not, they must be placed in the required positions. The boat is fixed by two angles, with an occasional third angle as a check; the distance between the fixes is dependent upon the scale of the chart and the rapidity with which the depth alters; the 3, 5 and 10 fathom lines should always be fixed, allowing roughly for the tidal reduction. The nature of the bottom must be taken every few casts and recorded. It is best to plot each fix on the sounding board at once, joining the fixes by straight lines and numbering them for identification. The tidal reduction being obtained, the reduced soundings are written in the field-book in red underneath each sounding as originally noted; they are then placed in their proper position on the board between the fixes. Suspicious ground should be closely examined; a small nun buoy anchored on the shoal is useful to guide the boat while trying for the least depth. Sweeping for a reported pinnacle rock may be resorted to when sounding fails to discover it. Local information from fishermen and others is often most valuable as to the existence of dangers. Up to depths of about 15 fathoms the hand lead-line is used from the boats, but beyond that depth the small Lucas machine for wire effects a great saving of time and labour. The deeper soundings of a survey are usually obtained from the ship, but steamboats with wire sounding machines may assist very materially. By the aid of a steam winch, which by means of an endless rounding line hauls a 100-lb lead forward to the end of the lower boom rigged out, from which it is dropped by a slipping apparatus which acts on striking the water, soundings of 40 fathoms may be picked up from the sounding platform aft, whilst going at a speed of $4\frac{1}{2}$ knots. In deeper water it is quicker to stop the ship and sound from aft with the wire sounding machine. In running long lines of soundings on and off shore, it is very essential to be able to fix as far from the land as possible. Angles will be taken from aloft for this purpose, and a few floating beacons dropped in judiciously chosen positions will often well repay the trouble. A single fixed point on the land used in conjunction with two beacons suitably placed will give an admirable fix. A line to the ship or her smoke from one or two theodolite stations on shore is often invaluable; if watches are compared, observations may be made at stated times and plotted afterwards. True bearings of a distant fixed object cutting the line of position derived from an altitude of the sun is another means of fixing a position, and after dark the true bearing of a light may be obtained by the time azimuth and angular distance of a star near the prime vertical, or by the angular distance of Polaris in the northern hemisphere.

Vigias. A very large percentage of the bugbears to navigation denoted by vigias[1] on the charts eventually turn out to have no existence, but before it is possible to expunge them a large area has to be examined. No-bottom soundings are but little use, but the evidence of positive soundings should be conclusive. Submarine banks rising from great depths necessarily stand on bases many square miles in area. Of recent years our knowledge of the angle of slope that may be expected to occur at different depths has been much extended. From depths of upwards of 2000 fathoms the slope is so gradual that a bank could hardly approach the surface in less than 7 m. from such a sounding; therefore anywhere within an area of at least 150 sq. m. all round a bank rising from these depths, a sounding must show some decided indications of a rise in the bottom. Under such circumstances, soundings at intervals of 7 m., and run in parallel lines 7 m. apart, enclosing areas of only 50 sq. m. between any four adjacent soundings, should effectually clear up the ground and lead to the discovery of any shoal; and in fact the soundings might even be more widely spaced. From depths of 1500 and 1000 fathoms, shoals can scarcely occur within $3\frac{1}{2}$ m. and 2 m. respectively; but as the depth decreases the angle of slope rapidly increases, and a shoal might occur within three-quarters of a mile or even half a mile of such a sounding as 500 fathoms. A full appreciation of these facts will indicate the distance apart at which it is proper to place soundings in squares suitable to the general depth of water. Contour lines will soon show in which direction to prosecute the search if any irregularity of depth is manifested. When once a decided indication is found, it is not difficult to follow it up by paying attention to the contour lines as developed by successive soundings. Discoloured water, ripplings, fish jumping or birds hovering about may assist in locating a shoal, but the submarine sentry towed at a depth of 40 fathoms is here invaluable, and may save hours of hunting. Reports being more liable to errors of longitude than of latitude, a greater margin is necessary in that direction. Long parallel lines east and west are preferable, but the necessity of turning the ship more or less head to wind at every sounding makes it desirable to run the lines with the wind abeam, which tends to disturb the dead reckoning least. A good idea of the current may be obtained from the general direction of the ship's head whilst sounding considered with reference to the strength and direction of the wind, and it should be allowed for in shaping the course to preserve the parallelism of the lines, but the less frequently the course is altered the better. A good position in the morning should be obtained by pairs of stars on opposite bearings, the lines of position of one pair cutting those of another pair nearly at right angles. The dead reckoning should be checked by lines of position from observations of the sun about every two hours throughout the day, preferably whilst a sounding is being obtained and the ship stationary. Evening twilight stars give another position.

[1] A Spanish word meaning "look-out," used of marks on the chart signifying obstructions to navigation.

Tides.—The datum for reduction of soundings is low-water ordinary springs, the level of which is referred to a permanent bench mark in order that future surveys may be reduced to the same datum level. Whilst sounding is going on the height of the water above this level is observed by a tide gauge. The time of high-water at full and change, called the "establishment," and the heights to which spring and neap tides respectively rise above the datum are also required. It is seldom that a sufficiently long series of observations can be obtained for their discussion by harmonic analysis, and therefore the graphical method is preferred; an abstract form provides for the projection of high and low waters, lunitidal intervals, moon's meridian passage, declination of sun and moon, apogee and perigee, and mean time of high-water following superior transit, and of the highest tide in the twenty-four hours. A good portable automatic tide gauge suitable for all requirements is much to be desired.

Tidal Streams and Surface Currents are observed from the ship or boats at anchor in different positions, by means of a current log; or the course of a buoy drifted by the current may be followed by a boat fixing at regular intervals. Tidal streams often run for some hours after high and low water by the shore; it is important to find out whether the change of stream occurs at a regular time of the tide. *Undercurrents* are of importance from a scientific point of view. A deep-sea current meter, devised (1876) by Lieut. Pillsbury, U.S.N., has, with several modifications, been used with success on many occasions, notably by the U.S. Coast and Geodetic Survey steamer "Blake" in the investigation of the Gulf Stream.

Deep-sea Current Meter. The instrument is first lowered to the required depth, and when ready is put into action by means of a heavy weight, or messenger, travelling down the supporting line and striking on a metal plate, thus closing the jaws of the levers and enabling the instrument to begin working. The rudder is then free to revolve inside the framework and take up the direction of the current; the small cones can revolve on their axis and register the number of revolutions, while the compass needle is released and free to take up the north and south line. On the despatch of a second messenger, which strikes on top of the first and fixes the jaws of the levers open, every part of the machine is simultaneously locked. Having noted the exact time of starting each of the messengers, the time during which the instrument has been working at the required depth is known, and from this the velocity of the current can be calculated, the number of revolutions having been recorded, while the direction is shown by the angle between the compass needle and the direction of the rudder.

The instrument is shown in fig. 12. AA are the jaws of the levers through which the first messenger passes and strikes on the metal plate B. The force of the blow is sufficient to press B down, thus bringing the jaws as close together as possible, and putting the meter into action. The second messenger falling on the first opens the levers again and prevents their closing, thus keeping all parts of the machine locked. C is the rudder which takes up the direction of the current when the levers are unlocked. D is a set of small levers on the rudder in connexion with AA. The outer end on the tail of the rudder fits into the notches on the outer ring of the frame when the machine is locked and thus keeps the rudder fixed, but when the first messenger has started the machine by pressing down B and opening the levers AA, this small lever is raised and the rudder can revolve freely. EE are four small cones which revolve on their axis in a vertical plane, similar to an anemometer; the axis is connected by a worm screw to geared wheels which register the number of revolutions up to 5000, corresponding to about 4 nautical miles. There is a small lever in connexion with AA which prevents the cones revolving when the machine is locked, but allows them to revolve freely when the machine is in action. Below the rudder-post is a compass-bowl F, which is hung in gimbals and capable of removal. The needle is so arranged that it can be lifted off the pivot by means of a lever in connexion with AA; when the meter is in action the needle swings freely on its pivot, but when the levers are

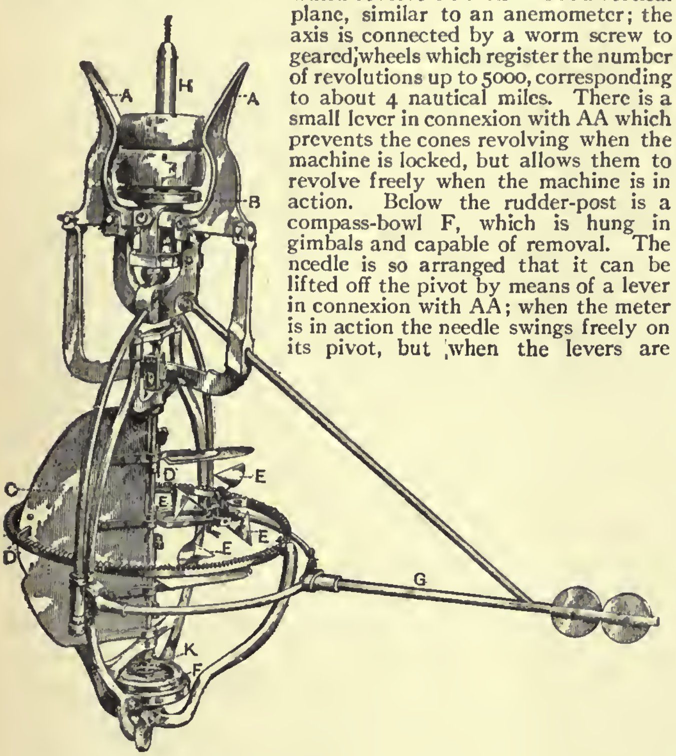

FIG. 12.

locked it is raised off its pivot by the inverted cup-piece K placed inside the triple claws on the top of the compass and screwed to the lever, thus locking the needle without chance of moving. The compass bowl should be filled with fresh water before lowering the instrument into the sea, and the top screwed home tightly. The needle should be removed and carefully dried after use, to prevent corrosion. The long arm G is to keep the machine steady in one direction; it works up and down a jackstay which passes between two sheaves at the extremity of the long arm. This also assists to keep the machine in as upright a position as possible, and prevents it from being drifted astern with the current. A weight of as much as 8 or 10 cwt. is required at the bottom of the jackstay in a very strong current. An elongated weight of from 60 to 80 lb must be suspended from the eye at the bottom of the meter to help to keep it as vertical as possible. On the outer part of the horizontal notched ring forming the frame, and placed on the side of the machine opposite to the projecting arm G, it has been found necessary to bolt a short arm supported by stays from above, from which is suspended a leaden counterpoise weight to assist in keeping the apparatus upright. This additional fitting is not shown in fig. 12. A $\frac{3}{4}$-in. phosphor-bronze wire rope is used for lowering the machine; it is rove through a metal sheave H and india-rubber washer, and spliced round a heart which is attached to metal plate B. The messengers are fitted with a hinged joint to enable them to be placed round the wire rope, and secured with a screw bolt. To obtain the exact value of a revolution of the small cones it is necessary to make experiments when the actual speed of the current is known, by immersing the meter just below the surface and taking careful observations of the surface-current by means of a current log or weighted pole. From the number of revolutions registered by the meter in a certain number of minutes, and taking the mean of several observations, a very fair value for a revolution can be deduced. On every occasion of using the meter for under-current observations the value of a revolution should be re-determined, as it is apt to vary owing to small differences in the friction caused by want of oil or the presence of dust or grit; while the force of the current is probably another important factor in influencing the number of revolutions recorded.

Topography. The features of the country should generally be delineated as far back as the skyline viewed from seaward, in order to assist the navigator to recognize the land. The summits of hills and conspicuous spurs are fixed either by lines to or by angles at them; their heights are determined by theodolite elevations or depressions to or from stations whose height above high-water is known. As much of the ground as possible is walked over, and its shape is delineated by contour lines sketched by eye, assisted by an aneroid barometer. In wooded country much of the topography may have to be shot in from the ship; sketches made from different positions at anchor along the coast with angles to all prominent features, valleys, ravines, spurs of hills, &c., will give a very fair idea of the general lie of the country.

Latitudes. Circum-meridian altitudes of stars on opposite sides of the zenith observed by sextant in the artificial horizon is the method adopted wherever possible for observations for latitudes. Arranged in pairs of nearly the same altitude north and south of zenith, the mean of each pair should give a result from which instrumental and personal errors and errors due to atmospheric conditions are altogether eliminated. The mean of several such pairs should have a probable error of not more than $\pm 1''$. As a rule the observations of each star should be confined to within 5 or 6 minutes on either side of the meridian, which will allow of from fifteen to twenty observations. Two stars selected to "pair" should pass the meridian within an hour of each other, and should not differ in altitude more than 2° or 3°. Artificial horizon roof error is eliminated by always keeping the same end of the roof towards the observer; when observing a single object, as the sun, the roof must be reversed when half way through the observations. The observations are reduced to the meridian by Raper's method. When pairs of stars are not observed, circum-meridian altitudes of the sun alone must be resorted to, but being observed on one side of the zenith only, none of the errors to which all observations are liable can be eliminated.

Chronometer Errors. Sets of equal altitudes of sun or stars by sextant and artificial horizon are usually employed to discover chronometer errors. Six sets of eleven observations, a.m. and p.m., observing both limbs of the sun, should give a result which, under favourable conditions of latitude and declination, might be expected to vary less than two-tenths of a second from the normal personal equation of the observer. Stars give equally good results. In high latitudes sextant observations diminish in value owing to the slower movement in altitude. In the case of the sun all the chronometers are compared with the "standard" at apparent noon; the comparisons with the chronometer used for the observations on each occasion of landing and returning to the ship are worked up to noon. In the case of stars, the chronometer comparisons on leaving and again on returning are worked up to an intermediate time. A convenient system, which retains the advantage of the equal altitude method, whilst avoiding the necessity of waiting some hours for the p.m. observation, is to observe two stars at equal altitudes on opposite sides of the meridian, and, combining the observations, treat them as relating to an imaginary star having the mean R.A. and mean declination of the two stars selected, which should have nearly the same declination and should differ from 4^h to 8^h in R.A.

Meridian Distances. The error of chronometer on mean time of place being obtained, the local time is transferred from one observation spot to another by the ship carrying usually eight box chronometers. The best results are found by using travelling rates, which are deduced from the difference of the errors found on leaving an observation spot and returning to it; from this difference is eliminated that portion which may have accumulated during an interval between two determinations of error at the other, or any intermediate, observation spot. A travelling rate may also be obtained from observations at two places, the meridian distance between which is known; this rate may then be used for the meridian distance between places observed at during the passage. Failing travelling rates, the mean of the harbour rates at either end must be used. The same observer, using the same instrument, must be employed throughout the observations of a meridian distance.

If the telegraph is available, it should of course be used. The error on local time at each end of the wire is obtained, and a number of telegraphic signals are exchanged between the observers, an equal number being transmitted and received at either end. The local time of sending a signal from one place being known and the local time of its reception being noted, the difference is the meridian distance. The retardation due to the time occupied by the current in travelling along the wire is eliminated by sending signals in both directions. The relative personal equation of the observers at either end, both in their observations for time, and also in receiving and transmitting signals, is eliminated by changing ends and repeating the operations. If this is impracticable, the personal equations should be determined and applied to the results. Chronometers keeping solar time at one end of the wire, and sidereal time at the other end, materially increase the accuracy with which signals can be exchanged, for the same reason that comparisons between sidereal clocks at an observatory are made through the medium of a solar clock. Time by means of the sextant can be so readily obtained, and within such small limits of error, by skilled observers, that in hydrographic surveys it is usually employed; but if transit instruments are available, and sufficient time can be devoted to erecting them properly, the value of the work is greatly enhanced in high latitudes.

True Bearings.

True bearings are obtained on shore by observing with theodolite the horizontal angle between the object selected as the zero and the sun, taking the latter in each quadrant as defined by the cross-wires of the telescope. The altitude may be read on the vertical arc of the theodolite; except in high latitudes, where a second observer with sextant and artificial horizon are necessary, unless the precise errors of the chronometers are known, when the time can be obtained by carrying a pocket chronometer to the station. The sun should be near the prime vertical and at a low altitude; the theodolite must be very carefully levelled, especially in the position with the telescope pointing towards the sun. To eliminate instrumental errors the observations should be repeated with the vernier set at intervals equidistant along the arc, and a.m. and p.m. observations should be taken at about equal altitudes.

At sea true bearings are obtained by measuring with a sextant the angle between the sun and some distant well-defined object making an angle of from 100° to 120° and observing the altitude of the sun at the same time, together with that of the terrestrial object. The sun's altitude should be low to get the best results, and both limbs should be observed. The sun's true bearing is calculated from its altitude, the latitude, and its declination; the horizontal angle is applied to obtain the true bearing of the zero. On shore the theodolite gives the horizontal angle direct, but with sextant observations it must be deduced from the angular distance and the elevation.

For further information see Wharton, *Hydrographical Surveying* (London, 1898); Shortland, *Nautical Surveying* (London, 1890). (A. M. F.*)

"SURVILLE, CLOTILDE DE," the supposed author of the *Poésies de Clotilde*. The generally accepted legend gave the following account of her. Marguerite Éléonore Clotilde de Vallon Challis, dame de Surville, was born in the early years of the 15th century at Vallon. In 1421 she married Bérenger de Surville, who was killed at the siege of Orleans in 1428. Her husband's absence at the war inspired her heroic verses and his death her elegiac poems. The last of her poems is a *chant royal* addressed to Charles VIII.

In 1803 Charles Vanderbourg published as the *Poésies de Clotilde* some forty poems dealing with love and war. The history given in the introduction of the discovery of the manuscript was evidently a fable, and the poems were set down by most authorities as forgeries, especially as they contained many anachronisms and were written in accordance with modern laws of prosody. The manuscript had been in the possession of Jean François Marie, marquis de Surville, an *émigré* who returned to France in 1798 to raise an insurrection in Provence, and had paid the penalty with his life. In 1863 Antonin Macé made further inquiries on the subject and discovered letters from Vanderbourg to Surville's widow. This correspondence makes it clear that Vanderbourg was innocent of forgery and believed that the poems were of 15th-century date, and that the anachronisms of matter and form were due to retouching by Surville. But the researches of M. Macé interested local antiquarians, and documentary evidence was produced that the wife of Bérenger de Surville was Marguerite Chalis, not Clotilde, and that the marriage dated only from 1428. Moreover Bérenger, whose death at the siege of Orleans was one of the leading motives of the book, lived for twenty years after that date. Friends of M. de Surville also disclosed the fact that the marquis had contributed archaic poetry to a Lausanne journal.

See A. Macé, *Un procès d'histoire littéraire* (1870); A. Mazon, *Marguerite Chalis et la légende de Clotilde de Surville* (1875); articles by Gaston Paris in the *Revue critique d'histoire et de littérature* (March 1, 1873 and May 30, 1874), by Paul Cottin in the *Bulletin du bibliophile* (1894); E. K. Chambers, *Literary Forgeries* (1891); and further references in the *Bibliographie des femmes célèbres* (Turin and Paris, 1892, &c.).

SUS, a province of southern Morocco, once an independent kingdom, and still too unruly to be opened to Europeans, who have nevertheless for centuries past made efforts to secure a foothold. Its principal towns are Tarudant, Iligh (the old capital), and Glimin on the Wad Nun. Tarudant, the present capital, flourished in the 12th century on account of the neighbouring copper-mines. Saltpetre is now the only important product. Ports might be opened at Agadir Ighir (once occupied by the Portuguese for thirty years as Santa Cruz), Massa, Ifni, Arksis and Assaka at the mouth of the Wad Nun. As a coveted district, all kinds of natural riches are attributed to Sus, but it may be assumed that they are exaggerated. Europeans land at their peril, since the coast is by imperial order closed to trade, no custom-house being provided. Most of the business of Sus is carried on at great fairs lasting eight or fifteen days, during which time all roads of approach are guaranteed safe by the tribesmen that trade may be uninterrupted. Caravans from Sus laden with copper-ware, olive oil, butter, saffron, wax, skins, dates, dried roses, &c., are sent to Marrakesh, four days' journey from Tarudant. Susis are well known in the north of Morocco as able tradesmen and clever metal workers. They live frugally, and are only prodigal in powder and human life. Their language is almost exclusively Shilhah, a dialect of Berber. (K.A.M.*)

SUSA (Biblical, *Shushan*), the capital of Susiana or Elam and from the time of Darius I. the chief residence of the Achaemenian kings. It had been the centre of the old monarchy of Elam and had undergone many vicissitudes before it fell into the hands of the Persians (see ELAM). The site, fixed by the explorations of W. K. Loftus, lies in the plain, but within sight of the mountains, between the courses of the Kerkha (Choaspes) and the Dizful, one of the affluents of the Pasitigris. The Shaur, a small tributary of the Dizful, washes the eastern base of the mounds of Shush, and seems to be the representative of the ancient Ulai or Eulaeus. Thus the whole district was fruitful and well watered; the surrounding rivers with their canals gave protection and a waterway to the Persian Gulf; while the position of the town between the Semitic and Iranian lands of the empire was convenient for administrative purposes. Susa therefore became a vast and populous capital; Greek writers assign to it a circuit of 15 or 20 m.

The remains include four mounds, of which one is the site of the citadel called Memnonion by the Greeks, while another (the Apadana to the east of it) represents the palace of Darius I. and Artaxerxes II. *Mnemon*. This latter has been excavated by M. Dieulafoy and the enamelled bricks with which its walls were adorned are now in the Louvre. South of these two mounds is the site of the royal Elamite city. The fourth mound, covering the remains of the poorer houses, is on the right bank of the river between the Shaur and the Kerkha. J. de Morgan's excavations (since 1897) have been principally in the citadel mound, which measures rougnly 1500 ft. by 825 ft. and is 125 ft. high. The two lowest strata belong to the stone age, and the first is characterized by a fine thin pottery, with yellow paste decorated with geometrical patterns and animal or vegetable figures in black and brown-red. Some of it is similar to the prehistoric pottery of Egypt. The pottery of the second neolithic stratum is much inferior. Above these strata come the remains of Elamite and early Babylonian civilization with inscribed objects, the oldest of which exhibit the pictorial characters out of which the cuneiform were evolved. Under the foundations of the temple of In-Susinak (in the north-west part of the mound) a vast quantity of bronze objects has been discovered, for the most part earlier than the 10th century B.C. Among the monuments brought to light in other parts of the mound are the obelisk of Manistusu (see BABYLONIA), the stela of Naram-Sin and the code of Khammurabi, along with a great number of historically valuable boundary-stones. The upper portions of the mounds have yielded, besides Persian remains, Greek pottery and inscriptions of the 4th century B.C., numerous coins of the Kamnaskires dynasty and other kings of Elymais in the Seleucid era, and Parthian and Sassanian relics. In the Sassanian period the city was razed in consequence of a revolt, but rebuilt by Sapor (Shapur) II.; the walls were again destroyed at the time of the Mahommedan conquest, but the site, which is now deserted, was a seat of sugar manufacture in the middle ages.

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SUSA (Fr. *Sousse*), a city of Tunisia, on the Gulf of Hammamet, in 35° 49′ N., 10° 39′ E., 36 m. by rail E. by N. of Kairawan, of which it is the port, and 93 m. S. by E. by rail of Tunis. Susa, which occupies part of the site of the ancient Hadrumetum, is built on the side of a hill sloping seawards, and is surrounded by a crenellated wall, strengthened by towers. Recesses in the inner side of the wall are used as shops and warehouses. The kasbah, or citadel, built on the highest point within the town, was thoroughly restored by the French after their occupation of the country in 1881, and serves as military headquarters for the district, the camp for the troops being outside the walls west of the citadel. The native town has been little changed since the French occupation, but north of the port a European quarter has been created, and here are public buildings such as law courts, a museum and a town-hall. The museum contains many archaeological treasures, notable mosaics and sculptures. The most interesting buildings in the old town are the Kasr-er-Ribat and the Kahwat-el-Kubba. The Kasr-er-Ribat is a square fortress with a high tower and seven bastions. Its date is uncertain, but is not later than the 9th century. The Kahwat-el-Kubba (Café of the Dome) is a curious house, square at the base, then cylindrical, and surmounted by a fluted dome. It was probably a church during the Byzantine period. Another domed building, now used as oil-mills, dates from Roman and Byzantine times. In the Bab-el-Gharbi (West Gate) a Roman sarcophagus of marble has been built into the wall, and serves as a drinking fountain. The grand mosque is in the north-east part of the town. The ancient harbours are silted up, but vestiges of the Roman breakwaters may be seen. The modern port, completed in 1901, enables steamers drawing 21 ft. to lie at the quays. Exports are chiefly phosphates and other minerals, olive oil, esparto and cereals; imports: cotton goods, building material, &c. The population, less than 10,000 at the time of the French occupation, had increased in 1907 to over 25,000, of whom 1500 were French and 4000 other Europeans, chiefly Italians and Maltese.

Susa, the Arab town which succeeded Hadrumetum (*q.v.*), was fortified by the Aghlabite rulers of Kairawan in the 9th century A.D. It shared the general fortunes of Tunisia and became a noted haunt of pirates, who raided the coast of Italy. In 1537 it was unsuccessfully besieged by the marquis of Terra Nova, in the service of Charles V., but in 1539 was captured for the emperor by Andrea Doria. As soon as the imperial forces were withdrawn it became again the seat of Turkish piracy. The town was attacked by the French and the Knights of St John in 1770, and by the Venetians in 1764. It remained, however, in the possession of the bey of Tunis.

Some 35 m. due south of Susa, and half way on the road to Sfax is El Jem, the site of the city of Thysdrus. Of the ancient city there are scarcely any remains save the amphitheatre—a magnificent ruin scarcely inferior to that of the Colosseum in Rome. There is no record of the building of the amphitheatre, which is usually assigned to the reign of Gordian III. (A.D. 238–244). It is made of limestone brought from Sallecta, 20 m. distant, bears evidence of hasty construction, and was probably never finished. It is of four storeys—three open arcades crowned by a fourth storey with windows. The first and third arcades are Corinthian; the middle one Composite. Each of these galleries has sixty-four columns and the same number of arches. Constantly used as a fortress since the Arab invasion, the amphitheatre suffered much, and in 1697 the bey of Tunis made a great breach in its western end to prevent it being again used for defence. But even in its present condition the amphitheatre—standing solitary in a desolate district—is grandly impressive. Its major axis is 488 ft., its minor axis 406 ft. (The figures of the Colosseum are 615 and 510½ respectively.)

SUSA (anc. *Segusio*, *q.v.*), a city and episcopal see of Piedmont, Italy, in the province of Turin, from which it is 33 m. W. by rail. Pop. (1901), 3607 (town); 5023 (commune). It is situated on the Dora Riparia, a tributary of the Po, 1625 ft. above sea-level, and is protected from the northern winds by the Rocciamelone. Among the medieval buildings of Susa the first place belongs to the church of San Giusto, founded in 1029 by Olderico Manfredi II. and the countess Berta, and in 1772 raised to be the cathedral. It has a fine brick campanile and brick decoration, and contains a bronze triptych of 1358 in niello, with the Virgin and Child. In the Valle di Susa, about 14 m. east of it, towards Turin, near S. Ambrogio di Torino, is the monastery of S. Michele with a Romanesque church, situated on a rocky mountain (998–1002).

After the time of Charlemagne a marquisate of Susa was established ; and the town became in the 11th century the capital of Adelaide countess of Savoy, who was mistress of the whole of Piedmont. On his retreat from Legnano in 1176 Barbarossa set fire to Susa; but the town became more than ever important when Emmanuel Philibert fortified it at great expense in the 16th century. It was, however, dismantled by Napoleon I. in 1796.

SUSARION, Greek comic poet, a native of Tripodiscus in Megaris. About 580 B.C. he transplanted the Megarian comedy (if the rude extempore jests and buffoonery deserve the name) into the Attic deme of Icaria, the cradle also of Greek tragedy and the oldest seat of the worship of Dionysus. According to the Parian Chronicle, there appears to have been a competition on this occasion, in which the prize was a basket of figs and an amphora of wine. Susarion's improvements in his native farces did not include a separate actor or a regular plot, but probably consisted in substituting metrical compositions for the old extempore effusions of the chorus. These were intended for recitation, and not committed to writing. But such performances did not suit the taste of the Athenians, and nothing more is heard of them until eighty years after the time of Susarion. U. von. Wilamowitz-Möllendorff (in *Hermes*, ix.) considers the so-called Megarian comedy to have been an invention of the Athenians themselves, intended as a satire on Megarian coarseness and vulgarity. The lines attributed to Susarion (in Meineke, *Poetarum comicorum graecorum fragmenta*) are probably not genuine.

SUSO [SEUSE], **HEINRICH** (1300–1366), German mystic, was born of good family at Überlingen on Lake Constance on the 21st of March, in all probability in the year 1300; he assumed the name of his mother, his father being a Herr von Berg. He was educated for the Church, first at Constance, then at Cologne, where he came under the influence of the greatest of the German mystics, Meister Eckart. He subsequently entered a monastery in Constance, where he subjected himself to the severest ordeals of asceticism. In 1335 he wandered through Swabia as a preacher, and won all hearts by his gentle, persuasive eloquence; the effusive lyricism of his language made him an especial favourite among the nuns. About 1348 he seems to have settled in Ulm, where he died on the 25th of January 1366. Suso's first work, *Das Büchlein der Wahrheit*, was written in Cologne about 1329; setting out from Eckart's doctrines, he presents the mystic faith from its speculative or theoretical side; whereas in *Das Büchlein der ewigen Weisheit*, written some years later in Constance, he discusses the practical aspects of mysticism. The latter work, which Suso also translated into Latin under the title of *Horologium sapientiae*, has been called the finest fruit of German mysticism. Suso is the poet of the early mystic movement, "the Minnesinger of *Gottesminne*." But his faith is purely medieval in tone, inspired by the romanticism of the age of chivalry; the individualism, the philosophic insight and the anti-Catholic tendencies which made the mystic movement in its later manifestations so important a forerunner of the Reformation are absent.

Suso's works were collected as early as 1482 and again in 1512; recent editions: Heinrich Suso's *Leben und Schriften*, ed. by M. Diepenbrock (1829; 4th ed., 1884); Suso's *Deutsche Schriften*, by F. H. S. Denifle (1878–1880, not completed), and *Deutsche Schriften*, by K. Bihlmeyer (2 vols., 1907). See also W. Preger, *Die Briefe Heinrich Susos* (1867); W. Preger, *Geschichte der deutschen Mystik* (1882), vol. ii.; J. Jäger, *Heinrich Seuse aus Schwaben* (1894).

SUSPENSURA, the architectural term given by Vitruvius (v. 10) to the hollow space under the floor of a Roman bath, in which the smoke from the furnace passed to the vertical flues in the wall (see HYPOCAUST).

SUSSEX, EARLS OF. The early history of the earldom of Sussex, a title that has been borne at different periods by several English families, is involved in some obscurity, owing to the fact that under the Norman kings the titles of earls were often indifferently derived from a county, from its chief town, or from the earl's principal residence, although the distinctive mark of an earl was deemed to be his right to "the third penny" of the pleas of a county (see EARL). Thus in the 12th century the same person is sometimes found described as earl of Sussex, sometimes as earl of Chichester, and sometimes as earl of Arundel, while the inclusion of the counties of Sussex and Surrey under the jurisdiction of a single sheriff led at one time, as will be seen, to a further confusion between the earldoms of those counties. The difficulty is, again, increased by the Crown's admission in 1433 that the possession of the castle of Arundel carried with it the right to the title of earl of Arundel, though later investigation (see *Lords' Reports on the Dignity of a Peer*, i. 404–429) has proved the invalidity of the claim, and Mr J. H. Round and other modern authorities maintain that inasmuch as Norman earls were earls of counties, the earldom of Arundel was strictly that of Sussex.

On the other hand G. E. Cockayne (*Complete Peerage*, i. 138, 139) holds that Roger de Montgomery, who received grants from William the Conqueror of a large part of the county of Sussex, including the city of Chichester and the castle and honour of Arundel, besides lands in Shropshire with the castles of Shrewsbury and Montgomery, but who does not appear to have had "the third penny" of any county, "was an earl pure and simple, and that, as was usual in those early times, his earldom was indifferently styled either from the territories of Chichester or of Shropshire, or from the castles of Arundel, Shrewsbury or Montgomery." This Roger de Montgomery was considered by Dugdale, a 17th-century authority, to have been earl of Sussex.

Whatever Roger's titles may have been, they were forfeited to the Crown when his son Robert was attainted in 1102, and the forfeited estates were conferred by Henry I. on his second wife Adelicia, who after Henry's death married William de Albini, or d'Aubigny. The latter was created earl of Sussex by King Stephen, and "the third penny" of that county was confirmed to him by an instrument of the reign of Henry II., in which however, he is styled earl of Arundel, a designation by which he was more generally known. His grandson William, 3rd earl of Sussex, was one of King John's sureties for the observance of Magna Carta; and the earldom remained in his family till 1243, when it reverted to the Crown on the death of Hugh de Albini, 5th earl of the line (see ARUNDEL, EARLS OF). This Hugh married Isabel, daughter of William de Warenne, earl of Surrey, who survived him by nearly forty years, during which time she held the estates of the earldom of Sussex in dower; after her death in 1282 her brother John de Warenne, earl of Surrey, was in various writs described as "earl of Surrey and Sussex," the same style being also used by his grandson and successor, another John de Warenne (1286–1347), though it is not clear that either of these Warennes had any right to the Sussex title, the confusion having perhaps arisen through both counties being under the jurisdiction of one sheriff. In any case the earldom of Sussex, if vested in the younger Warenne, reverted to the Crown on his death without legitimate issue in 1347, when his estates devolved on his nephew Richard Fitzalan, earl of Arundel. Since the death of the last earl of the de Albini line in 1243 the earldoms of Arundel and Sussex had been separate.

For nearly two hundred years, from 1347 to 1529, the title of earl of Sussex did not exist in the English peerage. In 1529, however, it was conferred on Robert Radcliffe, Radclyffe or Ratclyffe (*c.* 1483–1542), who had been made Viscount Fitzwalter in 1525. Radcliffe was a son of John Radcliffe, Baron Fitzwalter (*c.* 1452–1496), and a grandson of Sir John Radcliffe of Attleborough in Norfolk, who became Baron Fitzwalter by right of his wife Elizabeth. The younger John Radcliffe shared in the conspiracy of Perkin Warbeck and was beheaded for high treason in 1496. The attainder being reversed in 1506, his son Robert became Baron Fitzwalter in 1506 and was soon a prominent person at the court of Henry VIII. In 1529 he was created earl of Sussex and in 1540 he was appointed great chamberlain of England. He died on the 26th of November 1542, when his son Henry (*c.* 1506–1557) became the 2nd earl. Henry's son, Thomas Radcliffe (see below), became the 3rd earl. Thomas was succeeded in 1583 by his brother Henry (*c.* 1530–1593) who served Elizabeth in Ireland. His son Robert (*c.* 1569–1629), the 5th earl, was a soldier and a patron of men of letters. When Robert's son, Edward, the 6th earl (*c.* 1552–1641), died, the title became extinct, but the barony of Fitzwalter passed to the family of Mildmay, which held it until 1756, when it fell into abeyance.

In 1644 Thomas Savile (*c.* 1590–*c.* 1659), son of John Savile, 1st Baron Savile of Pontefract (1566–1630), was created earl of Sussex. Having been elected to the House of Commons as member for Yorkshire in 1624, Savile became an opponent of Wentworth, afterwards earl of Strafford, the rivalry between the Saviles and the Wentworths having long been a feature of the history of Yorkshire, and attaching himself to the duke of Buckingham, he was created Viscount Savile of Castlebar in the peerage of Ireland in 1628, and two years later succeeded to his father's English peerage. His growing enmity to Strafford led him into violent opposition to the government as the earl's power increased, and in 1640 he entered into correspondence with the Scots, to whom he sent a promise of support to which he forged the signatures of six peers. He was appointed lord president of the council of the north in succession to Strafford, but after the fall of the latter he went over to the Royalist party, in whose interest he exerted his influence in Yorkshire in a manner that brought upon him the displeasure of the parliament in 1642. His efforts to exonerate himself led to his being suspected by the Royalists, and to his arrest, while his residence, Howley Hall, was sacked by Newcastle, the Royalist general. Having been pardoned by Charles, whom Savile attended at Oxford, he was created earl of Sussex in 1644; but his efforts to promote peace on terms distasteful to the king brought him again into disfavour, and in 1645 he was imprisoned and accused of high treason. Escaping from this charge on the ground of his privilege as a peer, he went to London and again ingratiated himself with the popular party. Intriguing simultaneously with both parties, he continued to play a double game with considerable skill, although he suffered imprisonment in 1645 for accusing Holles and Whitelocke of treachery in negotiations with the king, and was heavily fined. After this he retired into private life at Howley Hall, where he died about 1659. He was succeeded in the earldom of Sussex by his son James, on whose death without issue in 1671 the title became extinct. It was revived in 1684 in favour of Thomas Lennard, 15th Baron Dacre, whose wife Ann (d. 1722) was a daughter of the famous duchess of Cleveland by King Charles II., and again became extinct at this nobleman's death in 1715. The title was next conferred in 1717 on Talbot Yelverton, 2nd Viscount de Longueville and 16th Baron Grey de Ruthyn (*c.* 1692–1731), from whom it descended to his two sons successively, becoming once more extinct on the death of the younger of these, Henry, 3rd earl of Sussex of this creation, in 1799.

In 1801 Prince Augustus Frederick (1773–1843) the sixth son of George III., was created duke of Sussex. Spending his early years abroad, the prince was married in Rome in 1793 to Lady Augusta (d. 1830) daughter of John Murray, 4th earl of Dunmore. The ceremony was repeated in London and two children were born, but under the Royal Marriage Act of 1772 the Court of Arches declared the union illegal. The children took the name of d'Este. The son, Sir Augustus Frederick d'Este (1794–1848), became a colonel in the British army. In 1843 he claimed his father's honours, but the House of Lords decided against him. He died unmarried. The daughter, Augusta Emma (1801–1866) married Sir Thomas Wilde, afterwards Lord Truro. Unlike his brothers the duke of Sussex was a man of liberal ideas; he favoured the abolition of the slave trade, the repeal of the corn laws, and the removal of the civil disabilities of Roman Catholics, Dissenters and Jews. His second wife, Cecilia, widow of Sir George Buggin, was created duchess of Inverness in 1840. He died at Kensington Palace on the 21st of April 1843.

The older title of earl of Sussex was revived in 1874 when it was conferred upon Prince Albert, the third son of Queen Victoria, who at the same time was created duke of Connaught and Strathearn.

See G. E. C., *Complete Peerage, s.v.* "Sussex," "Surrey," "Arundel," vols. i. and vii. (London, 1887–1896); Sir William Dugdale, *The Baronage of England* (London, 1675). For the earls of the Radcliffe family see also John Strype, *Memorials of Thomas Cranmer* (London, 1694), *Annals of the Reformation* (London, 1725), and *Ecclesiastical Memorials* (3 vols., London, 1721); P. F. Tytler, *England under the Reigns of Edward VI. and Mary* (2 vols., London, 1839); *Calendars of State Papers: Letters and Papers of the Reign of Henry VIII.* For the 1st earl of the Savile line see S. R. Gardiner, *Hist. of England, 1603–1642* (10 vols., London, 1883–1884), and *Hist. of the Great Civil War* (3 vols., London, 1886–1891); and John Rushworth, *Historical Collections* (8 vols., London, 1659–1701).

SUSSEX, THOMAS RADCLYFFE [or RATCLYFFE], 3RD EARL OF (*c.* 1525–1583), lord-lieutenant of Ireland, eldest son of Henry, 2nd earl of Sussex (see SUSSEX, EARLS OF), by his first wife, Elizabeth, daughter of Thomas Howard, 2nd duke of Norfolk, was born about 1525, and after his father's succession to the earldom in 1542 was styled Viscount Fitzwalter. After serving in the army abroad, he was employed in 1551 in negotiating a marriage between Edward VI. and a daughter of Henry II., king of France. His prominence in the kingdom was shown by his inclusion among the signatories to the letters patent of the 16th of June 1553 settling the crown on Lady Jane Grey; but he nevertheless won favour with Queen Mary, who employed him in arranging her marriage with Philip of Spain, and who raised him to the peerage as Baron Fitzwalter in August 1553.

Returning to England from a mission to the emperor Charles V. in April 1556, Fitzwalter was appointed lord deputy of Ireland. The prevailing anarchy in Ireland, a country which, nominally subject to the English Crown, was torn by feuds among its practically independent native chieftains, rendered the task of the lord deputy one of no ordinary difficulty; a difficulty that was increased by the ignorance of English statesmen concerning Ireland and Irish conditions, and by their incapacity to devise or to carry into execution any consistent and thoroughgoing policy for bringing the half-conquered island under an orderly system of administration. The measures enjoined upon Fitzwalter by the government in London comprised the reversal of the partial attempts that had been made during the short reign of Edward VI. to promote Protestantism in Ireland, and the "plantation" by English settlers of that part of the country then known as Offaly and Leix. But before Fitzwalter could give his attention to such matters he found it necessary to make an expedition into Ulster, which was being kept in a constant state of disturbance by the Highland Scots from Kintyre and the Islands who were making settlements along the Antrim coast in the district known as the Glynnes (glens), and by the efforts of Shane O'Neill to convert into effective sovereignty the chieftainship of his clan which he had recently wrested from his father, Conn, 1st earl of Tyrone. Having defeated O'Neill and his allies the MacDonnells, the lord deputy, who by the death of his father in February 1557 became earl of Sussex, returned to Dublin, where he summoned a parliament in June of that year. Statutes were passed declaring the legitimacy of Queen Mary, reviving the laws for the suppression of heresy, forbidding the immigration of Scots, and vesting in the Crown the territory comprised in what are now the King's County and Queen's County, which were then so named after Philip and Mary respectively. Having carried this legislation, Sussex endeavoured to give forcible effect to it, first by taking the field against Donough O'Conor, whom he failed to capture, and afterwards against Shane O'Neill, whose lands in Tyrone he ravaged, restoring to their nominal rights the earl of Tyrone and his reputed son Matthew O'Neill, baron of Dungannon (see O'NEILL). In June of the following year Sussex turned his attention to the west, where the head of the O'Briens had ousted his nephew Conor O'Brien, earl of Thomond, from his possessions, and refused to pay allegiance to the Crown; he forced Limerick to open its gates to him, restored Thomond, and proclaimed The O'Brien a traitor. In the autumn of 1558 the continued inroads of the Scottish islanders in the Antrim glens called for drastic treatment by the lord deputy. Sussex laid waste Kintyre and some of the southern Hebridean isles, and landing at Carrickfergus he fired and plundered the settlements of the Scots on the Antrim coast before returning to Dublin for Christmas.

In the metropolis the news reached him of the queen's death. Crossing to England, he took part in the ceremonial of Queen Elizabeth's coronation in January 1559; and in the following July he returned to Ireland with a fresh commission, now as lord lieutenant, from the new queen, whose policy required him to come to terms if possible with the troublesome leaders of the O'Neills and the MacDonnells. Shane O'Neill refused to meet Sussex without security for his safety, and having established his power in Ulster he demanded terms of peace which Elizabeth was unwilling to grant. Sussex failed in his efforts to bring Shane to submission, either by open warfare or by a shameful attempt to procure the Irish chieftain's assassination. He was preparing for a fresh attempt when he was superseded by the earl of Kildare, who was commissioned by Elizabeth to open negotiations with O'Neill, the result of which was that the latter repaired to London and made formal submission to the queen. Shane's conduct on his return to Ireland was no less rebellious than before, and energetic measures against him became more imperative than ever. Having obtained Elizabeth's sanction, Sussex conducted a campaign in the summer of 1563 with Armagh as his temporary headquarters; but except for some indecisive skirmishing and the seizure of many of O'Neill's cattle, the operations led to no result and left Shane O'Neill with his power little diminished. His continued failure to effect a purpose for the accomplishment of which he possessed inadequate resources led Sussex to pray for his recall from Ireland; and his wish was granted in May 1564. His government of Ireland had not, however, been wholly without fruit. Sussex was the first representative of the English Crown who enforced authority to any considerable extent beyond the limits of the Pale; the policy of planting English settlers in Offaly and Leix was carried out by him in 1562 with a certain measure of success; and although he fell far short of establishing English rule throughout any large part of Ireland, he made its influence felt in remote parts of the island, such as Thomond and the Glynnes of Antrim, where the independence of the native septs had hitherto been subjected not even to nominal interference. His letters from Ireland display a just conception of the problems with which he was confronted, and of the methods by which their solution should be undertaken; and his failure was due, not to lack of statesmanship or of executive capacity on his own part, but to the insufficiency of the resources placed at his command and want of insight and persistence on the part of Elizabeth and her ministers.

On his return to England, Sussex, who before leaving Ireland had to endure the indignity of an inquiry into his administration instigated by his enemies, threw himself into opposition to the earl of Leicester, especially in regard to the suggested marriage between that nobleman and the queen. He does not appear to have on that account incurred Elizabeth's displeasure, for in 1566 and the following year she employed him in negotiations for bringing about a different matrimonial alliance which he warmly supported, namely, the proposal that she should bestow her hand on the archduke Charles. When this project fell to the ground Sussex returned from Vienna to London in March 1568, and in July he was appointed lord president of the north, a position which threw on him the responsibility of dealing with the rebellion of the earls of Northumberland and Westmorland in the following year. The weakness of the force at his disposal rendered necessary at the outset a caution which engendered some suspicion of his loyalty; and this suspicion was increased by the counsel of moderation which he urged upon the queen; but in 1570 he laid waste the border, invaded Scotland, and raided the country round Dumfries, reducing the rebel leaders to complete submission. In July 1572 Sussex became lord chamberlain, and he was henceforth in frequent attendance on Queen Elizabeth, both in her progresses through the country and at court, until his death on the 9th of June 1583.

The earl of Sussex was one of the great nobles of the Elizabethan period. Though his loyalty was questioned by his enemies, it was as unwavering as his patriotism. He shone as a courtier; he excelled in diplomacy; he was a man of cultivation and even of scholarship, a patron of literature and of the drama on the eve of its blossoming into the glory it became soon after his death. He was twice married: first to Elizabeth, daughter of Thomas Wriothesley, earl of Southampton; and secondly to Frances, daughter of Sir William Sidney. His second wife was the foundress of Sidney Sussex College at Cambridge, which she endowed by her will, and whose name commemorates the father and the husband of the countess. The earl left no children, and at his death his titles passed to his brother Henry (see SUSSEX, EARLS OF).

See P. F. Tytler, *England under the Reigns of Edward VI. and Mary* (2 vols., London, 1839); Richard Bagwell, *Ireland under the Tudors* (3 vols., London, 1885–1890); *Calendar of the Carew MSS.*; John Stow, *Annales* (London, 1631); Charles Henry Cooper, *Athenae cantabrigienses*, vol. i. (Cambridge, 1858), containing a biography of the earl of Sussex; John Strype, *Ecclesiastical Memorials* (Oxford, 1822); Sir Cuthbert Sharpe, *Memorials of the Rebellion of 1569* (London, 1840); John Nichols, *Progresses and Public Processions of Queen Elizabeth* (3 vols., London, 1823); Sir William Dugdale, *The Baronage of England* (London, 1675). (R. J. M.)

SUSSEX, a southern county of England, bounded N. by Surrey, N.E. by Kent, S. by the English Channel, and W. by Hampshire. The area is 1459·2 sq. m. The extreme length from E. to W. is 78 m., while the breadth never exceeds 28 m., but the county is not wholly on the southward slope, for in the middle northern district it contributes a small drainage area to the Thames basin, and the river Medway rises in it. A line of hills known as the Forest Ridges forms the watershed. Its direction is E.S.E. from the northern part of the county to the coast at Fairlight Down east of Hastings, and it reaches a height of about 800 ft. in the neighbourhood of Crowborough. The salient physical feature of the county, however, is the hill range called the South Downs (see DOWNS). Entering in the west, where its summit is about 10 m. from the sea, it runs east for some 50 m., gradually approaching the coast, and terminating in the bold promontory of Beachy Head near Eastbourne. The average height is about 500 ft., though some summits exceed 700, and Ditchling Beacon is over 800. The portion of the county north of the South Downs is called the Weald (*q.v.*). It was formerly covered with forest, and this part of the county is still well wooded. About 1660 the total area under forest was estimated to exceed 200,000 acres, but much wood was cut to supply the furnaces of the ironworks which formed an important industry in the county down to the 17th century, and survived even until the early years of the 19th.

The rivers wholly within the county are small. All rise in the Forest Ridges, and all, except the Rother, which forms part of the boundary with Kent, and falls into the sea below Rye, breach the South Downs. From east to west they are the Cuckmere, rising near Heathfield; the Ouse, Adur and Arun, all rising in the district of St Leonard's Forest, and having at their mouths the ports of Newhaven, Shoreham and Littlehampton respectively. The natural trench known as the Devil's Dike is a point greatly favoured by visitors from Brighton. The coast-line is practically coextensive with the extreme breadth of the county, and its character greatly varies. The sea has done great damage by incursion at some points, and has receded in others, within historic times. Thus what is now marshland or "Levels" round Pevensey was formerly an island-studded bay. In the east Winchelsea and Rye, members of the Cinque Ports, and great medieval towns, are deprived of their standing, the one wholly and the other in part, since a low flat tract interposes between their elevated sites where formerly was a navigable inlet. Yet the total submergence of the site of Old Winchelsea was effected in the 13th century. The site of the ancient cathedral of Selsey is a mile out at sea. Between 1292 and 1340 upwards of 5500 acres were submerged. In the early part of the 14th century Pagham Harbour was formed by a sudden irruption of the sea, devastating 2700 acres, since reclaimed. There is reason to believe that the whole coastline has subsequently been slightly raised. These changes are reflected in the numerous alterations recorded in the course of certain of the rivers near their mouths. Thus the Rother was diverted by a great storm on the 12th of October 1250, before which date it entered the sea 12 m. to the east. The outlet of the Ouse was at Seaford until 1570, and that of the Adur formerly shifted from year to year, ranging east and west over a distance of 2 m. Submerged forests are found off the shore at various points. Long stretches of firm sand, and the mild climate of the coast, sheltered by the hills from north and east winds, have resulted in the growth of numerous watering-places, of which the most popular are Brighton, Hastings, Eastbourne, Bexhill, Seaford, Shoreham, Worthing, Littlehampton and Bognor.

Geology.—The disposition of the rock formations of Sussex is simple. The South Downs consist of chalk, which extends from Beachy Head by Seaford, Brighton, Lewes, Steyning and Goodwood to the western border. The dip of the chalk is southerly, while a strong escarpment faces the north. From the summit of the Downs the hilly country observed on the northern side is occupied mainly by the Hastings Beds and the Weald Clay; at the foot of the escarpment lie the Gault and Upper Greensand, while between these formations and the Wealden rocks there is an elevated ridge of ground formed by the Lower Greensand. On the southern side, narrow at Brighton but broadening westward, is a level tract, 8 m. wide in the peninsula of Selsey, which owes its level character to the action of marine planation. This tract is occupied partly by Chalk and partly by Tertiary rocks, both much obscured by more recent deposits. On this side the chalk hills are deeply notched by dry valleys or coombs, which frequently end in cirques near the northward escarpment. The present aspect of the strata has been determined by the broad east and west fold with its subordinate members, known as the Wealden anticline. Only the southern and central portions of this anticline are included in this country; at one time there is no doubt that the Chalk, Greensand and Gault covered the entire area in the form of an uplifted dome, but denudation has removed the Chalk and most of the other formations as far as the North Downs, exposing thereby the underlying Wealden Beds. The oldest rocks thus brought to light along the crest of the anticline are the Purbeck Beds, small patches of shale and limestone, with some important beds of gypsum, which lie north-west of Battle. A deep boring (1905 ft.) at Netherfield, passed through Portlandian Beds and Kimmeridge Clay into Oxford Clay, but these do not appear anywhere at the surface. Above the Purbeck Beds, and covering all the north-eastern portion of the county from the coast at Bexhill and Rye to Horsham, are sands and clays of the Lower Wealden or Hastings Beds. This includes the following local subdivisions, in ascending order; the Fairlight Clay, Ashdown Sand, Wadhurst Clay, Lower Tunbridge Wells Sand, Grinstead Clay and Upper Tunbridge Wells Sand (with Tilgate stone at the top and Cuckfield Clay at the base). The Weald Clay occupies a belt of lower ground on the south and west of the Hastings Sands, it consists of blue and mottled clays with thin sand layers and beds of hard limestone, the "Sussex marble" with the shells of *Paludina*. The Horsham Stone is another local hard bed. Near Tilgate the remains of *Iguanodon* have been found in this formation. Bordering the outcrop of the Weald Clay is the Lower Greensand; it appears a little north of Eastbourne and passes thence through Ringmer, Storrington, Pulborough, Petworth, Midhurst and Linchmere. It contains the following divisions in ascending order—the Atherfield Clay, Hythe Beds (sandy limestone, sandstone and chert), Sandgate Beds and Folkestone Beds. The Eocene strata lying south of the Downs and west of Brighton—with the exception of some outliers of Reading Beds near Seaford—include the Woolwich and Reading Beds, London Clay (with hard "Bognor Rock"), the Bagshot and Bracklesham Beds; the last-named formation is very fossiliferous in the bay of that name. As already mentioned, superficial deposits cover much of the low ground west of Brighton; these include glacial deposits with large boulders, raised beaches, brick earth and gravels, marine and estuarine, and the interesting Coombe rock or Brighton Elephant Bed, a coarse rubble of chalk waste formed late in the Glacial period, well exposed in the cliff at Black Rock east of Brighton, where it rests on a raised beach. The natural gas of Heathfield comes from the Lower Wealden and Purbeck Beds. The Wadhurst Clay was formerly an important source of iron ore.

Climate and Agriculture.—The climate of the coast district is mild, equable and dry, while that of the Wealden shows greater extremes of temperature, and is rather wetter. The mean daily range of temperature in the Weald is about half as much again as on the coast. The influence of the sea in modifying the temperature of the coast district is specially noticeable in the autumn months, when the temperature is higher than in the Weald and other parts of England northwards. The coast district is specially suitable for market gardens and for growing fruit trees. The fig gardens of West Tarring are celebrated. About seven-tenths of the total area is under cultivation, and of this nearly three-fifths is in permanent pasture. Sussex is still one of the best-wooded counties in England. The acreage under grain crops shows a large decrease; nearly the whole of it is occupied by oats and wheat. The acreage under green crops is mainly devoted to turnips and other food for cattle and to the supply of vegetables for the London market. The growing of hops has not kept pace with that in the neighbouring county of Kent. Cattle are kept in increasing numbers both for breeding and for dairy purposes. The South Downs afford excellent pasture for sheep and Sussex is famed for a special breed of black-faced sheep. The numbers, however, show a steady decrease. Poultry farming is largely carried on in some parts. The custom of borough-English, by which land descends to the youngest son, prevailed to an extraordinary degree in Sussex, and no fewer than 140 manors have been catalogued in which it was found. Gavelkind tenure existed in Rye, in the large manor of Brede, and in Coustard manor (in Brede parish).

Other Industries.—The manufacturing industries are meagre. The London, Brighton & South Coast Railway Company has large works at Brighton. At Heathfield in 1901 the development of the field of natural gas was begun by a private company. The fisheries are of great importance, including cod, herrings, mackerel, sprats, plaice, soles, turbot, shrimps, crabs, lobsters, oysters, mussels, cockles, whelks and periwinkles. Bede records that St Wilfrid, when he visited the county in 681, taught the people the art of net-fishing. At the time of the Domesday survey the fisheries were extensive, and no fewer than 285 *salinae* (saltworks) existed. The customs of the Brighton fishermen were reduced to writing in 1579.

Communications.—Communications are provided by the London, Brighton & South Coast railway by lines from the north to St Leonards and Hastings, to Eastbourne, to Lewes and Newhaven, to Brighton, to Shoreham, and to Arundel and Chichester, with numerous branches and a connecting line along the coast. The South-Eastern & Chatham railway serves Bexhill, St Leonards and Hastings, with a coastal branch eastward by Rye. Light railways run from Chichester to Selsey (Selsey railway) and from Robertsbridge to Bodiam and Tenterden (Rother Valley railway). There are no good harbours, and none of the ports is of first importance. From Newhaven, however, a large trade is carried on with France, and daily services of passenger steamers of the Brighton Railway Company ply to Dieppe.

Population and Administration.—The area of the ancient county is 933,887 acres, with a population in 1891 of 550,446 and in 1901 of 605,202. The earliest statement as to the population is made by Bede, who describes the county as containing in the year 681 land of 7000 families; allowing ten to a family (not an unreasonable estimate at that date), the total population would be 70,000. In 1693 the county is stated to have contained 21,537 houses. If seven were allowed to a house at that date, the total population would be 150,759. It is curious, therefore, to observe that in 1801 the population was only 159,311. The decline of the Sussex ironworks probably accounts for the small increase of population during several centuries, although after the massacre of St Bartholomew upwards of 1500 Huguenots landed at Rye, and in 1685, after the revocation of the Edict of Nantes, many more refugees were added to the county.

An act of Henry VII. (1504) directed that for convenience the county court should be held at Lewes as well as at Chichester, and this apparently gave rise to the division of Sussex into east and west parts, each of which is an administrative county. East Sussex has an area of 528,807 acres and West Sussex of 403, 602 acres. Sussex includes the county boroughs of Brighton and Hastings. East Sussex contains the municipal boroughs of Bexhill (pop. 12,213), Brighton (123,478), Eastbourne (43,344), Hastings (65,528), Hove (36,535), Lewes (11,249) and Rye (3900). The urban districts in this division are Battle (2996), Burgess Hill (4888), Cuckfield (1813), East Grinstead (6094), Haywards Heath (3717), Newhaven (6772), Portslade-by-Sea (5217), Seaford (3355) and Uckfield (2895). In West Sussex the municipal boroughs are Arundel (2739), Chichester, a city (12,244) and Worthing (20,015). The urban districts are Bognor (6180), Horsham (9446), Littlehampton (7363), Shoreham (3837) and Southwick (3364). The ancient county, which is almost entirely in the diocese of Chichester, contains 377 ecclesiastical parishes or districts, wholly or in part. The total number of civil parishes is 338. Sussex is divided into the following parliamentary divisions: northern or East Grinstead, eastern or Rye, southern or Eastbourne, mid or Lewes, south-western or Chichester, north-western or Horsham, each returning one member; and contains the parliamentary boroughs of Brighton, returning two members, and Hastings, returning one.

History.—Apart from conclusions to be drawn from prehistoric remains, the history of Sussex begins in 477, when the Saxons landed in the west of the county under Ella and his three sons, and built up the kingdom of the South Saxons (see SUSSEX, KINGDOM OF, below). They took the Roman city of Regnum, which became Chichester, and drove the British westward, into the forest of Andred. The Roman fortress of Anderida, the site of the castle of Pevensey, also fell to the Saxons. Ella became the most influential of the contemporary Saxon chiefs, and was, according to Bede, the first Bretwalda. After his time the kingdom of Sussex gradually declined, and fell entirely under the dominion of Wessex in 823. Interesting Saxon remains are found in numerous cemeteries, and scattered burial places along the south slopes of the Downs. The cemetery on High Down hill, where weapons, ornaments and vessels of various kinds were found, and the Chanctonbury hoard of coins, are among the most noticeable relics. A coin of Offa of Mercia, found at Beddingham, recalls the charter of Archbishop Wilfred in 825, in which Offa's connexion with the monastery in that place is recorded. From 895 Sussex suffered from constant raids by the Danes, till the accession of Canute, after which arose the two great forces of the house of Godwine and of the Normans. Godwine was probably a native of Sussex, and by the end of the Confessor's reign a third part of the county was in the hands of his family. Norman influence was already strong in Sussex before the Conquest; the harbours of Hastings, Rye, Winchelsea and Steyning being in the power of the Norman abbey of Fécamp, while the Norman chaplain of Edward the Confessor, Osbern, afterwards bishop of Exeter, held the estate of Bosham.

The county was of great importance to the Normans; Hastings and Pevensey being on the most direct route for Normandy. William was accordingly careful to secure the lines of communication with London by placing the lands in the hands of men bound by close ties to himself, such as his half-brother, the count of Mortain, who held Pevensey, and his son-in-law, William de Warenne, who held Lewes. With the exception of lands held by the Church and the Crown, the five rapes of Sussex were held by these and three other Norman tenants-in-chief: William de Braose, the count of Eu, and Roger, earl of Montgomery, who held respectively Bramber, Hastings and Arundel. The honour of Battle was afterwards made into a rape by the Conqueror, and provides one of the arguments in favour of the theory of the Norman origin of these unique divisions of the county. The county was divided into five (afterwards six) strips, running north and south, and having each a town of military, commercial and maritime importance. These were the rapes, and each had its sheriff, in addition to the sheriff of the whole county. Whether the origin of the rapes, as districts, is to be found in the Icelandic territorial division *hreppr* (rejected in the *New English Dictionary*), or in the Saxon *rap*, a rope, or is of Norman origin, as lordships they undoubtedly owed their existence to the Normans. The holdings—which had been scattered under the Saxons, so that one man's holding might be in more than one rape—were now determined, not by the manors in which they lay, but by the borders of the rape. Another peculiarity of the division of land in Sussex is that, apparently, each hide of land had eight instead of the usual four virgates.

The county boundary was long and somewhat indeterminate on the north, owing to the dense forest of Andredsweald, which was uninhabited till the 11th century. Evidence of this is seen in Domesday Book by the survey of Worth and Lodsworth under Surrey, and also by the fact that as late as 1834 the present parishes of north and south Amersham in Sussex were part of Hampshire. At the time of the Domesday Survey Sussex contained sixty hundreds, which have been little altered since. A few have been split up into two or three, making seventy-three in all; and the names of some have changed, owing probably to the meeting-place of the hundred court having been altered. These courts were in private hands in Sussex; either of the Church, or of great barons and local lords. The county court was held at Lewes and Shoreham until the Great Inquest, when it was moved to Chichester. After several changes the act of 1504 arranged for it to be held alternately at Lewes and Chichester. There was no gaol in the county until 1487; that at Guildford being used in common by Surrey and Sussex, which were under one sheriff until 1567.

Private jurisdictions, both ecclesiastical and lay, played a large part in the county. The chief ecclesiastical franchises were those of the archbishop of Canterbury, of the bishop of Chichester, of the Saxon foundation of Bosham, where Bishop Wilfred had found the only gleam of Christianity in the county, and of the votive abbey of Battle, founded by the Conqueror. This abbey possessed, besides land in many other counties, the "Lowy of Battle," a district extending for 3 m. round the abbey. The see of Chichester was co-extensive with the county, and has altered little. It is one of the oldest bishoprics, having been founded by Wilfred at Selsey; the seat was removed to Chichester by William I. Among the lay franchises, the most noticeable are those of the Cinque Ports and of the honor of Pevensey, named the honor of the Eagle from the lords of L'Aigle or Aguila.

Sussex, from its position, was constantly the scene of preparations for invasion, and was often concerned in rebellions. Pevensey and Arundel play a great part in rebellions and forfeiture during the troubled times of the early Norman kings. In the barons' wars the county was a good centre for the king's forces; Lewes being in the hands of the king's brother-in-law, John de Warenne, earl of Surrey, Pevensey and Hastings in those of his uncle, Peter of Savoy. The forces of the king and of De Montfort met at Lewes, where the famous battle and "Mise of Lewes" took place. The corrupt and burdensome administration of the county during the 13th and 14th centuries, combined with the constant passage of troops for the French wars and the devastating plagues of the 14th century, were the causes of such rebellions as the Peasants' Rising of 1381 and Jack Cade's Rebellion in 1450. In the former Lewes Castle was taken, and in the latter we find such men engaged as the abbot of Battle and the prior of Lewes. During Elizabeth's reign there was again constant levying of troops for warfare in Flanders and the Low Countries, and preparations for defence against Spain. The sympathies of the county were divided during the Civil War, Arundel and Chichester being held for the king, Lewes and the Cinque Ports for the parliament. Chichester and Arundel were besieged by Waller, and the Roundheads gained a strong hold on the county, in spite of the loyalty of Sir Edward Ford, sheriff of Sussex. A royalist gathering in the west of the county in 1645 caused preparations for resistance at Chichester, of which Algernon Sidney was governor. In the same year the "Clubmen" rose and endeavoured to compel the armies to come to terms. Little active part in the national history fell to Sussex from that time till the French Revolution, when numbers of volunteers were raised in defence. At the outbreak of war with France in 1793 a camp was formed at Brighton; and at Eastbourne in 1803, when the famous Martello towers were erected.

The parliamentary history of the county began in 1290, for which year we have the first extant return of knights of the shire for this county, Henry Hussey and William de Etchingham, representatives of two well-known Sussex families, being elected. Drastic reformation was effected by the Redistribution Act of 1832, when Bramber, East Grinstead, Seaford, Steyning and Winchelsea were disfranchised after returning two members each, the first being classed among the worst of the "rotten" boroughs. Before 1832 two members each had been returned also by Arundel, Chichester, Hastings, Horsham, Lewes, Midhurst, New Shoreham (with the rape of Bramber) and Rye. Arundel, Horsham, Midhurst and Rye were each deprived of a member in 1832, Chichester and Lewes in 1867, and Hastings in 1885. Arundel was disfranchised in 1868, and Chichester, Horsham, Midhurst, New Shoreham and Rye in 1885. In the 18th century the duke of Newcastle was all-powerful in the county, where the Pelham family had been settled from the time of Edward I.; the earl of Chichester being the present representative of the family. Among the oldest county families of Sussex may be mentioned the Ashburnhams of Ashburnham, the Gages of Firle and the Barttelots of Stopham.

The industries of Sussex, now mainly agricultural, were once varied. Among those noted in the Domesday Survey were the herring fisheries, the salt pans of the coast and the wool trade; the South Down sheep being noted for their wool, at home and abroad, as early as the 13th century. The iron mines of the county, though not mentioned in Domesday, are known to have been worked by the Romans; and the smelting and forging of iron was the great industry of the Weald from the 13th to the 18th century, the first mention of the trade in the county being in 1266. In the 15th century ordnance for the government was made here. Some old banded guns with the name of a Sussex maker on them may be seen at the Tower of London. The first cast-iron cannon made in England came from Buxted in Sussex, and were made by one Ralph Hogge, whose device can be seen on a house in Buxted. The large supply of wood in the county made it a favourable centre for the industry, all smelting being done with charcoal till the middle of the 18th century. In the time of Henry VIII. the destruction of the forest for fuel began to arouse attention, and enactments for the preservation of timber increased from this time forward, till the use of pit-coal for smelting was perfected, when the industry moved to districts where coal was to be found. Camden, Thomas Fuller, and Drayton in his *Polyolbion* refer to the busy and noisy Weald district, and lament the destruction of the trees. The glass-making industry, which had flourished at Chiddingfold in Surrey, and at Wesborough Green, Loxwood and Petworth in Sussex, was destroyed by the prohibition of the use of wood fuel in 1615. The timber trade had been one of the most considerable in early times; the Sussex oak being considered the finest shipbuilding timber. Among the smaller industries weaving and fulling were also to be found, Chichester having been noted for its cloth, also for malt and needles.

Antiquities.—From early times castles guarded three important entries from the coast through the South Downs into the interior provided by the valleys of the Ouse, the Adur and the Arun. These are respectively at Lewes, Bramber and Arundel. The ruins of the first two, though imposing, do not compare in grandeur with the third, which is still the seat of the dukes of Norfolk. More famous than these are the massive remains, in part Norman but mainly of the 13th century, of the stronghold of Pevensey, within the walls of Roman Anderida. Other ruins are those of the finely situated Hastings Castle; the Norman remains at Knepp near West Grinstead; the picturesque and remarkably perfect moated fortress of Bodiam, of the 14th century; and Hurstmonceaux Castle, a beautiful 15th-century building of brick. Specimens of ancient domestic architecture are fairly numerous; such are the remnants of old palaces of the archbishops of Canterbury at Mayfield and West Tarring; Amberley Castle, a residence until the 16th century of the bishops of Chichester; and the Elizabethan mansions of Parham and of Danny at Hurstpierpoint. There are many fine residences dating from the 18th century or later; Goodwood is perhaps the most famous. Here and elsewhere are fine collections of paintings, though the county suffered a loss in this respect through the partial destruction by fire of the modern castle of Knepp in 1904.

Monastic remains are few and generally slight. The ruins of Bayham Abbey near Tunbridge Wells, and of Battle Abbey, may be noticed. There are numerous churches, however, of great interest and beauty. Of those in the towns may be mentioned the cathedral of Chichester, the churches of Shoreham and Rye, and the mother church of Worthing at Broadwater. Construction of pre-Norman date is seen in the churches of Bosham, Sompting and, most notably, Worth. There is very rich Norman work of various dates in the church of St Nicholas, Steyning. Several perfect specimens of small Early English churches are found, as at West Tarring, and at Climping near Littlehampton. Perhaps the most interesting church in the county is the magnificent Decorated fragment at Winchelsea; another noteworthy church of this period is at Etchingham, near the eastern border. The church of St Denis, Midhurst, is mainly Perpendicular; but this style is not otherwise predominant. The large church at Fletching, of various styles, contains the tomb of Gibbon the historian. At Cowfold, south-east of Horsham, is a great Carthusian monastery, founded in 1877. The iron memorial slabs occurring in several churches recall the period of the iron industry in Sussex.

Dialect.—A large number of Saxon words are retained and pronounced in the old style; thus *gate* becomes *ge-at*. The letter *a* is very broad in all words, as if followed by *u*, and in fact converts words of one syllable into words of two, as *faüs* (face), *taüst* (taste), &c. Again, *a* before double *d* becomes *ar*, as *arder* and *larder* for *adder* and *ladder*; *oi* is like a long *i*, as *spile* (spoil), *intment* (ointment); an *e* is substituted for *a* in such words as *rag*, *flag*, &c. The French refugees in the 16th and 17th centuries introduced many words which are still in use. Thus a Sussex woman when unprepared to receive visitors says she is in *dishabille* (déshabillé, undress); if her child is unwell, it looks *pekid* (piqué), if fretful, is a little *petergrievous* (petit-grief); she cooks with a *broach* (broche, a spit), and talks of *coasts* (coste, O. Fr.), or ribs of meat, &c.

Authorities.—See T. W. Horsfield, *History, Antiquities and Topography of Sussex* (Lewes, 1835); J. Dallaway, *History of the Western Division of Sussex* (London, 1815–1832); M. A. Lower, *History of Sussex* (Lewes, 1870), *Churches of Sussex* (Brighton, 1872) and *Worthies of Sussex* (Lewes, 1865); *Sussex Archaeological Society's Collections*; W. E. Baxter, *Domesday Book for . . . Sussex* (Lewes, 1876); Sawyer, *Sussex Natural History and Folklore* (Brighton, 1883), *Sussex Dialect* (Brighton, 1884) and *Sussex Songs and Music* (Brighton, 1885); A. J. C. Hare, *Sussex* (London, 1894).

SUSSEX, KINGDOM OF (*Súð Seaxe, i.e.* the South Saxons), one of the kingdoms of Anglo-Saxon Britain, the boundaries of which coincided in general with those of the modern county of Sussex. A large part of that district, however, was covered in early times by the forest called Andred. According to the traditional account given in the Anglo-Saxon Chronicle, it was in 477 that a certain Ella (Ælle) led the invaders ashore at a place called Cymenes ora and defeated the inhabitants. A further battle at a place called Mearcredes burne is recorded under the year 485, and in the annal for 491 we read that Ella and Cissa his son sacked Anderida and slew all the inhabitants. Ella is the first king of the invading race whom Bede describes as exercising supremacy over his fellows, and we may probably regard him as an historical person, though little weight can be attached to the dates given by the Chronicle.

The history of Sussex now becomes a blank until 607, in which year Ceolwulf of Wessex is found fighting against the South Saxons. In 681 Wilfrid of York, on his expulsion from Northumbria by Ecgfrith, retired into Sussex, where he remained until 686 converting its pagan inhabitants. According to Bede, Æthelwald, king of Sussex, had been previously baptized in Mercia at the suggestion of Wulfhere, who presented him with the Isle of Wight and the district about the Meon. After Wilfrid's exertions in relieving a famine which occurred in Sussex the king granted to him eighty-seven hides in and near the peninsula of Selsey which, with a lapse until 709 after Wilfrid's retirement, remained the seat of the South Saxon bishopric until the Norman Conquest. Shortly afterwards, however, Æthelwald was slain and his kingdom ravaged by the exiled West Saxon prince Ceadwalla. The latter was eventually expelled by two princes named Berhthun and Andhun, who thereupon assumed the government of the kingdom. In 686 the South Saxons attacked Hlothhere, king of Kent, in support of his nephew Eadric, but soon afterwards Berhthun was killed and the kingdom subjugated for a time by Ceadwalla, who had now become king of Wessex.

Of the later South Saxon kings we have little knowledge except from occasional charters. In 692 a grant is made by a king called Nothelm to his sister, which is witnessed by two other kings called Nunna and "Uuattus." Nunna is probably to be identified with Nun, described in the Chronicle as the kinsman of Ine of Wessex who fought with him against Gerent, king of the West Welsh, in 710. According to Bede, Sussex was subject to Ine for a number of years. A grant, dated by Birch about 725, is made by Nunna to Eadberht, bishop of Selsey, and to this too "Uuattus" appears as a witness. In 722 we find Ine of Wessex at war with the South Saxons, apparently because they were supporting a certain Aldbryht, probably an exile from Wessex. An undated grant is made by Nunna about this time, which is witnessed by a King Æthelberht. After this we hear nothing more until shortly before 765, when a grant of land is made by a king named Aldwulf with two other kings, Aelfwald and Oslac, as witnesses. In 765 and 770 grants are made by a King Osmund, the latter of which is witnessed by Offa of Mercia. Offa also appears as witness to two charters of an Æthelberht, king of the South Saxons, and in 772 he grants land himself in Sussex, with Oswald, *dux* of the South Saxons, as a witness. It is probable that about this time Offa definitely annexed the kingdom of Sussex, as several persons, Osmund, Ælfwald and Oslac, who had previously used the royal title, now sign with that of *dux*. In 825 the South Saxons submitted to Ecgberht, and from this time they remained subject to the West Saxon dynasty. The earldom of Sussex seems later to have been held sometimes with that of Kent.

Authorities.—*Anglo-Saxon Chronicle*, pp. 449, 477, 485, 491, 607, 722, 725, 823, 827 (ed. Earle and Plummer, Oxford, 1899); Bede, *Historia Ecclesiastica*, i. 15, ii. 5, iv. 13, 15, 16, 26, v. 18, 19, 23 (ed. C. Plummer, Oxford, 1896); W. de G. Birch, *Cartularium Saxonicum*, Nos. 78, 144, 145, 197, 198, 206, 208, 211, 212, 1334 (London, 1885–1893). (F. G. M. B.)

SUTHERLAND, EARLS AND DUKES OF. The first earl of Sutherland was a certain William (d. 1284), whose father, Hugh Freskin (d. 1204), acquired the district of Sutherland about 1197. Probably about 1230 William was created earl of Sutherland. His descendant William, the 4th earl (d. 1370), was a person of some importance in the history of Scotland; he married Margaret (d. 1358), daughter of King Robert Bruce. His descendant John, the 9th earl, a man of weak intellect, died unmarried in 1514.

John's sister Elizabeth (d. 1535) married Adam Gordon (d. 1537), a younger son of George Gordon, 2nd earl of Huntly, and a grandson of King James I., and before 1516 Gordon became earl of Sutherland by right of his wife. He was succeeded by his grandson John (*c.* 1526–1567), the 2nd earl of his line, who played his part in the turbulent politics of the time and was poisoned at the instigation of George Sinclair, 4th earl of Caithness. His great-grandson John, the 5th earl (1609–1663), was a strong Covenanter, being called by his associates "the good Earl John"; he fought against Montrose at Auldearn, but afterwards he rendered good service to Charles II. John Gordon (*c.* 1660–1733), who became the seventh earl in 1703, supported the revolution of 1688 and was a commissioner for the union of England and Scotland. He was a Scottish representative peer in four parliaments, president of the board of trade and manufactures, and lord-lieutenant of the eight northern counties of Scotland. He was active in putting down the rising of 1715. This earl, who took the name of Sutherland instead of that of Gordon, was succeeded by his grandson William (*c.* 1708–1750), a representative peer, who helped to suppress the rebellion of 1745. William, the next earl, died without male issue in 1766. This earl's daughter Elizabeth (1765–1839) claimed the peerage, and although her title thereto was contested by Sir Robert Gordon, Bart., a descendant of the first Gordon earl, it was confirmed by the House of Lords in 1771.

Established in the possession of the title and the vast estates of the earldom, the countess of Sutherland was married in 1785 to George Granville Leveson-Gower (1758–1833), who succeeded his father as second marquess of Stafford in 1803. In addition to the estates of the marquessate of Stafford, Leveson-Gower inherited the Bridgewater Canal and estates from his maternal uncle, Francis Egerton, 2nd duke of Bridgewater, and these properties, together with his wife's estates, which included almost the whole of the county of Sutherland, made him a "leviathan of wealth," as he is called by Charles Greville. In 1833 he was created duke of Sutherland. Leveson-Gower was a member of parliament from 1778 to 1784 and again from 1787 to 1798 and was British ambassador in Paris from 1790 to 1792. From 1799 to 1810 he was joint postmaster-general. He was a collector of paintings, and purchased Stafford House, still the London residence of the dukes of Sutherland. As a landlord he greatly improved his estates in Staffordshire and Shropshire and then turned his attention to those of his wife in Sutherlandshire. He was responsible for the construction of about 450 m. of road and of many bridges, but his policy of removing a large number of his tenants from the interior to the coast aroused bitterness and criticism. However, he reduced rents and brought thousands of acres into cultivation. He died at Dunrobin Castle on the 5th of July 1833.

His elder son, George Granville (1786–1861), became the 2nd duke, but the valuable Bridgewater estates passed to his younger son, Lord Francis Leveson-Gower, who was created earl of Ellesmere in 1846. The 2nd duke's wife, Harriet Elizabeth Georgiana (1806–1868), a daughter of George Howard, 6th earl of Carlisle, was one of Queen Victoria's most intimate friends. She was mistress of the robes to the queen, whose refusal to part with her in 1839 led to a ministerial crisis. Some of her letters are published in *Stafford House Letters*, edited by her son Lord Ronald Gower (1891).

George Granville William, the 3rd duke (1828–1892), spent large sums in improving his estates. His wife Anne (1829–1888), daughter of John Hay Mackenzie, was created countess of Cromartie in 1861, and the earldom descended to her second son Francis (1852–1893). When he died without sons the earldom fell into abeyance, but this was terminated in 1895 in favour of his daughter Sibell Lilian (b. 1878), the author of *The Days of Fire* and other books.

In 1892 Cromartie Leveson-Gower (b. 1851), who had been M.P. for Sutherlandshire, became 4th duke of Sutherland. His wife, Millicent Fanny, daughter of the 4th earl of Rosslyn, became well known in literary as well as in social and philanthropic circles.

See Sir Robert Gordon and George Gordon, *Genealogical History of the Earldom of Sutherland* (Edinburgh, 1813); and also the article STAFFORD, EARLS AND MARQUESSES OF.

SUTHERLANDSHIRE, a northern county of Scotland, bounded N. and W. by the Atlantic, E. by Caithness, S.E. by the North Sea and S. by the shire of Ross and Cromarty. It has an area of 1,297, 846 acres or 2,028 sq. m., being the fifth largest shire in Scotland. The western and northern shores are much indented and terminate at many points in precipices and rugged headlands. The mountains are distinguished by grandeur of outline. Ben More (3273 ft.) in Assynt is the highest in the shire, and next to it in height is Ben Clibreck (3154). Ben Hope (Icelandic *hôp*, haven, 3040), in the north, is noted as the only place in Great Britain where the Alpine *Alsine rubella* is found, and also for its fauna, ptarmigan being common, and even the wild cat and golden eagle occurring at rare intervals. Other lofty hills include Foinaven (wart mountain, 2980) in the north-west; Ben Hee (2864), the highest point in Reay Forest; the serrated ridge of Quinag (2653) and Glasven (2541) north, and the cone of Canisp (2779) south of Loch Assynt; the precipitous Carn Stackie (2630) in Durness; Ben Arkle (2580) and Ben Stack (2364), frowning above Loch Stack; the fantastic peaks of Ben Loyal (the hill of the young calves, or deer, 2504) in Tongue; and Suilven (2399). The greater part of the mountainous region consists of wild and desolate moorlands. The chief river is the Oykell, which, rising in Coniveall (3234), a peak of Ben More, flows south and then south-east for 33 m. to Dornoch Firth, forming the major part of the southern boundary of the shire. Its principal left-hand tributaries are the Shin and Cassley. Other rivers flowing to Dornoch Firth are the Helmsdale (22 m.), issuing from Loch an Ruathair; the Brora (28 m.), rising in Mt Uaran and preserving in its name (bridge river) the fact that its bridge was once the only important one in the county; and the Fleet (17), the head of the estuary of which was embanked for 1000 yds. in 1813 by Thomas Telford, whereby a considerable tract of rich alluvial land was reclaimed from the sea. The longest rivers flowing to the north coast are the Dionard (14) to Kyle of Durness, the Naver (17) to Torrisdale Bay, and the Halladale (22), rising in Knockfin on the borders of Caithness and entering the sea to the east of Portskerry. Much of the surface in the district of Assynt is honeycombed with lakes and tarns, but the only large lake is Loch Assynt, which is 6½ m. long, lies 215 ft. above the sea, has a drainage area of 43 sq. m., and a greatest depth of 282 ft., and empties into the sea by the Inver. Other lakes are Loch Crocach, little more than 1 m. long by ⅓ m. wide, in which the ratio of the area of islands to the total area of the loch is greater than in any other British lake; Loch Shin (17 m. long); Loch Loyal (4 m.); Loch Hope (6 m.); Loch Naver (6 m.); and Loch More (4 m.). The principal inlets of the sea are, on the north coast, Kyle of Tongue—on the east shore of which stands Tongue House, once the property of the Reay family, now a seat of the duke of Sutherland—Loch Eriboll and Kyle of Durness; on the west, Lochs Inchard, Laxford (salmon fjord), Cairnbawn, Glendhu, Glencoul, Eddrachilis Bay and Loch Inver; and, on the south-east, Loch Fleet. There are many waterfalls in the county. Those of Escuallin, near the head of Glencoul, are among the finest in Great Britain. There are three principal capes—Strathy Point on the north; Cape Wrath at the extreme north-west; and Ru Stoer, near which is the Old Man of Stoer, a detached pillar of rock about 250 ft. high. On its seaward face Cape Wrath (a corruption of the Icelandic *hvarf*, turning-point) rises in precipitous cliffs to a height of 300 ft. The gneiss rocks are scored with pink granite. Sunken reefs keep the sea almost always in tumult. Of the larger islands Handa, usually visited from Scourie on the west coast, has magnificent cliff scenery, distinguished for its beautiful coloration, its caverns and the richness and variety of the bird life, especially on the north-west, where the Torridonian sandstone rocks are 406 ft. high. The cave of Smoo (Icelandic *smuga*, hole: same root as smuggle) on the north coast, 1 m. east of Durness, is the most famous cavern in the shire; it consists of three chambers hollowed out of the limestone; the entrance hall, 33 ft. high and 203 ft. long, is separated from the inner chamber, 70 ft. long by 30 ft. wide, by a ledge of rock beneath which pours a stream that descends as a cataract from a hole in the roof, 80 ft. above. Behind the waterfall is the third chamber, 120 ft. long by 8 ft. wide, which can only be seen by artificial light.

Geology.—A very irregular line from Loch Eriboll on the north coast to the neighbourhood of Cromalt near the southern boundary separates the two rock groups that form the foundation of the major portion of the county. On the western side of this line are the ancient gneisses and schists (the Lewisian gneiss); these are penetrated by innumerable basic and acid dikes which generally have a north-west to south-east trend. On the eastern side of the line, occupying the whole of the remaining area except the eastern fringe of the county, is a younger series of metamorphic rocks, the Moine schists. Resting with marked unconformability upon the old gneiss near Cape Wrath, at Ru Stoer, Quinag, Canisp and Suilven are the dark red conglomerates, breccias and sandstones of Torridonian age. Cambrian rocks succeed the Torridonian, again with strong unconformity; they are represented in ascending order by (1) false bedded quartzite, (2) quartzite with annelid burrows, the "pipe rock," (3) the fucoid beds with *Olenellus* band, (4) serpulite grit, (5) Durness limestone and dolomite and their marmorized equivalents. The white quartzite that has been left as a cap on such dark Torridonian hills as Quinag and Canisp forms a striking feature in the landscape. These Cambrian rocks occupy a very irregular belt along the line above mentioned; the broadest tract is in the neighbourhood of Loch Assynt, another large area lies about the southern end of Loch Eriboll and the Durness limestone is extensively developed near the loch of that name. Along the belt of Cambrian rocks there is abundant evidence of crustal deformation on the most extensive scale; one after another great slices of rock, often miles in extent, have been sheared off and pushed forward by thrusts from a south-easterly direction, so that in several places it is possible to find the Lewisian gneiss dragged up and carried forward right on to the Cambrian; in the Durness district the eastern schists have been so transported from a distance of 10 m. The most striking of the planes of thrusting is that known as the Moine, others of great magnitude occur to the west of it, such as those by Glencoul and Ben More. Masses of granite appear in the eastern schists on the county boundary by Strath Halladale, at Ben Laoghal, Ben Stomino and east of Lairg. The Old Red Sandstone forms some elevated ground around Dornoch and Golspie and patches occur at Portskerra and elsewhere. A narrow strip of Mesozoic strata lies along the coast from Golspie Burn to Ord. Triassic marls are seen in the Golspie stream; these are succeeded northwards, near Dunrobin Castle, by Lias, then by Great Oolite, with the Brora coal, followed by Oxfordian, Corallian and Kimeridgian beds. Evidence of ice action is everywhere apparent, the striations show that the ice travelled towards the north-west and north, and from the eastern part of the county, towards Moray Firth.

Climate and Agriculture.—The rainfall varies greatly, being lowest on the south-east and highest in the mountainous hinterland of the west, with an annual mean of 44·7 in. The average temperature for the year is 47° F., for January 38·5° F., for July 56·5° F. Only one-fortieth of the total area is under cultivation, the shire ranking lowest in Scotland in this respect. The great mass of the surface is grazing ground and deer forest. The best land adjoins Dornoch Firth, where farming is in an advanced condition, but there are fertile patches along the river valleys. At the beginning of the 19th century the crofters occupied almost every cultivable spot, and were more numerous than the soil could support. The first duke of Sutherland (then marquis of Stafford) adopted a policy of wholesale clearance. Between 1811 and 1820 fifteen thousand peasants were evicted from their holdings in the interior and transferred to the coast. The duke incurred great obloquy, but persisted in his reforms, which included reduction of rent, improvement in the well-being of the people, reclamation of thousands of acres, and abolition of the tacksman or middleman, so that tenants should hold directly of himself. He also did much to open up the shire generally. Between 1812—when there was only one bridge and no road in Sutherland—and 1832, he bore half the cost, the government contributing the rest, of constructing 450 m. of road, 134 bridges, some of considerable size, and the iron bridge at Bonar of 150 ft. span. The 3rd duke (1828–1892) carried out a large plan of reclamation. Attempts have been made to repeople some of the glens (Strathnaver, for example) depopulated by the clearances. Crofters still largely predominate, nearly two-thirds of the holdings being under 5 acres—the highest proportion in Scotland. The chief grain crops are oats and barley, the chief green crops turnips (including swedes) and potatoes. The raising of livestock is the staple business of the county. The sheep are mostly Cheviots, the cattle West Highland, shorthorn and crossbred. Horses—principally ponies, though Clydesdales are used on the bigger farms—are almost wholly kept for agricultural purposes, and pigs are also reared. The deer forests belonging to the duke of Sutherland are Reay, 64,600 acres; Ben Armine and Coirna-fearn, 35,840; Glen Canisp, 34,490; and Dunrobin, 12,180—in all 147,110 acres, or more than one-ninth of the whole area. Excepting the south-east coast, the valley of the Shin, and a considerable portion of Strath Oykell, there are very few districts under wood.

Other Industries.—Next to agriculture, the deep-sea fishery and the salmon fisheries in the rivers are the most important interest. Helmsdale (pop. 1259) is the only port of any consequence. Herrings are the principal catch, but cod, ling and other fishes are also taken. Whisky is distilled at Clyne and Brora; some woollens are manufactured at Rogart; coal is mined at Brora, marble quarried in Assynt and limestone and sandstone in several districts. The exceptional facilities offered by the deer forests, moors and the many lochs and rivers attract large numbers of sportsmen whose custom is valuable to the inhabitants; and Dornoch and Lochinver are in growing repute as holiday resorts. The Highland railway enters the county at Invershin, goes northward to Lairg, then east to Brora and north-east to Helmsdale, whence it runs north-west to Kildonan, and north to Forsinard, where it shortly afterwards leaves the shire. The Glasgow steamers call at Lochinver once a week, and mail-cars run periodically from Lairg to Lochinver and Scourie in the west and to Durness and Tongue in the north; from Helmsdale, by the coast, to Berriedale, Dunbeath, Latheron and Lybster; and from Tongue to Thurso. Considering its scanty and scattered population and mountainous character, the county is well intersected by roads, many of which were constructed by successive dukes of Sutherland, who own four-fifths of the shire.

Population and Administration.—In 1891 the population amounted to 21,896, and in 1901 it was 21,440, or 11 persons to the square mile, the least populous of Scottish counties. Several islands lie off the west and north coast, but only Roan, at the entrance to Kyle of Tongue, is inhabited (67). In 1901 there were 469 persons speaking Gaelic only, 14,083 who spoke Gaelic and English. The county returns a member to parliament, and Dornoch, the county town, belongs to the Wick group of parliamentary burghs. Sutherland forms a joint sheriffdom with Ross and Cromarty, and a sheriff-substitute presides at Dornoch. The county is under school-board jurisdiction; some of the schools earn the grant for higher education, and the "residue" grant is expended in bursaries. The Sutherland combination poorhouse is situated in Creich and there is a hospital, the Lawson Memorial, in Golspie.

History and Antiquities.—Of the Picts, the original inhabitants, there are considerable remains in the form of *brochs* (or round towers), numerous and widely scattered, Picts' houses, tumuli, cairns and hut circles. Dun Dornadilla, in the parish of Durness, 4 m. south of Loch Hope, is a tower, 150 ft. in circumference, still in good preservation. The Norse jarl Thorfinn overran the country in 1034 and the Scandinavian colonists called it, in relation to their settlements in the Orkneys and Shetlands, *Sudrland*, the "southern land," or Sutherland. After the conquest of the district by the Scottish kings, Sutherland was conferred on Hugh Freskin (a descendant of Freskin of Moravia or Moray), whose son William was created earl of Sutherland in 1228 by Alexander II. Assynt was peopled by a branch of the Macleods of Lewis, till they were dispossessed by the Mackenzies, who sold the territory to the earl of Sutherland about the middle of the 18th century. The vast tract of the Reay country, belonging to the Mackays, an ancient clan, also fell piece by piece into the hands of the Sutherland family. Killin, on the east bank of Loch Brora, was the site of an old chapel dedicated to St Columba, an association commemorated in the name of Kilcolmkill House, hard by. On the south shore of Helmsdale creek stand the ruins of the castle in which the 11th earl of Sutherland and his wife were poisoned by his uncle's widow in 1567, with a view to securing the title for her only child who was next of kin to the earl and his son. Ardvreck Castle, now in ruins, at the east end of Loch Assynt, was the prison of the marquis of Montrose after his defeat at Invercarron (1650), whence he was delivered up by Neil Macleod of Assynt for execution at Edinburgh. In the graveyard of the old church of Durness is a monument to Robert Mackay, called Rob Donn (the brown), the Gaelic poet (1714–1778).

Bibliography.—Sir Robert Gordon, *History of the Earldom of Sutherland* (1813); R. Mackay, *House and Clan of Mackay* (1829); C. W. G. St John, *Tour in Sutherlandshire* (1849); Hugh Miller, *Sutherland as it was and is* (1843); D. W. Kemp, *Bishop Pococke's Tour in 1760 in Sutherland and Caithness* (1888); Sir W. Fraser, *The Sutherland Book* (1893); A. Gunn and S. J. Mackay, *Sutherland and the Reay Country* (1897).

SUTLEJ, a river of India, one of the "Five Rivers" of the Punjab. It rises E.S.E. of the Manasarowar lakes in Tibet, at an elevation of about 15,200 ft., threads its way through the gorges of the Himalayas with heights of 20,000 ft. on either side, crosses Bashahr and the Simla hill states, and enters the British district of Hoshiarpur. Thence it flows through the plains of the Punjab, receives the Beas in Kapurthala state, and joins the Chenab near Madwala. From that point the whole river bears the name of Panjnad ("five rivers") until it falls into the Indus near Mithankot after a course of 900 m. In the time of Ranjit Singh the Sutlej formed the boundary line between the Sikh and British dominions, and the Sikh states south of the river still bear the title of Cis-Sutlej.

The Sutlej supplies two systems of irrigation works: the Sirhind canal, which draws off the whole of the cold season supply of the Sutlej at Rupar, 100 m. above its junction with the

Beas; and the inundation canals of the Upper and Lower Sutlej, Ferozepur and Bahawalpur, which come below the junction.

SUTLER, a camp-follower who sells provisions, liquor and other things to an army in the field, in camp or in quarters. The word was one of the numerous naval and military terms adapted in English from the Dutch, where it appears as *soetelaar* or *zoetelaar*. It meant originally one who does dirty work, a drudge, a scullion, and is derived from *zoetelen*, to foul, sully, a word cognate with "suds," hot soapy water, "seethe," to boil, and "sodden."

SUTRI (anc. *Sutrium*), a town and episcopal see of Italy, in the province of Rome, 4 m. W.N.W. of the railway station of Capranica, which is 36 m. from Rome; 955 ft. above sea-level. Pop. (1901), 2701. The town is picturesquely situated on a narrow hill, surrounded by ravines, a narrow neck on the west alone connecting it with the surrounding country. There are some remains of the ancient city walls of rectangular blocks of tufa on the southern side of the town, and some rock-cut sewers in the cliffs below them. The cathedral is modern, but the crypt, with twenty columns, is old, and the campanile dates from the 13th century. In the cliffs opposite the town on the south is the rock-cut church of the Madonna del Parto, developed, no doubt, out of an Etruscan tomb, of which there are many here; and close by is a rock-hewn amphitheatre of the Roman period, with axes of 55 and 44 yds., now most picturesque.

The position of Sutri was important, commanding as it did the road into Etruria, the later Via Cassia; and it is spoken of by Livy as one of the keys of Etruria, Nepet being the other. It came into the hands of Rome after the fall of Veii, and a Latin colony was founded there; it was lost again in 386, but was recovered and recolonized in 383 (?). It was besieged by the Etruscans in 311–10 B.C., but not taken. With Nepet and ten other Latin colonies it refused further help in the Hannibalic War in 209 B.C. Its importance as a fortress explains, according to Festus, the proverb *Sutrium ire*, of one who goes on important business, as it occurs in Plautus. It is mentioned in the war of 41 B.C., and received a colony of veterans under the triumviri (*Colonia coniuncta Iulia Sutrina*). Inscriptions show that it was a place of some importance under the empire, and it is mentioned as occupied by the Lombards.

See G. Dennis, *Cities and Cemeteries of Etruria*, i. 62 (London, 1883). (T. As.)

SUTTEE (an English corruption of Sanskrit *sati*, "good woman" or true "wife"), the rite of widow-sacrifice, *i.e.* the burning the living widow on the funeral pyre of her husband, as practised among certain Hindu castes. As early as the *Atharva Veda* the rite is mentioned as an "old custom," but European scholars have shown that the text of the still earlier *Rig Veda* had been corrupted, probably wilfully, by the Hindu priesthood, and that there was no injunction that the rite should be observed. The directions of the *Rig Veda* seem to have involved a merely symbolic suttee: the widow taking her place on the funeral pile, but being recalled to "this world of life" at the last moment by her brother-in-law or adopted child. The practice was sporadically observed in India when the Macedonians reached India late in the 4th century B.C. (Diod. Sic. xix. 33–34); but the earlier Indian law books do not enjoin it, and Manu simply commands the widow to lead a life of chastity and asceticism. About the 6th century A.D. a recrudescence of the rite took place, and with the help of corrupted Vedic texts it soon grew to have a full religious sanction. But even so it was not general throughout India. It was rare in the Punjab; and in Malabar, the most primitive part of southern India, it was forbidden. In its medieval form it was essentially a Brahminic rite, and it was where Brahminism was strongest, in Bengal and along the Ganges valley and in Oudh and Rajputana, that it was most usual.

The manner of the sacrifice differed according to the district. In south India the widow jumped or was forced into the fire-pit; in western India she was placed in a grass hut, supporting the corpse's head with her right hand while her left held the torch; in the Ganges valley she lay down upon the already lighted pile; while in Nepal she was placed beside the corpse, and when the pile was lighted the two bodies were held in place by long poles pressed down by relatives. The earliest attempt to stop suttee was made by Akbar (1542–1605), who forbade compulsion, voluntary suttees alone being permitted. Towards the end of the 18th century the British authorities, on the initiative of Sir C. Malet and Jonathan Duncan in Bombay, took up the question, but nothing definite was ventured on till 1829 when Lord William Bentinck, despite fierce opposition, carried in council on the 4th of December a regulation which declared that all who abetted suttee were "guilty of culpable homicide." Though thus illegal, widow-burning continued into modern days in isolated parts of India. In 1905 those who assisted at a suttee in Behar were sentenced to penal servitude.

Widow sacrifice is not peculiar to India, and E. B. Tylor in his *Primitive Culture* (ch. 11) has collected evidence to support a theory that the rite existed among all primitive Aryan nations. He thinks that in enjoining it the medieval priesthood of India were making no innovation, but were simply reviving an Aryan custom of a barbaric period long antedating the Vedas. See also Jakob Grimm, *Verbrennen der Leichen.*

SUTTNER, BERTHA, BARONESS VON (1843–), Austrian writer, was born at Prague on the 9th of July 1843, the daughter of Count Franz Kinsky, Austrian field marshal, who died shortly after her birth. On her mother's side she was descended from the family of the German poet, Theodor Körner. After receiving a careful education she travelled abroad and resided for a long period in Paris and in Italy. In 1876 she married the novelist, Freiherr Arthur Gundaccar von Suttner (1850–1902), and for the next nine years lived with him at Tiflis in the Caucasus. After 1885 she resided at Schloss Harmansdorf, near Eggenburg, in Lower Austria. The Baroness von Suttner, a fertile writer, has produced numerous tales, books on social science and romances, among which the best known are *Inventarium einer Seele* (1882), *Die Waffen nieder* (1889), *Hanna* (1894), *La Traviata* (1898), *Schach der Qual* (1898), *Martha's Kinder* (1903), a continuation of *Die Waffen nieder*. She was at one time secretary to Alfred Nobel, and as a champion of the "brotherhood of nations," had much influence on him and others; and in this connexion has published *Krieg und Frieden* (1896), *Das Maschinen-Zeitalter*, *Zukunfts-Vorlesungen über unsere Zeit* (1899) and *Die Haager Friedenskonferenz* (1900). In 1905 she was awarded a Nobel prize of £5000 for her endeavours in the cause of peace.

Her *Memoiren*, full of interesting autobiographical matter, were published at Stuttgart in 1908.

SUTTON, SIR RICHARD (d. *c.* 1524), the founder, with William Smyth, bishop of Lincoln, of Brasenose College, Oxford, and the first lay founder of any college, is said to have come of a good north-country family, the Suttons of that ilk, near Macclesfield, Cheshire. Little is known of his life, but he was a barrister, and in 1497 a member of the privy council. In 1513 he became steward of the monastery of Sion, a house of Brigittine nuns at Isleworth. How Smyth and Sutton came to plan a college is not known, but in 1508 we find Edmund Croston, or Crofton, bequeathing £6, 13s. 4d. towards the building of "a college of Brasynnose" if the projects of "the bishop of Lincoln and master Sotton" were carried into effect within a stipulated period. In the same year Sutton obtained a ninety-two year lease of Brasenose Hall and Little University Hall for £3 per annum, and from that time until the end of his life was occupied in purchasing estates with which he might endow the new college. He is thought to have contributed to the funds of Corpus Christi College, Oxford, as well. He was knighted some years before his death, which occurred about 1524.

SUTTON, THOMAS (*c.* 1532–1611), founder of Charterhouse school and hospital, was the son of an official of the city of Lincoln, and was educated at Eton College and probably at Cambridge. He then spent some time travelling in Europe and appears to have acted as secretary to two or three English noblemen. He became a soldier, and in 1569 was with the troops engaged in suppressing the rising in the north of England; in 1570 he was made master and surveyor of the ordnance in the northern parts of the realm and in this capacity he took part in the siege of Edinburgh Castle by the English in May 1573. Sutton obtained great wealth by the ownership of coal mines in Durham and also by his marriage in 1582 with Elizabeth (d. 1602), widow of John Dudley of Stoke Newington. His wish to devote some of his money to charitable purposes led him in 1611 to purchase for £13,000 the Charterhouse (*q.v.*) from Thomas Howard, earl of Suffolk. On this spot Sutton erected the hospital and school which he had originally intended to build at Hallingbury in Essex. Sutton died at Hackney on the 12th of December 1611 and was buried in the chapel in the Charterhouse. His wealth was left for charitable uses, but in 1613 James I. ordered his executors to make an allowance to his natural son, Roger Sutton.

SUTTON, an urban district in the Epsom parliamentary division of Surrey, England, 11 m. S. of London by the London Brighton & South Coast railway. Pop. (1891), 13,977; (1901), 17,223. It is pleasantly situated at the edge of the Downs, and is in favour as an outer residential district of London. The manor, according to Domesday, belonged to the abbey of Chertsey at the Conquest and continued so until the dissolution of the monasteries by Henry VIII.

SUTTON COLDFIELD, a municipal borough in the Tamworth parliamentary division of Warwickshire, England, 7 m. N.E. from Birmingham on branches of the London & North-Western and Midland railways. Pop. (1901), 14,264. The town, which lies high in a hilly situation, is the centre of a residential district for persons having their business offices in Birmingham, Walsall and other towns. The church of the Holy Trinity, Early English and Late Perpendicular, enlarged in 1879, contains a fine Norman font and the tomb of Bishop Vesey. On the picturesque park near the town, 2400 acres in extent, the inhabitants have the right of grazing horses and cattle at a small fee. This, with the Crystal Palace gardens, forms a recreation ground for the people of Birmingham. In the vicinity are New Hall, an interesting mansion of the 13th century, with a hall of the 16th, used as a boys' school; and Peddimore Hall, a moated mansion of the ancient family of Arden, of which there are slight remains. The town is governed by a mayor, 6 aldermen and 18 councillors. Area, 12,828 acres.

Sutton Coldfield (*Svtone, Sutton in Colefeud, Sutton Colfild, King's Sutton*) is mentioned in the Domesday Survey as a possession of the Conqueror and as having been held before that time by Edwin, earl of Mercia. Henry I. exchanged it with Roger de Newburgh, earl of Warwick, whose descendant, William de Beauchamp, in the reign of Edward I., claimed by prescription a court leet with assize of bread and ale and other liberties here, which were allowed him, as it was found that his ancestors had held the same. By the time of Henry VIII. the town had fallen "into much ruin," according to Leland, and would never have reached its present position but for the interest of John Vesey, bishop of Exeter, a native of the place, who procured for it a charter of incorporation in 1529 under the title of the "Warden and Society of the Royal Town of Sutton Coldfield." The charter also appointed a warden and twenty-two fellows to be the common hall, and granted the town and park to the corporation at a yearly rent of £58. Another charter, dated 1664, appointed two capital burgesses to be justices of the peace with the warden. In 1855 Sutton was divided into six wards, with an alderman and three councillors for each. Markets granted in 1300, 1353 and 1529 have been discontinued. Fairs were granted in 1300, 1353 and 1529, to be held at the feasts of Trinity, Michaelmas and St Simon and St Jude, and are now held on Trinity Monday, the 14th of March, the 19th of September and the 8th of November. Vesey set up here a cloth trade which, however, soon became neglected.

SUTTON-IN-ASHFIELD, an urban district in the Mansfield parliamentary division of Nottinghamshire, England, lying in a picturesque district on the border of Sherwood Forest, on branch lines of the Midland and Great Northern railways, 15 m. N. by W. of Nottingham. Pop. (1891), 10,562; (1901), 14,862. The church of St Mary Magdalene of the 12th and 14th centuries was restored in 1868. There are collieries and limeworks in the vicinity. Cotton hosiery and thread are the principal manufactures.

SUVÁROV. ALEXANDER VASILIEVICH, COUNT SUVÁROV RIMNIKSKY, PRINCE ITALYSKY (1729–1800), Russian field marshal, was born at Moscow on the 24th of November 1729, the descendant of a Swede named Suvor who emigrated to Russia in 1622. He entered the army as a boy, served against the Swedes in Finland and against the Prussians during the Seven Years' War. After repeatedly distinguishing himself in battle he was made a colonel in 1762. He next served in Poland, dispersed the Polish forces under Pulawski, stormed Cracow (1768) and was made a major-general. In his first campaigns against the Turks in 1773–74, and particularly in the battle of Kosludscki in the latter year, he laid the foundations of his reputation. In 1775 he suppressed the rebellion of Pugachev, who was decapitated at Moscow. From 1777–1783 he served in the Crimea and the Caucasus, becoming a lieutenant-general in 1780, and general of infantry in 1783, on the conclusion of his work there. From 1787 to 1791 he was again fighting the Turks and won many victories; he was wounded at Kinburn (1787), took part in the siege of Ochakov, and in 1788 won two great victories at Focsani and on the Rimnik. For the latter victory, in which an Austrian corps under Prince Josias of Saxe-Coburg participated, Catherine II. made him a count with the name Rimniksky in addition to his own name, and the emperor Joseph II. created him a count of the Holy Roman Empire. On the 22nd of December 1790 Suvárov stormed Ismail in Bessarabia, and the sack and the massacre that followed the capture equals in horror such events as the "Spanish Fury" and the fall of Magdeburg. He was next placed at the head of the army which subdued the Poles, and repeated the triumph, and some of the cruelties, of Ismail at Warsaw. He was now made a field marshal, and was retained in Poland till 1795, when he returned to St Petersburg. But his sovereign and friend Catherine died in 1796, and her successor Paul dismissed the veteran in disgrace. Suvárov then lived for some years in retirement on his estate of Konchauskoy, near Moscow. He criticized the new military tactics and dress introduced by the emperor, and some of his caustic verse reached the ears of Paul. His conduct was therefore watched and his correspondence with his wife, who had remained at Moscow—for his marriage relations had not been happy—was tampered with. On Sundays he tolled the bell for church and sang among the rustics in the village choir. On week days he worked among them in a smock frock. But in February 1799 he was summoned by the tsar to take the field again, this time against the French Revolutionary armies in Italy.

The campaign (see FRENCH REVOLUTIONARY WARS) opened with a series of victories (Cassano, Trebbia, Novi) which reduced the French government to desperate straits and drove every French soldier from Italy, save for the handful under Moreau, which maintained a foothold in the Maritime Alps and around Genoa. Suvárov himself was made a prince. But the later events of the eventful year went uniformly against the allies. Suvárov's lieutenant Korsákov was defeated by Masséna at Zürich, and the old field marshal, seeking to make his way over the Swiss passes to the Upper Rhine, had to retreat to the Vorarlberg, where the army, much shattered and almost destitute of horses and artillery, went into winter quarters. Early in 1800 Suvárov returned to St Petersburg in disgrace. Paul refused to give him an audience, and, worn out and ill, he died a few days afterwards on the 18th of May 1800 at St Petersburg. Lord Whitworth, the English ambassador, was the only person of distinction present at the funeral. Suvárov lies buried in the church of the Annunciation in the Alexandro-Nevskii monastery, the simple inscription on his grave being, according to his own direction, "Here lies Suvárov." But within a year of his death the tsar Alexander I. erected a statue to his memory in the Field of Mars, St Petersburg.

His son Arkadi (1783–1811) was a general officer in the

Russian army during the Napoleonic and Turkish wars of the early 19th century, and was drowned in the river Rimnik in 1811. His grandson Alexander Arkadievich (1804–1882) was also a Russian general.

Among the Russians the memory of Suvárov is cherished to this day. A great captain, viewed from the standpoint of any age of military history, he is specially the great captain of the Russian nation, for the character of his leadership responded to the character of the Russian soldier. In an age when war had become an act of diplomacy he restored its true significance as an act of force. He was reckless of human life, bent only on the achievement of the object in hand, and he spared his own soldiers as little as he showed mercy to the population of a fallen city. He was a man of great simplicity of manners, and while on a campaign lived as a private soldier, sleeping on straw and contenting himself with the humblest fare. But he had himself passed through all the gradations of military service; moreover, his education had been of the rudest kind. His gibes procured him many enemies. He had all the contempt of a man of ability and action for ignorant favourites and ornamental carpet-knights. But his drolleries served, sometimes to hide, more often to express, a soldierly genius, the effect of which the Russian army has not outgrown. If the tactics of the Russians in the war of 1904–05 reflected too literally some of the maxims of Suvárov's Turkish wars, the spirit of self-sacrifice, resolution and indifference to losses there shown was a precious legacy from those wars. Dragomirov (*q.v.*) avowed that his teaching was based on Suvárov's practice, which he held to be representative of the fundamental truths of war and of the military qualities of the Russian nation.

See Anthing, *Versuch einer Kriegsgeschichte des Grafen Suworow* (Gotha, 1796–1799); F. von Smitt, *Suworows Leben und Heerzüge* (Vilna, 1833–1834) and *Suworow und Polens Untergang* (Leipzig, 1858); Von Reding-Biberegg, *Der Zug Suworows durch die Schweiz* (Zürich, 1896); Lieut.-Colonel Spalding, *Suvórof* (London, 1890); G. von Fuchs, *Suworows Korrespondenz, 1799* (Glogau, 1835); *Souvorov en Italie*, by Gachot, Masséna's biographer (Paris, 1903); and the standard Russian biographies of Polevoi (1853; Ger. trans., Mitau, 1853); Rybkin (Moscow, 1874) and Vasiliev (Vilna, 1899).

SUWALKI, a government of Russian Poland, of which it occupies the N.E. corner, extending to the N. between East Prussia and the Russian governments of Vilna and Grodno, with the government of Kovno on the N. Its area is 4846 sq. m. It includes the east of the low Baltic swelling (800 to 1000 ft. above the sea) and is studded with lakes. Its northern slopes descend to the valley of the Niemen, while in the south it falls away gently to the marshy tract of the Biebrz. The rivers flow there in deep-cut gorges and hollows, diversifying the surface. The Niemen forms its eastern and northern boundary and has many affluents from both slopes of the swelling. The Augustowo canal connects the navigable Hancza, a tributary of the Niemen, with a tributary of the Biebrz, which belongs to the basin of the Vistula, and an active traffic is carried on by this canal. Forests cover about one-fourth of the area. Tertiary and cretaceous strata occupy large areas, and the entire surface is covered with Post-Tertiary deposits. The bottom moraine of the great ice-sheet of north Germany, containing scratched boulders and furrowed by depressions having a direction N.N.E. and S.S.W., extended over immense tracts of the ridge of the lake-districts and its slopes, while limited spaces are covered with well-washed glacial sands and gravel. On the northern slopes of the coast-ridge, the boulder-clay being covered with lacustrine deposits, there are in many places areas of fertile soil; and in the southern parts of the province the boulder-clay is stony, and sometimes covered with gravel. Still, nearly nine-tenths of the surface are suitable for cultivation.

The population in 1906 was estimated at 633,900. The majority (52·2%) are Lithuanians, mostly in the north; there are 21·5% Poles (and Mazurs), chiefly in the towns; 16·7% Jews; 5·3% Germans and 4·2% Russians. The chief towns of the seven districts into which the government is divided are Suwalki, Augustowo, Kalwarya, Mariampol, Seiny, Wilkowiszki (or Volkovyshki) and Wladislawow. The principal crops are rye, wheat, oats, barley and potatoes, which are largely exported to Prussia for use in the distilleries. Bee-keeping is widely spread, and about 40,000 ℔ of honey are obtained every year. The weaving of linen, woollen cloth and fishing-nets is extensively carried on in the villages as a domestic industry, and in small factories. A large number of the inhabitants are compelled to seek work in winter in other parts of the empire. The felling of timber, which is floated down the Niemen, gives occupation to many.

SUWALKI, a town of Russian Poland, capital of the government of the same name, situated at the source of the Hancza, a tributary of the Niemen, 65 m. by rail N.W. of Grodno. Pop. 27,165. In the 15th century it was a small village amid forests, peopled by Lithuanians. Its trade is chiefly in timber, grain, woollen cloth and other manufactured goods.

SUYŪṬĪ [Abū-l Fadhl'Abd ur-Rahmān ibn Abī Bakr Jalāl ud-Dīn us-Suyūṭī] (1445–1505), Arabian encyclopaedic writer, was the son of a Turkish slave woman. His father, who was of Persian descent, had been cadi in Suyūṭ (Upper Egypt) and professor in Cairo, but died before his son was six years old. The boy's training was taken in hand by a Sufi friend of the father. He was precocious and is said to have known the Koran by heart before he was eight years old. In 1462 he was already a teacher; in 1464 he made the pilgrimage to Mecca; in 1472 he became a professor, and in 1486 was promoted to a chair in the mosque of Bibars. Here, however, he provoked a revolt among the students and in 1501 was discharged for maladministration of trust funds. Two years later he was offered the same post again, but declined, and worked in seclusion at Rauḍa, an island of the Nile, and there died in 1505. He was one of the most prolific writers of the East, though many of his works are only pamphlets and some are mere abridgments of the work of others.

We know of 561 separate titles of his works, and over 316 exist in manuscript. A list of these is given in C. Brockelmann's *Gesch. der Arabischen Litteratur*, ii. 144–158 (Berlin, 1902). They deal with almost every branch of Moslem science and literature. Among the best known are the *Itqān fi 'Ulūm ul-Qurān* (on the exegetic sciences of the Koran), published with an analysis by A. Sprenger (Calcutta, 1852–1854) and often in Cairo; the commentary on the Koran, known as the *Tafsīr ul-Jalalain*, begun by Jalāl ud-Dīn ul-Maḥalli (1389–1459) and finished by Suyūṭī, published often in the East; and the history of the caliphs, published at Calcutta (1858) and elsewhere. (G. W. T.)

SUZERAINTY. "Suzerain," a term of feudal law, is now used to describe persons or states in positions of superiority to others. Its etymology, according to Professor W. W. Skeat (*Etymological Dictionary*), is as follows: "A coined word; made from French *sus*, Latin *susum* or *sursum*, above, in the same way as sovereign is made from Latin *super*; it corresponds to a Low Latin type *suseranus*." Another form of the word is souseran (F. Godefroy, *De l'Ancienne langue française*). Suzerain has been defined as "Qui possède un fief dont d'autres fiefs relèvent" (*Littré* and *Dictionnaire de l'académie française*). C. Loyseau, in his *Traité des seigneuries* (3rd ed., 1610, p. 14), explains that there are two kinds of public seigneuries, that is, sovereign seigneurs, possessing *summum imperium*, and suzerains, "Les suzeraines sont celles qui ont puissance supérieure mais non suprême." Elsewhere he says that suzerainty is a form of public seigneuries which has been "usurpée par les particuliers pour laquelle exprimer il nous a fallu forger un mot exprés, et l'appeller suzeraineté, mot qui est aussi étrange comme celle espèce de seigneuries est absurde" (p. 11). Loyseau adds, "Seigneurie suzeraine est dignité d'un fief ayant justice" (p. 38). Bousquet (*Nouveau dictionnaire de droit*) defines suzerain as "supérieur, celui dont un fief relevait"; Rogulau (*Glossaire du droit françois*), "supérieur en quelque charge ou dignité autre que le roy." The name does not occur in the *Consuetudines feudorum*, or in Hotoman's *De verbis feudalibus commentarius*. It was rare in feudal times in England. But it was used in France to describe a feudal lord, the supreme suzerain being the king. Merlin, under *suzeraineté*, shows that the word was not used by all feudal writers in the same sense. (See also Chas. Butler's note to *Coke on Litt.* 191 *a.*)

Definition.

In modern times the term has come to be used as descriptive of relations, ill-defined and vague, which exist between powerful and dependent states; its very indefiniteness being its recommendation. According to feudal law the vassal owed certain duties to the lord; he promised fidelity and service; and the lord was bound to perform reciprocal duties, not very

Modern Usage.

clearly defined, to the vassal—*Dominus vassallo conjux et amicus dicitur.* The relation between a lord and his vassals, implied in the oath of fealty, has been extended to states of unequal power; it has been found convenient to designate certain states as vassal states, and their superiors as suzerains. Originally and properly applicable to a status recognized by feudalism, the term vassal state has been used to describe the subordinate position of certain states once parts of the Ottoman Empire, and still loosely connected therewith. Such are Egypt and Bulgaria. Rumania, Servia and Montenegro, once vassal states, may now be regarded as independent. The relations of these states to the Ottoman Porte are very varied. Egypt has been variously described as a vassal state or as a protectorate. But all of these pay tribute to the sultan, or in some way acknowledge his supremacy (Emanuel Ullmann, *Völkerrecht*, § 16); M. de Martens (*Traité de droit international*, 1883, i. 333 n.) thus defines the term: "La suzeraineté est la souveraineté limitée exercée par le pouvoir suprême d'un état sur un gouvernment mi-souverain," a definition applicable to protectorates, with which it is often confounded. Thus Mommsen (*History of Rome*) indiscriminately describes the supremacy of Rome over Armenia as "suzerainty" or "protectorate." To illustrate the vague use of the word in modern diplomacy may be quoted the description of suzerainty given by Lord Kimberley, which Mr Chamberlain in the correspondence as to South Africa mentioned with approval: "Superiority over a state possessing independent rights of government subject to reservations with reference to certain specified matters" (1899 [C. 9057], p. 28).

Protectorate and Suzerainty.

M. Gairal (*Le Protectorat international*) distinguishes suzerainty from protectorate in these respects: (*a*) suzerainty proceeds from a concession on the part of the suzerain (p. 112); (*b*) the vassal state is bound to perform specific services; and (*c*) the vassal state has larger powers of action than those belonging to a protected state; (*d*) there is reciprocity of obligation. According to M. F. Despagnet the term suzerain is applicable to a case in which a state concedes a fief, in virtue of its sovereignty (*Essai sur le protectorat international*, p. 46), reserving to itself certain rights as the author of this concession.

Another writer draws these distinctions: (*a*) a state connected by protectorship with another previously enjoyed autonomy; the vassal state did not; (*b*) the protected state retains its nationality and its internal administration; the vassal state acquires a distinct nationality; (*c*) the establishment of a protectorate modifies few of the institutions of the protectorate state except as to foreign relations; the establishment of a suzerainty changes the institutions of the vassal state; (*d*) the protected state exercises its internal sovereignty *à peu près pleinement*; the vassal state remains subordinate in several respects; (*e*) while the protected state has the right to be assisted in case of war by the protecting state, but is not bound to defend the latter, the vassal state is bound to aid its suzerain (Tchomacoff, *De la Souveraineté*, p. 53). See also Hachenburger, *De la Nature juridique du protectorat.*

W. E. Hall thus defines vassal states: "States under the suzerainty of others are portions of the latter which during a process of gradual disruption or by the grace of the sovereign have acquired certain of the powers of an independent community, such as that of making commercial conventions, or of conferring their exequatur on foreign consuls. Their position differs from that of the foregoing varieties of states (protectorates, &c.), in that a presumption exists against the possession by them of any given international capacity (*International Law*, 4th ed., p. 31).

Another suggested distinction is this: Suzerainty is title without corresponding power; protectorate is power without corresponding title (Professor Freund, *Political Science Quarterly*, 1899, p. 28).

On the whole, usage seems to favour this distinction: while a protectorate flows from, or is a reduction of, the sovereignty of the protected state, suzerainty is conceived as derived from, and a reduction of, the sovereignty of the dominant state.

As to the power of making treaties, a vassal state cannot, as a rule, conclude them; such power does not exist unless it is specially given. On the other hand, a protected state, unless the contrary is stipulated, retains the power of concluding treaties (Bry, p. 294).

It is sometimes said that a protected state, unlike a vassal state, has the right of sending representatives to foreign states. But such distinctions are of doubtful value: the facts of each case must be considered (Ullmann, § 26).

There is one practical difference between the two relations: while the protecting and protected states tend to draw nearer, the reverse is true of the suzerain and vassal states; a protectorate is generally the preliminary to incorporation, suzerainty to separation. Sometimes it is said that the territory of the vassal state forms part of the territory of the suzerain; a proposition which is true for some purposes, but not for all.

Instances of Suzerainty.

All definitions of suzerainty are of little use. Each instrument in which the word is used must be studied in order to ascertain its significance. Even in feudal times suzerainty might be merely nominal, an instance in point being the suzerainty or over-lordship of the papacy over Naples. In some cases it may be said that suzerainty brings no practical advantages and implies no serious obligations. Among the instances in which the term is actually used in treaties are these: the General Treaty, Peace of Paris, 1856 (arts. 21 and 22), recognized the suzerainty of Turkey over the Danubian principalities Moldavia and Wallachia, modifying the "sovereignty" of Turkey recognized by the Treaty of Adrianople. "Les principautés de Valachie et de Moldavia continueront à jouir, sous la suzeraineté de la Porte et sous la garantie des Puissances contractantes, des privilèges et des immunités dont elles sont en possession." The convention of the 19th of August 1858 (Hertslet x. 1052) organized the then principalities "under the suzerainty of the sultan" (art. 1). The internal government was to be exercised by a hospodar, who received his investiture from the sultan, the sign of vassalship, it has been said (Tchomacoff p. 45). The autonomy of these vassal states has been fully recognized by the Treaty of Berlin of 1878 (art. 1). In the Interpretation Act, 1889, s. 18 (5), "suzerainty" is used to describe the authority of the sovereign over native princes.

The word suzerain is used in the Pretoria convention of the 3rd of August 1881 between the British government and the late South African Republic. The convention (by its preamble) granted to the inhabitants complete self-government, "subject to the suzerainty of her Majesty," and this suzerainty was reaffirmed in the articles. Even when the convention was being negotiated doubts arose as to its meaning, and legal authorities were divided as to its effect (see speech of Lord Cairns, *Hansard*, 269, p. 261; Lord Selborne, 260, p. 309; answer of attorney-general 260, 1534). It was doubtful whether territory could be ceded by the Crown of its own authority; and if the power existed the cession could, it was said, be made only by virtue of clear words. From the articles substituted in the London convention of the 27th of February 1884 for those of 1881, the word "suzerainty" was omitted. Fresh doubts arose as to the effect of this omission; and a correspondence on the subject took place between the British government and the government of the republic before the outbreak of hostilities in South Africa, the former maintaining that the preamble of 1881, by which alone any self-government was granted, was still in force, and therefore that the suzerainty—whatever it involved—remained; the Transvaal government, on the other hand, contending that the suzerainty had been abolished by the substitution of the 1884 convention for that of 1881. Writers on international law differ greatly as to the exact position of the South African republic under the later convention. Some considered it an independent sovereign state. Mr Taylor (*A Treatise of International Public Law*, p. 174) treats the Transvaal after the convention of 1884 as a "neutralized state only part sovereign." Other writers describe the relation as that of a protectorate (see Professor J. Westlake, *Revue de droit international*, 1896, p. 268 seq.; *International Law*, pt. 1, p. 27). Professor de Louter defines it as "une servitude du droit des gens (servitus juris gentium), et qui diffère de la servitude du droit privé en ce qu'elle ne constitue pas un droit réel (jus in re aliena) mais un droit entre deux personnes de droit international (subjecta juris gentium)" (*Revue de droit international*, 1899, p. 330). Dr F. Von Liszt (*Das Völkerrecht*, p. 331) treats the South African republic as an example of a half sovereign state. M. Gairal describes it as a vassal state. Probably the soundest opinion is that the British Crown reserved no other rights than those expressly stated in the convention of 1884.

See Stubbs, "Suzerainty, or the Rights and Duties of Suzerain and Vassal States" (1882), *Revue de droit international* (1896), pp. 39, 278; Westlake, "L'Angleterre et la république sud-africaine," *Revue de droit international* (1896), p. 268; Bornhak, *Einseitige Abhängigkeitsverhältnisse unter den modernen Staaten* (1896); Ullmann, *Völkerrecht* (1908), p. 25; Tchomacoff, *De la Souveraineté* (1901); Jellinek, *Die Lehre von den Staatenverbindungen* (1882); *Correspondence Relating to South African Republic* (1899) [C. 9507]; *Law Magazine* (1900), p. 413; *Law Quarterly Review* (1896), p. 122; *Journal of Comparative Legislation*, new series, vol. i. p. 432; Merignhac, *Droit public international* (1905), p. 204. (J. M.)

SVANE [or SVANING], **HANS** (1606–1668), Danish statesman and ecclesiastic, was born on the 27th of March 1606, at Horsens, where his father, Hans Riber, was burgomaster. His mother Anne was a daughter of the historian Hans Svaning, whose name, subsequently altered to Svane, he adopted. At Copenhagen Svane devoted himself to the study of Oriental languages, and between 1628 and 1635 completed his education abroad, at Franeker in Friesland, Wittenberg, Oxford and Paris. After seven years' residence abroad Svane returned to occupy the chair of Oriental languages at the university of Copenhagen. In 1646, finding promotion slow, he turned to theology and was "created" Dr theol. by his old patron Jesper Brochmand, now bishop of Sjaelland, whom he succeeded in the metropolitan see of Denmark on the 26th of January 1655. As a theologian he belonged to the severely orthodox Lutheran school. His scholarship, despite the erudition of his commentary to the prophet Daniel in two huge folio volumes, is questionable. But in Latin and Danish he won distinction as a speaker, and his funeral orations in both languages were admired by his contemporaries. At the famous *rigsdag* of 1660 he displayed debating talent of a high order and played an important political rôle. It was Svane who, at the opening of the *rigsdag*, proposed that only members of the council of state should be entitled to fiefs and that all other estates should be leased to the highest bidder whatever his social station. At a hint from the king he laboured to get the royal charter abolished and the elective monarchy transformed into an hereditary monarchy. The clerical deputies followed him in a serried band, as the burgesses followed Nansen, and the bishop's palace was one of the meeting-places for the camarilla which was privy to the absolutist designs of Frederick III. Throughout the session Svane was chairman of "the Conjoined Estates" in their attacks upon the nobility, his watchword being: Equal rights for all and a free hand for the king. It was on his motion (Oct. 8) that the Commons agreed "to offer his majesty the crown as an hereditary crown," to which proposition the nobility acceded, under severe pressure, two days later. When, on the 13th, the three estates assembled at the castle, it was Svane's speech, as president of the estate of the clergy, which gave the solemnity its ultra-royalist character. He, too, quashed the timid attempt of the more liberal minded of the deputies to obtain a promise from the king of some sort of a constitution. In fact, excepting the king and queen, nobody contributed so powerfully to the introduction of absolutism into Denmark as the bishop of Copenhagen. He was raised to the dignity of archbishop, a title which no other Danish prelate has since borne, and as president of the academic consistory of the university (an office which was invented for and died with him) he took precedence of the rector magnificus. He was also created a royal councillor, an assessor of the supreme court and a member of the *stats kollegiet* or council of state. His elevation seems to have turned his head. The university suffered the most from his extravagant pretensions; and his quarrels with all the professors at last caused such a scandal that the king had to interfere personally. A bishop who was at the same time a privy councillor, a minister of state and a judge of the supreme court could have but little time for spiritual duties. Yet Svane was not altogether neglectful of them. Especially noteworthy is his plan for the erection of a consistorial college for managing all the temporal affairs of the church, including education and poor relief, anticipating to some extent the modern ministries of education and public worship, which unfortunately was not adopted. Moreover, the privileges which he obtained for the clergy did much to increase the welfare and independence of the Danish Church in difficult times, while his representations to the king that Danish theology was not likely to be promoted by placing Germans over the heads of native professors bore good fruit. Svane died on the 26th of July 1668, in his 62nd year.

See Detlev Gotthard Zwergius, *Siellandske clerisie* (Copenhagen, 1754). (R. N. B.)

SVANETIA, a mountainous district on the south slopes of the Caucasus, immediately underneath the loftiest glaciated peaks of the middle of the system. It extends over the upper valleys of the Rion, Ingur and Tskhenis-tskhali, and is included in the modern government of Kutais. The Svanetians belong to the Georgian race. (See CAUCASIA and CAUCASUS.)

SVENDBORG, a seaport of Denmark, capital of the *amt* (county) of its name, on the south shore of the island of Fünen. Pop. (1901), 11,543. The situation is pleasant. The narrow Svendborg Sund separates Fünen from the lesser islands of Taasinge and Turö, of which the former rises to 245 ft. Inland from the town there is also elevated ground, the Ovinehöi. The harbour is accessible to vessels drawing 20 ft. There are tobacco and earthenware manufactories, boat-building yards, and distilleries. Butter is the principal export, and petroleum, coal and iron the imports. Neighbouring to the town are the ruined castle of Örkil, the watering-place Christiansminde, and the extensive orchards of Gammel Hestehave, where wine is produced.

SVENDSEN, JOHANN SEVERIN (1840–), Norwegian composer, was born in Christiania on the 30th of September 1840. He learnt the elements of music and violin-playing from his father, and after serving for some time in the army, and later touring as violinist with a troup of instrumentalists, he entered the conservatorium at Leipzig through the aid of the king of Sweden. After another tour, which extended to the British Isles, Svendsen spent a year in Paris, and in 1871–1872 was leader of the once famous Euterpe concerts in Leipzig. In 1871 he married an American, and from 1872 to 1877 he conducted the Christiania Musical Society, while in 1877–1879 he lived in Rome, London and Paris. In 1883 Svendsen became court kapellmeister at Copenhagen. Probably we have to go back to Schubert to find a composer whose Opus 1 has attained the wide popularity of Svendsen's A minor string quartet, while his beautiful octet, Opus 3, added to his fame. Though Svendsen was at one time intimate with Wagner, the latter does not seem to have influenced his music, which includes two symphonies, a violin concerto, and a romance for violin, as well as a number of Norwegian rhapsodies for the orchestra.

SVERDRUP, JOHAN (1816–1892), Norwegian statesman, was born at Jarlsberg on the 30th of July 1816. His father, Jakob Sverdrup, was a land steward, and the founder of the first school of agriculture in Norway. Johan entered the Storthing in 1850, sitting first for Laurvik, and then for the district of Akershus, and was its president from 1871 to 1884, during the whole of the dispute over the prerogative of the Crown. He built up a strong political party, which, relying for support chiefly on the Norwegian peasantry, was determined to secure strict constitutional government and practically to destroy the power of the king. Under his leadership the opposition, in 1872, secured the passing of a bill for the admission of the ministers to the Storthing, which was a step to the establishment of the dependence of the cabinet on a majority in that assembly. King Charles XV. refused his sanction to this bill, and on its third passing in 1880 Oscar II. opposed his veto, at the same time claiming his right to the absolute veto. Sverdrup then proposed the proclamation of the law in defiance of the king's action. The retirement of Frederik Stang removed Sverdrup's chief political opponent from the field. He was aided in his campaign by Björnstjerne Björnson, and after a series of political crises he became prime minister in June 1884. But when he became prime minister he soon found himself at issue with Björnson on church matters. Inspired chiefly by his nephew Johan he secured the refusal of a pension to the novelist Kielland because of his anti-clerical views, and he further wished to give the parish councils the right to strike off the voting list persons who had broken away from church discipline. Therefore, although during his term of office no fewer than eighty-nine measures, many of them involving useful reforms, became law, he failed to satisfy the extremists among his supporters, and was driven to rely on the moderate Liberals. He was compelled to retire in 1889, and died on the 17th of February 1892 at Christiania.

SWABIA, SUABIA or SUEVIA (Ger. *Schwaben*), one of the stem-duchies of medieval Germany, taking its name from the Suevi, a tribe who inhabited the district in the first century of the Christian era. Dwelling in the angle formed by the Rhine and the Danube, they were joined by other tribes, and were called Alamanni, whilst the district was called Alamannia, until about the 11th century, when the form Swabia began to prevail. In 496 the Alamanni were defeated by Clovis, king of the Franks, brought under Frankish rule, and governed by dukes who were dependent on the Frankish kings. In the 7th century the people were converted to Christianity, bishoprics were founded at Augsburg and Constance, and in the 8th century abbeys at Reichenau and St Gall. The Alamanni had gradually thrown off the Frankish yoke, but in 730 Charles Martel again reduced them to dependence, and his son Pippin the Short abolished the tribal duke and ruled the duchy by two counts palatine, or *Kammerboten*.

The duchy, which was divided into *gaus* or counties, took about this time the extent which it retained throughout the middle ages, and was bounded by the Rhine, the lake of Constance, the Lech and Franconia. The Lech, separating Alamannia from Bavaria, did not form, either ethnologically or geographically, a very strong boundary, and there was a good deal of intercommunion between the two races. During the later and weaker years of the Carolingian rule the counts became almost independent, and a struggle for supremacy took place between them and the bishops of Constance. The chief family in Alamannia was that of the counts of Raetia, who were sometimes called margraves, and one of whom, Burkhard, was called *duke of the Alaminnia*. Burkhard was killed in 911, and two counts palatine, Bertold and Erchanger, were accused of treason, and put to death by order of the German king Conrad I. In 917, Burkhard, count in Raetia, took the title of duke, and was recognized as such by King Henry I., the Fowler, in 919. His position was virtually independent, and when he died in 926 he was succeeded by Hermann, a Franconian noble, who married his widow. When Hermann died in 948 Otto the Great gave the duchy to his own son Ludolf, who had married Hermann's daughter Ida; but he reduced the ducal privileges and appointed counts palatine to watch the royal interests. Ludolf revolted, and was deposed, and other dukes followed in quick succession. Burkhard II., son of Burkhard I., ruled from 954 to 973, Ludolf's son, Otto, afterwards duke of Bavaria, to 982, and Conrad I., a relative of Duke Hermann I., until 997. Hermann II., possibly a son of Conrad, succeeded, and, dying in 1003, was followed by his son Hermann III. During these years the Swabians were loyal to the kings of the Saxon house, probably owing to the influence of the bishops. Hermann III. had no children, and the succession passed to Ernest, son of his eldest sister Gisela and Ernest I., margrave of Austria. Ernest held the duchy for his son until his own death in 1015, when Gisela undertook the government, and was married a second time, to Conrad, duke of Franconia, who was afterwards the German king Conrad II. When Ernest came of age he quarrelled with his step-father, who deposed him, and, in 1030, gave the duchy to Gisela's second son, Hermann IV. and, on his death in 1038, to Henry, his own son by Gisela. In 1045 Henry, who had become German king as Henry III., granted Alamannia to Otto, grandson of the emperor Otto II. and count palatine of the Rhine, and, in 1048, to Otto, count of Schweinfurt. Rudolph, count of Rheinfelden, was the next duke, and in 1077 he was chosen German king in opposition to the emperor Henry IV., but found little support in Swabia, which was given by Henry to his faithful adherent, Frederick I., count of Hohenstaufen. Frederick had to fight for his position with Bertold, son of Duke Rudolph, and the duke's son-in-law, Bertold II., duke of Zähringen, to whom he ceded the Breisgau in 1096. Frederick II. succeeded his father in 1105, and was followed by Frederick III., afterwards the emperor Frederick I. The earlier Hohenstaufen increased the imperial domain in Swabia, where they received steady support, although ecclesiastical influences were very strong. In 1152 Frederick I. gave the duchy to his kinsman, Frederick, count of Rothenburg and duke of Franconia, after whose death in 1167 it was held successively by three sons of the emperor, the youngest of whom, Philip, was chosen German king in 1198. During his struggle for the throne Philip purchased support by large cessions of Swabian lands, and the duchy remained in the royal hands during the reign of Otto IV., and came to Frederick II. in 1214. Frederick granted Swabia to his son Henry, and, after his rebellion in 1235, to his son Conrad, whose son Conradin, setting out in 1266 to take possession of Sicily, pledged his Swabian inheritance to Ulrich II. count of Württemberg. The duchy was ripe for dissolution and, after Conradin's death, in 1268, the chief authority in Swabia fell to the counts of Württemberg, the margraves of Baden, the counts palatine of Tübingen, the counts of Hohenzollern and others.

When the emperor Maximilian I. divided Germany into circles in 1512, one, which was practically coterminous with the duchy, was called the Swabian circle. The area, which was formerly Swabia, is now covered by the kingdom of Württemberg, the grand-duchy of Hesse and the western part of the kingdom of Bavaria. Although the name Swabia is occasionally used in a general way to denote the district formerly occupied by the duchy, the exact use of the name is now confined to a Bavarian province, with its capital at Augsburg.

See J. Leichtlen, *Schwaben unter den Römern* (Freiburg, 1825); J. C. v. Pfister, *Pragmatische Geschichte von Schwaben* (Heilbronn, first part, 1803, continuation to 1496, 1827).

SWABIAN LEAGUE, an association of German cities, principally in the territory which had formed the old duchy of Swabia. The name, though usually given to the great federation of 1488, is applicable also to several earlier leagues (*e.g.* those of 1331, 1376). The Swabian cities had attained great prosperity under the protection of the Hohenstaufen emperors, but the extinction of that house in 1268 was followed by disintegration. Cities and nobles alike, now owing allegiance to none but the emperor, who was seldom able to defend them, were exposed to the aggression of ambitious princes.

In 1331, twenty-two Swabian cities, including Ulm, Augsburg, Reutlingen and Heilbronn, formed a league at the instance of the emperor Louis the Bavarian, who in return for their support promised not to mortgage any of them to a vassal. The count of Württemberg was induced to join in 1340. Under Charles IV. the lesser Swabian nobles began to combine against the cities, and formed the *Schlegelerbund* (from *Schlegel*, a maul). Civil war ensuing in 1367, the emperor, jealous of the growing power of the cities, endeavoured to set up a league under his own control, for the maintenance of public peace (*Landfriedensbund*, 1370). The defeat of the city league by Eberhard II. of Württemberg in 1372, the murder of the captain of the league, and the breach of his obligations by Charles IV., led to the formation of a new league of fourteen Swabian cities led by Ulm in 1376. This league triumphed over the count of Württemberg at Reutlingen in 1377, and the emperor having removed his ban, it assumed a permanent character, set up an arbitration court, and was rapidly extended over the Rhineland, Bavaria and Franconia. In 1382 an alliance was made at Ehingen with the archduke of Austria, and through his mediation with the three chief knightly associations of Swabia. The new king, Wenceslaus, hoped at first, like his father Charles, to check the federal movement by associating all estates of the realm under his own lead in *Landfriedenseinigungen*, but such a compact made at Heidelberg in 1384, although renewed at Mergentheim three years later, was a mere makeshift. The struggle between burghers and nobles was precipitated by the inclusion of the urban members of the Swiss confederation in the league in 1385 and the overthrow of Archduke Leopold of Austria by the latter at Sempach in the following year. A quarrel between the duke of Bavaria and the archbishop of Salzburg gave the signal for a general war in Swabia, in which the cities, weakened by their isolation, mutual jealousies and internal conflicts, were defeated by Count Eberhard II. at Döffingen (Aug. 24, 1388), and were severally taken and devastated. Most of them quietly acquiesced when Wenceslaus proclaimed a *Landfriede* at Eger in 1389 and prohibited all leagues between cities. The professed aims of the cities which had formed this league of 1376 were the maintenance of their imperial status (*Reichsunmittelbarkeit*), security against sale or mortgage and against excessive taxation, the protection of property, trade and traffic, and the power to suppress disturbances of the peace. There is no trace of co-operation with the Hanseatic towns. The league necessarily opposed the pretensions of the emperors and the electoral princes, especially as set forth in the Golden Bull, and in accordance with the growing spirit of civil freedom demanded a share in the government, but that there was any widespread conscious desire for a fundamental change in the constitution, for the abolition of aristocratic privilege or for a republic, as certain historians maintain, is improbable (K. Klüpfel, *Der schwäbische Bund*).

For nearly a century there was no great effort at federation among the Swabian cities, attention being diverted to the ecclesiastical controversies of the time, but there were partial and short-lived associations, *e.g.* the league of twelve Swabian cities in defence of their liberties in 1392, the Marbach league in 1405 against the German king, Rupert, and in 1441 the union of twenty-two cities (in 1446 thirty-one) headed by Ulm and Nuremberg, for the suppression of highway robbery. This latter union in 1449 formed a standing army and waged war on a confederation of princes led by Albert Achilles, afterwards elector of Brandenburg (*q.v.*).

The growing anarchy in Swabia, where the cities were violently agitated by the constant infringement of their liberties (*e.g.* the annexation of Regensburg by Bavaria in 1486), induced Frederick III., who required men and money for the Hungarian War, to conciliate the cities by propounding a scheme of pacification and reform. His commissioner, Count Hugo of Werdenberg, met the Swabian estates at Esslingen and laid before them a plan probably drawn up by Bertold, elector of Mainz, and on the 14th of February 1488 the Great Swabian League was constituted. There were four constituent parties, the archduke Sigismund of Austria, Count Eberhard V. (afterwards duke) of Württemberg, who became the first captain of the league, the knightly league of St George, and lastly twenty-two Swabian imperial cities. The league received a formal constitution with a federal council consisting of three colleges of nine councillors each, a captain and a federal court with judicial and executive powers. The armed force which was to police Swabia consisted of 12,000 foot and 1200 horse, each party contributing one-fourth. The league gained strength by the speedy accession of Augsburg and other Swabian cities, the margraves of Brandenburg-Ansbach, Baireuth and Baden, the four Rhenish electors, &c., and in 1490 of Maximilian, king of the Romans, whom the league had helped to rescue from the hands of the Netherlanders in 1488. It did not render him the support he expected in his foreign policy, but it performed its primary work of restoring and maintaining order with energy and efficiency. In 1492 it compelled Duke Albert of Bavaria to renounce Regensburg; in 1519 it expelled the turbulent duke, Ulrich of Württemberg, who had seized Reutlingen, and it sold his duchy to Charles V.; and in 1523 it defeated the Franconian knights who had taken up arms with Franz von Sickingen. In 1525, Truchsess, the league captain, aided by the forces of Trier and the palatinate, overthrew the rebel peasants of Königshofen on the Tauber and at Ingolstadt.

The league, which had been several times renewed, expired on the 2nd of February 1534, its dissolution being due to internal dissensions regarding the reformation. Futile attempts were made to renew it, in 1535 by the Bavarian chancellor, Eck, and in 1547 by Charles V.

See E. Osann, *Zur Geschichte des schwäbischen Bundes* (Giessen, 1861); K. Klüpfel, "Der schwäbische Bund" (in *Hist. Taschenbuch*, 1883–1884), *Urkunden zur Geschichte des schwäbischen Bundes* (Stuttgart, 1846–1853). (A. B. Go.)

SWADLINCOTE, a town in the southern parliamentary division of Derbyshire, England, 15 m. S.S.W. of Derby, and 4 m. S.E. of Burton-upon-Trent, on the Midland railway. Pop. (1901), urban district of Swadlincote district, 18,014. This includes the civil parishes of Swadlincote, Church Gresley and Stanton and Newhall, which together form a large industrial township, mainly devoted to the manufacture of earthenware and fireclay goods. There are collieries in the neighbourhood.

SWAFFHAM, a market town in the south-western parliamentary division of Norfolk, England; 111 m. N.N.E. from London by the Great Eastern railway. Pop. of urban district (1901), 3371. The town lies high, in an open, healthy district. The church of St Peter and St Paul is Perpendicular, a handsome cruciform structure with central tower, and has a fine carved roof of wood. The town, which has a town-hall and assembly rooms, possesses iron foundries and a considerable agricultural trade, with cattle fairs. At Castle Acre, 4 m. N., are the picturesque ruins of a Cluniac priory, founded shortly after the Conquest by William de Warren. These comprise portions of the church, including the fine west front, arcaded, with three Norman doors and a Perpendicular window, with the chapter-house, cloisters and conventual buildings. The majority of the remains are Norman or Perpendicular. The castle of the same founder has left little but its foundations, but it was erected within the protection of a remarkable series of earthworks, which remain in good condition. These are apparently in part Roman, in part earlier. The site, on which Roman coins, pottery and other remains have been discovered, was on an ancient trackway running north and south. It may be noted that de Warren founded a similar castle and priory at Lewes in Sussex. The church of St James, Castle Acre, contains good Early English and Perpendicular work.

SWAHILI (*Wa-Swahili*, *i.e.* coast people, from the Arabic *sāhil*, coast), a term commonly applied to the inhabitants of Zanzibar and of the opposite mainland between the parallels of 2° and 9° S., who speak the Ki-Swahili language. The Swahili are essentially a mixed people, the result of long crossing between the negroes of the coast and the Arabs, with an admixture of slave blood from nearly all the East African tribes. Among Swahili are found every shade of colour and every type of physique from the full-blooded negro to the pure Semite. Usually they are a powerfully built, handsome people, inclined to stoutness and with Semitic features. They number about a million. They figured largely in the history of African enterprise during the 19th century. The energy and intelligence derived from their Semitic blood have enabled them to take a leading part in the development of trade and the industries, as shown in the wide diffusion of their language, which, like the Hindustani in India and the Guarani in South America, has become the principal medium of intercommunication in a large area of Africa south of the equator. During his journey from the Indian Ocean to the Atlantic (1873–1874) Commander V. Lovett Cameron found that a knowledge of this language enabled him everywhere to dispense with the aid of an interpreter, as it was understood by one or more persons in all the tribes along the route. Owing to this circumstance the Swahili have been found invaluable assistants in every expedition from the eastern seaboard to the interior after they began to be employed by J. H. Speke and Richard Burton as porters and escorts in 1857. The language is somewhat archaic Bantu, much mixed with Arabic, while Indian, Persian and even English, Portuguese and German words have contributed to the vocabulary. Grammatical treatises on it have been published, and into it portions of the Bible have been translated by Bishop Steere.[1] The Swahili are Mahommedans, but in disposition are genuine negroes. Christian missions among them have met with little success.

See Johann Ludwig Krapf, *Dictionary of Swahili Language* (London, 1882); Bishop Steere, *Handbook of the Swahili Language* (London, 1894); *Collection of Swahili Folk-Tales* (1869); A. C. Madan, *English-Swahili Dictionary* (Oxford, 1894); Delaunay, *Grammaire Kiswahili* (Paris, 1898). See also BANTU LANGUAGES.

SWALLOW (A. S. *swalewe*, Icel. *svala*, Du. *zwaluw*, Ger. *Schwalbe*), the bird which of all others is recognized as the harbinger of summer in the northern hemisphere. The name *Hirundo rustica* of Linnaeus is now employed for the common chimney-swallow of Europe, which has been divided into four or five races. In summer it ranges all over Europe, and in Asia extends to Manchuria and China; in winter it migrates south, reaching India, Burma, the Malay Peninsula and the whole of Africa. The common swallow of North America, usually called the barn-swallow, is *H. erythrogastra*, but in summer it also reaches Alaska and Greenland and extends across to Lake Baikal. The winter migration extends to Burma for the Asiatic swallows and to South Brazil for those of America. In all some twenty-seven species of Hirundo are recognized, the range of the genus being practically world-wide. Returning, usually already paired, to its summer haunts, after its winter sojourn in southern lands, and generally reaching England about the first week in April, the English swallow at once repairs to its old quarters, nearly always around the abodes of men; and, about a month later, the site of the nest is chosen, resort being had in most cases to the very spot that has formerly served the same purpose—the old structure, if still remaining, being restored and refurnished. So trustful is the bird that it commonly establishes itself in any of men's works that will supply the necessary accommodation, and a shed, a barn, or any building with an open roof, a chimney that affords a support for the nest, or even the room of an inhabited house—if chance should give free access thereto—to say nothing of extraordinary positions, may be the place of its choice. Wheresoever placed, the nest is formed of small lumps of moist earth, which, carried to the spot in the bird's bill, are duly arranged and modelled, with the aid of short straws or slender sticks, into the required shape. This is generally that of a half-saucer, but it varies according to the exigencies of the site. The materials dry quickly into a hard crust, which is lined with soft feathers, and therein are laid from four to six white eggs, blotched and speckled with grey and orange-brown deepening into black. Two broods are usually reared in the season, and the young on leaving the nest soon make their way to some leafless bough, whence they try their powers of flight, at first accompanying their parents in short excursions on the wing, receiving from them the food which they are as yet unable to capture, until able to shift for themselves. They collect in flocks, often of many hundreds, and finally leave the country about the end of August or early in September, to be followed, after a few weeks, by their progenitors. They moult their feathers in their winter quarters, and this fact affords one of the strongest arguments against the popular belief (which, curious to say, is still partly if not fully entertained by many who should know better) of their becoming torpid in winter, for a state of torpidity would suspend all animal action.[2] The chestnut forehead and throat, the shining steel-blue upper plumage, and the dusky white—in some cases reddening so as almost to vie with the frontal and gular patches—of the lower parts are well known to every person of observation, as is the markedly forked tail, which is become proverbial of this bird.

Taking the word swallow in a more extended sense, it is used for all the members of the family Hirundinidae,[3] excepting a few to which the name martin (*q.v.*) has been applied, and this family includes from 80 to 100 species, which have been placed in many different genera. The true swallow has very many affines, some of which range almost as widely as itself does, while others seem to have curiously restricted limits, and much the same may be said of several of its more distant relatives. But altogether the family forms one of the most circumscribed and therefore one of the most natural groups of Oscines, having no near allies; for, though in outward appearance and in some habits the swallows bear a considerable resemblance to swifts (*q.v.*), the latter belong to a different order, and are not Passerine birds at all, as their structure, both internal and external, proves. It has been sometimes stated that the Hirundinidae have their nearest relations in the flycatchers (*q.v.*); but the assertion is very questionable, and the supposition that they are allied to the Ampelidae (cf. WAXWING), though possibly better founded, has not been confirmed. An affinity to the Indian and Australian *Artamus* (the species of which genus are often known as wood-swallows or swallow-shrikes) has also been suggested but has not been accepted. (A. N.)

SWALLOW-HOLE, in physical geography the name applied to a cavity resulting from the solution of rock under the action of water, and forming, or having at some period formed, the entrance to a subterranean stream-channel. Such holes are common in calcareous (limestone or chalky) districts, or along the line of outcrop of a limestone belt among non-calcareous strata. These cavities are also known as sinks, dolinas or butter-tubs, and by other local names, and sometimes as pot-holes; the last term, however, is also synonymous with Giant's Kettle (*q.v.*). See CAVE.

SWAMMERDAM, JAN (1637–1680), Dutch naturalist, was born on the 12th of February 1637 at Amsterdam, the son of an apothecary and naturalist. He was destined for the Church; but he preferred the profession of medicine, taking his doctor's degree at Leiden in 1667. Having necessarily to interest himself in human anatomy, he devoted much attention to the preservation and better demonstration of the various structures, and he devised the method of studying the circulatory system by means of injections. He also spent much time in the study of insects, investigating the subject of their metamorphosis, and in this and other ways laying the beginnings of their natural classification, while his researches on the anatomy of mayflies and bees were also of great importance. His devotion to science led to his neglect of practice; his father, resenting this, stopped all supplies and thus Swammerdam experienced a period of considerable privation, which had the most unfortunate consequences to his health, both bodily and mental. In 1675 his father died, leaving him an adequate fortune, but the mischief was irreparable. He became a hypochondriac and mystic, joined the followers of Antoinette Bourignon, and died at Amsterdam on the 15th of February 1680.

His *Allgemeene Verhandeling van bloedeloose diertjens* appeared at Utrecht in 1669, and his *Biblia naturae, sive Historia insectorum in certas classes redacta* was published after his death by H. Boerhaeve in 1737–1738. He was also the author of *Miraculum naturae, seu Uteri muliebris fabrica* (Leiden, 1672).

SWAN, JOHN MACALLAN (1847–1910), English painter and sculptor, received his art training first in England at the Worcester and Lambeth schools of art and the Royal Academy schools, and subsequently in Paris, in the studios of J. L. Gérôme and E. Frémiet. He began to exhibit at the Academy in 1878, and was elected associate in 1894 and academician in 1905. He was appointed a member of the Dutch Water-Colour Society in 1885; and associate of the Royal Society of Painters in Water Colours in 1896 and full member in 1899. A master of the oil, water-colour and pastel mediums, an accomplished

[1] The language was first reduced to writing by the Arabs, who still use the Arabic character. But the European missionaries have replaced this by the Roman system, which is more suited for the transliteration of most African, and especially of the Bantu, tongues.

[2] See John Hunter's *Essays and Observations in Natural History*, edited by Sir R. Owen in 1861 (ii. 280). An excellent bibliography of the swallow-torpidity controversy, up to 1878, is given by Professor Coues (*Birds of the Colorado Valley*, pp. 378–390), who seems still to hanker after the ancient faith in "hibernation."

[3] An enormous amount of labour has been bestowed upon the Hirundinidae by R. B. Sharpe (*Cat. B. Brit. Mus.* x. 85–210), and in the finely-illustrated *Monograph* which he and C. W. Wyatt have published (2 vols. 4to, London, 1885–1894).

painter and a skilful draughtsman, he ranks also as a sculptor of distinguished ability. He has treated the human figure with notable power, but it is by his representations of the larger wild animals, mainly the felidae, that he chiefly established his reputation; in this branch of practice he has scarcely a rival. His picture "The Prodigal Son," bought for the Chantrey collection in 1889, is in the National Gallery of British Art. He was awarded first class gold medals for painting and sculpture in the Paris Exhibition, 1900. He died on the 14th of February 1910.

See SCULPTURE; "The Work of J. M. Swan," by A. L. Baldry, in *The Studio*, vol. xxii.; and *Drawings of John M. Swan, R.A.* (George Newnes, Ltd.).

SWAN, SIR JOSEPH WILSON (1828–   ), English physicist and electrician, was born at Sunderland on the 31st of October 1828. After serving his apprenticeship with a chemist in his native town, he became first assistant and later partner in a firm of manufacturing chemists in Newcastle. Among its operations this firm included the manufacture of photographic plates, and thus Swan was led to one of the advances in photography with which his name is associated—the production of extremely rapid dry plates, which were the outcome of an original observation made by him on the effect of heat in increasing the sensitiveness of a gelatino-bromide of silver emulsion. In 1862 he patented the first commercially practicable process for carbon printing in photography. This depended on the fact that when gelatine is exposed to light in the presence of bichromate salts it is rendered insoluble and non-absorbent of water. Swan took a surface of gelatine, dusted over with lampblack and sensitized with bichromate of ammonium, and exposed it to light below a photographic negative; the result was to make the gelatine from the surface downwards insoluble to a depth depending on the intensity, and therefore penetration, of the light which had reached it through the negative. In this operation the surface of the gelatine was also rendered insoluble, and it therefore became necessary to get at its back in order to be able to wash away the portions that still remained soluble; this was effected by cementing the insoluble surface to a fresh sheet of paper by means of indiarubber solution, and then detaching the original support. It thus became possible to reach the soluble portions with water and to obtain a representation of the picture, though reversed as to right and left, in relief on the pigmented gelatine. This process has been simplified and improved by subsequent workers, but in its essential features it forms the basis of some of the methods of photographic reproduction most widely used at the present day. But Swan's name deserves remembrance even more in connexion with the invention of the incandescent electric lamp than with improvements in photographic technique. He was one of the first to undertake the production of an electric lamp in which the light should be produced by the passage of an electric current through a carbon filament, and he was almost certainly far ahead, in point of time, of any other worker in the same field in realizing the conditions to be met and the difficulties to be overcome. So far back as 1860 he constructed an electric lamp with a carbon filament, which was formed by packing pieces of paper or card with charcoal powder in a crucible and subjecting the whole to a high temperature. The carbonized paper thus obtained he mounted in the form of a fine strip in a vacuous glass vessel and connected it with a battery of Grove's cells, which though not strong enough to raise it to complete incandescence, were sufficient to make it red-hot. This was substantially the method adopted by Edison nearly twenty years later, after various fruitless efforts to make a practical lamp with a filament of platinum or a platinum alloy had convinced him of the unsuitability of that metal for the purpose—a conclusion which Swan had reasoned out for himself many years before. By the time Edison had hit upon the idea of carbonizing paper or bamboo by heat to form the filament, Swan had devised the further improvement of using cotton thread "parchmentized" by the action of sulphuric acid, and it was by the aid of such carbon filaments that on the 20th of October 1880 he gave at Newcastle the first public exhibition on a large scale of electric lighting by means of glow lamps. In another method devised by him for the manufacture of filaments, collodion was squirted into a coagulating solution and the tough threads thus obtained carbonized by heat. He also devoted attention to apparatus for measuring electric currents, to the improvement of accumulators and to the conditions governing the electro-deposition of metals. He was elected a fellow of the Royal Society in 1894, and served as president of the Institution of Electrical Engineers in 1898–1899 and of the Society of Chemical Industry in 1901. In the last-named year he received the honorary degree of D.Sc. from Durham University, and he was knighted in 1904.

SWAN (A. S. *swan* and *swon*, Icel. *svanr*, Du. *zwaan*, Ger. *Schwan*), a large swimming-bird, well known from being kept in a half-domesticated condition throughout many parts of Europe, whence it has been carried to other countries. In England it was far more abundant formerly than at present, the young, or cygnets,[1] being highly esteemed for the table, and it was under especial enactments for its preservation, and regarded as a "bird royal" that no subject could possess without licence from the Crown, the granting of which licence was accompanied by the condition that every bird in a "game" (to use the old legal term) of swans should bear a distinguishing mark of ownership (*cygninota*) on the bill. Originally this privilege was conferred on the larger freeholders only, but it was gradually extended, so that in the reign of Elizabeth upwards of 900 distinct swan-marks, being those of private persons or corporations, were recognized by the royal swanherd, whose jurisdiction extended over the whole kingdom. It is impossible here to enter into further details on this subject, interesting as it is from various points of view.[2] It is enough to remark that all the legal protection afforded to the swan points out that it was not indigenous to the British Islands, and indeed it is stated (though on uncertain authority) to have been introduced to England in the reign of Richard Cœur de Lion; but it it now so perfectly naturalized that birds having the full power of flight remain in the country. There is no evidence to show that its numbers are ever increased by immigration from abroad, though it is known to breed as a wild bird not farther from the British shores than the extreme south of Sweden and possibly in Denmark, whence it may be traced, but with considerable vacuities, in a south-easterly direction to the valley of the Danube and the western part of Central Asia. In Europe, however, no definite limits can be assigned for its natural range, since birds more or less reclaimed and at liberty consort with those that are truly wild, and either induce them to settle in localities beyond its boundary, or of themselves occupy such localities, so that no difference is observable between them and their untamed brethren. From its breeding-grounds, whether they be in Turkestan, in south-eastern Europe or Scania, the swan migrates southward towards winter, and at that season may be found in north-western India (though rarely), in Egypt, and on the shores of the Mediterranean.

The swan just spoken of is by some naturalists named the mute or tame swan, to distinguish it from one to be presently mentioned, but it is the swan simply of the English language

[1] Here, as in so many other cases, we have what may be called the "table-name" of an animal derived from the Norman-French, while that which it bore when alive was of Teutonic origin.

[2] The king and the Companies of Dyers and Vintners still maintain their swans on the Thames, and a yearly expedition is made in the month of August to take up the young birds—thence called "swan-upping" and corruptly "swan-hopping"—and mark them. The largest swannery in England, indeed the only one worthy of the name, is that belonging to Lord Ilchester, on the water called the Fleet, lying inside the Chesil Bank on the coast of Dorset, where from 700 to double that number of birds may be kept—a stock doubtless too great for the area, but very small when compared with the numbers that used to be retained on various rivers in the country. The swanpit at Norwich seems to be the only place now existing for fattening the cygnets for the table—an expensive process, but one fully appreciated by those who have tasted the results. The English swan-laws and regulations have been concisely but admirably treated by Serjeant Manning (*Penny Cyclopaedia*, xxiii. 271, 272).

and literature. Scientifically it is usually known as *Cygnus olor*. Its large size, its spotless white plumage, its orange-red bill, surmounted by a black knob (technically the "berry") larger in the male than in the female, its black legs and stately appearance on the water are familiar, either from figures innumerable or from direct observation, to almost every one. When left to itself its nest is a large mass of aquatic plants, often piled to the height of a couple of feet and possibly some six feet in diameter. In the midst of this is a hollow which contains the eggs, generally from five to nine in number, of a greyish-olive colour. The period of incubation is between five and six weeks, and the young when hatched are clothed in sooty-grey down, which is succeeded by feathers of sooty-brown. This suit is gradually replaced by white, but the young birds are more than a twelvemonth old before they lose all trace of colouring and become wholly white.

It was, however, noticed by Plot (*N.H. Staffordshire*, p. 228) more than 200 years ago that certain swans on the Trent had white cygnets; and it was subsequently observed of such birds that both parents and progeny had legs of a paler colour, while the young had not the "blue bill" of ordinary swans at the same age that has in some parts of the country given them a name, besides offering a few other minor differences. These, being examined by W. Yarrell led him to announce (*Proc. Zool. Society*, 1838, p. 19) the birds presenting them as forming a distinct species, *C. immutabilis*, to which the English name of "Polish" swan had already been attached by the London poulterers,[1] but which is now regarded merely as a variety, not in any way specially associated with Poland but possibly a dimorphic form.

The whooper, whistling or wild swan[2] of modern usage, *Cygnus musicus*, which was doubtless always a winter-visitant to Britain, though nearly as bulky and quite as purely white in its adult plumage, is at once recognizable from the species which has been half domesticated by its wholly different but equally graceful carriage, and its bill—which is black at the tip and lemon-yellow for a great part of its base. This entirely distinct species is a native of Iceland, eastern Lapland and northern Russia, whence it wanders southward in autumn, and the musical tones it utters (contrasting with the silence that has caused its relative to be often called the mute swan) have been celebrated from the time of Homer to our own. Otherwise in a general way there is little difference between the habits of the two, and very closely allied to the whooper is a much smaller species, with very well marked characteristics, known as Bewick's Swan, *C. bewicki*. This was first indicated as a variety of the last by P. S. Pallas, but its specific validity is now fully established. Apart from size, it may be externally distinguished from the whooper by the bill having only a small patch of yellow, which inclines to an orange rather than a lemon tint; while internally the difference of the vocal organs is well marked, and its cry, though melodious enough, is unlike. It has a more easterly home in the north than the whooper, but in winter not infrequently occurs in Britain.

Both the species last mentioned have their representatives in North America, and in each case the transatlantic bird is considerably larger than that of the Old World. The first is the trumpeter-swan, *C. buccinator*, which has the bill wholly black, and the second the *C. columbianus*—greatly resembling Bewick's swan, but with the coloured patches on the bill of less extent and deepening almost into scarlet. South America produces two very distinct birds commonly regarded as swans, *Cygnus melanocoryphus*, the black-necked swan, and that which is called *Coscoroba*. This last, *C. candida*, which inhabits the southern extremity of the continent to Chile and the Argentine territory and visits the Falkland Islands, is the smallest species known—pure white in colour except the tip of its primaries, but having a red bill and red feet.[3] The former, if not discovered by earlier navigators, was observed by Narbrough on the 2nd of August 1670 in the Strait of Magellan, as announced in 1694 in the first edition of his *Voyage* (p. 52). It was subsequently found on the Falkland Islands during the French settlement there in 1764–1765, as stated by Pernetty (*Voyage*, 2nd ed., ii. 26, 99), and was first technically described in 1782 by Molina (*Saggio sulla stor. nat. del Chile*, pp. 234, 344). Its range seems to be much the same as that of the Coscoroba, except that it comes farther to the northward, to the coast of southern Brazil on the east, and perhaps into Bolivia on the west. It is a very handsome bird, of large size, with a bright red nasal knob, a black neck and the rest of its plumage pure white. It has been introduced into Europe, and breeds freely in confinement.

A greater interest than attaches to the South American birds last mentioned is that which invests the black swan of Australia, *Chenopis atrata*. Considered for so many centuries to be an impossibility, the knowledge of its existence seems to have impressed (more perhaps than anything else) the popular mind with the notion of the extreme divergence—not to say the contrariety—of the organic products of that country. By a singular stroke of fortune we are able to name the precise day on which this unexpected discovery was made. The Dutch navigator Willem de Vlaming, visiting the west coast of Zuidland (Southland), sent two of his boats on the 6th of January 1697 to explore an estuary he had found. There their crews saw at first two and then more black swans, of which they caught four, taking two of them alive to Batavia; and Valentyn, who several years later recounted this voyage, gives in his work[4] a plate representing the ship, boats and birds, at the mouth of what is now known from this circumstance as Swan river, the most important stream of the thriving colony of West Australia, which has adopted this very bird as its armorial symbol. Valentyn, however, was not the first to publish this interesting discovery. News of it soon reached Amsterdam, and the burgomaster of that city, Witsen by name, himself a fellow of the Royal Society, lost no time in communicating the chief facts ascertained, and among them the finding of the black swans, to Martin Lister, by whom they were laid before that society in October 1698, and printed in its *Philosophical Transactions*, xx. 361. Subsequent voyagers, Cook and others, found that the range of the species extended over the greater part of Australia, in many districts of which it was abundant. It has since rapidly decreased in numbers, but is not likely soon to cease to exist as a wild bird, while its singular and ornamental appearance will probably preserve it as a modified captive in most civilized countries. The species scarcely needs description: the sooty black of its general plumage is relieved by the snowy white of its flight-feathers and its coral-like bill banded with ivory.

The Cygninae admittedly form a well-defined group of the family Anatidae, and there is now no doubt as to its limits, except in the case of the Coscoroba above mentioned. This bird would seem to be, as is so often found in members of the South American fauna, a more generalized form, presenting several characteristics of the Anatinae, while the rest, even its black-necked compatriot and the almost wholly black swan of Australia, have a higher morphological rank. Excluding from consideration the little-known *C. davidi*, of the five or six species of the northern hemisphere four present the curious character, somewhat analogous to that found in certain cranes (*q.v.*), of the penetration of the sternum by the trachea nearly to the posterior end of the keel, whence it returns forward and upward again to revert and enter the lungs; but in the two larger of these species, when adult, the loop of the trachea between the walls of the keel takes a vertical direction, while in the two smaller the bend is horizontal, thus affording an easy mode of recognizing the respective species of each. Fossil remains of more than one species of swan have been found. The most remarkable is *C. falconeri*, which was nearly a third larger than the mute swan, and was described from a Maltese cave by W. K. Parker in the Zoological Society's *Transactions*, vi. 119–124, pl. 30. (A. N.)

SWANAGE, a watering-place and seaport in the eastern parliamentary division of Dorsetshire, England, 9 m. S.S.W. from Bournemouth by sea, and 132 m. S.W. by W. from London by the London & South-Western railway. Pop. of urban district (1901), 3408. It lies on the picturesque Swanage Bay, on the east coast of the so-called Isle of Purbeck, the district lying south of Poole Harbour. The coast is wild and precipitous, and numerous caves occur in the cliffs. Inland are open, high-lying downs. Swanage Bay has a beautiful sandy beach affording excellent bathing. In the town, the church

[1] M. Gerbe, in his edition of Degland's *Ornithologie Européenne* (ii. 477), makes the amusing mistake of attributing this name to the *fourreurs* (furriers) of London, and of reading it *Cygne du pôle* (polar, and not Polish, swan)!

[2] In some districts it is called by wild-fowlers "elk," which perhaps may be cognate with the Icelandic *Alft* and the Old German *Elbs* or *Elps* (cf. Gesner, *Ornithologia*, pp. 358, 359), though by modern Germans *Elb-schwan* seems to be used for the preceding species.

[3] Dr Stejneger (*Proc. U. S. Nat. Museum*, 1882, pp. 177–179) has been at much pains to show that this is no swan at all, but merely a large Anatine form. Further research may prove that his views are well founded, and that this, with another very imperfectly known species, *C. davidi*, described by Swinhoe (*Proc. Zool. Soc.*, 1870, p. 430) from a single specimen in the Museum of Peking, should be removed from the sub-family Cygninae. Of *C. coscoroba* Mr Gibson remarks (*Ibis*, 1880, pp. 36, 37) that its "note is a loud trumpet-call," and that it swims with "the neck curved and the wings raised after the true swan model."

[4] Commonly quoted as *Oud en nieuw Oost Indien* (Amsterdam, 1726). The incidents of the voyage are related in Deel iii. Hoofdst. iv. (which has for its title Description of Banda), pp. 68–71.

of St Mary has a massive tower possibly of pre-Norman date; there are a town-hall, an institute with library and lecture hall, and memorials to a victory gained by King Alfred over the Danes in the bay in 877, and to Albert, Prince Consort. A large export trade is carried on in stone from the Purbeck quarries.

SWANSEA, a municipal, county and parliamentary borough, market town, and seaport of Glamorganshire, South Wales, finely situated in an angle between lofty hills, on the river Tawe or Tawy near its mouth in Swansea Bay, a beautiful recess of the Bristol Channel, 201 m. W. of London by rail and 45½ m. W.N.W. of Cardiff. The Great Western main line has a junction within the borough at Landore, whence a branch runs into a more central part of the town. The Vale of Neath branch of the same railway and the Rhondda & Swansea Bay railway (now worked by the Great Western) have terminal stations near the docks on the other (eastern) side of the river, as also has the Midland railway from Hereford and Brecon. All these lines approach the town from the north and east through an unattractive industrial district, but the central Wales branch of the London & North-Western railway from Craven Arms in entering it on the west passes through some beautiful woodlands and then skirts the bay, having parallel to it for the last 3 m. the light (passenger) railway which runs from Swansea to Mumbles Pier. The older part of the town, being the whole of the municipal borough previous to 1836, occupies the west bank of the Tawe near its mouth and is now wholly given up to business. Stretching inland to the north along the river for some 3 m. through Landore to Morriston, and also eastwards along the sea margin towards Neath, is the industrial quarter, while the residential part occupies the sea front and the slopes of the Town Hill (580 ft. high) to the west, stretching out to the pleasant suburb of Sketty. The east side of the river (known as St Thomas's and Port Tennant) is approached from the west by a road carried over the North Dock Lock and the river by two girder drawbridges, each of which has a double line of roadway (on which tramways are laid), two footpaths and a line of railway. All the main thoroughfares are spacious, and in two or three instances even imposing, but most of the residential part consists of monotonous stuccoed terraces. The climate is mild and relaxing and the rainfall averages about 40 in. annually.

Public Buildings, &c.—The old castle, first built by Henry de Newburgh about 1099, has entirely disappeared; but of the new castle, which was probably intended only as a fortified house, there remain the great and lesser halls, a tower and a so-called keep with the curtain wall connecting them, its chief architectural feature being a fine embattled parapet with an arcade of pointed arches in a style similar to that of the episcopal palaces of St Davids and Lamphey built by Henry Gower (d. 1347), bishop of St Davids, to whom the building of the new "castle" is also ascribed. Part of it is now used as the headquarters of the 4th Welsh (Howitzer) Brigade R.F.A. Possibly some traces of St Davids Hospital, built by the same prelate in 1331, are still to be seen at Cross Keys Inn. The parish church of St Mary was entirely rebuilt in 1895–1898. It previously consisted of a tower and chancel (with a fine Decorated window) built by Bishop Gower, the piers of the chancel arch being partly built on earlier Norman work, the Herbert Chapel (originally St Ann's) of about the same date as the chancel and rebuilt in the early part of the 16th century, and a nave built in 1739. Of the earlier work there remains the door of the rood loft (built into a wall), a 15th-century brass-inlaid marble slab with a representation of the resurrection, in memory of Sir Hugh Johnys (d. *c.* 1463) and his wife, and three canopied altar tombs—one with the effigy of a priest and another with effigies of Sir Matthew Cradock and his wife. Within the parish of St Mary was St John's, the church of a small parish of the same name lying to the north of St Mary's and once owned by the Knights Hospitallers. This church, which was entirely rebuilt in 1820, was renamed St Matthew in 1880, when a new St John's was built within its own parish. There are 26 other churches and 10 mission rooms belonging to the Church of England, besides 2 Roman Catholic churches, a synagogue and 84 Nonconformist chapels (31 Welsh and 53 English) and 20 mission rooms, but all are modern buildings. There are 9 ecclesiastical parishes and parts of two or three others, all in the diocese of St Davids. The Royal Institution of South Wales, founded in 1835, is housed in a handsome building in the Ionic style erected in 1838–1839 and possesses a museum in which the geology, mineralogy, botany and antiquities of the district are well represented, there being a fine collection of neolithic remains from the Gower Caves and from Merthyr Mawr. Its library is rich in historical and scientific works relating to Wales and Welsh industries and contains the collection of historical MSS. made by Colonel Grant-Francis, some time its honorary librarian, but one of its most valued possessions is the original contract of affiance between Edward II. (when prince of Wales) and Isabella. Its art gallery has many prints and drawings of great local interest and here the Swansea Art Society holds its annual exhibition. The Swansea Scientific Society also meets here. In its early days the institution was the chief centre of scientific activity in South Wales, those associated with its work including L. W. Dillwyn, James Motley, Dr Gutch and J. E. Bicheno, all botanists, J. Gwyn Jeffreys, conchologist, Sir W. R. Grove and the 1st Lord Swansea, the last three being natives of the town.

The free library and art gallery of the corporation, a four-storeyed building in Italian style erected in 1887, contains the library of the Rev. Rowland Williams (one of the authors of *Essays and Reviews*), the rich Welsh collection of the Rev. Robert Jones of Rotherhithe, a small Devonian section (presented by the Swansea Devonian Society), and about 8000 volumes and 2500 prints and engravings, intended to be mutually illustrative, given by the Swansea portrait-painter and art critic, John Deffett Francis, from 1876 to 1881, to receive whose first gift the library was established in 1876. It also contains a complete set of the patent office publications.

The grammar school founded in 1682 by Hugh Gore (1613–1691), bishop of Waterford, is now carried on by the town council under the Welsh Intermediate Education Act of 1889, and there is a similar school for girls. The technical college is also carried on by the town council, the chief features of its curriculum being chemistry, metallurgy and engineering. A training college for school-mistresses, established by the British and Foreign School Society in 1872, was transferred to the town council in 1908.

The other public buildings of the town include the gildhall and law courts, in the Italian style with Corinthian pillars and pilasters, built in 1847 and internally remodelled in 1901; a prison (1829); a fine market hall (1830), rebuilt in 1897; a cattle market and abattoirs (1869); the Albert Hall for concerts and public meetings (1864); the Royal Metal Exchange (1897); harbour trust offices (1904); a central post office (1901) and two theatres. The benevolent institutions include the general hospital, founded in 1817, removed to the present site in 1867, extended by the addition of two wings in 1878 and of an eye department in 1890; a convalescent home for twenty patients from the hospital only (1903); the Royal Cambrian Institution for the Deaf and Dumb, established in 1847 at Aberystwyth, removed to Swansea in 1850, and several times enlarged, so as to have at present accommodation for ninety-eight pupils; the Swansea and South Wales Institution for the Blind, established in 1865 and now under the Board of Education; the Swansea and South Wales Nursing Institute (1873), providing a home for nurses in the intervals of their employment; a nursing institution (1902) for nursing the sick poor in their own homes, affiliated with the Queen's Jubilee Institute of London; the Sailors' Home (1864); a Sailors' Rest (1885); and a Mission to Seamen's Institute (1904).

The town possesses 103 acres of parks and open spaces, the chief being Llewelyn Park of 42 acres in the north of the town near Morriston, Victoria Park (16 acres) and recreation ground (8 acres) abutting on the sands in the west, with the privately owned football field between them, Cwmdonkin (13 acres) commanding a fine panoramic view of the bay, and Brynmill (9 acres) with a disused reservoir constructed in 1837 and now converted into an ornamental lake. Other features of these parks are a small botanical garden in Cwmdonkin, a good collection of waterfowl in Brynmill, and a small aviary of the rarer British birds in Victoria Park, which also has a meteorological station in connexion with the meteorological office, and a statue of Mr William Thomas of Lan erected in 1905 in appreciation of the work done by him in preserving and obtaining "open spaces" for Swansea. In the town itself there are statues of J. Henry Vivian and of his son Sir Henry Hussey Vivian (created Lord Swansea in 1893) each in his turn the "copper king." The corporation owns about 645 acres of land within the limits of the ancient borough. This consists mainly of land acquired under an Inclosure Act of 1761, but a small part is surplus land acquired in 1876–1879 in connexion with an improvement scheme for clearing a large insanitary area in the centre of the town.

The town is lighted with gas supplied by a gas company first incorporated in 1830 and by electricity supplied by the corporation. There is a good system of electrically worked tramways, $5\frac{1}{2}$ m. being owned by a company and nearly 6 m. by the corporation, but the whole worked by the company. The town obtains its chief supply of water from moorlands situated on the Old Red Sandstone formation in the valley of the Cray, a tributary of the Usk in Breconshire where a reservoir of 1,000,000,000 gallons capacity has been constructed at a cost of £547,759, under parliamentary powers obtained in 1892, 1902 and 1905. The water is brought to the town in a conduit consisting of $23\frac{1}{4}$ m. of iron pipes and 3 m. of tunnel into a service reservoir of 3,000,000 gallons capacity made on the Town Hill at an elevation of 580 ft. above sea-level. There is a further supply obtained from three reservoirs of a combined capacity of 513,000,000, constructed in 1866, 1874 and 1889 respectively in the Lliw and adjoining valleys, in the drainage area of the Loughor, about 10 m. to the north of Swansea.

Harbour and Commerce.—Swansea owes its commercial prosperity to its great natural advantages as a harbour and its situation within the South Wales coal basin, for the anthracite portion of which it is the natural port of shipment. It is the most westerly port of the Bristol Channel and the nearest to the open sea, only 35 m. from the natural harbour of refuge at Lundy, and there is sheltered anchorage under the Mumbles Head at all states of the tide.

The modern development of the port dates from about the middle of the 18th century when coal began to be extensively worked at Llansamlet and copper smelting (begun at Swansea in 1717, though at Neath it dated from 1584) assumed large proportions. The coal was conveyed to the works and for shipment to a wharf on the east bank, on the backs of mules and somewhat later by means of a private canal. The common quay was on the west bank; all ships coming in had to lie in the river bed or in a natural tidal basin known as Fabian's Bay, on the east. Under an act of 1791 harbour trustees were appointed who cleared and deepened the river bed and built a long pier on either side of it; in 1796 the approach to the port was made safer by means of an improved light on Mumbles Head. A canal connecting the tidal part of the river Neath with the mouth of the Tawè, made in 1789, was in 1824 connected with the Vale of Neath canal by means of an aqueduct across the Neath river, when also a small dock, Port Tennant (so named after its owner) or Salthouse Dock, was made near the east pier, and this continued to be used till 1880. Meanwhile in 1798 the whole coalfield of the Swansea Valley was connected with the port by a canal $16\frac{1}{2}$ m. long (acquired by the Great Western railway in 1872). In 1851 the river was diverted eastward into a new channel (called the New Cut) and its old channel was locked and floated, thereby forming the North Dock with an area of $11\frac{1}{2}$ acres and a half-tide basin 500 yards long covering $2\frac{1}{2}$ acres. The Swansea Valley canal has a connecting lock with this dock, and on the island between the dock and the New Cut are patent fuel works, copper ore yards and other mineral sheds and large grain stores and flour mills. The South Dock, begun in 1847 under powers obtained that year by a private company, transferred in 1857 to the harbour trustees and opened in 1859, is mainly used for shipping coal and for discharging timber and fish. Lying parallel to the sea front and to the west of the entrance channel from which it runs at right angles, it has an area of 13 acres with a half-tide basin of 4 acres and a lock 300 ft. long by 60 ft. wide. The next development was on the east side of the river where the natural inlet of Fabian's Bay, inside the harbour mouth, was utilized for the construction of the Prince of Wales's Dock (authorized 1874, opened October 1881, extension opened March 1898). Its total area is 27 acres, its quays are nearly 7000 ft. long, and it is connected with the Tennant canal. The very rapid increase in the demand for anthracite coal (for the shipment of which Swansea has practically a monopoly) soon necessitated still further accommodation and in July 1904 was begun the King's Dock, which lies farther east and has an entrance direct from the bay. By means of the embankment made in connexion with it, 400 acres were reclaimed from the sea. It has an area of 68 acres, its lock measures 875 ft. by 90 ft. and its quays 10,550 ft. long, and it has a depth of 32 ft. of water, or inner cill. The total dock area of Swansea has thus been increased to about 147 acres with a total length of quays exceeding 3 m. The harbour docks and adjacent railways (which exceed 20 m.) are owned and administered by a harbour trust of 26 members, of whom one is the owner of the Briton Ferry estate (Earl Jersey), 4 represent the lord of the seigniory of Gower (the duke of Beaufort), 12 are proprietary members and 9 are elected annually by the corporation of Swansea. The trustees are conservators of the river Tawè and parts of Swansea Bay, and the pilotage and lighthouse authority of the district. They were incorporated by the Harbour Act of 1854. There are 9 private graving docks.

The total exports (foreign and coastwise) from Swansea during 1907 amounted to 4,825,898 tons, of which coal and coke made up 3,655,050 tons; patent fuel, 679,002 tons; tin, terne and black plates, 348,240 tons; iron and steel and their manufactures, 38,438 tons; various chemicals (mostly the by-products of the metal industries), 37,100 tons; copper, zinc and silver, 22,633 tons. Its imports during the same year amounted to 899,201 tons, including 172,319 tons of grain and other agricultural produce, 156,620 tons of firewood, 145,255 tons of pig-iron and manufactured iron and steel, 47,201 tons of iron ore, 121,168 tons of copper, silver, lead, tin and nickel with their ores and alloys, 63,009 tons of zinc, its ores and alloys, 41,029 tons of sulphur ore, phosphates and other raw material for the chemical trade. The town (which is often called "the metallurgical capital of Wales") is the chief seat of the copper, spelter, tin-plate and patent fuel industries, and has within a compass of 4 m. over 100 different works of 36 varieties (exclusive of collieries) for the treatment or manufacture of copper, gold, silver, lead, sulphate of copper, spelter, tinplates, steel and iron, nickel and cobalt, yellow metal, sulphuric acid, hydrochloric acid, creosote, alkali, galvanized sheets, patent fuel as well as engineering works, iron foundries, large flour and provender mills, fuse works and brick works. Copper smelting, which during most of the 19th century was the chief industry, has not maintained its relative importance, though Swansea is still the chief seat of the trade, but three-fourths of the tinplates manufactured in Great Britain and nineteen-twentieths of the spelter or zinc are made in the Swansea district, and its tube works are also the largest in the kingdom. While the bulk of the coal is sent to France and the Mediterranean ports, an increasing quantity of anthracite is shipped to Germany, and, in sailing vessels to the Pacific ports of America, patent fuel is largely sent to South America, whence return cargoes of mineral ores and grain are obtained, while Germany, France, Italy, Rumania, the United States and the Far East are the chief customers for tinplates. Over one hundred fishing-smacks and trawlers usually land their catches at the south dock, where there is a flourishing fish-market. There is also a large ice factory.

From 1535 to 1832 (with the exception of 1658–1659) Swansea was associated with the other boroughs of Glamorgan in sending one representative to Parliament. In 1658 Cromwell gave the town the right of separately returning a member of its own, but this right lapsed with the Restoration. In 1832 St John's, St Thomas and parts of the parishes of Llansamlet and Llangyfelach were added to the parliamentary borough of Swansea, to which along with the boroughs of Neath, Aberavon, Kenfig and Loughor a separate representative was given. In 1836 the municipal borough was made coextensive with the parliamentary borough and continued so till 1868, when some further small additions were made to the latter, with which the municipal borough was once more made co-extensive in 1889. Meanwhile in 1885 the parliamentary constituency was made into two divisions with a member each, namely Swansea Town consisting of the original borough with St Thomas's, and Swansea District consisting of the remainder of the borough with the four contributory boroughs. In 1888 Swansea was made a county borough and in 1900 the various parishes constituting it were consolidated into the civil parish of Swansea. Its total area is 5194 acres. The corporation consists of 10 aldermen and 30 councillors. The assizes and quarter sessions for Glamorgan are held at Swansea alternately with Cardiff. The borough has a separate commission of the peace, and, since 1891, a court of quarter sessions.

The population of the old borough was 6099 in 1801 and 13,256 in 1831; after the first extension it amounted to 24,604 in 1841. The population in 1901 was 94,537. Of those who were three years of age and upwards, nearly 67% were returned as speaking English only, 29% as speaking both English and Welsh, and $3\frac{1}{2}$% as speaking Welsh only.

History.—No traces of any Roman settlement have been discovered at Swansea, though there seems to have been a small one at Oystermouth, 5 m. to the south, and the *Via Julia* from Nidum (Neath) to Loughor probably passed through the northern part of the present borough where a large quantity of Roman coins was found in 1835. The name Swansea stands for Sweyn's "ey" or inlet, and may have been derived from King Sweyn Forkbeard, who certainly visited the Bristol Channel and may have established a small settlement at the estuary of the Tawe. The earliest known form of the name is Sweynesse, which occurs in a charter granted by William earl of Warwick some time previous to 1184; in King John's charter (1215) it appears as Sweyneshe, and in the town seal, the origin of which is supposed to date from about the same period, it is given as "Sweyse." An attempt has been made to derive the name from Sein Henydd, the Welsh name of a Gower castle which has been plausibly identified with the first castle built at Swansea, but that derivation is etymologically impossible. The Welsh name, Aber Tawy, first appears in Welsh poems of the beginning of the 13th century. The town grew up round the castle which Henry de Beauchamp (or Beaumont) on his conquest of Gower about 1099, built on the west bank of the river. The castle passed with the lordship or seigniory of Gower, of which it was the *caput*, into the hands of the De Braose family in 1203 (by grant from King John) and eventually it came by marriage to the Somersets and is still held by the dukes of Beaufort, whose title of barons de Gower dates from 1506. The castle was frequently attacked and on several occasions more or less demolished, in the 12th and 13th centuries by the Welsh under the princes of Dynevor. It was visited by King John in 1210 and probably by Edward II. in 1326, for, after his capture, the chancery rolls were found deposited in the castle and were thence removed to Hereford. It was finally destroyed by Glendower, was a "ruinous building" when seen by Leland (1536) and has since wholly disappeared. In the Civil War the town was royalist till the autumn of 1645 when Colonel Philip Jones, a native of the adjoining parish of Llangyfelach and subsequently a member of Cromwell's upper house, was made its governor. Cromwell stayed in the town in May 1648, and July 1649, on his way to Pembroke and Ireland respectively, and later showed it exceptional favour by giving it a liberal charter and parliamentary representation.

The town claimed to be a borough by prescription, for its only known charters of incorporation are those of Cromwell and James II., which were never acted upon. It probably received its first grant of municipal privileges from William 3rd earl of Warwick some time before 1184. By a charter of 1215 (confirmed by Henry II. in 1234, by Edward II. in 1312 and Edward III. in 1332), John himself granted the burgesses the right of trading, free of all customs due, throughout the whole kingdom (except in London), a right which was previously limited to the seigniory. By 1305 the burgesses had become so powerful as to wring a most liberal grant of privileges from their then seigneur William de Braose (fourth in descent from his namesake to whom Gower was granted by King John in 1203), and he bound himself to pay £500 to the king and 500 marks to any burgess in the event of his infringing any of the rights contained in it. By this charter the burgesses acquired the right of nominating annually two of their number for the office of portreeve so that the lord's steward might select one of them to exercise the office, an arrangement which continued till 1835; the bailiff's functions were defined and curtailed, and the lord's chancery was to be continually kept open for all requiring writs, and in Gower—not wherever the lord might happen to be. A patent of murage and pavage—from which it may probably be inferred that Swansea was a walled town—was granted by Edward II. in 1317 and another by Edward III. in 1338. Cromwell's charter of 1655, though reciting that "time out of mind" Swansea had been "a town corporate," incorporated it anew, and changed the title of portreeve into mayor, in whom, with twelve aldermen and twelve capital burgesses, it vested the government of the town. The mayor, ex-mayor and one selected alderman were to be justices of the peace with exclusive jurisdiction and the mayor was the coroner. Four annual fairs were appointed, namely on the 8th of May, 2nd of July, 15th of August and 8th of October—the first, however, being the only new one. In 1658 the protector by another charter granted the town independent representation in parliament. At the Restoration, Cromwell's charters lapsed, but in 1685 James II. granted another charter which contained the arbitrary proviso that the king by order in council might remove any officer or members of the corporation. This charter was not adopted by the burgesses.

De Braose's charter of 1305 bears some evidence to the importance of the shipping of Swansea even at that date, for by it there was granted or confirmed to the burgesses the right to take from the lord's woods sufficient timber to make four great ships at a time and as many small vessels as they wished. Coal was even then worked in the district. Cromwell in his charter of 1655 recognized Swansea as "an ancient port town and populous, situate on the sea coast towards France convenient for shipping and resisting foreign invasions." Its status was only that of a "creek" in the port of Cardiff till 1685, when it was made an independent port with jurisdiction over Newton (now Porthcawl), Neath or Briton Ferry and South Burry, its limits being defined in 1847 as extending from Nash Point on the east to Whitford Point on the west, but in 1904 Port Talbot, which was included in this area, was made into a separate port.

From about 1768 to 1850 Swansea had a somewhat famous pottery. Beginning with earthenware which twenty years later was improved into "opaque china," it produced from 1814 to 1823 superior porcelain which was beautifully decorated with landscapes, birds, butterflies and flowers and is much prized by connoisseurs. During a short period (1845–1850) an imitation of Etruscan ware was also produced with figures of rich red colour over a body of black.

See Lewis W. Dillwyn, *Contributions towards a History of Swansea* (1840); Colonel G. Grant-Francis, *Charters Granted to Swansea* (1867), and *The Smelting of Copper in the Swansea District* (2nd ed., 1881); S. C. Gamwell, *A Guide to Swansea and District* (1880); Lieut.-Colonel W. Ll. Morgan, R.E., *An Antiquarian Survey of East Gower*. (D. Ll. T.)

SWANWICK, ANNA (1813–1899), English writer and philanthropist, was the youngest daughter of John Swanwick of Liverpool, and was born on the 22nd of June 1813. She was educated partly at home and partly at one of the fashionable boarding-schools of the day, where she received the usual education of accomplishments. Dissatisfied with her own intellectual attainments she went in 1839 to Berlin, where she took lessons in German, Greek and Hebrew. On her return to London she continued these pursuits, aloug with the study of mathematics. In 1843 appeared her first volume of translations, *Selections from the Dramas of Goethe and Schiller*. In 1847 she published a translation of Schiller's *Jungfrau von Orleans;* this was followed in 1850 by *Faust*, *Tasso*, *Iphigenie* and *Egmont*. In 1878 she published a complete translation of both parts of *Faust*, which appeared with Retsch's illustrations. It passed through several editions, was included in Bohn's series of translations, and ranks as a standard work. It was at the suggestion of Baron Bunsen that she first tried her hand at translation from the Greek. In 1865 she published a blank verse translation of Aeschylus's *Trilogy*, and in 1873, a complete edition of Aeschylus, which appeared with Flaxman's illustrations. Miss Swanwick is chiefly known by her translations, but she also published some original work. In 1886 appeared *Books, our Best Friends and Deadliest Foes*; in 1888, *An Utopian Dream and How it may be Realized*; in 1892, *Poets, the Interpreters of their Age*; and in 1894, *Evolution and the Religion of the Future*. Miss Swanwick was interested in many of the social and philanthropic movements of her day. In 1861 she signed John Stuart Mill's petition to parliament for the political enfranchisement of women. She helped in the higher education movement, took part in the foundation of Queen's and Bedford Colleges, and continued to take a sympathetic interest in the movement which led to the opening of the universities to women. Her work was acknowledged by the university of Aberdeen, which bestowed on her the degree of LL.D. She died in November 1899.

See *Memoir*, by Miss Bruce (1904).

SWARTZ, OLOF (1760–1818), Swedish botanist, was born in 1760. He commenced his botanical studies in Upsala, under

Linnaeus and Thunberg, and began early to make excursions. He made a voyage to America in 1783, visited England in 1788, returned to Sweden in 1789, and was made professor of natural history in Stockholm. He was the author of many systematic works, and largely extended our knowledge of both flowering plants and cryptogams. He died in 1818.

SWAT, a tract on the Peshawar border of the North-West Frontier Province of India, consisting of the valley of the Swat river above its confluence with the Panjkora. This valley is some 70 m. long, varying from 10 m. to a few hundred yards in breadth; it is intersected by ravines and glens, which bring down the drainage of the ranges on either side. Only that portion of the valley which lies beyond the Peshawar frontier hills, and which is reached by the Malakand, the Shahkot and other passes from the south, is Swat. To the east are the independent hill tracts of Kohistan and Buner, all bordering the Indus, and to the west are Dir and Bajour.

The Swat river rises among snow mountains in the Kohistan, not far from the source of the Gilgit river. After flowing due south for nearly 70 m., it turns to the west and is joined by the Panjkora. It then passes through the Mohmand country, and on entering Peshawar district spreads out to the south-east in many channels which ultimately fall into the Kabul river. Total length about 400 m. In British territory its waters have been utilised by a series of canals to irrigate an area of about 160,000 acres; and the system is now being extended by means of a tunnel through the Malakand range, which will tap the river much higher up.

Swat was better known to the ancients, and to the warriors of Baber's time, than it was to us until the frontier risings of 1895–97 gave British surveyors the opportunity of visiting the country. The ancient name of the river was Suastos, and that of the Panjkora was Ghoura, under which names they figure in the history of Alexander's campaign. The site of the city Massaga, the capital of the Assakeni, is supposed to be near the modern Manglaur. But since the adoption of the Khyber as the main high road from Kabul to India the Swat routes had passed into oblivion. Only the lower portion of the Swat valley, where the river intervenes between Malakand and the passes leading to Dir from the Panjkora, is of military significance. The upper valley is closely gripped between mountain spurs stretching southwards from the Hindu Koh, rising to 15,000 ft. on one side and 19,000 ft. on the other, leaving but a narrow space between their rugged summits and the banks of the river. The valley, narrow though it is, and traversed by the worst conceivable type of hill tracks, contains many villages or hamlets, and is pretty thickly populated. The district has come into prominence of recent years, on account of its lying on the direct road to Chitral.

The Swatis are a clan of Yusafzai Pathans numbering 40,000 fighting men but are of weakly and thin physique, due to the malaria with which the valley is saturated. They are divided into three main clans, the Baizais, Ranizais and Khwazozais. They had not much name for valour, but they opposed a stout resistance to Sir Robert Low's advance over the Malakand Pass in 1895 to the relief of Chitral; and again in 1897, under the influence of fanaticism, they showed desperate bravery in the attack on the Malakand Fort and Chakdara. They are all Suni Mahommedans, and have earned the reputation of being the most bigoted of all the Afghan tribes. For many years they were under the religious dominance of the Akhund of Swat, Abdul Ghafur, who, born in 1794, obtained ascendancy by means of his ascetic practices, ruled practically undisputed in Swat for the last 30 years of his life, and died in 1877. The Akhund, after his experience of the British strength in the Umbeyla Campaign of 1863, always exerted his influence in favour of peace with the British government, though in his earlier days he was sometimes troublesome. He was succeeded by his son Mian Gul, who never possessed the same influence as his father.

SWATOW (also *Shan'tow*), a port of China, in the province of Kwang-tung, opened to foreign trade in 1869. The population is upwards of 60,000. The town is situated at the mouth of the main branch of the river Han, which 30 miles inland flows past the great city of Ch'aochow Fu or Tai-chu (Tie-chu), while the surrounding country is more populous and full of towns and villages than any other part of the province. The climate is good, but being situated at the southern end of the Formosa Strait the town is exposed to the full force of the typhoons, and much destruction is occasionally wrought. English merchants settled on Double Island in the river as early as 1856; but the city, which is built on ground but recently recovered from the sea, was formerly a mere fishing village. The trade of the port has rapidly increased. In 1869 the total value of the trade was £4,800,000, in 1884 £5,519,772, and in 1904 £7,063,579. The surrounding country is a great sugar-cane district producing annually about 2,400,000 cwt. of sugar, and there is an extensive refinery in the town employing upwards of 600 workmen and possessing a reservoir for 7,000,000 gallons of water. Next in value comes the manufacture of bean-cake, which is also imported in large quantities from Niu-chwang, Chifu, Shanghai, Amoy and Hong-Kong. Among the leading exports are tea (since about 1872); grass-cloth, manufactured at Swatow from so-called Taiwan hemp (the fibre of the *Boehmeria nivea* from Formosa); pine-apple cloth, manufactured in the villages about Chieh-Yang (a town 22 m. distant); oranges, for which the district is famous; cheap fans; and pewter, iron and tin wares. Swatow is also a great emigration port and was the scene of many kidnapping adventures on the part of foreigners in the early days. Their outrages gave rise to much hostile feeling towards foreigners who were not allowed to enter the city of Ch'aochow Fu until the year 1861. Of the whole foreign trade of the port upwards of 83% is in British bottoms, the trade with Hong-Kong being of especial importance.

About 1865 the whole Swatow district was still divided into a number of "independent townships, each ruled by its own head-men," and the population was described in the official gazetteer, as "generally rebellious and wicked in the highest degree." Mr Forrest, British consular agent, relates that in that year he was witness to the preparations for a fight between the people living on the opposite sides of the estuary, which was only prevented by a British war-vessel. The T'aip'ings swept over the country, and by their ravages and plundering did much to tame the independence of the clans. The punishment inflicted in 1869 by Commander Jones on the inhabitants of Otingpui (Ou-ting-pei), about 8 m. from Swatow, for the attack they had made on the boats of H.M.S. "Cockchafer," showed the Chinese authorities that such piratical villages were not so strong as had been supposed. General Fang (a native of Ch'aochow Fu) was sent to reduce the district to order, and he carried out his instructions with remorseless rigour.

SWAZILAND (native name Pungwane), a country of British South Africa bounded S., W. and N. by the Transvaal, E. by the Portuguese possessions at Delagoa Bay and the Ingwavuma division of Zululand. It lies between the Drakensberg and Lebombo Mountains and is separated from the Indian Ocean by low land varying in width from 30 to 50 m. It has an area of 6536 sq. m. (being somewhat larger than Yorkshire) and a population (1904), of 85,484, of whom 898 were whites. The natives are nearly all Ama-Swazi Bantus, commonly called Swazis, and are closely allied to the Zulus.

Spurs from the Drakensberg occupy a large part of the country, which may be divided into three parallel belts running north and south. The western belt has an average altitude of about 4500 ft., and is known as the high veld. It is succeeded by the middle veld—not more than 2500 ft. above the sea, and that by the low veld—1000 ft. high, which reaches to the foot of the Lebombo Mountains. These are flat-topped, nowhere higher than 2000 ft. The country is well watered by numerous rivers, all of which discharge into Delagoa Bay. The central and southern parts are drained by the Usutu and other tributaries of the Maputa; the northern region by the Komati (*q.v.*) and the Umbelozi. The Umbelozi has two chief headstreams, the Black and the White Umbelozi, the White branch being the more southerly. The climate is warm but healthy save in some of the river valleys. The flora and fauna differ in no essential respects from the corresponding regions of the TRANSVAAL and ZULULAND (see those articles).

Towns and Communications.—The seat of the administration is Embabaan (Mbabane), a town on a northern tributary of the Usutu 4300 ft. above the sea, 40 m. south of Barberton and 180 m. east of Johannesburg. It replaced (1904) the former capital of Bremersdorp situated in the middle veld 23 m. south-east of Embabaan, and destroyed by Boer forces during the war of 1899–1902. Pigg's Peak and Forbes Reef are mining settlements in northern Swaziland. Hlatikulu, the chief place in southern Swaziland, is built on a plateau about 3000 ft. above the sea. Zombodi, the principal native kraal, lies about 18 m. east of Embabaan.

A railway from Lourenço Marques, 47 m. long, runs through Portuguese territory to the Swaziland border at Umbelozi Poort. This line is the eastern link in the direct railway connexion designed between Johannesburg and Delagoa Bay. From Johannesburg the line runs eastward past Springs and had reached Breyten (143 m.) in 1907. A number of good roads have been constructed. There is telegraphic connexion with the Transvaal.

Industries and Trade.—The soil is generally fertile. On the high veld, where green herbage is found all the year round, large numbers of sheep and cattle are pastured. This region serves as a winter grazing ground for sheep from the Transvaal. The middle veld is suitable for grain crops as well as bananas, sugar, coffee, tea and other semi-tropical produce. Millet, maize, pumpkins and ground-nuts are extensively cultivated. On the low veld cotton is grown. Some species of the cotton plant are indigenous.

Besides agriculture the only considerable industries are gold, tin and coal mining. The goldfields, situated in the north-western part of the country, are a continuation of the De Kaap (Barberton) fields. The auriferous region is stated to be about 25 sq. m. in extent. Up to the outbreak of the Anglo-Boer War in 1899 the value of the gold exported from Swaziland was about £350,000. Gold mining re-started on a small scale in 1904. The output for 1906–1908 was valued at £40,000. Alluvial tin mining is carried on successfully in the neighbourhood of Embadaan, cassiterite to the value of £46,000 being exported in 1905–1907. The output for 1908–1909 was valued at £36,000. Anthracite coal of a good quality is found over a large area of the low veld. Copper is also found. All mining is carried on under concessions. Imports are chiefly food-stuffs and cotton goods; they were valued in 1906 at £38,000 and in 1909 at £47,000. Up to 1906 no statistics of the trade of the country were kept. Trade is with the Transvaal and Delagoa Bay. The abolition of monopolies in 1904 (see below *History*) gave an impetus to trade. Up to that date some £4,000,000 of foreign capital had been sunk in the country with very little return. A large number of Swazis find employment in the Rand gold mines.

Administration, &c.—Swaziland forms a crown colony under the government of the High Commissioner for South Africa. It is administered by a resident commissioner. Legislation is by ordinance. Roman-Dutch common law prevails except when modified by statute, the laws of the Transvaal being in force as far as applicable to the country. Native laws and customs are generally respected and the chiefs exercise civil jurisdiction over their tribesmen, subject to appeal to the resident commissioner's court. There is a special court to deal with serious civil and criminal cases in which Europeans are concerned. Order is maintained by a special police force. Education is mainly dependent on the efforts of missionary societies, but the administration has a few schools.

Revenue is derived chiefly from a poll-tax on natives of £1 per annum, concession rents, royalties and customs. For the period 1904–1909 the revenue—apart from loans—was about £40,000 a year, the normal expenditure being approximately the same amount. Since 1904 considerable sums (*e.g.* £49,000 in 1909) have been spent by the administration on the expropriation of monopolies. Swaziland is a member of the South African Customs Union (see SOUTH AFRICA).

History.—Ama-Swazi tribes are believed to have occupied the country now known as Swaziland from the period of the invasion of South East Africa by the Bantu peoples. They were formerly called Ba-Rapuza or Barabuza after a chief under whom in the 18th century they acquired homogeneity. In the early part of the 19th century they fell under the dominion of the newly constituted Zulu nation. In 1843, the year in which the British annexed Natal and with it a part of the country hitherto ruled by the Zulus, the Barabuza, under a chief named Swazi, took advantage of the comparative weakness of the Zulu power, achieved independence and founded the present state. According to Kaffir custom they adopted the name of their deliverer. The Boers of the Transvaal were then beginning to occupy the regions adjacent to Swaziland and in 1855 the Swazis in order to get a strip of territory between themselves and the Zulus, whose power they still dreaded, ceded to the Boers the narrow strip of land north of the Pongola river now known as the Piet Retief district. The Zulus under Cetywayo claimed the ceded district as theirs and the Swazis as their subjects and for over ten years no white farmers were able to settle in the district. With the Boers the Swazis remained on friendly terms and this friendship was extended to the British on the occupation of the Transvaal in 1877. In 1879 they joined the British in the attack on the Bapedi chief Sikukuni, whom they looked upon as an ally of the Zulus.

They captured from Sikukuni certain "rain medicine," the possession of which has since greatly increased the prestige of the paramount chief of the Swazis among the Kaffirs of South Africa. On the retrocession of the Transvaal in 1881 the independence of the Swazis was recognized by the Boers and the Pretoria convention of that year defined the boundaries of the country. By the London convention of 1884 the Transvaal again recognized the independence of Swaziland. Immediately afterwards, however, the Boers began a series of efforts to obtain control of the country. In 1886 the governor of Natal received a paper from Umbandine (Mbandini), the paramount chief of the Swazis, stating that Piet Joubert had called on him and requested him to sign a paper saying that "he and all the Swazis agreed to go over and recognize the authority of the Boer government, and have nothing more to do with the English." On his refusal the Boers replied to him, "Why do you refuse to sign the paper? You know we defeated the English at Majuba." The Boers further added that if the Swazis were relying on the British, they were leaning on a broken reed, and would find themselves left in the lurch. Umbandine followed up this communication with a request for British protection, but without result. Later on, in 1887, both Boers and gold prospectors of all nationalities were overrunning his country, and Umbandine asked for a British resident. This request was also refused. The Boers now determined to adopt towards Swaziland the policy which had proved so successful in Zululand. A colony of Boers settled within the Swazi territories and proclaimed "The Little Free State." Umbandine was then at length induced to ask the Transvaal for annexation. The Transvaal applied in 1889 to Great Britain for permission to accede to this request, but the British government replied that the only intervention to which they would consent must be a dual one. Consequently a joint commission was appointed to visit Swaziland and report on the condition of things there. Sir Francis de Winton, the British commissioner, who was accompanied by Generals Joubert and Smit on behalf of the Transvaal, reported that Umbandine had already granted concessions, such as "postal, telegraphic, banking, customs," &c., to the Transvaal, and concessions of land mining and grazing rights to various adventurers. Umbandine had in short granted concessions of every conceivable character, including exemption from taxation. A charter of self-government had also been granted (1888) to the whites in the country. In the circumstances de Winton considered a British protectorate inadvisable and impracticable. A dual control was arranged in 1890, but the convention then signed proved abortive owing to the objection of the Transvaal to join the South African Customs Union. In 1893 a further conference on the Swazi question took place between Sir Henry Loch, high commissioner for South Africa, and President Kruger, the result of which was that the administration of Swaziland, with certain reservations as to the rights of the natives, was made over to the South African Republic. In the following year six Swazi envoys visited England for the purpose of asking Queen Victoria to take Swaziland under her protection. In view, however, of the arrangement come to, this petition had to be refused. In 1894 a convention was signed between Great Britain and the Transvaal, and the Boers, in spite of the Swazi opposition, assumed administration of the country. The Boers' object in intriguing to acquire Swaziland was not merely that of obtaining that country. They desired also to annex the coast lands to its east and thus obtain—at Kosi Bay—a seaport of their own. This object they might have attained if they had agreed to de Winton's proposals, but Great Britain in view of the increasingly hostile attitude assumed by the Transvaal government now intervened and by annexing in 1895 Amatongaland, the region in question, blocked the Boers' further progress towards the sea (see SOUTH AFRICA: *History*).

Swaziland suffered during the struggle between the Transvaal and Great Britain as to its destiny. Umbandine died in 1889 and had various successors. Ubanu, installed by the Boers as paramount chief in 1894, was a sanguinary despot and was compelled to flee in 1898. The principal personage in the country after Umbandine's death was, however, his widow Naba Tsibeni, known to Europeans as the queen regent. She more than once appealed to the British to cause the Boers to respect the terms of the conventions, and before the outbreak of the Anglo-Boer war in 1899 she took the side of the British. On the annexation of the Transvaal in 1901 the queen regent asked that Swaziland might be annexed also. On the cessation of hostilities a British special commissioner was sent into the country—then in a condition bordering on anarchy—and a provisional administration established. In June 1903 an order in council formally conferred the government of the country on the governor of the Transvaal (then Lord Milner). Lord Milner visited Swaziland in July 1904 and denounced "the abominable network of concessions" in which the country was entangled. On the 3rd of October following the governor issued a proclamation providing further for the administration, and for the expropriation of the concessions other than those relating to land and minerals. In September 1906 Lord Selborne, who had succeeded Lord Milner, conferred with the queen regent and her councillors on questions specially affecting the natives. A lad named Sobhuza, born about 1898, was selected as paramount chief, Naba Tsibeni, his grandmother, being confirmed as regent during his minority. In December 1906 the control of Swaziland was severed from the governorship of the Transvaal and transferred to the High Commissioner for South Africa, and in March 1907 a resident commissioner was appointed. When the Union of South Africa was established in 1910, Swaziland, with other native territories, remained under direct Imperial control.

See A. M. Miller, "Swaziland," in *Journ. Roy. Col. Inst.* (1900), vol. xxxi., and "Swaziland: its agricultural and pastoral future," in *Transvaal Agricultural Journ.*, vol. iv. (1906); T. R. Jones, "Notes on the Geology of West Swaziland" in *Geol. Mag.* (1899), vol. vi. Colonial office reports on the country have been issued annually since 1908. Consult also the *Colonial Office List* issued yearly. In it are cited the Blue Books dealing with Swaziland. For history see also TRANSVAAL: *Bibliography*.

(A. P. H.; F. R. C.)

SWEARING (O. Eng. *swerian*, to swear, originally to speak aloud, cf. *andswerian*, to answer, Ger. *schwören*, Dan. *svaerge*, &c., all from root *swer-*, to make a sound, cf. "swarm," properly the buzzing of bees, Lat. *susurrus*), the affirmation or uttering of a solemn declaration with an appeal to the Deity, some holy personage or sacred object as confirmation, hence the act of declaring the truth of a statement upon oath (see OATH and EVIDENCE). The common use of the word is for the uttering of profane oaths or curses. In English law, while blasphemy (*q.v.*) was at common law an indictable offence, cursing or swearing was left to the ecclesiastical courts. The Profane Oaths Act 1745 inflicted a sliding scale of fines for the use of profane oaths according to the rank of the offender, 1s. for a common labourer, soldier or seaman, 2s. for everyone below the rank of gentleman and 5s. for those of or above that rank; procedure under this act is regulated by the Summary Jurisdiction Acts. By s. 8 of the Town Police Clauses Act 1847 the use of profane or obscene language is an offence punishable on summary conviction by a fine not exceeding 40s. or imprisonment not exceeding 14 days. The offence must be committed in a street and the act is confined to urban sanitary districts or to such rural districts to which s. 276 of the Public Health Act 1875 has extended it. By s. 12 of the Metropolitan Police Court Acts 1839 a similar offence is punishable in the metropolitan police area, and various districts have put in force by-laws for punishing swearing, cursing, or causing annoyance in public places. The restriction as to the place where the offence must be committed to be liable to punishment has led to the enforcement on occasions of the Profane Oaths Act, which applies to the whole of England and Wales and is not limited to cursing in the streets. It should not, however, apply to obscene language.

SWEATING-SICKNESS. A remarkable form of disease, not known in England before, attracted attention at the very beginning of the reign of Henry VII. It was known indeed a few days after the landing of Henry at Milford Haven on the 7th of August 1485, as there is clear evidence of its being spoken of before the battle of Bosworth on the 22nd of August. Soon after the arrival of Henry in London on the 28th of August it broke out in the capital, and caused great mortality. This alarming malady soon became known as the sweating-sickness. It was regarded as being quite distinct from the plague, the pestilential fever or other epidemics previously known, not only by the special symptom which gave it its name, but also by its extremely rapid and fatal course.

From 1485 nothing more was heard of it till 1507, when the second outbreak occurred, which was much less fatal than the first. In 1517 was a third and much more severe epidemic. In Oxford and Cambridge it was very fatal, as well as in other towns, where in some cases half the population are said to have perished. There is evidence of the disease having spread to Calais and Antwerp, but with these exceptions it was confined to England.

In 1528 the disease recurred for the fourth time, and with great severity. It first showed itself in London at the end of May, and speedily spread over the whole of England, though not into Scotland or Ireland. In London the mortality was very great; the court was broken up, and Henry VIII. left London, frequently changing his residence. The most remarkable fact about this epidemic is that it spread over the Continent, suddenly appearing at Hamburg, and spreading so rapidly that in a few weeks more than a thousand persons died. Thus was the terrible sweating-sickness started on a destructive course, during which it caused fearful mortality throughout eastern Europe. France, Italy and the southern countries were spared. It spread much in the same way as cholera, passing, in one direction, from north to south, arriving at Switzerland in December, in another northwards to Denmark, Sweden and Norway, also eastwards to Lithuania, Poland and Russia, and westwards to Flanders and Holland, unless indeed the epidemic, which declared itself simultaneously at Antwerp and Amsterdam on the morning of the 27th of September, came from England direct. In each place which it affected it prevailed for a short time only—generally not more than a fortnight. By the end of the year it had entirely disappeared, except in eastern Switzerland, where it lingered into the next year;[1] and the terrible "English sweat" has never appeared again, at least in the same form, on the Continent.

England was, however, destined to suffer from one more outbreak of the disease, which occurred in 1551, and with regard to this we have the great advantage of an account by an eye-witness, John Kaye or Caius, the eminent physician.

Symptoms.—The symptoms as described by Caius and others were as follows. The disease began very suddenly with a sense of apprehension, followed by cold shivers (sometimes very violent), giddiness, headache and severe pains in the neck, shoulders and limbs, with great prostration. After the cold stage, which might last from half-an-hour to three hours, followed the stage of heat and sweating. The characteristic sweat broke out suddenly, and, as it seemed to those accustomed to the disease, without any obvious cause. With the sweat, or after that was poured out, came a sense of heat, and with this headache and delirium, rapid pulse and intense thirst. Palpitation and pain in the heart were frequent symptoms. No eruption of any kind on the skin was generally observed; Caius makes no allusion to such a symptom. In the later stages there was either general prostration and collapse, or an irresistible tendency to sleep, which was thought to be fatal if the patient were permitted to give way to it. The malady was

[1] Guggenbühl, *Der englische Schweiss in der Schweiz* (Lichtensteig, 1838).

remarkably rapid in its course, being sometimes fatal even in two or three hours, and some patients died in less than that time. More commonly it was protracted to a period of twelve to twenty-four hours, beyond which it rarely lasted. Those who survived for twenty-four hours were considered safe.

The disease, unlike the plague, was not especially fatal to the poor, but rather, as Caius affirms, attacked the richer sort and those who were free livers according to the custom ol England in those days. "They which had this sweat sore with peril of death were either men of wealth, ease or welfare, or of the poorer sort, such as were idle persons, good ale drinkers and taverne haunters."

Causes.—Some attributed the disease to the English climate, its moisture and its fogs, or to the intemperate habits of the English people, and to the frightful want of cleanliness in their houses and surroundings which is noticed by Erasmus in a well-known passage, and about which Caius is equally explicit. But we must conclude that climate, season, and manner of life were not adequate, either separately or collectively, to produce the disease, though each may have acted sometimes as a predisposing cause. The sweating-sickness was in fact, to use modern language, a specific infective disease, in the same sense as plague, typhus, scarlatina or malaria.

The only disease of modern times which bears any resemblance to the sweating-sickness is that known as *miliary fever* ("Schweiss-friesel," "suette miliaire" or the "Picardy sweat"), a malady which has been repeatedly observed in France, Italy and southern Germany, but not in the United Kingdom. It is characterized by intense sweating, and occurs in limited epidemics, not lasting in each place more than a week or two (at least in an intense form). On the other hand, the attack lasts longer than the sweating-sickness did, is always accompanied by eruption of vesicles, and is not usually fatal. The first clearly described epidemic was in 1718 (though probably it existed before), and the last in 1861. Between these dates some one hundred and seventy-five epidemics have been counted in France alone.

Authorities.—For history see Bacon's *Life of Henry VII.*, and the chronicles of Grafton, Holinshed, Baker, Fabyan, &c. The only English medical account is that of John Caius, who wrote in English *A Boke or Counseill Against the Disease commonly called the Sweate, or Sweating Sicknesse* (London, 1552); and in Latin *De ephemera britannica* (Louvain, 1556; reprinted London, 1721). The English tract is reprinted in Babington's translation of Hecker's *Epidemics of the Middle Ages* (Syd. Soc., 1844). This also contains Hecker's valuable treatise on the English sweat, published in German (1834), and also printed in his *Volkskrankheiten des Mittelalters*, edited by Hirsch (Berlin, 1865). Grüner's *Scriptores de sudore anglico* (Jena, 1847), contains nearly all the original documents, including the two treatises of Caius. See also Hirsch, *Handbook of Geographical and Historical Pathology*, trans. by Creighton (New Syd. Soc., 1885).

SWEATING SYSTEM, a term loosely used in connexion with oppressive industrial conditions in certain trades. This "system" originated early in the 19th century, when it was known as "the contract system." Contractors supplying the government with clothing for the army and navy got the work done by giving it out to sub-contractors, who in some cases made the garments or boots themselves, with the assistance of other workmen, and in others sublet their sub-contracts to men who carried them out with similar help. Afterwards this plan was adopted in the manufacture of ready-made clothing for civilian use, and of "bespoke" garments (made to the order of the customer). Previously the practice had been for coats, &c., to be made up by workmen employed on the premises of the master tailor or working together in common workshops, but in either case directly employed by the master tailor. The new plan brought a large number of workpeople possessing little skill and belonging to a very needy class into competition with the regular craftsmen; and in consequence a fall in wages took place, which affected, to a greater or less extent, the whole body of workmen in the tailoring trade. The work was done in overcrowded and insanitary rooms, and the earnings of the workers were extremely low. In 1850 a vigorous agitation against "the sweating system" was commenced, based mainly upon a series of articles in the *Morning Chronicle*, which were followed by a pamphlet, *Cheap Clothes and Nasty*, written by Charles Kingsley under the name of "Parson Lot," and by his novel *Alton Locke*. Kingsley and his friends, the Christian Socialists, proposed to combat the evils of the sweating system by promoting the formation of co-operative workshops; and several experiments of this nature were made, which, however, met with little success. Except that in 1876–1877 the outcry against the sweating system was renewed (principally on the ground of the risk of infection from garments made up in insanitary surroundings), the matter attracted little public notice until 1887, when the system again came into prominence in connexion with the immigration of poor foreigners into East London, where large numbers of these people were employed in various trades, especially in the tailoring, boot-making, and cabinet-making industries, under conditions generally similar to those complained of in the earlier agitations. In 1888 a select committee of the House of Lords was appointed to inquire into the subject; and after a lengthy investigation—in the course of which evidence was given by 291 witnesses in relation to tailoring, boot-making, furriery, shirt-making, mantle-making, cabinet-making and upholstery, cutlery and hardware manufacture, chain and nail-making, military accoutrements, saddlery and harness-making, and dock labour—this committee presented its final report in April 1890. The committee found themselves unable to assign an exact meaning to the term "sweating," but enumerated the following conditions as those to which that name was applied: "(1) A rate of wages inadequate to the necessities of the workers or disproportionate to the work done; (2) excessive hours of labour; (3) the insanitary state of the houses in which the work is carried on." They stated that, "as a rule, the observations made with respect to sweating apply, in the main, to unskilled or only partially skilled workers, as the thoroughly skilled workers can almost always obtain adequate wages." With regard to the sweating system, the committee declared that this cannot be regarded as responsible for the industrial conditions described; for "the middleman is the consequence, not the cause of the evil; the instrument, not the hand which gives motion to the instrument, which does the mischief. Moreover, the middleman is found to be absent in many cases in which the evils complained of abound." While, on the one hand, we find, as pointed out by this committee, that "sweating" exists without the presence of the "middleman" (the fact being that many grossly underpaid workpeople are in the direct employment of large firms), it is, on the other hand, no less true that the "middleman" (*i.e.* subordinate employer) is common in numerous trades in which there is no trace of any such oppression of the workpeople employed by the sub-contractors as is denoted by the term "sweating." Thus, for example, in shipbuilding in many cases men work in squads, the leading workmen employing their own helpers; in the cotton trade the mule-minders engage and pay their own piecers, and the weavers their own tenters; in the manufactured-iron trade, in mining, &c., a good deal of work is done under sub-employers employing their own assistants, none of these sub-contractors being alleged to "sweat" their helpers. There is, in short, no system of employment which can properly be called "the sweating system." At the same time, wherever workers possessing a small degree of skill and deficient in organization are employed under a number of small masters, there "sweating" is likely to obtain.

The common idea that the "sweater" is an unscrupulous tyrant, who fulfils no useful function, and who makes enormous profits, has no counterpart in fact. Whatever may have been the case in earlier days, before the internecine competition of the "middlemen" had time to produce its inevitable effects upon the position of these sub-employers, it may now be considered to be beyond dispute that the small master ("sub-contractor," "garret master," "fogger," &c.) usually works at least as hard as his employés, and that his gains are, as a rule, no more than a fair return for the work which he performs—work which in many instances consists in doing some difficult part of the job, and in all cases in organizing the labour engaged. So far as concerns the "manufacturer," by whom the "sweater" is employed, and who is clearly the *causa causans* of "the sweating system," for him the practice of getting his work done in outside workshops is undoubtedly convenient, especially in localities where rent is high, because he is saved the expense of providing accommodation for those who do his work. He is also free from restrictions as to the subdivision of labour and the employment of a certain class of workpeople which the sentiment of the regular factory workers would impose upon him. The regular tailor, for example, thinks that no one who has not, by a lengthy period of tuition, acquired the capacity to make a coat "right out" ought to be allowed to enter the tailoring trade. But in the workshop of the sub-contractor the work is split up into fractions, each of which is soon learned, so that it becomes possible to introduce into the trade persons possessing no previous training, and generally willing to work for wages far lower than those to which the regular tailors consider themselves entitled, and which, so long as they are not exposed to the competition of these outsiders, they are usually able to secure. On the other hand, while it may suit the manufacturer, anxious to keep down the cost of production, to give his work out to middlemen, it is beyond question that any form of the "small master" system is necessarily liable to abuse in many directions. Among these small masters the eagerness to secure employment is usually so keen that the work is often taken at a price too low for it to be possible for these sub-employers to pay to their workpeople wages adequate to provide the reasonable requirements of working-class life. The workshops of the middlemen are scattered over large districts, and these little masters frequently move their business from one house to another. Both of these are circumstances which tend strongly to make efficient regulation by the factory and the sanitary inspectors very difficult. Not seldom, especially when trade is brisk, these work-places are overcrowded in a manner injurious to health, and in not a few cases their sanitary condition is defective. It will readily be understood that combination among the people employed in these numerous small isolated work-places is much less easy than among the compact bodies of workers employed in large factories, so that any attempt to resist oppressive conditions of employment by trade-union organization meets with serious obstacles. But perhaps the worst of all the features which this method of manufacture presents is the absence of motor power and machinery. The fact that a manufacturer has laid out a large sum in plant, thus entailing a heavy expenditure in "standing charges," necessarily induces him to do his best to make employment regular. In the little outside workshop, on the other hand, lengthy spells of enforced idleness are followed by short periods of most severe toil, during which the hours of daily labour are prolonged to an inhuman extent. At the same time, the workpeople employed in the ill-equipped workshop of the little master are competing with the much more efficient production of the factory provided with labour-saving machinery driven by steam or other mechanical power; and in many cases their only chance of retaining the work under these circumstances is to take it at starvation prices. But the progress of invention moves fast, and antiquated methods of production are gradually being abandoned. Already, in many of the trades in which the sweating system has hitherto largely prevailed, especially in the tailoring, the boot-making, the cabinet-making and the nail-making industries, the factory system is coming so far to the front in the race for cheapness of production that, although in certain industrial centres, in which the rents of factories are high and a specially abundant supply of needy and unskilled workpeople is available, a good deal of work is still given out to small outside masters, the proportion of the total output manufactured in this manner is day by day diminishing. (D. Sch.)

An endeavour has been made in the United Kingdom to combat legislatively the evils of sweating. The Trade Boards Act 1909 established trade boards for trades to which the act applied. The trades specified were ready-made and wholesale tailoring, the making of paper or chip boxes, machine-lace making and chain-making, but the board of trade was given power to apply the act under a provisional order to any other trade in which exceptionally low wages prevailed. The duties of the trade boards are to fix, subject to certain restrictions, minimum rates of wages for time-work for their trades, while they may also fix general minimum rates of wages for piece-work, and these rates may apply either universally to the trade, or to any special process in the work of the trade or to any special class of workers, or to any special area. The rates so fixed become obligatory by order of the board of trade upon the expiration of six months from the date when made by a trade board, but they may, in the meantime, have a limited operation (1) in the absence of a written agreement; (2) where an employer has given written notice to the board of trade that he is willing to pay them; and (3) in the case of contracts vith government departments and local authorities. If the minimum rate of wages has been made obligatory and an employer has been summarily convicted of not paying same, he is liable to a penalty of not exceeding £20 in respect of each offence and to a penalty of not exceeding £5 for each day on which the offence is continued after conviction. He may also be ordered to pay, in addition, a sum equal to the wages due. The trade boards consist of an equal number of representative members of employers and workers, together with appointed members whose number must be less than half the total of representative members. Trade boards may also establish district trade committees with a constitution similar to their own and may delegate to them their powers and duties under the act. Women are eligible for membership of trade boards or district committees indeed, in case of a trade board for a trade in which women are largely employed, at least one of the appointed members must be a woman.

SWEDEN [*Sverige*], a kingdom of northern Europe, occupying the eastern and larger part of the Scandinavian peninsula. It is bounded N.E. by Finland (Russian Empire), E. by the Gulf of Bothnia and the Baltic Sea, S.W. by the Cattegat and Skagerrack, and W. by Norway. It extends from 69° 3′ 21″ to 55° 20′ 18″ N., and from 11° 6′ 19″ E. on the south-west coast to 24° 9′ 11″ E. on the Finnish frontier, the extreme length being about 990 m., the extreme breadth (mainland) about 250 m., and the total area estimated at 173,547 sq. m. Out of a detailed total estimate of the boundary line at 6100 m., 4737 m. are coastal, the Norwegian frontier is 1030 m., and the Finnish 333 m.

Physical Features.—The backbone of the Scandinavian peninsula is a range, or series of masses, of mountains (in Swedish *Kölen*,[1] the keel) extending through nearly the whole length of the peninsula towards the western side. The eastern or Swedish flank has, therefore, the slighter slope. This range forms, in a measure, a natural boundary between Sweden and Norway from the extreme north to the north of Svealand, the central of the three main territorial divisions of Sweden (Norrland, Svealand and Götaland); though this boundary is not so well markd that the political frontier may follow it throughout. Sweden itself may be considered in four main physical divisions—the mountains and highland district, covering all Norrland and the western part of Svealand; the lowlands of central Sweden; the so-called Småland highlands, in the south and south-east; and the plains of Skåne, occupying the extreme southward projection of the peninsula.

Northern Highlands.

The first district, thus defined, is much the largest, and includes the greatest elevations in the country and the finest scenery. The highest mountains are found in the north, the bold peak of Kebnekaise reaching 7005 ft., Sarjektjåcko, 6972 ft., being the loftiest point of a magnificent group including the Sarjeksfjäll, Alkasfjäll and Partefjäll, which range from 6500 ft. upwards; and, farther south, Sulitelma, 6158 ft., long considered the highest point in Scandinavia. Elevation then decreases slightly, through Stuorevarre (5787 ft.) and Areskutan (4656 ft.), to the south of which the railway from Trondhjem in Norway into Sweden crosses the fine pass at Storlien. South of this again, before the main chain passes into Norway, are such heights as Helagsfjäll (5896 ft.) and Storsylen (5781 ft.); and a group of mountains in the northern part of the province of Dalecarlia (Dalarne), ranges from 3600 to 4500 ft. in height. The neighbourhood of Åreskutan and the Dalarne highlands, owing to the railway and the development of communications by steamer on the numerous lakes, are visited by considerable numbers of travellers, both Swedish and foreign, in summer; but the northern heights, crossed only by a few unfrequented tracks, are known to few, and to a considerable extent, indeed, have not been closely explored. From the scenic standpoint the relatively small elevation of these mountains finds compensation in the low snow-line, which ranges from about 3000 ft. in the north to 5500 ft. in the south of the region. All the higher parts are thus snow-clad; and glaciers, numerous in the north, occur as far south as the Helagsfjäll. The outline of the mountains is generally rounded, the rocks having been subjected to erosion from a very early geological age, but hard formations cause bold peaks at several points, as in Kebnekaise and the Sarjeksfjäll.

[1] In Swedish the definite article (masc. and fem. *en*, neut, *et*) is added as a suffix to the substantive (when there is no epithet). Geographical terms are similarly suffixed to names, thus *Dalelfven*, the river Dal. The commonest geographical terms are : ***elf***, ***ström***, river; ***sjö***, lake; ***ö***, island; ***holm***, small island; ***fjäll***, mountain, group or range; ***dal***, valley; ***vik***, bay. In Norrland the following terms are common: ***å***, river, often attached to the names of the large rivers, as Torneå, Luleå (although properly it means a smaller river than *elf*); the names of towns at their mouths always following this form; *träsk* (local, properly meaning marsh), *jaur* (Lapp), *afva*, lake (provincial Swedish, properly a kind of creek opening from a river). *Å* is pronounced *ō*.

Rivers of the North. From the spinal mountain range a series of large rivers run in a south-easterly direction to the Gulf of Bothnia. In their upper parts they drain great lakes which have resulted from the formation of morainic dams, and in some cases perhaps from the incidence of erratic upheaval of the land. All lie at elevations between 900 and 1300 ft. All are narrow in comparison with their length, which is not infrequently magnified to view when two lakes are connected by a very short stretch of running water with a navigable fall of a few feet, such as those between Hornafvan, Uddjaur and Storafvan on the Skellefte river. The following are the principal rivers from north to south: The Torne, which with its tributary the Muonio, forms the boundary with Finland, has a length of 227 m., and drains lake Torne (Torneträsk), the area of which is 126 sq. m. The Kalix is 208 m. in length. The Lule is formed of two branches, Stora and Lilla (Great and Little) Lule; the length of the main stream is 193 m. The Stora Lule branch drains the Langas and Stora Lule lakes (Langasjaur, Luleträsk), which have a length together exceeding 50 m., a fall between them of some 16 ft. and a total area of only 87 sq. m., as they are very narrow. Below Stora Lule lake the river forms the Harsprång (hare's leap; Njuommelsaska of the Lapps), the largest and one of the finest cataracts in Europe. The sheer fall is about 100 ft., and there is a further fall of 150 ft. in a series of tremendous rapids extending for 1¼ m. Farther up, at the head of Langasjaur, is the Stora Sjöfall (great lake fall; Lapp, Ätna Muorki Kartje), a fall of 130 ft. only less grand than the Harsprång. Both are situated in an almost uninhabited country and are rarely visited. Following the Pite river (191 m.), the Skellefte (205 m.) drains Hornafvan and Storafvan, with a fall of 20 ft., and an area together of 275 sq. m. Hornafvan is a straight and sombre trough, flanked by high hills of unbroken slope, but Storafvan and the intervening Uddjaur are broad, throwing off deep irregular inlets, and picturesquely studded with numerous islets. The Ume (237 m.) receives a tributary, the Vindel, of almost equal length, on the north bank some 20 m. from its mouth, and among several lakes drains Stor Uman (64 sq. m.). The further principal rivers of this region are the Ångerman (242 m.), Indal (196 m.), draining the large lakes Kallsjö and Storsjö, Ljusnan (230 m.), Dal and Klar. Of these the two last rise in the southernmost part of the mountain region described, but do not as a whole belong to the region under consideration. The Ångerman receives the waters of a wider system of streams and lakes than the rivers north of it, and has thus a drainage area of 12,591 sq. m., which is exceeded only by that of the Torne (16,690 sq. m.), the average of the remaining rivers named being about 7700 sq. m.

Beyond the Harsprång and the Stora Sjöfall the northern rivers do not generally form great falls, though many of the rapids are grand. The Indal, by changing its course in 1796 near Bispgården on the northern railway, has left bare the remarkable bed of a fall called Döda (dead) Fall, in which many "giant's caldrons" are exposed. In the uplands above the chain of lakes called Strömsvattudal, which are within the drainage area on the Ångerman, the Hälling stream forms the magnificent Hällingså Fall. In the southern mountain valleys of the region there are several beautiful falls, such as the Tännfors, not far from Åreskutan, the Storbo, Handöl and Rista.

Eastward from the main mountain range the highland region is divided into two belts: a middle belt of morainic deposits and marshes, and a coastal belt. The middle belt is gently undulating; viewed from rare eminences the landscape over the boundless forests resembles a dark green sea, through which the great rivers flow straight between steep, flat-topped banks, with long quiet reaches broken by occasional rapids. The few lakes they form in this belt are rather mere widenings in their courses; but the tributary streams drain numerous small lakes and peat-mosses. In the extreme north this belt is almost flat, a few low hills standing isolated and conspicuous; and the rivers have serpentine courses, while steep banks are absent. The middle belt merges into the coastal belt, covered by geologically recent marine deposits, reaching an extreme height of 700 to 800 ft., and extending inland some 60 to 80 m. in the north and 40 m. in the south. Small fertile plains are characteristic, and the rivers have cut deep into the soft deposits of sand and clay, leaving lofty and picturesque bluffs (*nipor*).

Central Lowlands. The orographical division of the central lowlands bears comparison in formation with the coastal belt of marine deposits to the north. Here are flat fertile plains of clay, well wooded, with innumerable lakes, including the four great lakes, Vener, Vetter, Mälar and Hjelmar. These, except the last, far exceed in area any of the northern lakes, and even Hjelmar (185 sq. m.) is only exceeded by Hornafvan-Storafvan. The areas of the other three lakes are respectively 2149, 733 and 449 sq. m. Vener, Vetter and Hjelmar are broad and open; Mälar is very irregular in form, and of great length. Mälar, Vener and Hjelmar contain many islands; in Vetter there are comparatively few. None of the lakes is of very great depth, the deepest sounding occurring in Vetter, 390 ft. In Hjelmar, which measures 38 m. from east to west, and is 12 m. in extreme width, the greatest depth is only 59 ft., but as its flat shores were formerly subject to inundation its level was sunk 6 ft. by deepening the navigable channel through it and clearing out various waterways (the Eskilstuna river, Hjelmar canal, &c.) in 1878–1887. The scenery of these lakes, though never grand, is always quietly beautiful, especially in the case of Mälar, the wooded shores and islands of which form a notable feature in the pleasant environs of the city of Stockholm. The elevation of the central lowlands seldom exceeds 300 ft., but a few isolated heights of Silurian rock appear, such as Kinnekulle, rising 988 ft. above sea-level on the south-eastern shore of Vener, Billingen (978 ft.) between that lake and Vetter, and Omberg (863 ft.) on the eastern shore of Vetter. Noteworthy local features in the landscape of the central lowlands are the eskers or gravel-ridges (*åsar*), traversing the land in a direction from N.N.W. to S.S.E., from 100 to 200 ft. in height above the surrounding surface. Typical instances occur in the cities of Stockholm (Brunkebergsåsen) and Upsala (Upsala-åsen).

Småland Highlands. South of the central lowlands the so-called Småland highlands extend over the old province of Småland in the south-east, and lie roughly south of Lake Vetter and of Gothenburg, where they reach the south-west coast. The general elevation of this region exceeds 300 ft., and in the eastern part 600 ft.; the principal heights are Tomtabacken (1237 ft.) and Ekbacken (1175 ft.), about 25 m. respectively south-east and west of the town of Jönköping at the southern extremity of Lake Vetter. Gentle forest-clad undulations, many small lakes and peat-mosses, are characteristic of the region; which, in fact, closely resembles the middle belt of the northern highland region. The Småland highlands abut southward upon the plains of Skåne, the last of the main orographical divisions, which coincides roughly with the old province of Skane (Scania). Level plains, with rich open meadows and cultivated lands, the monotony of which is in some parts relieved by beech woods, are separated by slight ridges with a general direction from N.W. to S.E., such as Hallandsåsen in the north-west, with an extreme elevation of 741 ft.

Rivers of the South. The hydrographical survey may now be completed. The Dal river, which enters the Gulf of Bothnia near Gefle, is formed of the union of eastern and western branches (Oster Dal, Vester Dal) not far from the town of Falun. The eastern branch drains various small lakes on the Norwegian frontier, and in its lower course passes through the beautiful Lake Siljan. The length of the whole river including the eastern as the main branch is 283 m. The Klar river (228 m.) rises as the Faemund river in Faemundsjö, a large lake in Norway close west of the sources of the Dal. The Klar flows south into Lake Vener, which is drained to the Cattegat by the short Göta river, on which, not far below the lake, are the celebrated falls of Trollhättan. Lake Vetter drains eastward by the Motala to the Baltic, Lake Mälar drains in the same direction by a short channel at Stockholm, the normal fall of which is so slight that the stream is sometimes reversed. The Småland highlands are drained to the Baltic and Cattegat by numerous rivers of less importance. Excepting Finland no country is so full of lakes as Sweden. About 14,000 sq. m., nearly one-twelfth of the total area, are under water.

Coast. The coast of Sweden is not indented with so many or so deep fjords as that of Norway, nor do the shores of the Gulf of Bothnia, the Baltic and the Cattegat share in the peculiar grandeur of the North Sea coast. All, however, have a common feature in the fringe of islands which, throughout nearly the entire length, shelters the coast of the mainland from the open sea. This "skerry-fence" (in Swedish, *skärgård*) is only interrupted for any considerable distance (in the case of Sweden) round the southern shore off the flat coast of Skåne, between the towns of Varberg on the west and Åhus on the east. Between it and the mainland lies a connected series of navigable sounds of the greatest advantage to coastwise traffic, and also of no little importance as a natural defence. The skärgård of the Cattegat, north of Varberg, is bald and rugged. The two largest islands are Orust and Tjörn, north of Gothenburg. Off the south-east coast the place of the skärgård is in a measure taken by the long narrow island of Öland, but north of this the skärgård begins to widen, and the most considerable fjords are found, such as Bråvik, which penetrates the land for 35 m. nearly up to the town of Norrköping. The island belt is widest (some 45 m.) off the city of Stockholm, the approach to which from the sea is famous for its beauty. Farther north, a narrow sound (Ålands Haf) intervening on the Swedish side, the vast Åland archipelago, belonging to Russia, extends across to the Finnish coast. The skärgård of the Gulf of Bothnia is less fully developed than that of either the Baltic or the Cattegat. The islands of the skärgård as a whole are rugged and picturesque, though never lofty like many of those off the Norwegian coast. In the Baltic many are well wooded, but the majority are bare or heath-clad, as are those of the Gulf of Bothnia. Of the large islands in the Baltic and Cattegat, besides Öland, only Gotland is Swedish.

Geology.—The fundamental rocks of Sweden belong to the Azoic or pre-Cambrian formation, and consist of crystalline rocks. Three divisions are distinguished by some authors—the grey gneiss, the red iron gneiss and the granulite.

The grey gneiss predominates in the northern and eastern parts of the country, from Vesternorrland down to the province of Kalmar. The rock has a prevalent grey colour, and contains as characteristic minerals garnet and in some parts graphite.

The red iron gneiss prevails in western Sweden in the provinces of Vermland, Skaraborg, Elfsborg, and down to the province of Kristianstad. The formation is very uniform in its character, the gneiss having a red colour and containing small granules of magnetite, but, nevertheless, not a single iron mine belongs to this region. The red gneiss contains in many places beds or masses of hyperite.

The granulite, also called eurite and hälleflinta, is the most important of the Pre-Cambrian formation, as it contains all the metalliferous deposits of Sweden. It prevails in the middle part of the country, in Kopparberg, Vestmanland, Upsala and parts of Vermland. It occurs also in Östergötland, Kalmar and Kronoberg. The rock is a very compact and fine-grained mixture of felspar, quartz and mica, often graduating to mica schist, quartzite and gneiss. With these are often associated limestones, dolomites and marbles containing serpentine (Kolmården). The metalliferous deposits have generally the form of beds or layers between the strata of granulite and limestone. They are often highly contorted and dislocated.

The iron deposits occur in more or less fine-grained gneiss or granulite (Gellivara, Grängesberg, Norberg, Striberg), or separated from the granulite by masses of augitic and amphibolous minerals (*grönskarn*), as in Persberg and Nordmark. Sometimes they are surrounded by hälleflinta and limestone, as at Dannemora, Långban, Pajsberg, and then carry manganiferous minerals. Argentiferous galena occurs at Sala in limestone, surrounded by granulite, and at Guldsmedshytta (province of Örebro) in dark hälleflinta. Copper pyrites occur at Falun in mica-schists, surrounded by hälleflinta. Zinc-blende occurs in large masses at Ammeberg, near the northern end of Lake Vetter. The cobalt ore consists of cobalt-glance (Tunaberg in the province of Södermanland) and of linneite (at Gladhammar, near Vestervik). The nickel ore of Sweden is magnetic pyrites, containing only a very small percentage of nickel, and generally occurs in diorite and greenstones. Besides the crystalline gneiss and hälleflinta there are also sedimentary deposits which are believed to be of pre-Cambrian age. The most important of these are the Dala Sandstone (chiefly developed in Dalarne), the Almasåkra and Visingsö series (around Lake Vetter) and the Dalsland formation (near Lake Vener).

Large masses of granite are found in many parts of Sweden, in Kronoberg, Örebro, Göteborg, Stockholm, &c. Sometimes the granite graduates into gneiss; sometimes (as north of Stockholm) it encloses large angular pieces of gneiss. Intrusions of hyperite, gabbro (anorthite-gabbro at Rädmansö in the province of Stockholm) and diorite are also abundant.

The Cambrian formation generally occurs along with the Ordovician, and consists of many divisions. The oldest is a sandstone, in which are found traces of worms, impressions of *Medusae*, and shells of *Mickwitzia*. The upper divisions consist of bituminous limestones, clay-slates, alum-slate, and contain numerous species of trilobites of the genera *Paradoxides*, *Conocoryphe*, *Agnostus*, *Sphaerophthalmus*, *Peltura*, &c. The Ordovician formation occurs in two distinct facies—the one shaley and containing graptolites; the other calcareous, with brachiopods, trilobites, &c. The most constant of the calcareous divisions is the Orthoceras limestone, a red or grey limestone with *Megalaspis* and *Orthoceras*. The subdivisions of the system may be grouped as follows: (1) Ceratopyge Limestone; (2) Lower Graptolite Shales and Orthoceras Limestone; (3) Middle Graptolite Shales, Chasmops and other Limestones, Trinucleus beds. The Cambrian and Ordovician strata occur in isolated patches in Vesterbotten, Jemtland (around Storsjö), Skaraborg, Elfsborg, Örebro, Östergötland and Kristianstad. The whole of the island of Öland consists of these strata. The deposits are in most places very little disturbed and form horizontal or slightly inclined layers. South of Lake Vener they are capped by thick beds of eruptive diabase (called *trapp*). North of Lake Siljan (province of Kopparberg), however, they have been very much dislocated. The Silurian has in Sweden almost the same character as the Wenlock and Ludlow formation of England and consists partly of graptolite shales, partly of limestones and sandstones. The island of Gotland consists entirely of this formation, which occurs also in some parts of the province of Kristianstad. In the western and northern alpine part of Sweden, near the boundaries of Norway, the Silurian strata are covered by crystalline rocks, mica schists, quartzites, &c., of an enormous thickness, which have been brought into their present positions upon a thrust-plane. These rocks form the mass of the high mountain of Åreskutan, &c.

The Triassic formation (Rhaetic division) occurs in the northern part of Malmöhus. It consists partly of sandstones with impressions of plants (cycads, ferns, &c.), and partly of clay-beds with coal.

The Cretaceous formation occurs in the provinces of Malmöhus and Kristianstad and a few small patches are found in the province of Blekinge. Only the higher divisions (Senonian and Danian) of the system are represented. The deposits are marls, sandstones and limestones, and were evidently formed near the shore-line.

The most recent deposits of Sweden date from the Glacial and Post-Glacial periods. At the beginning of the Glacial period the height of Scandinavia above the level of the sea was greater than at present, Sweden being then connected with Denmark and Germany and also across the middle of the Baltic with Russia. On the west the North Sea and Cattegat were also dry land. On the elevated parts of this large continent glaciers were formed, which, proceeding downwards to the lower levels, gave origin to large streams and rivers, the abundant deposits of which formed the diluvial sand and the diluvial clay. In most parts of Sweden these deposits were swept away when the ice advanced, but in Skåne they often form still, as in northern Germany, very thick beds. At its maximum the inland ice not only covered Scandinavia but also passed over the present boundaries of Russia and Germany. When the climate became less severe the ice slowly receded, leaving its moraines, called in Sweden *krosstenslera* and *krosstensgrus*. Swedish geologists distinguish between *bottengrus* (bottom gravel, bottom moraine) and ordinary *krossgrus* (terminal and side moraine). The former generally consists of a hard and compact mass of rounded, scratched and sometimes polished stones firmly embedded in a powder of crushed rock. The latter is less compact and contains angular boulders, often of a considerable size, but no powder. Of later origin than the krosstensgrus is the *rullstensgrus* (gravel of rolled stones), which often forms narrow ranges of hills, many miles in length, called *åsar*. During the disappearance of the great inland ice large masses of mud and sand were carried by the rivers and deposited in the sea. These deposits, known as glacial sand and glacial clay, cover most parts of Sweden south of the provinces of Kopparberg and Vermland, the more elevated portions of the provinces of Elfsborg and Kronoberg excepted. In the glacial clay shells of *Yoldia arctica* have been met with in many places (*e.g.* near Stockholm). At this epoch the North Sea and the Baltic were connected along the line of Vener, Vetter, Hjelmar and Mälar. On the other side the White Sea was connected by Lakes Onega and Ladoga with the Gulf of Finland and the Baltic. In the depths of the Baltic and of Lakes Vener and Vetter there actually exist animals which belong to the arctic fauna and are remnants of the ancient ice-sea. The glacial clay consists generally of alternate darker and lighter coloured layers, which give it a striped appearance, for which reason it has often been called *hvarfvig lera* (striped clay). The glacial clay of the Silurian regions is generally rich in lime and is thus a marl of great fertility. The deposits of glacial sand and clay are found in the southern part of Sweden at a height ranging from 70 to 150 ft. above the level of the sea, but in the interior of the country at a height of 400 ft. above the sea.

On the coasts of the ancient ice-sea, in which the glacial clay was deposited, there were heaped-up masses of shells which belong to species still extant around Spitzbergen and Greenland. Most renowned among these shell-deposits are the Kapellbackarne near Uddevalla. With the melting of the great ice-sheet the climate became milder, and the southern part of Sweden was covered with shrubs and plants now found only in the northern and alpine parts of the country (*Salix polaris*, *Dryas octopetala*, *Betula nana*, &c.). The sea fauna also gradually changed, the arctic species migrating northward and being succeeded by the species existing on the coasts of Sweden. The Post-Glacial period now began. Sands (*mosand*) and clays (*åkerlera* and *fucuslera*) continued to be deposited on the lower parts of the country. They are generally of insignificant thickness. In the shallow lakes and enclosed bays of the sea there began to be formed and still is in course of formation a deposit known by the name *gyttja*, characterized by the diatomaceous shells it contains. Sometimes the gyttja consists mainly of diatoms, and is then called *bergmjöl*. The gyttja of the lakes is generally covered over by peat of a later date. In many of the lakes of Sweden there is still in progress the formation of an iron ore, called *sjömalm*, ferric hydroxide, deposited in forms resembling peas, coins, &c., and used for the manufacture of iron. (P. LA.)

Climate.—The climate of the Scandinavian peninsula as a whole is so far tempered by the warm Atlantic drift from the south-west as to be unique in comparison with other countries of so high a latitude. The mountains of the Keel are not so high as wholly to destroy this effect over Sweden, and the maritime influence of the Baltic system has also to be considered. Sweden thus occupies a climatic position between the purely coastal conditions of Norway and the purely continental conditions of Russia; and in some years the climate inclines to the one character, in others to the other. As a result of the wide latitudinal extent of the country there are also marked local variations to be contrasted. About one-seventh of the whole country is north of the Arctic Circle. The mean annual temperature ranges from 26·6° F. at Karesuando on the northern frontier to 44·8° at Gothenburg and 44·6° at Lund in the south (or 29·5° to 45° reduced to sea-level). Between these extremes the following actual average temperatures have been observed at certain stations from north to south which are appropriately grouped for the purpose of comparison (heights above sea-level following each name):—

Jockmock (850 ft.), at the foot of the lake-chain on the Little Lule River—29·7°; and Haparanda (30 ft.), at the head of the Gulf of Bothnia—32·4°.

Stensele (1076 ft.), at the foot of the lake-chain on the Ume—31·8°; and Umeå (39 ft.) at its mouth on the Gulf of Bothnia—34·9°.

Östersund (1056 ft.) on Storsjö—35·2°; and Hernösand (49 ft.) on the Gulf of Bothnia—37·8°.

Karlstad (180 ft.) at the head of Lake Vener—42·3°; Örebro (102 ft.) at the west of Lake Hjelmar—41·4°; and Stockholm (144 ft.)—42·1°.

Gothenburg (26 ft.) on the Cattegat—44·8°; Jönköping (312 ft.)


SOUTHERN SWEDEN
(For General Map see Norway)
Scale, 1:2,750,000
English Miles
0 10 20 40 60 80
Boundaries of Provinces
County (Län) boundaries
Capitals of Counties
Railways
Canals
St. = Stora, great;
Skt. = Sankt, Saint;
C. = Canal;
G. = Gamla, old;
Ytt. = Ytter, outer;
Longitude East 14° of Greenwich
Gulf of Bothnia
BALTIC SEA
Skagerrack
Cattegat
NORWAY
DENMARK
SVEALAND
GÖTALAND
KOPPARBERG
GEFLEBORG
UPSALA
STOCKHOLM
VESTMANLAND
VERMLAND
ÖREBRO
SÖDERMANLAND
SKARABORG
ÖSTERGÖTLAND
GÖTEBORG
JÖNKÖPING
KRONOBERG
BLEKINGE
KRISTIANSTAD
MALMÖHUS
Vener
Vetter
Christiania
Stockholm
Gothenburg
Copenhagen
Malmö
Kalmar
Visby
Bornholm (to Denmark)
Hanö Bay
Norrköping Bay
Laholm Bay
Kalmar Sound
Öland
Gotland
Emery Walker sc.

at the south of lake Vetter—42·4°; and Vestervik (43 ft.) on the Baltic—43·2°.

But the local variations thus indicated are brought out more fully by a consideration of seasonal, and especially winter, temperatures. In Sweden July is generally the hottest month, the average temperature ranging from about 51° to 62°. In January, however, it ranges from 4° to 32° (February is generally a little colder). Moreover, there are two well-marked centres of very low winter temperature in the inland parts. The one is in the mountainous region of the south of Jemtland and the north of Dalarne, extending into Norway and thus lying in the middle of the peninsula about 62° N. Here the average temperature in January is 8·5°, whereas at Östersund it is over 15°. The other and more strongly marked centre is in the far north, extending into Norway and Finland, where the average is 3·8°. The effect of the spinal mountain range in modifying oceanic conditions is thus illustrated. The same effect is well shown by the linguiform isotherms. In January, for example, the isotherm of 14°, after skirting the north coast of the Scandinavian peninsula, turns southward along the Keel, crossing the upper part of the district of the great northern lakes. It continues in this direction as far as the northern end of Lake Mjösen in Norway (61° N.), then turns sharply north-north-eastward, runs west of Lake Siljan and bends north-east to strike the Bothnian coast near Skellefteå. In July, on the other hand, the isotherms show an almost constant temperature all over the country, and the linguiform curves are wanting.

The relative length of the seasons shows contrasts similar to those of temperature. In the north spring begins in May, summer in the middle of June and autumn in the middle of August. In the south and south-west spring begins in March, summer in the middle of May and autumn in October. At Karesuando the last frost of spring occurs on an average on the 15th of June, and the first of autumn on the 27th of August, though night frosts may occur earlier; while at Stockholm 4½ months are free of frost. Ice forms about October in the north, in November or December in the midlands and south, and breaks up in May or June and in April respectively. Ice covers the lakes for 100 to 115 days annually in the south, 150 in the midlands and 200 to 220 in the north. A local increase of the ice period naturally takes place in the upper parts of the Småland highlands; and in the case of the great lakes of Norrland, the western have a rather shorter ice period than the eastern. As to the seas, the formation of ice on the west and south coasts is rare, but in the central and northern parts of the Baltic drift-ice and a fringe of solid ice along the coast arrests navigation from the end of December to the beginning of April. Navigation in the southern part of the Gulf of Bothnia is impeded from the end of November to the beginning of May, and in the north the gulf is covered with ice from November to the last half of May. Snow lies 47 days on an average on the plains of Skåne, while in the north it lies from 140 to 190 days.

The northern summers find compensation for brevity in duration of sunshine and light. At Karesuando in 68° 26′ N. and 1093 ft. above sea-level the sun is seen continuously above the horizon from the 26th of May to the 18th of July; at Haparanda for 23 hours, at Stockholm for 18½ hours and at Lund for 17½ hours at the summer solstice. Atmospheric refraction causes the sun to be visible for periods varying from south to north for a quarter to half an hour after it has actually sunk below the horizon. With the long twilight, perhaps the most exquisite period of a season which provides a succession of beautiful atmospheric effects, daylight lasts without interruption from the 16th to the 27th of June as far south as Hernösand (62° 38′ N.).

The average annual rainfall for Sweden is 19·72 in., locally increasing on the whole from north to south, and reaching a maximum towards the south-west, precipitation on this coast greatly exceeding that on the south-east. Thus the average in the north of Norrland is 16·53 in., in the south of Norrland 22·6 in. At Borås, midway between the south end of Lake Vetter and the Cattegat, the average is 35·08 in., and 45·82 in. were registered in 1898. At Kalmar, however, on the Baltic opposite Öland, the average is 14·6 in. This is an extreme instance for the locality, but the minimum for all Sweden is found at Karesuando, with 12·32 in. The period of maximum is generally the latter half of summer, and the minimum in February and March; but the maximum occurs in October at coast stations in Skåne and in the island of Gotland. The proportion of total precipitation which falls as snow ranges from 36% in the north to 9% in the south.

Flora.—In the preceding physical description indications are given of the vast extent of forest in Sweden. The alpine treeless region occupies only the upper flanks of the spinal mountain-range above an elevation varying from 1800 ft. in the north to 3000 ft. in the south. It is belted by a zone of birch woods, with occasional mountain-ash and aspen, varying in width from about 20 m. in the north to a fraction of a mile in the south. Below this extends a great region of firwood covering the whole country north-east of Lake Vener and north of the Dal River. The fir (*Pinus sylvestris*) and pine (*Pinus abies*) are the predominating trees Spruce is common, and even predominates in the higher parts (between the great valleys and immediately below the birch-belt) in the north of Norrland. South of the southern limit indicated, in the midland district of the great lakes, the oak (*Quercus pedunculata*) appears as well as pine and fir; and, as much of this area is under cultivation, many other trees have been introduced, as the ash, maple, elm and lime. South of a line running, roughly, from the foot of Lake Vener to Kalmar on the Baltic coast the beech begins to appear, and in Skåne and the southern part of the Cattegat seaboard becomes predominant in the woods which break the wide cultivated places. Of wild flowering plants only a very few are endemic species (though more are endemic varieties); the bulk are immigrants after the last glacial epoch. Of these most are common to arctic lands, or occur as alpine plants in lower latitudes. The number of species decreases according to geographical distribution from south to north; thus while upwards of 1000 are found in Skåne, there are only about 700 in the midlands, 500 in the lower parts of southern Norrland and less than 200 in the extreme north.

Fauna.—The effects of the great latitudinal range of Sweden on its climate and flora has its parallel to a modified extent in the case of fauna. Only a few animals are common to the entire country, such as the hare (*Lepus timidus*) and the weasel; although certain others may be added if the high mountain region be left out of consideration, such as the squirrel, fox and various shrews. Among large animals, the common bear and the wolf have been greatly reduced in numbers even within later historic times. These and the lynx are now restricted to the solitary depths of the northern forests. Characteristic of the high mountainous region are the arctic fox, the glutton and the lemming, whose singular intermittent migrations to the lowlands have a considerable temporary influence on the distribution of beasts and birds of prey. There may also be mentioned the wild reindeer, which is rare, though large domesticated herds are kept by the Lapps. The elk, carefully preserved, haunts the lonely forests from the Arctic Circle even to the Småland highlands. The roe-deer and red-deer are confined to the southern parts; though the first is found in the south of the midland plains. In these plains the fox is most abundant, and the badger and hedgehog are found. Martens and otters are to some extent hunted for their skins. A white winter fur is characteristic of several of the smaller animals, such as the hare, fox and weasel. The common and grey seals are met with in the neighbouring seas, and *Phoca foetida* is confined to the Baltic. Among birds by far the greater proportion is migrant. Characteristic types common to the whole country are the teal, snipe, golden plover and wagtail. In the northern mountains the ptarmigan is common, and like other creatures assumes a white winter dress; ducks and other water-fowl frequent the lakes; the golden eagle, certain buzzards and owls are found, and among smaller birds the Lappland bunting (*Plectrophanes laponicus*) may be mentioned. In the coniferous forests the black grouse, hazel grouse and willow grouse, capercailzie and woodcock are the principal game birds; the crane is found in marshy clearings, birds of prey are numerous, and the Siberian jay in the north and the common jay in the south are often heard. But in the northern forests small birds are few, and even in summer these wilds give a strong general impression of lifelessness. In the midlands the partridge is fairly common, though not readily enduring the harder winters; and ring-doves and stock-doves occur. The lakes are the homes of a variety of aquatic birds. On the coasts a number of gulls and terns are found, also the eider-duck and the sea-eagle, which, however, is also distributed far over the land. The species of reptiles and amphibians are few and chiefly confined to the southern parts. There are three species of snake, including the viper; three of lizard; and eleven of batrachians. The rivers and lakes are generally well stocked with fish, such as salmon, trout of various species, gwyniad and vendace (especially in the north), pike, eels, perch of various species, turbot, bream and roach. The few sportsmen who have visited the higher parts of the great northern rivers have found excellent trout-fishing, with pike, perch, char and grayling, the char occurring in the uppermost parts of the rivers, and the grayling below them. The fisheries, both fresh-water and sea, are important, and fall for consideration as an industry. The herring, cod, flatfish, mackerel and sprat are taken in the seas, and also great numbers of a small herring called *strömming.* In the brackish waters of the east coast sea fish are found, together with pike, perch and other fresh-water forms. The crayfish is common in many places in central and southern Sweden. Pearls are sometimes found in the fresh-water mussel (*Margaritana margaritifera*); thus a tributary of the Lilla Lule River takes its name, Perle River, from the pearls found in it. Among the lower marine animals a few types of arctic origin are found, not only in the Baltic but even in Lakes Vener and Vetter, having remained, and in the case of the lakes survived the change to fresh water, after the disappearance of the connexion with the Arctic seas across the region of the great lakes, the Baltic, and north-east thereof. The molluscan fauna is fairly rich, and insect fauna much more so, even in the north. In summer in the uplands and the north the mosquito is sufficiently common to cause some little annoyance.

People.—The population of Sweden in 1900 was 5,136,441. The census is taken in an unusual manner, being drawn up from the registries of the clergy according to parishes every ten years. Approximate returns are made by the clergy annually. The following table shows the distribution of population in that year through the *län* or administrative districts. The first column shows the older divisions of the county into provinces, the names and boundaries of which differ in many cases from the *län*. These names, as appears elsewhere in this article, remain in common use. The distribution of provinces and *län* between the three main territorial divisions, Norrland (northern), Svealand (central) and Götaland (southern) is also indicated.

Old Provinces.	Län.	Area sq. m.	Pop. 1900.
Norrland—			
Lappland, Norrbotten	Norrbotten	40,867	134,769
Lappland, Vesterbotten	Vesterbotten	22,771	143,735
Ångermanland, Medelpad	Vesternorrland	9,855	232,311
Jemtland, Herjedal	Jemtland	19,675	111,391
Helsingland, Gestrikland	Gefleborg	7,615	238,048
Svealand—			
Dalarne (Dalecarlia)	Kopparberg	11,524	217,708
Vermland	Vermland	7,459	254,284
Vestmanland, Nerike, Södermanland, Uppland	Örebro	3,511	194,924
	Vestmanland	2,612	148,271
	Södermanland	2,631	167,428
	Upsala	2,051	123,863
	Stockholm dist.	3,015	172,852
	Stockholm, city	13	300,624
Götaland—			
Östergötland, Vestergötland, Dal, Bohuslän	Östergötland	4,264	279,449
	Skaraborg	3,273	241,069
	Elfsborg	4,912	279,514
	Göteborg och Bohus	1,948	337,175
Halland	Halland	1,900	141,688
Småland	Jönköping	4,447	203,036
	Kronoberg	3,825	159,124
	Kalmar	4,456	227,625
Blekinge	Blekinge	1,164	146,302
Skåne	Kristianstad	2,488	219,166
	Malmöhus	1,864	409,304
Gotland	Gotland[1]	1,219	52,781
Öland [2]	—	—	—
	Total	172,875[3]	5,136,441

The population in 1908 was about 5,429,600. In 1751 it was 1,802,373, and in 1865, 4,114,141. The average annual increase was 7·86 per thousand in the 19th century, reaching a maximum of 10·39 in 1841–1860, before the period of extensive emigration set in. Emigrants numbered 584,259 men and 424,566 women between 1851 and 1900, these figures helping to account for the considerable excess of women over men in the resident population, which in 1900 was as 1049 to 1000. The periods of greatest emigration were 1868–1873 and 1879–1893; the decline in later years is regarded as a favourable sign. The United States of America receive a large majority of the emigrants, and only a very small percentage returns. The Swedish people belong to the Scandinavian branch, but the population includes in the north about 20,000 Finns and 7000 Lapps. Other foreigners, however, are few, and the population is as a whole homogeneous. Immigrants in the period 1851–1900 numbered only 165,357.

Population is naturally denser in the south than in the north, and densest of all in the districts along the southern coasts; thus Malmöhus Län has about 220 persons per sq. m., Göteborg och Bohus Län 174 and Blekinge 127. In Norrland as a whole, however, there are less than 9 persons per sq. m., in Norrbottens Län less than 4, and in the uplands of this division and Vesterbottens Län much less than this. However, the annual increase per thousand has been greater in Norrland than elsewhere. The annual excess of births over deaths is high, the proportion being as 1·68 to 1. The birth-rate between 1876 and 1900 averaged 28·51 per thousand; the death-rate between 1891 and 1900 was 16·36 per thousand, the lowest ever recorded over such a period for any European country. The lowest mortality is found in the districts about Lakes Vener and Vetter; the highest in Norbotten, the east midland districts, Skåne, and Göteborg och Bohus Län.

The percentage of illegitimacy is rather high (though it decreased during the second half of the nineteenth century); one cause of this may be found in the fact that the percentage of married persons is lower than in most European countries. As regards social evils generally, however, the low, though undoubtedly improving, standard of Sweden has had one of its chief reasons in the national intemperance. In 1775 Gustavus III. made the sale of spirits (*brännvin*) a government monopoly, and the drinking habit was actually fostered. About 1830 this evil reached its highest development, and it is estimated that nine gallons of spirits were then consumed annually per head of the population. Mainly through the efforts of Peter Wieselgren, dean of Gothenburg (1800–1877), a strong temperance reform movement set in, and in 1855 important liquor laws were passed to restrict both production and sale of intoxicating liquors. The so-called Gothenburg System, providing for municipal control of the sale of intoxicants (see LIQUOR LAWS), came into full operation in Gothenburg in 1865. The temperance movement has had its reward; the average of consumption of beer and spirits in Sweden is considerably lower than in Europe as a whole, though the effect of intoxicants is sometimes very apparent.

A marked difference of temperament is noticeable between the Swedes and Norwegians, the Swedes being the more light-hearted and vivacious. In some of the more remote parts of the country old customs are maintained and picturesque local costumes still worn, as in Dalecarlia (*q.v.*). The Lapps moreover retain their distinctive dress. In other cases early costumes are preserved only as a historical reminiscence at festivities. Although the characteristic celebrations at weddings or periodical festivals are, as elsewhere, decreasing in favour, there are certain occasions which are observed as holidays with much ceremony. Such are Christmas Day, and, not unnaturally in this northern land, Midsummer (June 23 and 24). The food of the people in the midlands and south is plentiful and good; in the remoter parts of the north an unfavourable summer is followed by a winter of scarcity or even famine; and in these parts meat is little used. Rye is extensively employed in the rural districts for the making of a hard bread in flat cakes (*knäckebröd*). A prevalent custom among the better classes is that of beginning meals with a selection of such viands as anchovies, smoked salmon or slices of meat, of which a number of small dishes are provided (*smörgåsbord*). These are taken with bread and butter and a glass of spirits. The more characteristic Swedish sports are naturally those of the winter. These include ski-running (*skidlöpning*), skating and skate-sailing, tobogganing and sledging. The numerous inland waters and sheltered channels within the *skärgård* have caused the high development of sailing as a summer sport, the Royal Swedish Yacht Club having its headquarters in Stockholm. Athletic sports are in high favour, especially such winter sports as snow-shoeing (*ski*), and, among ball games, lawn-tennis, and to some extent football, together with the game of *pärk*, peculiar to Gotland, are played.

Towns.—In the first half of the 19th century the percentage of urban population remained nearly stationary at a little less than 10. In 1880 it was 15·12, and in 1900 21·49. The towns with a population exceeding 15,000 in 1900 are Stockholm (300,624), Gothenburg (130,609), Malmö (60,857), Norrköping (41,008), Gefle (29,522), Helsingborg (24,670), Karlskrona (23,955), Jönköping (23,143), Upsala (22,855), Örebro (22,013), Lund (16,621), Borås (15,837), Halmstad (15,362).

Architecture.

Swedish towns, though rarely of quite modern foundation, generally appear so, for the use of brick in building is mainly of modern introduction, and is still by no means general, so that the partial or total destruction of a town by fire is now only less common than formerly. The rectangular method of laying out streets is general, and legislation has been directed against narrow streets and buildings of excessive height. The common material of the characteristic domestic architecture in rural districts is wood, except in Skåne, where stone is available and has been used from early times. Some of the old wooden farm-buildings, especially in Dalarne, such as are preserved in Skansen Museum at Stockholm, are extremely picturesque. Another notable form in old wooden building is the belfry (*klokstapel*) of some village churches, examples of which are seen at Habo near Jönköping and Håsjö in Jemtland on the northern railway. In the midlands and south fine castles and manor houses of the 16th and 17th centuries are fairly numerous, and there are a few remains of previous date. The fortified dwelling-house at Glimmingehus in the extreme south near Simrishamn is a good early example. Several of the southern ports have old citadels. That of Kalmar, on its island, is specially fine, while those at Vestervik (Ståkeholm), Malmö, Falkenberg and Varberg may also be mentioned. Among country palaces or mansions that of Gripsholm is notable, overlooking Lake Mälar, the shores of which are specially

[1] The island and adjacent islets.
[2] Island included in Kalmar Län.
[3] Including the four great lakes, Vener, Vetter, Mälar Hjelmar, 3516 sq. m.

rich in historic sites and remains In ecclesiastical architecture Sweden possesses the noble cathedrals of Lund, Upsala and Linköping; while that of Skara, near the southern shore of Lake Vener, dates originally from 1150, and that of Strengnäs on Lake Mälar was consecrated in 1291. There is a remarkably perfect Romanesque church, with aisles, eastern apse and ambulatory, at Varnhem in Skaraborg Län, and there are a few village churches of the same period in this district and in Skåne. The monastic church at Vadstena on Lake Vetter is a beautiful example of Gothic of the 14th and 15th centuries. But the richest locality as regards ancient ecclesiastical architecture is the island of Gotland (*q.v.*).

Travel and Communications.—As a resort for foreign travellers and tourists Sweden lacks the remarkable popularity of Norway. The Göta canal route, however, is used by many; the uplands of Dalecarlia (Dalarne) are frequented; and the railway through the Jemtland highlands to Trondhjem gives access to a beautiful region, where numerous sanatoria are in favour with the Swedes themselves. The northern railway offers a land route to the Arctic coast of Norway. Along the southern coasts there are many watering-places. Marstrand near Gothenburg is one of the most fashionable; Strömstad, Lysekil and Varberg on the same coast, Ronneby on the Baltic, with its chalybeate springs, Visby the capital of Gotland, and several villages in the neighbourhood of Stockholm may also be noted. The headquarters of the Swedish Touring Club (*Svenska Turistföreningen*) are in Stockholm, but its organization extends throughout the country, and is of special value to travellers in the far north.

Railways.

The first railway in Sweden was opened for traffic in 1856, and the system has developed extensively; more so, in fact, in proportion to population, than in any other European country. About 8000 m. of railway are open, but extensions are constantly in progress. About two-thirds are private lines and one-third government lines. The central administration of the government lines is in the hands of a board of railway directors, and there are local administrative bodies for each of five districts. A railway council, created in 1902, acts as an advisory body on large economical questions and the like. Private railways are controlled by the regulations of the board, while a joint traffic union has as its object the provision of uniformity of administration, tariff, &c. The government has made grants towards the construction of some of the private lines, and has in a few cases taken over such lines. The railways form a network over the country as far north as Gefle and the district about Lake Siljan. The government works the trunk lines from Stockholm to Malmö, to Gothenburg and to Christiania as far as the Norwegian frontier, and other important through routes in the south. The great northern line is also worked by the government. It runs north from Stockholm roughly parallel with the east coast, throwing off branches to the chief seaports, and also a branch from Bräcke to Östersund and Storlien, where it joins a line from Trondhjem in Norway. At Boden the main line joins a line originally built to connect the iron-mines of Gellivara with the port of Luleå; the system is continued past Gellivara to Narvik on the Ofoten Fjord in Norway, this being far north of the Arctic Circle, and the line the most northerly in the world. The gauge of all the government lines and about 66% of the private lines is 1·435 metres (4 ft. 8½ in.). Nearly all the lines are single. Passenger travelling is slow, but extremely comfortable. The principal connexions with the south are made across the sound from Malmö to Copenhagen, and from Trelleborg to Sassnitz in Germany.

Inland Navigation.

The extensive system of natural waterways, especially in central Sweden, has been utilized to the full in the development of internal navigation, just as the calm waters within the skärgård afford opportunity for safe and economical coastwise traffic. The earliest construction of canals dates from the 15th century, the patriot Engelbrekt and King Gustavus Vasa both foreseeing its importance. The theories of construction remained rudimentary until early in the 19th century, when the Göta (*q.v.*) canal was opened. The total length of the canalized water-system of Sweden is a little over 700 m., though wholly artificial waterways amount only to 115 m. out of this total. A large local traffic is carried on by steam launches on the lakes during the season of open navigation; and vessels have even been introduced on some of the lakes and rivers of the far north, principally in connexion with the timber trade. Posting, which is of importance only in the highland districts and the valley roads of Norrland, is carried on by posting-stations (*skjutsstation*) under government regulations; similar regulations apply when, as in the upper valleys of the great northern rivers, rowing boats on the lakes form the only means of travel. The condition of the high roads is fair as a whole, and has been much improved by increased state grants towards their upkeep; but in Norrland they are naturally not of the best class. The postal and telegraph system is efficacious, and the telephone service, maintained partly by the state and partly by companies, is very fully developed. About twenty telephones are in use per thousand of population, and a system of trunk-lines between the important towns has been established since 1889.

Agriculture.—Of the total land area of Sweden only about 12% is arable or meadow land, but the percentage varies greatly in different parts, as will be understood from a recollection of the main physical divisions. Thus in Skane nearly 60% of the land is under cultivation; in the midlands about 30%; in the north from 4·5% in southern Norrland to 3% in northern Norrland. Almost exactly half the total area is under forest, its proportion ranging from 25% in Skåne to upwards of 70% in the inland parts of Svealand and in the south of Norrland. Land which is neither cultivable nor under forest (marsh land or, in the northern mountainous districts, land above the upper limit of the forests) amounts to 61% in the far north and 36% in the Småland highlands, but only to 15% in the central plains and in Skåne. In the more highly cultivated districts of the south reclamation of such lands is constantly proceeding. Agriculture and cattle-breeding employ over one-half the whole population. The average size of farms is 25 acres of cultivated land; only 1% exceeds 250 acres, whereas 23% are of 5 acres or less. The greater part of the land has always been held by small independent farmers (only about 15% of the farms are worked by tenants), but until late in the 18th century a curious method of parcelling the land resulted in each man's property consisting of a number of detached plots or strips, the divisions often becoming so minute that dissension was inevitable. Early in the 19th century various enactments made it possible for each property to become a coherent whole. A legal parcelling (*laga skifte*) was introduced in 1827 and slowly carried out in the face of considerable local opposition; indeed, in the island of Gotland the system could not be enforced until 1870–1880. Roughly about 48·5% of the total cultivated area is under cereals, 33·8 under fodder plants, 5·8 under root-crops, and 11·8 fallow, this last showing a steady decrease. Oats, rye, barley, mixed grain and wheat are the grain-crops in order of importance. During the 19th century the percentage under wheat showed a general tendency to increase; that under oats increased much in the later decades as livestock farming became common, rye maintained a steady proportion, but barley, formerly the principal grain-crop, decreased greatly. This last is the staple crop in Norrland, becoming the only grain-crop in the extreme north; in the richer agricultural lands of the midlands and south rye is predominant in the east, oats in the west. The high agricultural development of the plains of Skåne appears from the fact that although that province occupies only one-fortieth of the total area of Sweden, it produces 30% of the entire wheat crop, 33% of the barley, 18% of the rye and 13% of the oats. A system of rotation (cereal, roots, grass) is commonly followed, each division of land lying fallow one year as a rule; not more than two ripe grain-crops are commonly taken consecutively. Potatoes occupy 4·4% of the total area, and other root-crops 1·4%. These include the sugar-beet, the profitable growing of which is confined to Skåne and the islands of Öland and Gotland. The sugar industry, however, is very important. Orchards and gardens occupy about 1% of the cultivated area. Fruit-trees are grown, mainly in the south and midlands; northward (as far as Hernösand) they flourish only in sheltered spots on the coast. Between 1850 and 1900 the total head of livestock increased from 4,500,000 to 5,263,000, and the great advance of cattle-farming is evident from the following proportions. Whereas in 1870–1875 imported cattle and cattle-farming produce exceeded exports as 12 to 7, in 1900 the value of exports was nearly double that of imports; and it may be added that whereas as late as 1870–1880 the exports of agricultural produce exceeded imports in value, in 1896–1900 they were less than one-tenth. The principal breeds of cattle are the alpine in Norrland, and Ayrshire, short-horn, and red-and-white Swedish in the midlands and south. The Gotland, an old native light yellow breed, survives in the island of Gotland. Oxen, formerly the principal draught animals, have been replaced by horses. Cattle, especially cows, and pigs form the bulk of the livestock, but sheep and goats have greatly decreased in numbers. The Lapps own upwards of 230,000 head of reindeer. Dairy-farming is profitable, England and Denmark being the principal foreign consumers of produce, and the industry is carefully fostered by the government. A board of agriculture had been in operation for many years when in 1900 a separate department of agriculture was formed. There are one or more agricultural societies in each län, and there are various state educational establishments in agriculture, such as the agricultural high schools at Ultuna near Upsala, and at Alnarp near Lund in Skåne, an important agricultural centre, with dairy schools and other branch establishments. Finally, there are numerous horticultural societies, large nurseries and gardening schools at Stockholm, Alnarp and elsewhere, and botanical gardens attached to the universities of Lund and Upsala.

Forests and Forestry.—Of the forests about one-third are public; the majority of these belong to the Crown, while a small proportion belongs to hundreds and parishes. The remainder is in private hands. The public forests are administered by the office of Crown lands through a forest service, which employs a large staff of forest-masters and rangers. The private forests are protected from abuse chiefly by the important legislation of 1903, which prescribes penalties for excessive lumbering and any action liable to endanger the regrowth of wood. The administration of the law devolves upon local forest conservancy boards. In the great fir forests of the north the limit set in respect of cutting down living trees for sawing and export is a diameter of the trunk, without bark, of 8¼ in. at 15½ ft. from the base. Members of the forest service undergo a preliminary course of instruction at a school of forestry, and a further course at the Institute of Forestry, Stockholm, which dates from 1828. There are very numerous sawmills, using water-power, steam and electricity; they are situated chiefly in the coast districts of the Gulf of Bothnia, from Gefle northwards, especially in the neighbourhood of Sundsvall and along the Angerman River, and in the neighbourhood of all the ports as far north as Luleå and Haparanda. There are also upland mills in Dalarne and Vermland, and a considerable number in the neighbourhood of Gothenburg. The wood-pulp industry centres in the districts west and north of Lake Vener and south of Lake Vetter. In the north vast quantities of timber are floated down the great rivers, and the lesser streams are used as floating-ways by the provision of flumes and dams. The millowners either own forests, or lease the right of cutting, or buy the timber when cut, in the Crown or private forests. Among the special articles exported may be mentioned railway-sleepers, pit-props, and wood-pulp.

Fisheries.—The sea-fisheries, which are prosecuted principally in the calm waters within the skärgård, are a variable source of wealth. For example, in 1894 nearly 2,000,000 cwt. of fresh fish (principally herring) were exported, but in subsequent years the fisheries were much less prolific; in 1900 only 80,000 cwt. were exported, and in 1903 less than 150,000 cwt. As a rule each crew jointly owns its boat and tackle. The fishery is of ancient importance; at the old towns of Falsterbo and Skanör, south of Malmö, thousands of fishermen were employed until the harbours became choked in 1631, and the fish were a valuable item in the Hanseatic commerce. There are rich salmon-fisheries in the lower parts of the great northern rivers, especially the Torne, Kalix, Lule, Ångerman and Indal; in the Dal, the Klar and Göta, and several of the lesser rivers of the south. In the majority of rivers no special necessity has been found to protect the fishing. As a general rule the owner of the shore owns the river-fishing. The chief inspector of fisheries is a member of the board of agriculture.

Mining.—The iron-mining industry is of high importance, the output of iron ore forming by far the largest item in the total output of ores and minerals. Thus in 1902 the total output was nearly $3\frac{1}{2}$ million tons, of which 2,850,000 tons were iron ore. The output of iron ore has greatly increased; in 1870–1880 it averaged annually little more than one-quarter of the amount in 1902. The deposits of iron ore are confined almost wholly to the extreme north of Norrland, and to a midland zone extending from the south of the Gulf of Bothnia to a point north of Lake Vener, which includes the Dannemora ore fields in the eastern part. In Norrland the deposits at Gellivara have long been worked, with the assistance of a railway to the Bothnian port of Luleå, but in 1903 the northern railway was completed across the Norwegian frontier to Narvik on Ofoten Fjord, and the vast deposits at the hills of Kirunavara and Luossavara began to be worked. These deposits alone are estimated to have an extent exceeding one-quarter of the total ore fields worked in the country. The deposits are generally in pockets, and the thickness of the beds ranges from 100 to nearly 500 ft. at Kirunavara, up to 230 ft. at Gellivara, and in the midland fields generally from 40 to 100 ft., although at the great field of Grängesberg, in Kopparberg and Örebro Län, a thickness of nearly 300 ft. is found. Nearly all the ore is magnetite, and in the midlands it is almost wholly free of phosphorus. The percentage of iron in the ore is high, as much as 66% in the Kirunavara-Luossavara ore; and little less in that of Grängesberg; this far exceeds other European ores, though it is equalled by some in America. Sweden possesses little coal, and pig-iron is produced with charcoal only; its quality is excellent, but Sweden's proportion to the world's produce is hardly more than 1%, whereas in the 17th and 18th centuries, before the use of coal elsewhere, it was much greater. As an industry, however, the production both of pig-iron and of wrought iron and steel is increasingly prosperous. The ironworks and blast-furnaces are almost wholly in the midland districts. Copper has been mined at Falun since the 14th century; it is also produced at Åtvidaberg in Östergötland. The production, however, has greatly decreased. A little gold and silver are extracted at Falun, and the silver mines at Sala in Vestmanlands Län have been worked at least since the 16th century, but here again the output has decreased. Lead is produced at Sala and Kafveltorp, and zinc ore at Åmmeberg. Coal is found in small beds in Skåne, east and north of Helsingborg, at Billesholm, Bjuf and Höganäs; but the amount raised, although increasing, is only some 300,000 tons annually. Mining administration is in the charge of a special bureau of the board of trade. The Iron Institute (*Järnkontoret*) was established in 1748 as a financial institution, in which the chief iron-mining companies have shares, for the advancement of advantageous loans and the promotion of the industry generally. It maintains a special education and investigation fund. There are schools of mining at Stockholm (the higher school), Falun and Filipstad in Vermland.

Manufactures.—If the total value of the output of the manufacturing industries in Sweden be taken as 100, the following are the most important of those industries, according to the approximate percentage of each to the whole: iron industries 18·3, and mechanical works 4; saw-milling 12·5 and wood-pulp works 2·5; cloth-factories and spinning-mills 8; flour-mills 6·4; sugar-refining and beet-sugar works 6; spirit distilling and manufacture 4·7, and brewing 2·6; dairy products 4·4; papermaking 1·6; leaving a remainder of 29% for other industries. The total annual value of the output is about £72,000,000. The great mechanical works are found at or near Malmö, Stockholm, Jönköping, Trollhättan, Motala on Lake Vetter, Lund, Gothenburg, Karlstad, Falun and Eskilstuna, which is especially noted for its cutlery. A few other establishments including both mechanical workshops and ore-extraction works may be mentioned: Domnarfvet, on the Dal River, near Falun; Sandviken, near Gefle; and Bofors in Örebro Län. The principal centres of the textile industry are Norrköping in Östergötland and Borås in Elfsborg Län, where there are weaving schools; and the industry is spread over Elfsborg Län and the vicinity of Gothenburg. There is a linen industry in Småland and in the south of Norrland. One of the most notable special industries of Sweden is match-making, for which there are large works at Jönköping, Tidaholm in Skaraborg Län and in the neighbourhood of Kalmar. The centre of the beet-sugar industry is Skåne, but it is also carried on in the island of Gotland; its great access of prosperity is chiefly owing to the existence of a protective duty on imported sugar. Spirit distillation centres in Kristianstad Län. Among other industries may be mentioned the earthenware works at Höganäs at the north end of the Sound, the cement works of Lomma in this vicinity, and the pottery works of Rörstrand in, and Gustafsberg near, Stockholm; where beautiful ware is produced. Stone is worked chiefly in Göteborg och Bohus and Blekinge Län.

Commerce.—Exports approach £30,000,000 and imports £40,000,000 in average annual value.

Of the total exports that of timber, wrought and unwrought, represents 50%; the other principal exports with approximate percentage are: iron and steel 13·5, iron ore 3·6, machinery and implements 3·2, and other iron and steel goods 2·7; butter 10; paper 3·4; carpentry work 3; matches 2·3. The principal imports with percentage to the whole are: coal and coke 15, grain 8, coffee 4·6, machinery 4, wool, yarn, thread, cotton and woollen goods 9·4; hides and skins 2·5. Oil and fish are also important. The principal countries trading with Sweden are the United Kingdom (exports from Sweden 38·2%, imports to Sweden 25·7), Germany (exports 16%, imports 39) and Denmark (exports 14%, imports 12·5). Other countries with which Sweden has mainly an export trade are France, the Netherlands and Norway. With Russia on the other hand the trade is principally import. In the case of the United Kingdom, Germany, Denmark and Norway, the transit trade forms an important proportion of the whole. The coal imported (which forms over 90% of the whole consumed) comes mainly from Great Britain; while most of the colonial produce, such as coffee and tobacco, comes through Germany. The match and paper export trade is principally with the United Kingdom. Between 1865 and 1888 Sweden employed a modified system of free trade, but various enactments in 1888 and 1892 reintroduced methods of protection.

Shipping.—The total number of vessels in the Swedish commercial fleet is about 3000 of 650,000 tons register; of which steamers represent about 380,000 tons. On an average about 73,000 vessels, of an aggregate tonnage of 17,500,000, enter and clear the ports. The principal ports of register are Gothenburg, Stockholm, Helsingborg and Gefle, in order; though the principal commercial ports are Stockholm, Gothenburg and Malmö. Owing to the natural configuration of the coast and the skärgård excellent natural harbours are almost without number. Artificial harbours are consequently few, but those at Helsingborg, Malmö, Halmstad, Ystad and Kalmar may be mentioned. The principal docks are at Gothenburg, Stockholm, Malmö, Oskarshamn and Norrköping, besides the naval docks at Karlskrona; and the principal ports where large vessels can be accommodated on slips are Malmö, Gothenburg, Stockholm, Karlskrona and Gefle. A list of the chief ports may be conveniently classified. On the west coast north of Gothenburg are Strömstad, near the Norwegian frontier, and Uddevalla, on a deep inlet behind the island of Orust, 35 m. from the open Cattegat. South of Gothenburg on the open coast are Varberg and Halmstad; and on the Sound are the three large ports of Helsingborg, Landskrona and Malmö. Passing to the Baltic, Trelleborg and Ystad lie on the southernmost coast of the country, and Simrishamn, Åhus the outport of Kristianstad, Karlshamn, Ronneby and Karlskrona on the wide Hanö Bay. On Kalmar Sound are Kalmar and Oskarshamn; and continuing northward, Vestervik, Söderköping at the head of the inlet Slätbäken, Norrköping, similarly situated on Bråviken, and Stockholm, far within the skärgård. On the Bothnian coast there is a port at or near the mouth of each great river, where the timber floated down from the interior is both worked and exported. The chief ports here, from south to north, are: Gefle, Söderhamn, Hudiksvall, Sundsvall, Hernösand, Ornsköldsvik, Umeå, Skellefteå, Piteå and Luleå, the last exporting the ore from the northern iron-mines.

Banks.—The first Swedish bank, called the Palmstruch bank after its founder, Johan Palmstruch, was incorporated in 1656. It began to issue notes in 1661. It was shortly afterwards bankrupt, and in 1668 the Bank of Sweden (*Sveriges Riksbank*) succeeded it. This is managed by a board of seven delegates, the chairman being elected by the government, while the Riksdag (parliament) elects the remainder. It began to issue notes in 1701. This ability was shared by private banks with solidary responsibility until 1903, but under a reform of 1897 the riksbank took over, from 1904, the whole right of issuing paper currency, which is in wide use. The capital of the riksbank is 50,000,000 kronor (£2,250,000). The other banks are joint-stock banks and savings-banks, of which the first was opened at Gothenburg in 1820. The post office savings bank was opened in 1884.

Coinage.—The counting unit in the Swedish coinage is the *krona*, equal to 1·1 shilling. The monetary unit is 10 kronor gold, and gold pieces, not widely met with in circulation, are struck of 20, 10 and 5 kronor. The krona equals 100 *öre*. Silver pieces of 2 and 1 krona, 50, 25 and 10 öre are struck, and bronze pieces of 5, 2, and 1 öre. Sweden, Norway and Denmark have the same monetary system.

Finance.—In the budget for 1910 revenue and expenditure were estimated at £12,674,300. The principal sources of income in the ordinary revenue are railways, forests, telegraphs and rent from Crown lands; and those in the revenue voted (*bevillningar*), which is about seven-eighths of the whole, customs, the taxes on spirits and beet-sugar, and income from the post office. The departments to which the bulk of expenditure is devoted are those of the army, the interior, the navy and education. A large proportion of the army expenditure was formerly defrayed by a system of military tenure on certain lands. Land-taxes, however, were finally abolished in 1904, and their place was taken by an increased taxation on real estate, revised triennially, and by an income tax arranged on a sliding scale, up to 4% of the income (9·6 pence in the £), settled according to individual declaration. The national debt was practically nil until *c.* 1855, and the debt contracted thereafter owes its existence almost wholly to railway construction. It increased from about £2,300,000 in 1860 to £6,400,000 in 1870 and £18,600,000 in 1900. In 1904 it exceeded £19,000,000. The greater proportion of communal revenue comes from income and property tax, the sale of spirits under the Gothenburg System, and contributions from the treasury. Primary education, poor relief, and Church purposes form the principal items of expenditure.

Constitution and Government.—Sweden is a limited monarchy, the constitution resting primarily on a law (*regerings-formen*) of the 6th of June 1809. The king is irresponsible, and executive power is vested in him alone. All his resolutions, however, must be taken in the presence of the cabinet (*statsråd*). The cabinet councillors are appointed by the king and are responsible to the parliament (*Riksdag*). They are eleven in number, one being prime minister, two others consultative ministers, and the remaining eight heads of the departments of administration, which are justice, foreign affairs, land defence, naval defence, home affairs, finance, public works, agriculture. The councillors must be of Swedish birth and adherents of the Lutheran confession. The appointment of the majority of public officials is vested in the king, who can himself dismiss cabinet ministers and certain others, whereas in most cases a judicial inquiry is necessary before dismissal. The king shares legislative powers with the Riksdag, (parliament or diet), possessing the rights of initiation and absolute veto. He has also, in certain administrative and economic matters, a special legislative right.

The Riksdag consists of two chambers. The members of the first chamber are elected by the *landsthing*, or representative bodies of the *län*, and by the municipal councils of some of the larger towns. They number 150, and are distributed among the constituencies in proportion to population; the distribution being revised every tenth year. Eligibility necessitates Swedish birth, an age of at least 35 years, and the possession, at the time of election and for three years previously, either of real property to the value of 80,000 kronor (£4400), or an annual income on which taxes have been paid of 4000 kronor (£220). Members are unpaid. The members of the second chamber number 230, of whom 150 are elected from rural constituencies and 80 from towns. The members receive a salary of 1200 kronor (£66), and are elected for a period of three years by electors, or directly, according to the resolution of the electoral district. If a member retires during that period, or if the chamber is dissolved, succeeding members are elected for the remainder of the three years, and thus the house is wholly renewed at regular intervals, which is not the case with the first house. The franchise was for long extremely limited in comparison with other countries, but in 1907 universal manhood suffrage was introduced, after protracted dissension and negotiation between the two houses. Eligibility to the lower house necessitates possession of the elective franchise, an age of at least 25 years, and residence within the constituency. Both chambers have in theory equal power. Before bills are discussed they may be prepared by committees, which play an important part in the work of the house. The agreement of both chambers is necessary before a bill becomes law, but when they differ on budget questions the matter is settled by a common vote of both, which arrangement gives the second chamber a certain advantage from the greater number of its members. By revisers elected annually the Riksdag controls the finances of the kingdom, and by an official (*justitieombudsman*) elected in the same way the administration of justice is controlled; he can indict any functionary of the state who has abused his power. The bank of the kingdom is superintended by trustees elected by the Riksdag, and in the same way the public debt is administered through an office (*riksgäldskontoret*), whose head is appointed by the Riksdag.

Local Government.—For the purposes of local government Sweden is divided into 25 administrative districts called *län*, a list of which is given in the paragraph dealing with population. The elected representative body in each is the *landsthing*, which deliberates on the affairs of the län and has a right to levy taxes. The chief official of the län is the *landshöfding*, under whom are secretarial and fiscal departments. Privileged towns, receiving their privileges from the government (not necessarily on the basis of population), are under a mayor (*borgmästare*) and aldermen (*rådmän*), the aldermen being elected by the citizens, while the mayor is appointed by the government from the first three aldermen on the poll, is paid, and holds office for life. Gothenburg has two mayors, and the city of Stockholm (*q.v.*), a län in itself, has a special form of government. The major rural divisions are the *fögderier*, under bailiffs, a subdivision of which is the *länsmansdistrikt* under a *länsman*.

Justice.—Justice is administered by tribunals of three instances. (1) There are 119 rural judicial districts (*domsagor*), which may be subdivided into judicial divisions (*tingslag*). Each *tingslag* has a court (*häradsrätt*), consisting of a judge and twelve unpaid assessors (*nämndemän*), of whom seven form a quorum, elected by the people. These, if unanimously of a different opinion to the judge, can outvote him. The town-courts in the privileged towns are called *rådstufvurätter*, and consist of the mayor and at least two aldermen. (2) There are three higher courts (*hofrätter*), in Stockholm, Jönköping and Kristianstad. (3) The Supreme Court (*Högsta Domstolen*) passes sentences in the name of the king, who is nominally the highest judicial authority. The court has a membership of 18 justices (*justitieråd*), two of whom are present in the council of state when law questions are to be settled; while the body also gives opinion upon all proposed changes of law.

Army and Navy.—General military service is enforced. Every Swedish man belongs to the conscripts (*värnpligtige*) between the age of 21 and 40, during which time he serves eight years in the first levy, four in the second, and eight in the reserves. The conscripts were formerly trained for 90 days, but according to the law of 1901, the conscript is bound to serve in time of peace—in the infantry, position artillery, fortress artillery, fortress engineers, and the army service corps a total of 240 days; and in the cavalry, field artillery, field engineers, and field telegraph corps a total of 365 days. The permanent cadres number about 22,000, and about 85,000 men are annually trained as recruits or recalled for further training. The organization of the army in time of peace is as follows: 82 battalions of infantry (28 regiments), 50 squadrons of cavalry, 71 field artillery and 7 position artillery batteries, 10 fortress artillery, 16 engineer, and 18 army service corps companies. There are six divisions, quartered at Helsingborg, Linköping, Sköfde, Stockholm (two), and Hernösand; in addition to the Gotland troops quartered at Visby. A division in time of war would probably consist of 2 battalions of infantry (4 regiments, 12 battalions), with 4 squadrons of cavalry, 1 artillery regiment, 1 company of engineers, &c. A cavalry division would consist of 2 brigades of 8 squadrons each, and 1 brigade of horse artillery. It is estimated that 500,000 men are available for service in the various capacities in case of war. There are fortresses at Stockholm (Vaxholm and Oscar-Fredriksborg), Boden on the northern railway near the Russian frontier, Karlsborg on Lake Vetter, and Karlskrona; and there are forts at Gothenburg and on Gotland. The reforms of 1901 abolished the *indelta*, a body including both infantry and cavalry who lived in various parts of the country, in some cases having their houses provided for them. This peculiar system of military tenure (*indelningsverket*) originated in the 17th century, when certain landowners were exempt from other military obligations if they provided and maintained armed men. The navy is small, including 11 ironclads of 3100 to 3650 tons. The personnel consists of a cadre, reserve and about 17,000 conscripts. It also includes two coast-artillery regiments, with headquarters at Vaxholm and Karlskrona. The principal naval station is Karlskrona, and there is another at Stockholm.

Religion.—More than 99% of the total population belong to the Swedish Lutheran Church, of which the king is the supreme head. Sweden is divided into 12 dioceses and 186 deaneries, the head of the diocese of Upsala being archbishop. The parish is an important unit in secular as well as ecclesiastical connexions. The rector presides over the local school board, which is appointed by the church assembly (*kyrkostämman*), and thus an intimate relation between the church and education has long been maintained. A peculiar duty of the clergy is found in the *husförhör* or meetings designed to enable the priest to test and develop the religious knowledge of his parishioners by methods of catechism. It was formerly enjoined upon the clergy to visit parishioners for this purpose, and the system is still maintained in the form of meetings, which have in some cases, however, acquired a character mainly devotional. The parishes number 2556, but one living may include more than one parish. In the sparsely inhabited districts of the north the parish is sometimes of enormous extent, thus that of Gellivara has an area of about 6500 sq. m. In such cases the priest often makes protracted journeys from farm to farm through his parish, and on certain occasions the congregation at his church will include many, both Swedes and Lapps, who have travelled perhaps for several days in order to be present. Dissenters are bound to contribute to the maintenance of the Swedish Church, in consideration of the secular duties of the priests.

Education.—The connexion between the church and education is so close that the control of both is vested in a single department of the government. Primary education is carried on in common schools of different grades, under both local and state inspection, the parish being the school district. Seminaries are maintained for common school teachers, with a four years' course. At Haparanda and Mattisudden in Norbotten there are special institutions for teachers for the Finnish and Lapp population respectively. Wide attention was attracted to Swedish educational methods principally by the introduction of the system of Sloyd (*slöjd*), initiated at the Nääs seminary near Gothenburg, and concerned with the teaching of manual occupations, both for boys and for girls. The higher education of the people is provided by people's high schools in the rural districts, especially for the peasantry, maintained by the county councils, agricultural societies and the state, and providing a two years' course both in general education and in special practical subjects according to local needs. The men's course is held in winter; and a women's course, in some instances, in summer. The workmen's institutes in the towns have a similar object. A system of university extension has been developed on the English pattern, summer courses being held at Upsala and Lund. In connexion with the army reform of 1901 a system of army high schools was proposed for conscripts while serving. Technical education is provided in higher schools at Stockholm, Gothenburg and certain other large industrial centres; and in lower schools distributed throughout the country, in which special attention is given to the prevailing local industries. The agricultural and forestry schools have been mentioned in the paragraphs on these subjects. Public schools for boys are provided by the state, each bishop being superintendent (*eforus*) of those in his diocese. In the three lowest classes (out of a total of nine) a single system of instruction is practised; thereafter there are classical and scientific sides. Greek is taught only in a section of the upper classical classes. Of modern languages, German is taught throughout; English in all classes of the scientific side, and the upper classical classes. Much attention is paid to singing, drill and gymnastics. The school terms together occupy 34½ weeks in the year. At the schools examinations are held for entrance to the universities and certain higher special schools. Owing to the high development of state public schools, private schools for boys are few; but higher schools for girls are all private, excepting the higher seminary for teachers and the state normal school at Stockholm. The state universities are at Upsala and Lund, and with these ranks the Caroline Medical Institution at Stockholm. There are universities (founded by private individual benefactions, but under state control) at Stockholm and Gothenburg. The faculties at Upsala and Lund are theology, law, medicine and philosophy (including both art and science). The courses are long, ranging from six to nine years; and the degrees are those of candidate, licentiate and doctor. The students, who are distinguished by their white caps, are divided for social purposes into "nations" (*landskap*) of ancient origin, based upon the distinctions between natives of different parts.

Scientific Institutions.—Among the scientific and literary societies are to be noted the Swedish Academy, consisting of 18 members, which was instituted in 1786 by Gustavus III., after the pattern of the Académie Française, for the cultivation of the Swedish language and literature; and the Academy of Science, founded in 1739 by Linnaeus and others for the promotion of the natural sciences. The first distributes one and the second two of the prizes of the Nobel Foundation. A fourth prize is distributed by the Caroline Institution at Stockholm. There may be mentioned further the Royal Academies of Literature, History and Antiquities (1786), of Agriculture (1811), of Arts (1735) and of Music (1771). The principal museums and art and other collections are in Stockholm, Upsala and Lund, and Gothenburg. The Royal Library in the Humlegård Park at Stockholm, and the university libraries at Upsala and Lund are entitled to receive a copy of every publication printed in the kingdom. Certain of the large towns have excellent public libraries, and parish libraries are widely distributed.

See *Sweden, its People and its Industry*, a government publication (ed. G. Sundbärg) dealing with the land and people in every aspect (Eng. vers., Stockholm, 1904); *Bidrag till Sveriges officiela statistik* (Stockholm, 1857 seq.); *Statistisk Tidskrift*, periodically from 1862; Publications (year-book, guides, &c.) of the *Svenska Turistföreningen* (Swedish Touring Club) Stockholm; periodical *Bulletin* of the Geological Institute of Upsala University, in which may be noted K. Ahlenius, *Beiträge zur Kenntniss der Seenkettenregion in Schwedisch-Lappland*, No. v. (1900); Also Dahlman, *Inledning til Sveriges physikalska geografi* (Stockholm, 1857); *Statistiskt Lexicon ofrer Sverige* (Stockholm, 1859–1870); M. Höjer, *Konungariket Sverige* (Stockholm, 1875–1883); C. Almqvist, *La Suède, ses progrès sociaux* (Stockholm, 1879); P. B. Du Chaillu, *The Land of the Midnight Sun* (London, 1881); C. M. Rosenberg, *Geografiskt-statistiskt handlexicon öfrer Sverige* (Stockholm, 1882–1883); W. W. Thomas, *Sweden and the Swedes* (Chicago and New York, 1891); Healey, *Educational Systems of Sweden, Norway and Denmark* (London, 1893); Nyström, *Handbok i Sveriges geografi* (Stockholm, 1895), and *Sveriges rike* (Stockholm, 1902); G. Andersson, *Geschichte der Vegetation Schwedens* (Leipzig, 1896); K. Ahlenius, *Sverige, geografisk, topografisk, statistisk beskrifning* (Stockholm); and for geology, A. G. Nathorst, *Sveriges geologi* (Stockholm). For more detailed accounts of the various districts see the publications of the *Sveriges Geologiska Undersökning*, and also the volumes of the *Geologiska Föreningens i Stockholm Förhandlingar*. (O. J. R. H.)

History

Remains dating from the Stone Age are found scattered over the southern half of Sweden, but it is only along the south coast and in the districts bordering on the Cattegat that they occur in any considerable quantity. The antiquities of the Bronze Age are much more widely distributed and reach as far as the north of Helsingland. It is evident that the country must at this time have been fairly populous. So far as can be judged from the human remains found the population in general in both the Stone and Bronze Ages seems to have been similar in type to that of the present day, and there is no clear evidence for the advent of a new race. The Iron Age probably began in the south of Sweden at any rate some three or four centuries before the beginning of the Christian era. (See further SCANDINAVIAN CIVILIZATION.)

Early Races and Divisions.

The first historical notice relating to Sweden is contained in Tacitus, *Germania*, cap. 44. This book was probably published in A.D. 98 or 99 and in the passage mentioned we find the name of the chief people of the peninsula, the Swedes proper, Suiones (O. N. *Sviar*, Swed. *Svear*, A. S. *Sweon*), who eventually gave their name to the whole country. According to Tacitus they were governed by a king whose power was absolute and comprehensive, and possessed a strong fleet which secured them from the fear of hostile incursions. Hence arms were not borne in times of peace but stored away under charge of a slave, and Tacitus suggests in explanation that the royal policy did not commit this trust to noble, freeman or freedman. Their original territories lay on both sides of the Mälar, in the provinces later known as Upland, Södermanland and Westmanland. Tacitus mentions another tribe, the Sitones, which he places next to the Suiones, but they have not been identified, and it is not clear from his description whether they lived within the peninsula or not. The only information he gives about them is that they were ruled over by a woman. Other early Roman writers, Mela and Pliny, mention the country under the name Scandinavia (Skåne), a name which in native records seems always to have been confined to the southernmost district in the peninsula. Little information, however, is given by these authorities with regard to the inhabitants.

The people next in importance to the Suiones in the peninsula (Swed. *Götar*, O. N. *Gautar*, A. S. *Geatas*) are first mentioned by Ptolemy (under the form Goutai for Gautoi), together with a number of other tribal names, most of which unfortunately cannot be identified, owing to the corrupt state of the text. Ptolemy puts the Götar in the southern part of the country, and from the earliest historical times their name has been given to the whole region between the Cattegat and the Baltic, exclusive of the provinces of Halland and Skåne which down to the 17th century always belonged to Denmark. The coast of the Cattegat north of the Göta Elv was reckoned in Norway. Götaland consisted of the provinces of Vestergötland and Östergötland divided from one another by Lake Vetter, together with Småland. In early times Vestergötland seems to have been by far the most important.

Vermland, the district to the north of Lake Vener and the whole of the country to the north of Svealand seem to have been of small importance. Jämtland was always considered a part of Norway. After the time of Ptolemy we hear no more of Sweden until the 6th century, when a surprisingly full account of its peoples is given by the Gothic historian Jordanes. He mentions both the Svear (Swethans) and the Götar together with other peoples, the names of several of which can be recognized in the district—names of later times, in spite of the numerous corruptions of the text. He praises the horses of the Svear and speaks of their great trade in furs of arctic animals which were transferred from merchant to merchant until they reached Rome. About the other peoples of Sweden he gives a few details, chiefly of physical or moral characteristics, commenting upon the warlike nature of the Visigauti, the mildness of the Finns, the lofty stature of the Vinovii and the meat and egg diet of the Rerefennae. Jordanes's statement regarding the prevalence of trade with Sweden is corroborated by the fact that many coins and bracteates of the period have been found in the country. Of these the coins are chiefly Roman and Byzantine gold pieces of the 5th century, the bracteates copies of Roman coins of the same period.

Account of Jordanes.

Procopius, the contemporary of Jordanes (*Gothica*, ii. 15) likewise gives an account of Sweden, which he calls Thule, but the only tribes which he names are the Skrithephinnoi (A. S. Scriðefinnas), a wild people of Finnish stock, and the Götar (Gautoi) whom he describes as a "nation abounding in men." For the same period we derive a considerable amount of information with regard to Swedish affairs from the Anglo-Saxon poem *Beowulf*. The hero himself belonged to the Greatas (*i.e.* in all probability Götar, though the identification is disputed by some scholars), his mother being the daughter of their king Hrethel. Haethcyn, the son and successor of this Hrethel, is said to have perished in a disastrous battle against the Svear, but his fall was avenged by his brother Hygelac in a subsequent engagement in which the Swedish king Ongentheow was killed. This Hygelac is clearly identical with that Chochilaicus wrongly described as a Danish king by Gregory of Tours (iii. 3) who made a piratical expedition to the lower Rhine which ended in his defeat aud death in a battle with the Franks under Theodberht about A.D. 520. The poem contains several allusions to this disaster. We learn further that about the time of Hygelac's death strife broke out in the royal family of the Svear, between Onela, the son and successor of Ongentheow, and Eanmund and Eadgils, the sons of his brother Ohthere. The latter fled for protection to the Götar and the war which ensued cost the lives of Eanmund and of Heardred the son and successor of Hygelac. According to the poem Beowulf himself now became king of the Götar and assisted Eadgils in a campaign which resulted in the death of Onela and the acquisition of the throne by his nephew. What is said in the poem with regard to the end of Beowulf belongs to the realm of myth, and for three centuries after this time we have no reference to Swedish affairs in English or other foreign authorities. Moreover after the time of Beowulf and Jordanes there are very few references to the kingdom of the Götar and in Olaf Sköttkonung's time it was merely an earldom. The kingdom must have come to an end between the 6th and 10th centuries A.D., and probably quite early in that period.

Beowulf.

The Ynglingatal, a poem said to have been composed by Thioðolfr of Hvín, court-poet of Harold Fairhair, king of Norway, gives a genealogy of Harold's family, which it carries back to the early kings of the Svear. Snorri Sturluson (1178–1241) the Icelandic author using this poem as a basis and amplifying it from other sources, wrote the Ynglinga Saga, which traces back the history of the family, generation by generation, to its beginning. In this saga Aðils (the Eadgils of *Beowulf*), son of Ottarr is one of the most prominent figures. The account given of him agrees in general with the statements in *Beowulf*, though the nature of his relations with Ali (Onela) has been misunderstood. The decisive battle between the two kings is said to have taken place on the frozen surface of Lake Wener. Ongentheow appears to have been entirely forgotten in Norse tradition and his place is taken by a certain Egill. The saga further states that Aðils was an enthusiastic horse-breeder and that he met with his death through a fall from his horse. This point is of interest in connexion with the notice of Jordanes, mentioned above, with regard to the horses of the Svear. Other northern authorities such as Saxo and the Hrolfs Saga Kraka represent Aðils in a very unfavourable light as niggardly and addicted to sorcery.

The Ynglingatals and Ynglinga Saga.

The Ynglingatal and Ynglinga Saga enumerate Aðil's ancestors to no less than seventeen generations, with short accounts of each. We have no means of checking the genealogy from other sources, and the majority of the characters are probably to be regarded as mythical. The origin of the family is traced to the god Frey, son of Niörðr, who is said to have founded Upsala, the ancient capital of Sweden. His reign is represented as a golden age of peace and prosperity and the great wealth of the sanctuary is said to have taken its beginning from the offerings at his tomb. His full name appears to have been Yngvifreyr or Ingunar Freyr and his descendants are collectively termed Ynglingar, though we also occasionally meet with the name Skilfingar, which corresponds with the name Scilfingar borne by the Swedish royal family in *Beowulf*.

After the time of Aðils the Ynglingar remained in possession of Upsala for four generations according to the saga. Ultimately the treachery and the murderous disposition of the king named Ingialdr led to his overthrow by a prince from Skåne, called Ivarr Viðfaðmi. His son Olafr Trételgia withdrew to Vermland, which he brought into a state of cultivation, though he was subsequently sacrificed by his subjects in a time of famine. It is stated in the saga that the Swedish kings were believed to have control over the seasons like their ancestor, the god Frey, and traces of this belief seem to have lingered in the country down to the times of Gustavus Vasa. The sons of Olafr Trételgia moved westward into Norway, and if we may trust the saga, the Swedish kingdom never again came into the possession of their family.

The subsequent kings of Sweden are said to have been descended from Ivarr Viðfaðmi. The most prominent figures in this family are Haraldr Hilditönn Ivarr's grandson and his nephew Sigurðr Hringr. The story of the battle between these two at Bråvik, in which Haraldr lost his life, is one of the most famous in northern literature. But the position of these kings with regard to Sweden is far from clear. Their home is probably to be placed on the Cattegat rather than on the Baltic. The same is true also of Ragnarr Loðbrók, who is said to have been the son of Sigurðr Hringr. About the year 830 the missionary bishop Ansgar made his first expedition to Sweden. He made his way to Birca on the Mälar. The king whom he found reigning there is called Björn (Bern) and is generally identified with the king Björn for whom Bragi the Old composed the poem called *Ragnarsdrápa*. On his subsequent journeys to Sweden Ansgar encountered kings called Olafr and Önundr. He appears to have met with considerable immediate success in his missionary enterprises, although there is no evidence to show that the churches he founded long survived his death, and no serious mission seems to have been attempted for more than a century afterwards.

Introduction of Christianity.

During the 9th century extensive Scandinavian settlements were made on the east side of the Baltic, and even as early as the reign of Louis I. we hear of piratical expeditions on the Black Sea and on the Caspian. The famous expeditions of Rurik and Askold which resulted in the origin of the Russian monarchy appear to have taken place towards the middle of the 9th century, but it has not been found possible to connect these names with any families known to us from Swedish tradition. Proofs of extensive Scandinavian settlement in Russia are to be found partly in the Russian names assigned to the Dnieper rapids by Constantine Porphyrogenitus, partly in references to this people made by foreign representatives at the court of Byzantium. The fact that many of the names which occur

Scandinavian Settlements in Russia.

in Russian chronicles seem to be peculiarly Swedish suggests that Sweden was the home of the settlers, and the best authorities consider that the original Scandinavian conquerors were Swedes who had settled on the east coast of the Baltic.

In the time of Harold Fairhair, probably about the beginning of the 10th century, we hear of a king named Eric the son of Emund at Upsala, whose authority seems to have reached as far as Norway. Later in the century there is record of a king named Björn á Haugi who is said to have been the son of Eric and to have reigned fifty years. Björn's sons and successors were Olaf and Eric the Victorious. Styrbiörn Starki, the son of Olaf, being refused his share of the government by Eric after his father's death, made himself a stronghold at Jomsborg in Pomerania and spent some years in piratical expeditions. Eventually he betook himself to Harold Bluetooth, then king of Denmark, and endeavoured to secure his assistance in gaining the Swedish throne by force of arms. Although he failed in this attempt he was not deterred from attacking Eric, and a battle took place between the two at the Fyriså (close to Upsala) in which Styrbiörn was defeated and killed. Eric himself died ten years after this battle, apparently about 993. According to the story he had obtained victory from Odin in return for a promise to give himself up at the end of ten years. Under his son and successor Olaf, surnamed Sköttkonung, Christianity was fully established in Sweden. Olaf Tryggvason, the king of Norway, had married his sister Ingibiörg to Ragnvald, earl of Vestergötland, on condition that he should receive baptism, and the Swedish king's wife was also a Christian, though he himself was not baptized until 1008 by Sigfrid at Husaby. A quarrel arose in the last years of the 10th century between Olaf Sköttkonung and Olaf Tryggvason. The latter had applied for the hand of Sigrið, the widow of Eric the Victorious, but had insulted her on her refusal to become a Christian. In the year 1000, when the Norwegian king was in Pomerania, a coalition was formed between the king of Sweden, Sweyn Forkbeard, king of Denmark, and earl Eric of Lade, and the allies waylaid their enemy off the coast near Rügen and overthrew him in the great sea-battle of Svolder. Under Olaf Sköttkonung Sweden became the mightiest of the kingdoms of the north, in spite of the king's own inactivity. She lost her lands east of the Baltic, but received as compensation in Norway part of Trondhjem and the district now called Bohüslan. These lands Olaf handed over to Earl Sweyn, brother of Earl Eric (whose father Haakon had governed Norway), as a marriage portion for his daughter Holmfrið. Some years later we hear of hostilities between Olaf Sköttkonung and another Norwegian prince, Olaf Haraldsson (the Fat), who raided Sweden and was besieged in the Mälar by the Swedish king. In 1014, the year of Earl Eric's departure to England with Canute, Olaf Haraldsson, returning to Norway as king, put an end to the Swedish and Danish supremacy, and in 1015 he forced Earl Sweyn to leave the country. Trifling border-quarrels followed, but in 1017 a truce was arranged between Norway and Vestergötland, where Earl Ragnvald was still in power. Olaf of Norway now sent his marshal Björn to Ragnvald to arrange a peace. Ragnvald brought him to a great assembly at Upsala in February 1018. At this meeting Björn, supported by the earl, asked for peace, and Olaf was compelled by the pressure of the lawman Thorgny to agree to this and also to promise his daughter Ingegerð in marriage to the Norse king. The marriage, however, never got beyond the betrothal stage, and at Earl Ragnvald's suggestion Astrid, her half-sister, was substituted, contrary to the will of Olaf Sköttkonung. Such was the anger of the king that Ragnvald was forced to accompany Ingegerð to Russia, where she was married to the grand-duke Jaroslav at Novgorod. In Sweden, however, both the Vestgötar and the Upland Sviar were discontented, the former on account of the breaking of the king's promise to Olaf of Norway and the latter on account of the introduction of the new religion, and their passions were further inflamed by the lawman Anund of Skara. A rising in Upland compelled Olaf to share his power with his son Jacob, whose name was changed to Anund by the leaders of the revolt. A meeting was then arranged between the kings of Norway and Sweden at Kongelf in 1019, and this resulted in a treaty. The death of Olaf Sköttkonung is assigned by Snorri Sturluson to the winter of 1021–1022. His grave is still shown at Husaby in Vestergötland.

Kings in the 10th Century.

Establishment of Christianity.

Reign of Olaf Sköttkonung.

Anund, now sole king, early in his reign allied himself with Olaf Haraldsson against Canute of Denmark, who had demanded the restitution of the rights possessed by his father Sweyn in Norway. The allies took advantage of the Danish king's absence to harry his land. On his return an indecisive battle was fought at Helgi Å, and Anund returned to Sweden. Olaf was driven from Norway by the Danes, but returning in 1030 he raised a small army in Sweden and marched through Jämtland to Trondhjem only to meet his death at the battle of Stiklestad. After death he was worshipped in Sweden, especially in Götland. We hear from Adam of Bremen that Anund was young in years but old in wisdom and cunning; he was called Kolbrännea because he had the houses of evildoers burnt. Like Olaf Sköttkonung he caused coins to be struck at Sigtuna, of which a few remain. The moneyers' names are English. The coins of Anund surpass all that were struck during the next two centuries. He appears to have died about 1050, according to Adam of Bremen. He was succeeded by his brother Emund the Old, who had been previously passed over because his mother was unfree, the daughter of a Slav prince and captured in war. This king had become a Christian, but soon quarrelled with Adalhard, archbishop of Bremen, and endeavoured to secure the independence of the Swedish church, which was not obtained for another century. Emund, who was given the name Slemme, had territorial disputes with Denmark in the early part of his reign. These disputes were settled by a rectification of boundaries which assigned Blekinge to Denmark.

King Anund, c. 1022–c. 1050.

Emund the Old, 1050–1060.

With the death of Emund, which took place in 1060, the old family of Swedish kings dies out. The successor of Emund the Old was a king named Steinkel who had married the daughter of his predecessor. He was the son of a certain Ragnvald, perhaps connected with the Vestergötland Ragnvald, of the reign of Olaf Sköttkonung. Steinkel was born in Vestergötland and was warmly attached to the Christian religion. The Adalhard who had quarrelled with Emund the Old now sent a bishop, Adalhard the younger, to Scara. Christianity was by this time firmly established throughout most of Sweden, its chief strength being in Vestergötland. The Uplanders, however, still held out against it, and Adalhard, though he succeeded in destroying the idols in his own district Vestergötland, was unable to persuade Steinkel to destroy the old sanctuary at Upsala. During his reign grants of land in Vermland made by the king to the Norse earl Haakon Ivarsson led to a successful invasion of Götaland by Harold Hardrada of Norway. Steinkel also had disputes with Denmark. On his death in 1066 a civil war broke out in which the leaders were two obscure princes named Eric. Probably the division of feeling between Vestergötland and Upland in the matter of religion was the real cause of this war, but nothing is known of the details, though we hear that both kings as well as the chief men of the land fell in it.

Steinkel, 1060–1066.

A prince called Haakon the Red now appears as king of Sweden and is said to have occupied the throne for thirteen years. In the Vestergötland regnal lists he appears before Steinkel and it is possible that the authority of that king was not regularly acknowledged in the province. In 1081 we find the sons of Steinkel, Inge and Halstan, reigning in Sweden. Inge's attachment to Christianity caused him to be expelled after a short time by his brother-in-law Sweyn or Blotsweyn, so called from his revival of the old sacrifices. Sweyn retained the kingship only for three years. After that interval Inge returned and slew him, and his fall marks the final overthrow of the old religion.

Haakon the Red, 1066–1079?

Halstan, Inge and Blotsweyn.

The interesting account of Upsala preserved by Adam of

Bremen in his *History* (iv. 26) apparently dates from the period immediately preceding these events. He describes the temple as one of great splendour and covered with gilding. In it stood the statues of the three chief deities Thor, Odin and Fricco (by whom he probably means Frey). Every nine years a great festival was held there to which embassies were sent by all the peoples of Sweden. A large number of animals and even men were sacrificed on such occasions. In the neighbourhood of the temple was a grove of peculiar sanctity in which the bodies of the victims were hung up. After the introduction of Christianity the importance of Upsala began steadily to decline, and owing to its intimate associations with the old religion the kings no longer made it their residence.

Temple at Upsala.

AUTHORITIES FOR EARLY HISTORY.—Tacitus, *Germania*, cap. 44; Claudius Ptolemaeus, *Geographica* ii. 11 *ad fin.*; Jordanes, *De origine actibusque Getarum*, cap. 3; Procopius, *De bello gothico*, ii. 15; *Beowulf*, Rimbertus, *Vita S. Ansgarii in monumenta Germaniae historica*, ii. 683–725 (Hanover, 1829); King Alfred's translation of *Orosius* i. 1; Adam of Bremen, *Gesta hammaburgensis ecclesiae pontificum* iii. and iv.; *Ynglinga Saga*, with the poem *Ynglingatal* contained in the *Heimskringla; Olafs Sagan Tryggvasonar* and *Olafs Saga hins Helga*, both contained in *Heimskringla* and in *Fornmanna sögur; Saxo grammaticus, gesta Danorum*; a collection of later Swedish Chronicles contained in *Rerum suecicarum scriptores*, vol. iii. (ed. Annerstedt, Upsala, 1871 and 1876); *Sveriges historia*, vol. i. (Montelius & Hildebrand, Stockholm, 1875–1877); Thomsen, *The Relations between Ancient Russia and Scandinavia and the Origin of the Russian State* (Oxford and London, 1877).
(F. G. M. B.)

Under Blotsweyn's grandson, King Sverker (1134–1155), who permanently amalgamated the Swedes and Goths (each of the two nations supplying the common king alternately for the next hundred years), Sweden began to feel the advantage of a centralized monarchical government. Eric IX. (1150–1160) organized the Swedish Church on the model prevalent elsewhere, and undertook a crusade against the heathen Finlanders, which marks the beginning of Sweden's overseas dominion. Under Charles VII.,[1] the archbishopric of Upsala was founded (1164). But the greatest medieval statesman of Sweden was Earl Birger, who practically ruled the land from 1248 to 1266. To him is attributed the foundation of Stockholm; but he is best known as a legislator, and his wise reforms prepared the way for the abolition of serfdom. The increased dignity which the royal power owed to Earl Birger was still further extended by King Magnus Ladulås (1275–1290). Both these rulers, by the institution of separate and almost independent duchies, attempted to introduce into Sweden a feudal system similar to that already established elsewhere in Europe; but the danger of thus weakening the realm by partition was averted, though not without violent and tragic complications. Finally, in 1319, the severed portions of Sweden were once more reunited. Meanwhile the political development of the state was steadily proceeding. The formation of separate orders, or estates, was promoted by Magnus Ladulås, who extended the privileges of the clergy and founded an hereditary nobility (Ordinance of Alsnö, 1280). In connexion with this institution we now hear of a heavily armed cavalry as the kernel of the national army. The knights too now became distinguishable from the higher nobility. To this period belongs the rise of a prominent burgess class, as the towns now began to acquire charters. At the end of the 13th century, and the beginning of the 14th too, provincial codes of laws appear and the king and his council execute legislative functions.

Organization of the Kingdom.

Separation of the Estates.

Nobles and Burghers.

The first union between Sweden and Norway occurred in 1319, when the three-year-old Magnus, son of the Swedish royal duke Eric and of the Norwegian princess Ingeborg, who had inherited the throne of Norway from his grandfather Haakon V., was in the same year elected king of Sweden (Convention of Oslo). A long minority weakened the royal influence in both countries, and Magnus lost both his kingdoms before his death. The Swedes, irritated by his misrule, superseded him by his nephew, Albert of Mecklenburg (1365). In Sweden, Magnus's partialities and necessities led directly to the rise of a powerful landed aristocracy, and, indirectly, to the growth of popular liberties. Forced by the unruliness of the magnates to lean upon the middle classes, the king summoned (1359) the first Swedish *Riksdag*, on which occasion representatives from the towns were invited to appear along with the nobles and clergy. His successor, Albert, was forced to go a step farther and, in 1371, to take the first coronation oath. In 1388, at the request of the Swedes themselves, Albert was driven out by Margaret, regent of Denmark and Norway; and, at a convention of the representatives of the three Scandinavian kingdoms held at Kalmar (1397), Margaret's great-nephew, Eric of Pomerania, was elected the common king, but the liberties of each of the three realms were expressly reserved and confirmed. The union was to be a personal, not a political union.

First Union with Norway.

Union of Kalmar, 1397.

Neither Margaret herself nor her successors observed the stipulation that in each of the three kingdoms only natives should hold land and high office, and the efforts of Denmark (at that time by far the strongest member of the union) to impose her will on the weaker kingdoms soon produced a rupture, or, rather, a series of semi-ruptures. The Swedes first broke away from it in 1434 under the popular leader Engelbrecht, and after his murder they elected Karl Knutsson Bonde their king under the title of Charles VIII. (1436). In 1441 Charles VIII had to retire in favour of Christopher of Bavaria, who was already king of Denmark and Norway; but, on the death of Christopher (1448), a state of confusion ensued in the course of which Charles VIII. was twice expelled and twice reinstated. Finally, on his death in 1470, the three kingdoms were reunited under Christian I. of Denmark, the prelates and higher nobility of Sweden being favourable to the union, though the great majority of the Swedish people always detested it as a foreign usurpation. The national party was represented by the three great *Riksföreståndare*, or presidents of the realm, of the Sture family (see STURE), who, with brief intervals, from 1470 to 1520 successively defended the independence of Sweden against the Danish kings and kept the national spirit alive. But the presidentship was too casual and anomalous an institution to rally the nations round it permanently, and when the tyranny of Christian II. (*q.v.*) became intolerable the Swedish people elected Gustavus Eriksson Vasa, who as president had already driven out the Danes (see DENMARK: *History*), king of Sweden at Strengnäs (June 6, 1523).

First Breach of the Union, 1436.

Election of Gustavus Vasa, 1523.

The extraordinary difficulties of Gustavus (see GUSTAVUS I.) were directly responsible for the eccentric development, both political and religious, of the new kingdom which his genius created. So precarious was the position of the young king, that he was glad to make allies wherever he could find them. Hence his desire to stand well with the Holy See. Only three months after his accession, he addressed letters to the pope begging him to appoint new bishops "who would defend the rights of the Church without detriment to the Crown." He was especially urgent for the confirmation of his nominee Johannes Magni as primate, in the place of the rebellious archbishop Gustavus Trolle, who as a convicted traitor had been formally deposed by the Riksdag and was actually an outlawed exile. If the pope would confirm the elections of his bishops, Gustavus promised to be an obedient son of the Church. Scarcely had these letters been despatched when the king received a papal bull ordering the immediate reinstatement of Gustavus Trolle. The action of the Curia on this occasion was due to its conviction of the imminent triumph of Christian II. and the instability of Gustavus's position. It was a conviction shared by the rest of Europe; but, none the less, it was another of the many blunders of the Curia at this difficult period. Its immediate effect was the loss of the Swedish Church. Gustavus could not accept as primate an open and

Gustavus I., 1523–1560.

[1] A legendary list of kings gives to this Charles six predecessors of the same name. Subsequent kings of Sweden have always given this Charles the title of Charles VII.

determined traitor like Trolle. He publicly protested, in the sharpest language, that unless Johannes Magni were recognized at Rome as archbishop of Upsala, he was determined, of his own royal authority, henceforward to order the affairs of the Church in his realm to the glory of God and the satisfaction of all Christian men. But the Holy See was immovable, and Gustavus broke definitely with Rome. He began by protecting and promoting the Swedish reformers Olavus and Laurentius Petri, and Laurentius Andreae. The new teaching was allowed to spread, though at first unostentatiously and gradually. A fresh step in the direction of Lutheranism was the translation of the New Testament into Swedish, which was published in 1526. Simultaneously, a systematic attack was made upon the religious houses, beginning with the sequestration of the monastery of Gripsholm in January 1526. But the affair caused such general indignation that Gustavus felt obliged, in May, to offer some justification of his conduct. A few months later there was an open rupture between the king and his own primate, who ultimately was frightened into exile by a sudden accusation of treason. But the other bishops were also against Gustavus, and, irritated by their conscientious opposition, the king abandoned the no longer tenable position of a moderator and came openly forward as an antagonist. In 1526 the Catholic printing-presses were suppressed, and two-thirds of the Church's tithes were appropriated to the payment of the national debt. On the 18th of February 1527 two bishops, the first martyrs of Catholicism in Sweden, were gibbeted at Stockholm after a trial which was a parody of justice. This act of violence, evidently designed to terrorize the Church into submission, was effectual enough, for at the subsequent Riksdag of Vesterås (June, 1527), the bishops durst not even present a protest which they had privately prepared, and the assembly itself was bullied into an absolute submission to the royal will. The result was the Vesterås Recess which transferred all ecclesiastical property to the Crown. By the subsequent Vesterås Ordinance the Swedish Church was absolutely severed from Rome. Nevertheless, the changes so made were mainly administrative. There was no modification of doctrine, for the general resolution that God's Word should be preached plainly and purely was not contrary to the teaching of the ante-Tridentine Church. Even at the synod of Örebro, summoned in February 1529, "for the better regulation of church ceremonies and discipline according to God's Word," there was no formal protest against Rome; and the old ritual was retained for two years longer, though it was to be explained as symbolical. Henceforth the work of the Reformation continued uninterruptedly. In 1531 Laurentius Petri was elected the first Protestant primate of Sweden. Subsequently matters were much complicated by the absolutist tendencies of Gustavus. From 1539 onwards there was a breach between him and his own prelates in consequence of his arbitrary appropriation of the Church's share of the tithes, in direct violation of the Vesterås Recess. Then Gustavus so curtailed the power of the bishops (ordinances of 1539 and 1540) that they had little of the dignity left but the name, and even that he was disposed to abolish, for after 1543 the prelates appointed by him, without any pretence of previous election by the cathedral chapters, were called ordinaries, or superintendents. Finally, at the Riksdag of Vesterås, in 1544, though no definite confession of faith was formulated, a final breach was made with the traditions of the old religion.

Breach with Rome.

Progress of the Reformation.

Recess and Ordinance of Vesteras, 1527.

Thus the Reformation in Sweden was practically the work of one strong man, acting (first from purely political and latterly from purely economical reasons) for the good of the state as he understood it. In this Gustavus acted contrary to the religious instincts of the vast majority of the Swedish nation; for there can be no doubt at all that the Swedes at the beginning of the 16th century were not only still devoted to the old Church, but violently anti-Protestant. This popular Romanism was the greatest of all Gustavus's difficulties, because it tended to alienate the Swedish peasants.

The Peasants.

For the last hundred years the peasants had been a leading factor in the political life of the land; and perhaps in no other contemporary European state could so self-reliant a class of yeomen have been found. Again and again they had defended their own and the national liberties against foreign foes. In the national assemblies, too, their voice had always been powerful, and not infrequently predominant. In a word, they were the sound kernel of the still but partially developed Swedish constitution, the democratic safeguard against the monarchical tendency which was enveloping the rest of Europe. Gustavus's necessities had compelled him to break with the ecclesiastical traditions of Sweden; and they also compelled him, contrary to his masterful disposition, to accept constitutionalism, because without it his footing in his own kingdom would have been insecure. The peasants therefore were his natural allies, but, from the nature of the case, they tended to become his most formidable rivals. They prided themselves on having "set King Gus in the high seat," but they were quite ready to unseat him if his rule was not to their liking, and there were many things with which they were by no means contented. This anomalous state of things was responsible for the half-dozen peasant risings with which Gustavus had to contend from 1525 to 1543. In all these rebellions the religious difficulty figured largely, though the increasing fiscal burdens were undoubtedly grievous and the peasants had their particular grievances besides. The wholesale seizure and degradation of Church property outraged them, and they formally protested against the introduction of "Luthery." They threatened, more than once, to march upon and destroy Stockholm, because the Reformers had made of it "a spiritual Sodom." They insisted on the restoration of the ancient Catholic customs, and would have made neglect of fasting and other sins of omission penal offences. Though he prevailed in the end, Gustavus was obliged to humour the people throughout. And thus, though he was strong enough to maintain what he had established and finish what he had begun, he was not strong enough to tamper seriously with the national liberties or to crush altogether Catholic aspirations. At the time of his death the Riksdag was already a power in the state, and a Catholic reaction in Sweden was by no means an impossibility, if only the Catholics had been able to find capable leaders.

Foreign Policy of Gustavus.

Gustavus's foreign policy at first aimed at little more than self-preservation. Only with the pecuniary assistance of the wealthy merchants of Lübeck had he been able to establish himself originally; and Lübeck, in return, had exploited Sweden, as Spain at a later day was to exploit her American colonies. When, with the aid of Denmark, Gustavus at last freed himself from this greedy incubus (see DENMARK; GUSTAVUS I.; CHRISTIAN III.) by the truce of the 28th of August 1537, Sweden for the first time in her history became the mistress of her own waters. But even so she was but of subordinate importance in Scandinavian politics. The hegemony of Denmark was indisputable, and Gustavus regarded that power with an ever-increasing suspicion which augured ill for peace in the future. The chief cause of dispute was the quartering by the Danish king of the three crowns of Sweden on the Dano-Norwegian shield, which was supposed to indicate a claim of sovereignty. Still more offensive was the attitude of Sweden's eastern neighbour Muscovy, with whom the Swedish king was nervously anxious to stand on good terms. Gustavus attributed to Ivan IV., whose resources he unduly magnified, the design of establishing a universal monarchy round the Baltic.

Expansion of Sweden.

Nevertheless events were already occurring which ultimately compelled Sweden to depart from her neutrality and lay the foundations of an overseas empire. In the last year of Gustavus's life (1560), the ancient military order of the Sword, amalgamated, since 1237, with the more powerful order of the Teutonic Knights, had by the secularization of the latter order into the dukedom of Prussia (1525) become suddenly isolated in the midst of hostile Slavonians. It needed but a jolt to bring down the crazy anachronism, and the jolt came when, in 1558–60, floods of Muscovites poured over the land, threatening the whole province with destruction. In his despair the last master of the order, Gotthard von Kettler, appealed to all his more civilized neighbours to save him, and his dominions were quickly partitioned between Poland, Denmark and Sweden. Sweden's original share of the spoil was Reval, which, driven to extremities, placed itself beneath the protection of the Swedish crown in March 1561. From the moment that Sweden got a firm footing in Esthonia by the acquisition of Reval she was committed to a policy of combat and aggrandisement. To have retreated would have meant the ruin of her Baltic trade, upon which the national prosperity so much depended. Her next-door neighbours, Poland and Russia, were necessarily her competitors; fortunately they were also each other's rivals; obviously her best policy was to counterpoise them. To accomplish this effectually she required to have her hands free, and the composition of her long-outstanding differences with Denmark by the Treaty of Stettin on the 13th of December 1570 (see DENMARK: *History*), which put an end to the Dano-Swedish war of 1563–1570, the chief political event of the reign of Eric XIV. (1560–1568), the eldest son and successor of Gustavus Vasa, was therefore a judicious act on the part of the new king of Sweden, John III. (1568–1592). Equally judicious was the anti-Russian league with Stephen Bathory, king of Poland, concluded in 1578. The war between Russia and Sweden for the possession of Esthonia and Livonia (1571–77) had been uninterruptedly disastrous to the latter, and, in the beginning of 1577, a countless Russian host sat down before Reval, Sweden's last stronghold in those parts. The energetic intervention of Bathory, however, speedily turned the scales in the opposite direction. Six months after his humiliating peace with the Polish monarch, Ivan IV. was glad to conclude a truce with Sweden also on a *uti possidetis* basis at Pliusa (Aug. 5, 1582).

Sweden and Poland.

The amicable relations between Sweden and Poland promised, at first, to be permanent. Sixteen years before his accession to the throne, John III., then duke of Finland, had wedded Catherine Jagiellonica, the sister of Sigismund II., king of Poland (Oct. 4, 1562). Duke Sigismund, the fruit of this union, was brought up by his mother in the Catholic religion, and, on the 19th of August 1587, he was elected king of Poland. Sixteen days later the Articles of Kalmar, signed by John and Sigismund, regulated the future relations between the two countries when, in process of time, Sigismund should succeed his father as king of Sweden. The two kingdoms were to be in perpetual alliance, but each of them was to retain its own laws and customs. Sweden was also to enjoy her religion, subject to such changes as a general council might make; but neither pope nor council was to claim or exercise the right of releasing Sigismund from his obligations to his Swedish subjects. During Sigismund's absence from Sweden that realm was to be ruled by seven Swedes, six elected by the king and one by his uncle Duke Charles of Sudermania, the leader of the Swedish Protestants. No new tax was to be levied in Sweden during the king's absence, but Sweden was never to be administered from Poland. Any necessary alterations in these articles were only to be made with the common consent of the king, Duke Charles, the senate and the gentry of Sweden.

Articles of Kalmar, 1587.

Sweden and the Catholic Reaction.

The endeavours of Swedish statesmen to bind the hands of their future king were due to their fear of the rising flood of the Catholic reaction in Europe. Under Eric XIV. the Reformation in Sweden had proceeded on much the same lines as during the reign of his father, retaining all the old Catholic customs not considered contrary to Scripture. Naturally, after 1544, when the Council of Trent had formally declared the Bible *and* tradition to be equally authoritative sources of all Christian doctrine, the contrast between the old and the new teaching became more obvious; and in many countries a middle party arose which aimed at a compromise by going back to the Church of the Fathers. King John III., the most learned of the Vasas, and somewhat of a theological expert, was largely influenced by these "middle" views. As soon as he had mounted the throne he took measures to bring the Swedish Church back to "the primitive Apostolic Church and the Catholic faith"; and, in 1574, persuaded a synod assembled at Stockholm to adopt certain articles framed by himself on what we should call a High Church basis. In February 1575 a new Church ordinance, approximating still more closely to the patristic Church, was presented to another synod, and accepted thereat, but very unwillingly. In 1576 a new liturgy was issued on the model of the Roman missal, but with considerable modifications. To a modern High Anglican these innovations seem innocent enough, and, despite the opposition of Duke Charles and the ultra-Protestants, they were adopted by the Riksdag of 1577. These measures greatly encouraged the Catholic party in Europe, and John III. was ultimately persuaded to send an embassy to Rome to open negotiations for the reunion of the Swedish Church with the Holy See. But though the Jesuit Antonio Possevino was sent to Stockholm to complete John's "conversion," John would only consent to embrace Catholicism under certain conditions which were never kept, and the only result of all these subterraneous negotiations was to incense the Protestants still more against the new liturgy, the use of which by every congregation in the realm without exception was, nevertheless, decreed by the Riksdag of 1582. At this period Duke Charles and his Protestant friends were clearly outnumbered by the promoters of the *via media*. Nevertheless, immediately after King John's death, a synod summoned to Upsala by Duke Charles rejected the new liturgy and drew up an anti-Catholic confession of faith (March 5, 1593). Holy Scripture and the three primitive creeds were declared to be the true foundations of Christian faith, and the Augsburg Confession was adopted. That Sigismund, now the lawful king of Sweden, should regard the summoning of the synod of Upsala without his previous knowledge and consent as a direct infringement of his prerogative was only natural. On his arrival in Sweden, however, he tried to gain time by provisionally confirming what had been done; but the aggressiveness of the Protestant faction and the persistent usurpations of Duke Charles (the Riksdag of 1595 proclaimed him regent though the king had previously refused him that office) made a civil war inevitable. The battle of Stångåbro (Sept. 25, 1598) decided the struggle in favour of Charles—and Protestantism. Sigismund fled from Sweden, never to return, and on the 19th of March 1600 the Riksdag of Linköping proclaimed the duke king under the title of Charles IX. Sigismund and his posterity were declared to have forfeited the Swedish crown which was to pass to the heirs male of Charles. Not till the 6th of March 1604, however, after Duke John, son of John III., had formally renounced his hereditary right to the throne, did Charles IX. begin to style himself king. At the Riksdag of the same year, the estates committed themselves irrevocably to Protestantism by excluding Catholics from the succession to the throne, and prohibiting them from holding any office or dignity in Sweden. Henceforth, too, every recusant was to be deprived of his estates and banished the realm.

John III. and the Swedish Church.

Civil War. Expulsion of Sigismund.

Proclamation of Charles IX., 1600.

Proscription of Catholics.

Establishment of a Regular Army.

It was in the reign of Charles IX. that Sweden became not only a predominantly Protestant, but also a predominantly military monarchy. This momentous change, which was to give a martial colouring to the whole policy of Sweden for the next hundred and twenty years, dates from a decree of the Riksdag of Linköping establishing, at the urgent suggestion of Charles, a regular army; each district in the country being henceforward liable to provide and maintain a fixed number of infantry and cavalry for the service of the state. The immediate enemy was Poland, now dynastically as well as territorially opposed to Sweden. The struggle took the shape of a contest for the possession of the northern Baltic provinces. Esthonia was recovered by the Swedes in 1600, but their

War with Poland and Russia.

determined efforts (1601–9) to gain a foothold in Livonia were frustrated by the military ability of the grand hetman of Lithuania, Jon Karol Chodkiewicz. In 1608 hostilities were transferred to Russian territory. At the beginning of that year Charles had concluded an alliance with Tsar Basil IV. (*q.v.*) against their common foe, the Polish king; but when, in 1611, Basil was deposed by his own subjects and the whole tsardom seemed to be on the verge of dissolution, Sweden's policy towards Russia changed its character. Hitherto Charles had aimed at supporting the weaker Slavonic power against the stronger; but now that Muscovy seemed about to disappear from among the nations of Europe, Swedish statesmen naturally sought some compensation for the expenses of the war before Poland had had time to absorb everything. A beginning was made by the siege and capture of Kexholm in Russian Finland (March 2, 1611); and, on the 16th of July, Great Novgorod was occupied and a convention concluded with the magistrates of that wealthy city whereby Charles IX.'s second son Philip was to be recognized as tsar, unless, in the meantime, relief came to Great Novgorod from Moscow. But now, when everything depended on a concentration of forces, Charles's imprudent assumption of the title of "King of the Lapps of Nordland," which people properly belonged to the Danish Crown, involved him in another war with Denmark, a war known in Scandinavian history as the war of Kalmar because the Swedish fortress of Kalmar was the chief theatre of hostilities. Thus the Swedish forces were diverted from their real objective and transferred to another field where even victory would have been comparatively unprofitable. But it was disaster, not victory, which Charles IX. reaped from this foolhardy enterprise. Still worse, the war of Kalmar, prudently concluded by Charles's son, Gustavus Adolphus, in the second year of his reign, by the peace of Knäred (Jan. 20, 1613) imposed such onerous pecuniary obligations and such intense suffering upon Sweden as to enkindle into a fire of hatred, which was to burn fiercely for the next two centuries, the long smouldering antagonism between the two sister nations of Scandinavia which dated back to the bloody days of Christian II.

War of Kalmar.

Peace of Knäred, 1613.

The Russian difficulty was more easily and more honourably adjusted. When Great Novgorod submitted provisionally to the suzerainty of Sweden, Swedish statesmen had believed, for a moment, in the creation of a Transbaltic dominion extending from Lake Ilmen northwards to Archangel and eastwards to Vologda. The rallying of the Russian nation round the throne of the new tsar, Michael Romanov, dissipated, once for all, this ambitious dream. By the beginning of 1616, Gustavus had become convinced of the impossibility of partitioning reunited Muscovy, while Muscovy recognized the necessity of buying off the invincible Swedes by some cession of territory. By the Peace of Stolbova (Feb. 27, 1617), the tsar surrendered to the Swedish king the provinces of Kexholm and Ingria, including the fortress of Nöteborg (the modern Schlüsselburg), the key of Finland. Russia, furthermore, renounced all claims upon Esthonia and Livonia, and paid a war indemnity of 20,000 roubles. In return for these concessions, Gustavus restored Great Novgorod and acknowledged Michael Romanov as tsar of Muscovy.

Peace of Stolbova, 1617.

The same period which saw the extension of the Swedish Empire abroad, saw also the peaceful development of the Swedish constitution at home. In this, as in every other matter, Gustavus himself took the initiative. Nominally the Senate still remained the dominant power in the state; but gradually all real authority had been transferred to the crown. The Riksråd speedily lost its ancient character of a grand council representing the semi-feudal landed aristocracy, and became a bureaucracy holding the chief offices of state at the good pleasure of the king. The Riksdag also changed its character at the same time. Whilst in every other European country except England, the ancient popular representation by estates was about to disappear altogether, in Sweden under Gustavus Adolphus it grew into an integral portion of the constitution. The Riksdag ordinance of 1617 first converted a turbulent and haphazard mob of "riksdagmen," huddling together like a flock of sheep "or drunken boors," into a dignified national assembly, meeting and deliberating according to rule and order. One of the nobility (first called the *Landtmarskalk*), or marshal of the Diet, in the Riksdag ordinance of 1526) was now regularly appointed by the king as the spokesman of the *Riddarhus*, or House of Nobles, while the primate generally acted as the *talman* or president of the three lower estates, the clergy, burgesses and peasants, though at a later day each of the three lower estates elected its own *talman*. At the opening of every session, the king submitted to the estates "royal propositions," or bills, upon which each estate proceeded to deliberate in its own separate chamber. The replies of the estates were delivered to the king at a subsequent session in congress. Whenever the estates differed amongst themselves, the king chose whatever opinion seemed best to him. The rights of the Riksdag were secured by the *Konungaförsäkran*, or assurance given by every Swedish king on his accession, guaranteeing the collaboration of the estates in the work of legislation, and they were also to be consulted on all questions of foreign policy. The king possessed the initiative; but the estates had the right of objecting to the measures of the government at the close of each session. It is in Gustavus's reign, too, that we first hear of the *Hemliga Utskott*, or "secret committee" for the transaction of extraordinary affairs, which was elected by the estates themselves. The eleven Riksdags held by Gustavus Adolphus were almost exclusively occupied in finding ways and means for supporting the ever-increasing burdens of the Polish and German wars. And to the honour of the Swedish people be it said that, from first to last, they showed a religious and patriotic zeal which shrank from no sacrifice. It was to this national devotion quite as much as to his own qualities that Gustavus owed his success as an empire-builder.

Rule of Gustavus Adolphus.

Constitutional Changes.

The wars with Denmark and Russia had been almost exclusively Scandinavian wars; the Polish war was of world-wide significance. It was, in the first place, a struggle for the Baltic littoral, and the struggle was intensified by the knowledge that the Polish Vasas denied the right of Gustavus to the Swedish throne. In the eyes of the Swedish king, moreover, the Polish War was a war of religion. Gustavus regarded the Scandinavian kingdoms as the two chief pillars on which the Evangelical religion reposed. Their disunion, he argued, would open a door in the north to the Catholic league and so bring about the destruction of Denmark and Sweden alike. Hence his alliance with Denmark to defend Stralsund in 1628. There is much of unconscious exaggeration in all this. As a matter of fact the Polish republic was no danger whatever to Protestantism. Sigismund's obstinate insistence upon his right to the Swedish crown was the one impediment to the conclusion of a war which the Polish Diet heartily detested and very successfully impeded. Apart from the semi-impotent Polish court, no responsible Pole dreamed of aggrandisement in Sweden. In fact, during the subsequent reign of Wladislaus IV. (1632–1648), the Poles prevented that martial monarch from interfering in the Thirty Years' War on the Catholic side. Gustavus, whose lively imagination was easily excited by religious ardour, enormously magnified clerical influence in Poland and frequently scented dangers where only difficulties existed.

War with Poland.

For eight years (1621–29) the exhausting and expensive Polish war dragged on. By the beginning of 1626 Livonia was conquered and the theatre of hostilities was transferred to the Prussian provinces of Poland (see Gustavus II. Adolphus; Koniecpolski [Stanislaus]). The fertile and easily defensible delta of the Vistula was now occupied and Gustavus treated it as a permanent conquest, making his great minister Axel Oxenstjerna its first governor-general. But this was the limit of the Swedish advance. All Gustavus's further efforts were frustrated by the superior strategy of the Polish grandhetman Koniecpolski, and, in June 1629, the king gladly accepted the lucrative truce of Altmark. By this truce Sweden was, for six years, to retain possession of her Livonian conquests, besides holding Elbing, the Vistula delta, Braunsberg in West, and Pillau and Memel in East Prussia, with the right to levy tolls at Pillau, Memel, Danzig, Labiau and Windau. From these tolls Gustavus derived, in 1629 alone, 500,000 rix-dollars, a sum equivalent to the whole of the extraordinary subsidies granted to him by the Riksdag. Thus Sweden held, for a time, the control of the principal trade routes of the Baltic up to the very confines of the empire; and the increment of revenue resulting from this commanding position was of material assistance to her during the earlier stages of the war in Germany, whither Gustavus transferred his forces in June 1630.

Sweden and the Thirty Years' War.

The motives of Gustavus in plunging into the Thirty Years' War and the details of the struggle as regards Sweden are elsewhere set forth (see GUSTAVUS II.; OXENSTJERNA [AXEL]; BANÉR [JOHAN]; TORSTENSSON [LENNART]). Here the only point to be insisted upon is the extreme precariousness of the Swedish position from first to last—a precariousness due entirely to inadequacy of material resources. In 1632 all Germany lay at the feet of Sweden; two years later a single disaster (Nördlingen) brought her empire to the verge of ruin. For the next seven years the German War as regards Sweden was a struggle for existence. She triumphed in the end, it is true, but it was a triumph due entirely to a lucky accident—the possession, during the crisis, of the greatest statesman and the greatest captain of the age. It was the exploits of Oxenstjerna and Banér which alone enabled Sweden to obtain even what she did obtain at the great Westphalian peace congress in 1648. Her original demands were Silesia (she held most of the fortresses there), Pomerania (which had been in her possession for nearly twenty years), and a war indemnity of 20,000,000 rix-dollars. What she actually got was (1) Upper Pomerania, with the islands of Rügen and Usedom, and a strip of Lower Pomerania on the right side of the Oder, including the towns of Stettin, Garz, Damm and Gollnow, and the isle of Wollin, with the right of succession to the rest of Lower Pomerania in the case of the extinction of the Brandenburg Hohenzollerns; (2) the town of Wismar with the districts of Poel and Neukloster; (3) the secularized bishoprics of Bremen and Verden; and (4) 5,000,000 rix-dollars. These German possessions were to be held as fiefs of the empire; and in respect thereof Sweden was to have a vote in the imperial Diet and to "direct" the Lower Saxon Circle alternately with Brandenburg. France and Sweden, moreover, became joint guarantors of the treaty with the emperor, and were entrusted with the carrying out of its provisions, which was practically effected by the executive congress of Nüremberg in 1650.

International Position of Sweden.

Sweden's reward for the exertions and sacrifices of eighteen years was meagre, almost paltry. Her newly won possessions were both small and scattered, though, on the other hand, she had secured the practical control of the three principal rivers of north Germany—the Oder, the Elbe and the Weser—and reaped the full advantage of the tolls levied on those great commercial arteries. The jealousy of France and the impatience of Queen Christina were the chief causes of the inadequacy of her final recompense. Yet, though the immediate gain was small, she had not dissipated her blood and treasure altogether in vain. Her vigorous intervention had saved the cause of religious liberty in Europe; and this remains, for all time, her greatest political achievement. Henceforth till her collapse, seventy years later, she was the recognized leader of Continental Protestantism. A more questionable benefit was her rapid elevation to the rank of an imperial power, an elevation which imposed the duty of remaining a military monarchy, armed *cap-à-pie* for every possible emergency. Every one recognizes now that the poverty and sparse population of Sweden unfitted her for such a tremendous destiny. But in the middle of the 17th century the incompatibility between her powers and her pretensions was not so obvious. All her neighbours were either decadent or exhausted states; and France, the most powerful of the Western powers, was her firm ally.

Queen Christina, 1644-1654.

For the moment, however, Sweden held the field. Everything depended upon the policy of the next few years. Very careful statesmanship might mean permanent dominion on the Baltic shore, but there was not much margin for blundering. Unfortunately the extravagance of Gustavus Adolphus's two immediate successors, Christina[1] and Charles X., shook the flimsy fabric of his empire to its very base. Christina's extravagance was financial. At the time of her abdication the state was on the verge of bankruptcy, and the financial difficulty had superinduced a serious political agitation. The mass of the Swedish people was penetrated by a justifiable fear that the external, artificial greatness of their country might, in the long run, be purchased with the loss of their civil and political liberties. In a word, the natural equilibrium of Swedish society was seriously threatened by the preponderance of the nobility; and the people at large looked to the new king to redress the balance. A better arbiter between the various estates than Charles X. it would have been difficult to find. It is true that, primarily a soldier, his whole ambition was directed towards military glory; but he was also an unusually sharp-sighted politician. He affected to believe that only by force of arms could Sweden retain the dominion which by force of arms she had won; but he also grasped the fact that there must be no disunion at home if she were to continue powerful abroad. The most pressing question of the day, the so-called *Reduktion*, or restitution of the alienated crown lands, was adjusted provisionally at the Riksdag of 1655. The king proposed that the actual noble holders of crown property should either pay an annual sum of 200,000 rix-dollars, to be allowed for out of any further crown lands subsequently falling in to them, or should surrender a fourth of the expectant property itself to the estimated amount of 600,000 rix-dollars. The nobility attempted to escape taxation as cheaply as possible by stipulating that the 6th of November 1632, the day of Gustavus Adolphus's death, should be the extreme limit of any restrospective action on the part of the crown in regard to alienated crown property, and that the present subsidy should be regarded as "a perpetual ordinance" unalterably to be observed by all future sovereigns—in other words, that there should be no further restitution of alienated crown property. Against this interpretation of the subsidy bill the already over-taxed lower estates protested so energetically that the Diet had to be suspended. Then the king intervened personally; not to quell the commons, as the senate insisted, but to compel the nobility to give way. He proposed that the whole matter should be thoroughly investigated by a special committee before the meeting of the next Riksdag, and that in the meantime a contribution should be levied on all classes proportionately. This equitable arrangement was accepted by the estates forthwith.

Charles X., 1654-1660.

Charles X.'s Wars.

Charles X. had done his best to obviate the effects of the financial extravagance of Christina. It may well be doubted, however, whether his own extravagant desire for military glory was not equally injurious to his country. In three days he had succeeded in persuading the Swedish estates of the lucrative expediency of his unnecessary and immoral attack on Poland (see POLAND: *History*); but when he quitted Stockholm for Warsaw, on the 10th of July 1654, he little imagined that he had embarked on an adventure which was to contribute far more to his glory than to the advantage of his country. How the Polish War expanded into a general European war; how Charles's miraculous audacity again and again ravished favours from Fortune and Nature (*e.g.* the passage of the Belts) when both those great powers combined against him; how, finally, he emerged from all his difficulties triumphant, indeed, but only to die of sheer exhaustion

[1] Christina's reign dates, properly, from 1644 when she attained her majority. From 1632 to 1644 Axel Oxenstjerna was virtually the ruler of Sweden.

in his thirty-eighth year—all this has elsewhere been described (see Charles X., king of Sweden; Czarniecki [Stephen]; Frederick III., king of Denmark). Suffice it to say that, immediately after his death, the regency appointed to govern Sweden during the minority of his only son and successor, Charles XI., a child four years old, hastened to come to terms with Sweden's numerous enemies, which now included Russia, Poland, Brandenburg and Denmark.

Charles XI.

Peace of Oliva, 1660.

The Peace of Oliva (May 3, 1660), made under French mediation, put an end to the long feud with Poland and, at the same time, ended the quarrel between Sweden on the one side, and the emperor and the elector of Brandenburg on the other. By this peace, Sweden's possession of Livonia, and the elector of Brandenburg's sovereignty over east Prussia, were alike confirmed; and the king of Poland renounced all claim to the Swedish crown. As regards Denmark, the Peace of Oliva signified the desertion of her three principal allies, Poland, Brandenburg and the emperor, and thus compelled her to reopen negotiations with Sweden direct. The differences between the two states were finally adjusted by the peace of Copenhagen (May 27, 1660), Denmark ceding the three Scanian provinces to Sweden but receiving back the Norwegian province of Trondhjem and the isle of Bornholm which she had surrendered by the peace of Roskilde two years previously. Denmark was also compelled to recognize, practically, the independence of the dukes of Holstein-Gottorp. The Russian War was terminated by the Peace of Kardis (July 2, 1661), confirmatory of the Peace of Stolbova, whereby the tsar surrendered to Sweden all his Baltic provinces—Ingria, Esthonia and Kexholm.

Sweden as a Great Power.

Thus Sweden emerged from the war not only a military power of the first magnitude, but also one of the largest states of Europe, possessing about twice as much territory as modern Sweden. Her area embraced 16,800 geographical square miles, a mass of land 7000 sq. m. larger than the modern German Empire. Yet the Swedish Empire was rather a geographical expression than a state with natural and national boundaries. Modern Sweden is bounded by the Baltic; during the 17th century the Baltic was merely the bond between her various widely dispersed dominions. All the islands in the Baltic, except the Danish group, belonged to Sweden. The estuaries of all the great German rivers (for the Niemen and Vistula are properly Polish rivers) debouched in Swedish territory, within which also lay two-thirds of Lake Ladoga and one-half of Lake Peipus. Stockholm, the capital, lay in the very centre of the empire, whose second greatest city was Riga, on the other side of the sea. Yet this vast empire contained but half the population of modern Sweden—being only 2,500,000, or about 140 souls to the square mile. Further, Sweden's new boundaries were of the most insecure description, inasmuch as they were anti-ethnographical, parting asunder races which naturally went together, and behind which stood powerful neighbours of the same stock ready, at the first opportunity, to reunite them.

Moreover, the commanding political influence which Sweden had now won was considerably neutralized by her loss of moral prestige. On Charles X.'s accession in 1655, Sweden's neighbours, though suspicious and uneasy, were at least not adversaries, and might have been converted into allies of the new great power who, if she had mulcted them of territory, had, anyhow, compensated them for the loss with the by no means contemptible *douceur* of religious liberty. At Charles X.'s death, five years later, we find Sweden, herself bled to exhaustion point, surrounded by a broad belt of desolated territory and regarded with ineradicable hatred by every adjacent state. To sink in five years from the position of the champion of Protestantism to that of the common enemy of every Protestant power was a degradation not to be compensated by any amount of military glory. Charles's subsequent endeavour, in stress of circumstances, to gain a friend by dividing his Polish conquests with the aspiring elector of Brandenburg was a reversal of his original policy and only resulted in the establishment on the southern confines of Sweden of a new rival almost as dangerous as Denmark, her ancient rival in the west.

Minority of Charles XI.

In 1660, after five years of incessant warfare, Sweden had at length obtained peace and with it the opportunity of organizing and developing her newly won empire. Unfortunately, the regency which was to govern her during the next fifteen years was unequal to the difficulties of a situation which might have taxed the resources of the wisest statesmen. Unity and vigour were scarcely to be expected from a many-headed administration composed of men of mediocre talent whose contrary opinions speedily gave rise to contending factions. There was the high-aristocratic party with a leaning towards martial adventure headed by Magnus de la Gardie (*q.v.*), and the party of peace and economy whose ablest representative was the liberal and energetic Johan Gyllenstjerna (*q.v.*). After a severe struggle, de la Gardie's party prevailed; and its triumph was marked by that general decline of personal and political morality which has given to this regency its unenviable notoriety. Sloth and carelessness speedily invaded every branch of the administration, destroying all discipline and leading to a general neglect of business. Another characteristic of the de la Gardie government was its gross corruption, which made Sweden the obsequious hireling of that foreign power which had the longest purse. This shameful "subsidy policy" dates from the Treaty of Fontainebleau, 1661, by a secret paragraph of which Sweden, in exchange for a considerable sum of money, undertook to support the French candidate on the first vacancy of the Polish throne. The complications ensuing from Louis XIV.'s designs on the Spanish Netherlands led to a bid for the Swedish alliance, both from the French king and his adversaries. After much hesitation on the part of the Swedish government, the anti-French faction prevailed; and in April 1668 Sweden acceded to the Triple Alliance, which finally checkmated the French king by bringing about the Peace of Aix-la-Chapelle. For the next four years Sweden remained true to the principles of the Triple Alliance; but, in 1672, Louis XIV. succeeded in isolating the Dutch republic and regaining his ancient ally, Sweden. By the Treaty of Stockholm (April 14, 1672), Sweden became, for the next ten years, a "mercenarius Galliae," pledging herself, in return for 400,000 crowns per annum in peace and 600,000 in war-time, to attack, with 16,000 men, any German princes who might be disposed to assist Holland. In 1674 Louis XIV. peremptorily called upon Sweden to fulfil her obligations by invading Brandenburg. In the course of May 1675 a Swedish army advanced into the Mark, but on the 18th of June was defeated at Fehrbellin, and hastily retreated to Demmin. The Fehrbellin affair was a mere skirmish, the actual casualties amounting to less than 600 men, but it rudely divested Sweden of her nimbus of invincibility and was the signal for a general attack upon her, known as the Scanian War.

Alliance with France.

The Scanian War.

In the course of the next three years her empire seemed to be crumbling away everywhere. In 1675 Pomerania and the bishopric of Bremen were overrun by the Brandenburgers, Austrians and Danes. In December 1677 the elector of Brandenburg captured Stettin. Stralsund fell on the 15th of October 1678. Greifswald, Sweden's last possession on the Continent, was lost on the 5th of November. A defensive alliance with Sobieski (August 4, 1677) was rendered inoperative by the annihilation of Sweden's sea-power (battle of Öland, June 17, 1676; battle of Fehmarn, June 1677) and the difficulties of the Polish king.

Two accidents at this crisis alone saved Sweden from ruin—the splendid courage of the young king who, resolutely and successfully, kept the Danish invaders at bay (see Charles XI., king of Sweden), and the diplomatic activity of Louis XIV. In March 1677 a peace congress began its sessions at Nijmwegen; and in the beginning of April 1678 the French king dictated the terms of a general pacification. One of his chief conditions was the complete restitution of Sweden. A strong Sweden was necessary to the accomplishment of his plans. He suggested, however, that Sweden should rid herself of her enemies by making some "small cession" to them. This Charles XI. refused to do, whereupon Louis took it upon himself to conclude peace on Sweden's account without consulting the wishes of the Swedish king. By this Treaty of Nijmwegen (Feb. 7) and of St Germain (June 29, 1679) Sweden virtually received full restitution of her German territory. On the 2nd of September by the Peace of Fontainebleau (confirmed by the subsequent Peace of Lund, Oct. 4, 1679), Denmark was also forced to retrocede her conquests. It is certain that Sweden herself could never have extorted such favourable terms, yet "the insufferable tutelage" of France on this occasion inspired Charles XI. with a personal dislike of the mighty ruler of France and contributed to reverse the traditional diplomacy of Sweden by giving it a strong anti-French bias (see CHARLES XI.; OXENSTJERNA, BENEDICT).

Treaty of Nijmwegen, 1679.

The remainder of the reign of Charles XI. is remarkable for a revolution which converted the government of Sweden into a semi-absolute monarchy. The king emerged from the war convinced that if Sweden were to retain her position as a great power she must radically reform her whole economical system, and, above all, circumscribe the predominant and mischievous influence of an aristocracy which thought far more of its privileges than of its public duties. He felt that he could now draw upon the confidence and liberality of the lower orders to an unlimited extent, and he proceeded to do so. The Riksdag which assembled in Stockholm in October 1680 begins a new era of Swedish history. On the motion of the Estate of Peasants, which had a long memory for aristocratic abuses, the question of the recovery of the alienated crown lands was brought before the Riksdag, and, despite the stubborn opposition of the magnates, a resolution of the Diet directed that all countships, baronies, domains, manors and other estates producing an annual rent of more than £70 per annum should revert to the Crown. The same Riksdag decided that the king was not bound by any particular constitution, but only by law and the statutes. Nay, they added that he was not even obliged to consult the council of state, but was to be regarded as a sovereign lord, responsible to God alone for his actions, and requiring no intermediary between himself and his people. The council thereupon acquiesced in its own humiliation by meekly accepting a royal brief changing its official title from *Riksråd* (council of state) to *Kungligaråd* (royal council)—a visible sign that the senators were no longer the king's colleagues but his servants.

Charles XI. and the Swedish Constitution.

Thus Sweden, as well as Denmark, had become an absolute monarchy, but with this important difference, that the right of the Swedish people, in parliament assembled, to be consulted on all important matters was recognized and acted upon. The Riksdag, completely overshadowed by the throne, was during the reign of Charles XI. to do little more than register the royal decrees; but nevertheless it continued to exist as an essential part of the machinery of government. Moreover, this transfer of authority was a voluntary act. The people, knowing the king to be their best friend, trusted him implicitly and cooperated with him cheerfully. The Riksdag of 1682 proposed a fresh Reduktion, and declared that the whole question of how far the king was empowered by the law of the land to bestow fiefs, or, in case of urgent national distress, take them back again, was exclusively his majesty's affair. In other words, it made the king the disposer of his subjects' temporal property. Presently this new principle of autocracy was extended to the king's legislative authority also, for, on the 9th of December 1682, all four estates, by virtue of a common declaration, not only confirmed him in the possession of the legislative powers enjoyed by his predecessors, but even conceded to him the right of interpreting and amending the common law.

The recovery of the alienated crown lands occupied Charles XI. for the rest of his life. It was conducted by a commission which was ultimately converted into a permanent department of state. It acted on the principle that the titles of all private landed estate might be called in question, inasmuch as at some time or other it must have belonged to the Crown; and the burden of proof of ownership was held not to lie with the Crown which made the claim, but with the actual owner of the property. The amount of revenue accruing to the Crown from the whole Reduktion it is impossible to estimate even approximately; but by these means, combined with the most careful management and the most rigid economy, Charles XI. contrived to reduce the national debt from £2,567,000 to £700,000.

These operations represent only a part of Charles XI.'s gigantic activity. Here we have only space sufficient to glance at his reorganization of the national armaments. Charles XI. re-established on a broader basis the *indelningsverk* introduced by Charles IX.—a system of military tenure whereby the national forces were bound to the soil. Thus there was the *rusthåll* tenure, under which the tenants, instead of paying rent, were obliged to equip and maintain a cavalry soldier and horse, while the *knekthållarer* supplied duly equipped foot soldiers. These *indelning* soldiers were provided with holdings on which they lived in times of peace. Formerly, ordinary conscription had existed alongside this *indelning*, or distribution system; but it had proved inadequate as well as highly unpopular; and, in 1682, Charles XI. came to an agreement with the peasantry whereby an extended *indelning* system was to be susbstituted for general conscription. The navy, of even more importance to Sweden if she were to maintain the dominion of the Baltic, was entirely remodelled; and, the recent war having demonstrated the unsuitability of Stockholm as a naval station, the construction of a new arsenal on a gigantic scale was simultaneously begun at Karlskrona. After a seventeen years' struggle against all manner of financial difficulties, the twofold enterprise was completed. At the death of Charles XI. Sweden could boast of a fleet of forty-three three-deckers (manned by 11,000 men and armed with 2648 guns) and one of the finest arsenals in the world.

Reorganization of Armaments.

Charles XI. had carefully provided against the contingency of his successor's minority; and the five regents appointed by him, if not great statesmen, were at least practical politicans who had not been trained in his austere school in vain. At home the Reduktion was cautiously pursued, while abroad the successful conclusion of the great peace congress at Ryswick was justly regarded as a signal triumph of Sweden's pacific diplomacy (see OXENSTJERNA FAMILY). The young king was full of promise, and had he been permitted gradually to gain experience and develop his naturally great talents beneath the guidance of his guardians, as his father had intended, all might have been well for Sweden. Unfortunately, the sudden, noiseless revolution of the 6th of November 1697, which made Charles XII. absolute master of his country's fate in his fifteenth year (see CHARLES XII.), and the league of Denmark, Saxony and Russia, formed two years later to partition Sweden (see PATKUL, JOHANN REINHOLD; PETER THE GREAT; CHARLES XII.), precipitated Sweden into a sea of troubles in which she was finally submerged.

Charles XII., 1697-1718.

From the very beginning of the Great Northern War Sweden suffered from the inability of Charles XII. to view the situation from anything but a purely personal point of view. His determination to avenge himself on enemies overpowered every other consideration. Again and again during these eighteen years of warfare it was in his power to dictate an advantageous peace. After the dissipation of the first coalition against him by the peace of Travendal (Aug. 18, 1700) and the victory of Narva (Nov. 20, 1700), the Swedish chancellor, Benedict Oxenstjerna, rightly regarded the universal bidding for the favour of Sweden by France and the maritime powers, then on the eve of the War of the Spanish Succession, as a golden opportunity of "ending this present lean war and making his majesty the arbiter of Europe." But Charles, intent on dethroning Augustus of Poland, held haughtily aloof. Subsequently in 1701 he rejected a personal appeal from William III. to conclude peace on his

Great Northern War.

own terms. Five years later (Sept. 24, 1706) he did, indeed, conclude the Polish War by the peace of Altranstädt, but as this treaty brought no advantage to Sweden, not even compensation for the expenses of six years of warfare, it was politically condemnable. Moreover, two of Sweden's Baltic provinces, Esthonia and Ingria, had been seized by the tsar, and a third, Livonia, had been well-nigh ruined. Yet even now Charles, by a stroke of the pen, could have recovered nearly everything he had lost. In 1707 Peter was ready to retrocede everything except St Petersburg and the line of the Neva, and again Charles preferred risking the whole to saving the greater part of his Baltic possessions (for details see CHARLES XII.; PETER THE GREAT). When at last, after the catastrophe of Poltava (June 1709) and the flight into Turkey, he condescended to use diplomatic methods, it was solely to prolong, not to terminate, the war. Even now he could have made honourable terms with his numerous enemies. The resources of Sweden were still very far from being exhausted, and, during 1710 and 1711, the gallant Magnus Stenbock (*q.v.*) upheld her military supremacy in the north. But all the efforts of the Swedish government were wrecked on the determination of Charles XII. to surrender nothing. Thus he rejected advantageous offers of mediation and alliance made to him, during 1712, by the maritime powers and by Prussia; and, in 1714, he scouted the friendly overtures of Louis XIV. and the emperor, so that when peace was finally concluded between France and the Empire, at the congress of Baden, Swedish affairs were, by common consent, left out of consideration. When, on the 14th of September 1714, he suddenly returned to his dominions, Stralsund and Wismar were all that remained to him of his continental possessions; while by the end of 1715 Sweden, now fast approaching the last stage of exhaustion, was at open war with England, Hanover, Russia, Prussia, Saxony and Denmark, who had formed a coalition to partition her continental territory between them. Nevertheless, at this the eleventh hour of her opportunities, Sweden might still have saved something from the wreck of her empire if Charles had behaved like a reasonable being (see CHARLES XII.; PETER THE GREAT; GÖRTZ, GEORG HEINRICH VON; OSTERMAN, ANDREI); but he would only consent to play off Russia against England, and his sudden death before Fredrikshald (Dec. 11, 1718) left Sweden practically at the end of her resources and at the mercy of her enemies. At the beginning of 1719 pacific overtures were made to England, Hanover, Prussia and Denmark. By the treaties of Stockholm (Feb. 20, 1719, and Feb. 1, 1720) Hanover obtained the bishoprics of Bremen and Verden for herself and Stettin for her confederate Prussia. By the treaty of Frederiksborg or Copenhagen (July 3, 1720) peace was also signed between Denmark and Sweden, Denmark retroceding Rügen, Further Pomerania as far as the Peene, and Wismar to Sweden, in exchange for an indemnity of 600,000 rix-dollars, while Sweden relinquished her exemption from the Sound tolls and her protectorate over Holstein-Gottorp. The prospect of coercing Russia by means of the British fleet had alone induced Sweden to consent to such sacrifices; but when the last demands of England and her allies had been complied with, Sweden was left to come to terms as best she could with the tsar. Negotiations were reopened with Russia at Nystad, in May 1720, but peace was not concluded till the 30th of August 1721, and then only under the direst pressure. By the peace of Nystad Sweden ceded to Russia Ingria and Esthonia, Livonia, the Finnish province of Kexholm and the fortress of Viborg. Finland west of Viborg and north of Kexholm was restored to Sweden. She also received an indemnity of two millions of thalers and a solemn undertaking of non-interference in her domestic affairs.

Treaties of Stockholm and Frederiksborg, 1719 and 1720.

Peace of Nystad, 1721. Loss of the Baltic Provinces.

It was not the least of Sweden's misfortunes after the Great Northern War that the new constitution, which was to compensate her for all her past sacrifices, should contain within it the elements of many of her future calamities. Early in 1720 Charles XII.'s sister, Ulrica Leonora, who had been elected queen of Sweden immediately after his death, was permitted to abdicate in favour of her husband the prince of Hesse, who was elected king under the title of Frederick I.; and Sweden was, at the same time, converted into the most limited of monarchies. All power was vested in the people as represented by the Riksdag, consisting, as before, of four distinct estates, nobles, priests, burgesses and peasants, sitting and deliberating apart. The conflicting interests and mutual jealousies of these four independent assemblies made the work of legislation exceptionally difficult. No measure could now become law till it had obtained the assent of three at least of the four estates; but this provision, which seems to have been designed to protect the lower orders against the nobility, produced evils far greater than those which it professed to cure. Thus, measures might be passed by a bare majority in three estates, when a real and substantial majority of all four estates in congress might be actually against it. Or, again, a dominant action in any three of the estates might enact laws highly detrimental to the interests of the remaining estate—a danger the more to be apprehended as in no other country in Europe were class distinctions so sharply defined as in Sweden.

Frederick I., 1720-1751. The Limited Monarchy.

Each estate was ruled by its *talman*, or speaker, who was now elected at the beginning of each Diet, but the archbishop was, *ex officio*, the *talman* of the clergy. The *landtmarskalk*, or speaker of the House of Nobles, presided when the estates met in congress, and also, by virtue of his office, in the *hemliga utskott*, or secret committee. This famous body, which consisted of 50 nobles, 25 priests, 25 burgesses, and, very exceptionally, 25 peasants, possessed during the session of the Riksdag not only the supreme executive but also the surpeme judicial and legislative functions. It prepared all bills for the Riksdag, created and deposed all ministries, controlled the foreign policy of the nation, and claimed and often exercised the right of superseding the ordinary courts of justice. During the parliamentary recess, however, the executive remained in the hands of the *rad*, or senate, which was responsible to the Riksdag alone.

Constitution of the Estates.

It will be obvious that there was no room in this republican constitution for a constitutional monarch in the modern sense of the word. The crowned puppet who possessed a casting vote in the *råd*, of which he was the nominal president, and who was allowed to create peers once in his life (at his coronation), was rather a state decoration than a sovereignty.

At first this cumbrous and complicated instrument of government worked tolerably well under the firm but cautious control of the chancellor, Count Arvid Beernhard Horn (*q.v.*). In his anxiety to avoid embroiling his country abroad, Horn reversed the traditional policy of Sweden by keeping France at a distance and drawing near to Great Britain, for whose liberal institutions he professed the highest admiration. Thus a twenty years' war was succeeded by a twenty years' peace, during which the nation recovered so rapidly from its wounds that it began to forget them. A new race of politicians was springing up. Since 1719, when the influence of the few great territorial families had been merged in a multitude of needy gentlemen, the first estate had become the nursery and afterwards the stronghold of an opposition at once noble and democratic which found its natural leaders in such men as Count Carl Gyllenborg and Count Carl Gustaf Tessin (*q.v.*). These men and their followers were never weary of ridiculing the timid caution of the aged statesman who sacrificed everything to perpetuate an inglorious peace and derisively nicknamed his adherents "Night-caps" (a term subsequently softened into "Caps"), themselves adopting the sobriquet "Hats," from the three-cornered hat worn by officers and gentlemen, which was considered happily to hit off the manly self-assertion of the opposition. These epithets instantly caught the public fancy and had already become party badges when the estates met in 1738. This Riksdag was to mark another turning-point in Swedish

Political Parties. Hats and Caps.

history. The Hats carried everything before them; and the aged Horn was finally compelled to retire from a scene where, for three and thirty years, he had played a leading part.

The policy of the Hats was a return to the traditional alliance between France and Sweden. When Sweden descended to her natural position as a second-rate power the French alliance became too costly a luxury. Horn had clearly perceived this; and his cautious neutrality was therefore the soundest statesmanship. But the politicians who had ousted Horn thought differently. To them prosperity without glory was a worthless possession. They aimed at restoring Sweden to her former position as a great power. France, naturally, hailed with satisfaction the rise of a faction which was content to be her armour-bearer in the north; and the golden streams which flowed from Versailles to Stockholm during the next two generations were the political life-blood of the Hat party.

French Alliance.

The first blunder of the Hats was the hasty and ill-advised war with Russia. The European complications consequent upon the almost simultaneous deaths of the emperor Charles VI. and Anne, empress of Russia, seemed to favour their adventurous schemes; and, despite the frantic protests of the Caps, a project for the invasion of Russian Finland was rushed through the premature Riksdag of 1740. On the 20th of July 1741 war was formally declared against Russia; a month later the Diet was dissolved and the Hat *landtmarskalk* set off to Finland to take command of the army. The first blow was not struck till six months after the declaration of war; and it was struck by the enemy, who routed the Swedes at Villmanstrand and captured that frontier fortress. Nothing else was done on either side for six months more; and then the Swedish generals made a "tacit truce" with the Russians through the mediation of the French ambassador at St Petersburg. By the time that the "tacit truce" had come to an end the Swedish forces were so demoralized that the mere rumour of a hostile attack made them retire panic-stricken to Helsingfors; and before the end of the year all Finland was in the hands of the Russians. The fleet, disabled by an epidemic, was, throughout the war, little more than a floating hospital.

War with Russia, 1741.

To face the Riksdag with such a war as this upon their consciences was a trial from which the Hats naturally shrank; but, to do them justice, they showed themselves better parliamentary than military strategists. A motion for an inquiry into the conduct of the war was skilfully evaded by obtaining precedence for the succession question (Queen Ulrica Leonora had lately died childless and King Frederick was old); and negotiations were thus opened with the new Russian empress, Elizabeth, who agreed to restore the greater part of Finland if her cousin, Adolphus Frederick of Holstein, were elected successor to the Swedish crown. The Hats eagerly caught at the opportunity of recovering the grand duchy and their own prestige along with it. By the peace of Åbo (May 7, 1743) the terms of the empress were accepted; and only that small part of Finland which lay beyond the Kymmene was retained by Russia.

Peace of Åbo, 1743.

In March 1751 old King Frederick died. His slender prerogatives had gradually dwindled down to vanishing point. Adolphus Frederick (*q.v.*) would have given even less trouble than his predecessor but for the ambitious promptings of his masterful consort Louisa Ulrica, Frederick the Great's sister, and the tyranny of the estates, who seemed bent upon driving the meekest of princes into rebellion. An attempted monarchical revolution, planned by the queen and a few devoted young nobles in 1756, was easily and remorselessly crushed; and, though the unhappy king did not, as he anticipated, share the fate of Charles Stuart, he was humiliated as never monarch was humiliated before.

Adolphus Frederick II., 1751-1771.

The same years which beheld this great domestic triumph of the Hats saw also the utter collapse of their foreign "system." At the instigation of France they plunged recklessly into the Seven Years' War; and the result was ruinous. The French subsidies, which might have sufficed for a six weeks' demonstration (it was generally assumed that the king of Prussia would give little trouble to a European coalition), proved quite inadequate; and, after five unsuccessful campaigns, the unhappy Hats were glad to make peace and ignominiously withdraw from a little war which had cost the country 40,000 men and £2,500,000. When the Riksdag met in 1760, the indignation against the Hat leaders was so violent that an impeachment seemed inevitable; but once more the superiority of their parliamentary tactics prevailed, and when, after a session of twenty months, the Riksdag was brought to a close by the mutual consent of both the exhausted factions, the Hat government was bolstered up for another four years. But the day of reckoning could not be postponed for ever; and when the estates met in 1765 it brought the Caps into power at last. Their leader, Ture Rudbeck, was elected marshal of the Diet over Frederick Axel von Fersen (*q.v.*), the Hat candidate, by a large majority; and, out of the hundred seats in the secret committee, the Hats succeeded in getting only ten.

The Seven Years' War.

The Caps struck at once at the weak point of their opponents by ordering a budget report to be made; and it was speedily found that the whole financial system of the Hats had been based upon reckless improvidence and wilful misrepresentation, and that the only fruit of their long rule was an enormous addition to the national debt and a depreciation of the note circulation to one-third of its face value. This revelation led to an all-round retrenchment, carried into effect with a drastic thoroughness which has earned for this parliament the name of the "Reduktion Riksdag." The Caps succeeded in transferring £250,000 from the pockets of the rich to the empty exchequer, reducing the national debt by £575,179, and establishing some sort of equilibrium between revenue and expenditure. They also introduced a few useful reforms, the most remarkable of which was the liberty of the press. But their most important political act was to throw their lot definitely in with Russia, so as to counterpoise the influence of France. Sweden was not then as now quite outside the European Concert. Alghough no longer a great power, she still had many of the responsibilities of a great power; and if the Swedish alliance had considerably depreciated in value, it was still a marketable commodity. Sweden's peculiar geographical position made her virtually invulnerable for six months out of the twelve, her Pomeranian possessions afforded her an easy ingress into the very heart of the moribund empire, while her Finnish frontier was not many leagues from the Russian capital.

Rule of the Caps.

Russian Alliance.

A watchful neutrality, not venturing much beyond defensive alliances and commercial treaties with the maritime powers, was therefore Sweden's safest policy, and this the older Caps had always followed out. But when the Hats became the armour-bearers of France in the north, a protector strong enough to counteract French influence became the cardinal exigency of their opponents, the younger Caps, who now flung themselves into the arms of Russia, overlooking the fact that even a pacific union with Russia was more to be feared than a martial alliance with France. For France was too distant to be dangerous. She sought an ally in Sweden and it was her endeavour to make that ally as strong as possible. But it was as a future prey, not as a possible ally, that Russia regarded her ancient rival in the north. In the treaty which partitioned Poland there was a secret clause which engaged the contracting powers to uphold the existing Swedish constitution as the swiftest means of subverting Swedish independence; and an alliance with the credulous Caps, "the Patriots" as they were called at St Petersburg, guaranteeing their constitution, was the corollary to this secret understanding. Thus, while the French alliance of the warlike Hats had destroyed the prestige of Sweden, the Russian alliance of the peaceful Caps threatened to destroy her very existence.

Fortunately, the domination of the Caps was not for long. The general distress occasioned by their drastic reforms had found expression in swarms of pamphlets which bit and stung the Cap government, under the protection of the new press laws. The senate retaliated by an order in council (which the king refused to sign) declaring that all complaints against the measures of the last Riksdag should be punished with fine and imprisonment. The king, at the suggestion of the crown prince (see GUSTAVUS III.), thereupon urged the senate to summon an extraordinary Riksdag as the speediest method of relieving the national distress, and, on their refusing to comply with his wishes, abdicated. From the 15th of December to the 21st of December 1768 Sweden was without a regular government. Then the Cap senate gave way and the estates were convoked for the 19th of April 1769.

On the eve of the contest there was a general assembly of the Hats at the French embassy, where the Comte de Modène furnished them with 6,000,000 livres, but not till they had signed in his presence an undertaking to reform the constitution in a monarchical sense. Still more energetic on the other side, the Russian minister, Ivan Osterman, became the treasurer as well as the counsellor of the Caps, and scattered the largesse of the Russian empress with a lavish hand; and so lost to all feeling of patriotism were the Caps that they openly threatened all who ventured to vote against them with the Muscovite vengeance, and fixed Norrköping, instead of Stockholm, as the place of meeting for the Riksdag as being more accessible to the Russian fleet. But it soon became evident that the Caps were playing a losing game; and, when the Riksdag met at Norrköping on the 19th of April, they found themselves in a minority in all four estates. In the contest for the marshalate of the Diet the leaders of the two parties were again pitted against each other, when the verdict of the last Riksdag was exactly reversed, Fersen defeating Rudbeck by 234, though Russia spent no less a sum than £11,500 to secure the election of the latter.

Defeat of the Caps.

The Caps had short shrift, and the joint note which the Russian, Prussian and Danish ministers presented to the estates protesting, in menacing terms, against any "reprisals" on the part of the triumphant faction, only hastened the fall of the government. The Cap senate resigned *en masse* to escape impeachment, and an exclusively Hat ministry took its place. On the 1st of June the Reaction Riksdag, as it was generally called, removed to the capital; and it was now that the French ambassador and the crown prince Gustavus called upon the new senators to redeem their promise as to a reform of the constitution which they had made before the elections. But when, at the fag-end of the session, they half-heartedly brought the matter forward, the Riksdag suddenly seemed to be stricken with paralysis. Impediments multiplied at every step; the cry was raised: "The constitution is in danger"; and on the 30th of January 1770 the Reaction Riksdag, after a barren ten months' session, rose amidst chaotic confusion without accomplishing anything.

The Reaction Riksdag.

Adolphus Frederick died on the 12th of February 1771. The elections held on the demise of the Crown resulted in a partial victory for the Caps, especially among the lower orders; but in the estate of the peasants their majority was merely nominal, while the mass of the nobility was dead against them. Nothing could be done, however, till the arrival of the new king (then at Paris), and every one felt that with Gustavus III. an entirely incalculable factor had entered into Swedish politics. Unknown to the party leaders, he had already renewed the Swedish alliance with France and had received solemn assurances of assistance from Louis XV. in case he succeeded in re-establishing monarchical rule in Sweden. France undertook, moreover, to pay the outstanding subsidies to Sweden, amounting to one and a half millions of livres annually, beginning from January 1772; and Vergennes, one of the great names of French diplomacy, was to be sent to circumvent the designs of Russia at Stockholm as he had previously circumvented them at Constantinople. Immediately after his return to Stockholm, Gustavus endeavoured to reconcile the jarring factions by inducing the leaders to form a composition committee to adjust their differences. In thus mediating he was sincere enough, but all his pacific efforts were frustrated by their jealousy of him and of each other. Still worse, the factions now intrenched still further on the prerogative. The new coronation oath contained three revolutionary clauses. The first aimed at making abdications in the future impossible by binding the king to reign uninterruptedly. The second obliged him to abide, not by the decision of all the estates together, as heretofore, but by that of the majority only, with the view of enabling the actually dominant lower estates (in which was a large Cap majority) to rule without, and even in spite of, the nobility. The third clause required him, in all cases of preferment, to be guided not "principally," as heretofore, but "solely" by merit, thus striking at the very root of aristocratic privilege. It was clear that the ancient strife of Hats and Caps had become merged in a conflict of classes; the situation was still further complicated by the ominous fact that the non-noble majority was also the Russian faction.

Gustavus III., 1771-1792.

All through 1771 the estates were wrangling over the clauses of the coronation oath. A second attempt of the king to mediate between them foundered on the suspicions of the estate of burgesses; and, on the 24th of February 1772, the nobility yielded from sheer weariness. The non-noble Cap majority now proceeded to attack the senate, the last stronghold of the Hats, and, on the 25th of April, succeeded in ousting their opponents. It was now, for the first time, that Gustavus, reduced to the condition of a *roi fainéant*, began seriously to consider the possibility of a revolution; of its necessity there could be no doubt. Under the sway of the now dominant faction, Sweden, already the vassal, could not fail speedily to become the victim of Russia. She was on the point of being absorbed in that Northern System, the invention of the Russian minister of foreign affairs, Nikita Panin (*q.v.*), which that patient statesman had made it the ambition of his life to realize. Only a swift and sudden *coup d'état* could save the independence of a country isolated from the rest of Europe by a hostile league. The details of the famous revolution of the 19th of August 1772 are elsewhere set forth (see GUSTAVUS III.; TOLL, JOHAN KRISTOFFER; SPRENGTPORTEN, JAKOB MAGNUS). Here we can only dwell upon its political importance and consequences. The new constitution of the 20th of August 1772, which Gustavus imposed upon the terrified estates at the bayonet's point, converted a weak and disunited republic into a strong but limited monarchy, in which the balance of power inclined, on the whole, to the side of the monarch. The estates could only assemble when summoned by him; he could dismiss them whenever he thought fit; and their deliberations were to be confined exclusively to the propositions which he might think fit to lay before them. But these very extensive powers were subjected to many important checks. Thus, without the previous consent of the estates, no new law could be imposed, no old law abolished, no offensive war undertaken, no extraordinary war subsidy levied. The estates alone could tax themselves; they had the absolute control of the Bank of Sweden, and the inalienable right of controlling the national expenditure. Thus the parliament held the purse; and this seemed a sufficient guarantee both of its independence and its frequent convention. The senate, not the Riksdag, was the chief loser by the change; and, inasmuch as henceforth the senators were appointed by the king, and were to be responsible to him alone, a senate in opposition to the Crown was barely conceivable.

Monarchial Coup d'état of 1772.

Abroad the Swedish revolution made a great sensation. Catherine II. of Russia saw in it the triumph of her arch-enemy France, with the prolongation of the costly Turkish War as its immediate result. But the absence of troops on the Finnish border, and the bad condition of the frontier fortresses, constrained the empress to listen to Gustavus's pacific assurances, and stay her hand. She took the precaution, however, of concluding a fresh secret alliance with Denmark, in which the Swedish revolution was significantly described as "an act of violence" constituting a *casus foederis*, and justifying both powers in seizing the first favourable opportunity for intervention to restore the Swedish constitution of 1720.

In Sweden itself the change was, at first, most popular. But Gustavus's first Riksdag, that of 1778, opened the eyes of the deputies to the fact that their political supremacy had departed. The king was now their sovereign lord; and, for all his courtesy and gentleness, the jealousy with which he guarded and the vigour with which he enforced the prerogative plainly showed that he meant to remain so. But it was not till after eight years more had elapsed that actual trouble began. The Riksdag of 1778 had been obsequious; the Riksdag of 1786 was mutinous. It rejected nearly all the royal measures outright, or so modified them that Gustavus himself withdrew them. When he dismissed the estates, the speech from the throne held out no prospect of their speedy revocation.

Nevertheless, within three years, the king was obliged to summon another Riksdag, which met at Stockholm on the 26th of January 1789. His attempt in the interval to rule without a parliament had been disastrous. It was only by a breach of his own constitution that he had been able to declare war against Russia (April 1788); the conspiracy of Anjala (July) had paralysed all military operations at the very opening of the campaign; and the sudden invasion of his western provinces by the Danes, almost simultaneously (September), seemed to bring him to the verge of ruin. But the contrast, at this crisis, between his self-sacrificing patriotism and the treachery of the Russophil aristocracy was so striking that, when the Riksdag assembled, Gustavus found that the three lower estates were ultra-royalist, and with their aid he succeeded, not without running great risks (see GUSTAVUS III.; NORDIN, GUSTAF; WALLQVIST, OLAF), in crushing the opposition of the nobility by a second *coup d'état* (Feb. 16, 1789), and passing the famous Act of Union and Security which gave the king an absolutely free hand as regards foreign affairs and the command of the army, and made further treason impossible. For this the nobility never forgave him. It was impossible, indeed, to resist openly so highly gifted and so popular a sovereign; it was only by the despicable expedient of assassination that the last great monarch of Sweden was finally removed, to the infinite detriment of his country.

The Act of Union and Security, 1789.

The ensuing period was a melancholy one. The aristocratic classes loudly complained that the young king, Gustavus IV., still a minor, was being brought up among crypto-Jacobins; while the middle classes, deprived of the stimulating leadership of the anti-aristocratic "Prince Charming," and becoming more and more inoculated with French political ideas, drifted into an antagonism not merely to hereditary nobility, but to hereditary monarchy likewise. Everything was vacillating and uncertain; and the general instability was reflected even in foreign affairs, now that the master-hand of Gustavus III. was withdrawn. The renewed efforts of Catherine II. to interfere in Sweden's domestic affairs were, indeed, vigorously repulsed, but without tact or discretion, so that the good understanding between the two countries was seriously impaired, especially when the proclivities of Gustaf Reuterholm (*q.v.*), who then virtually ruled Sweden, induced him to adopt what was generally considered an indecently friendly attitude towards the government at Paris. Despite the execution of Louis XVI. (Jan. 21, 1793), Sweden, in the hope of obtaining considerable subsidies, recognized the new French republic; and secret negotiations for contracting an alliance were actually begun in May of the same year, till the menacing protests of Catherine, supported as they were by all the other European powers, finally induced Sweden to suspend them.

Gustavus IV., 1792–1809.

Sweden and Revolutionary France.

The negotiations with the French Jacobins exacerbated the hatred which the Gustavians already felt for the Jacobin councillors of the duke-regent (see CHARLES XIII., king of Sweden). Smarting beneath their grievances and seriously believing that not only the young king's crown but his very life was in danger, they formed a conspiracy, the soul of which was Gustaf Mauritz Armfelt (*q.v.*), to overthrow the government, with the aid of a Russian fleet, supported by a rising of the Dalecarlians. The conspiracy was discovered and vigorously suppressed.

The one bright side of this gloomy and sordid period was the *rapprochement* between the Scandinavian kingdoms during the revolutionary wars. Thus, on the 27th of March 1794, a neutrality compact was formed between Denmark and Sweden; and their united squadrons patrolled the North Sea to protect their merchantmen from the British cruisers. This approximation between the two governments was happily followed by friendly feelings between the two nations, under the pressure of a common danger. Presently Reuterholm renewed his coquetry with the French republic, which was officially recognized by the Swedish government on the 23rd of April 1795. In return, Sweden received a subsidy of £56,000; and a treaty between the two powers was signed on the 14th of September 1795. On the other hand, an attempt to regain the friendship of Russia, which had broken off diplomatic relations with Sweden, was frustrated by the refusal of the king to accept the bride, the grand duchess Alexandra, Catherine II.'s granddaughter, whom Reuterholm had provided for him. This was Reuterholm's last official act. On the 1st of November 1796, in accordance with the will of his father, Gustavus IV., now in his eighteenth year, took the government into his own hands.

Alliance with Denmark.

The government of Gustavus IV. (*q.v.*) was almost a pure autocracy. At his very first Riksdag, held at Norrköping in March 1800, the nobility were compelled, at last, to ratify Gustavus III.'s detested Act of Union and Security, which hitherto they had steadily refused to do. Shortly after this Riksdag rose, a notable change took place in Sweden's foreign policy. In December 1800 Denmark Sweden and Russia acceded to a second Armed Neutrality of the North, directed against Great Britain; and the arsenal of Karlskrona, in all probability, was only saved from the fate of Copenhagen by the assassination of the emperor Paul, which was followed by another change of system in the north. Hitherto Sweden had kept aloof from continental complications; but the arrest and execution of the duc d'Enghien in 1804 inspired Gustavus IV. with such a hatred of Napoleon that when a general coalition was formed against the French emperor he was one of the first to join it (Dec. 3, 1804), pledging himself to send an army corps to co-operate with the English and Russians in driving the enemy out of Holland and Hanover. But his senseless quarrel with Frederick William III. of Prussia detained him in Pomerania; and when at last (December 1805) he led his 6000 men towards the Elbe district the third coalition had already been dissipated by the victories of Ulm and Austerlitz. In 1806 a rupture between Sweden and Prussia was only prevented by Napoleon's assault upon the latter power. After Jena Napoleon attempted to win over Sweden, but Gustavus rejected every overture. The result was the total loss of Pomerania, and the Swedish army itself was only saved from destruction by the ingenuity of J. K. Toll (*q.v.*).

Gustavus IV. joins the European Coalition, 1804.

At Tilsit the emperor Alexander I. had undertaken to compel "Russia's geographical enemy," as Napoleon designated Sweden, to accede to the newly established Continental System. Gustavus IV. naturally rejected all the proposals of Alexander to close the Baltic against the English; but took no measures to defend Finland against Russia, though, during the autumn of 1807, it was notorious that the tsar was preparing to attack the grand duchy. On the 21st of February 1808 a Russian army crossed the Finnish border without any previous declaration of war. On the 2nd of April the king ordered a general levy of 30,000 men; but while two army corps, under Armfelt and Toll, together with a British contingent of 10,000 men under Moore, were stationed in Scania and on the Norwegian border in anticipation of an attack from Denmark, which, at the instigation of Napoleon, had simultaneously declared war against Sweden, the little Finnish army was left altogether unsupported. The conquest of Finland, after

Russian Conquest of Finland, 1808.

an heroic struggle against overwhelming odds, is elsewhere recorded (see FINLAND: *History*). Its immediate consequence in Sweden proper was the deposition of Gustavus IV. (March 13, 1809), who was clearly incapable of governing.

Deposition of Gustavus IV., 1809.

The nobility took advantage of this opportunity to pay off old scores against Gustavus III. by excluding not only his unhappy son but also that son's whole family from the succession—an act of injustice which has never been adequately defended. But indeed the whole of this intermediate period is full of dark subterranean plots and counterplots, still inexplicable, as, for instance, the hideous Fersen murder (June 20, 1810) (see FERSEN, HANS AXEL VON) evidently intended to terrorize the Gustavians, whose loyalty to the ancient dynasty was notorious. As early as the 5th of June 1809 the duke regent was proclaimed king, under the title of Charles XIII. (*q.v.*), after accepting the new liberal constitution, which was ratified by the Riksdag the same day.

Charles XIII., 1809–1819.

The new king was, at best, a useful stopgap, in no way likely to interfere with the liberal revolution which had placed him on the throne. Peace was what the exhausted nation now required; and negotiations had already been opened at Fredrikshamn. But the Russian demands were too humiliating, and the war was resumed. But the defeats of Sävarsbruk and Ratan (Aug. 19, 1809) broke the spirit of the Swedish army; and peace was obtained by the sacrifice of Finland, the Åland islands, "the fore-posts of Stockholm," as Napoleon rightly described them, and Vesterbotten as far as the rivers Torneå and Muonio (treaty of Fredrikshamn, Sept. 17, 1809).

The succession to the throne, for Charles XIII. was both infirm and childless, was settled, after the mysterious death (May 28, 1810) of the first elected candidate, Prince Charles Augustus of Augustenburg, by the selection of the French marshal, Bernadotte (see CHARLES XIV., king of Sweden), who was adopted by Charles XIII. and received the homage of the estates on the 5th of November 1810.

Bernadotte chosen as Crown Prince.

The new crown prince was very soon the most popular and the most powerful man in Sweden. The infirmity of the old king, and the dissensions in the council of state, placed the government and especially the control of foreign affairs almost entirely in his hands; and he boldly adopted a policy which was antagonistic indeed to the wishes and hopes of the old school of Swedish statesmen, but, perhaps, the best adapted to the circumstances. Finland he at once gave up for lost. He knew that Russia would never voluntarily relinquish the grand duchy, while Sweden could not hope to retain it permanently, even if she reconquered it. But the acquisition of Norway might make up for the loss of Finland; and Bernadotte, now known as the crown prince Charles John, argued that it might be an easy matter to persuade the anti-Napoleonic powers to punish Denmark for her loyalty to France by wresting Norway from her. Napoleon he rightly distrusted, though at first he was obliged to submit to the emperor's dictation. Thus on the 13th of November 1810, the Swedish government was forced to declare war against Great Britain, though the British government was privately informed at the same time that Sweden was not a free agent and that the war would be a mere demonstration. But the pressure of Napoleon became more and more intolerable, culminating in the occupation of Pomerania by French troops in 1812. The Swedish government thereupon concluded a secret convention with Russia (treaty of Petersburg, April 5, 1812), undertaking to send 30,000 men to operate against Napoleon in Germany in return for a promise from Alexander guaranteeing to Sweden the possession of Norway. Too late Napoleon endeavoured to outbid Alexander by offering to Sweden Finland, all Pomerania and Mecklenburg, in return for Sweden's active co-operation against Russia.

Influence and Policy of Bernadotte.

The Orebro Riksdag (April–August 1812), remarkable besides for its partial repudiation of Sweden's national debt and its reactionary press laws, introduced general conscription into Sweden, and thereby enabled the crown prince to carry out his ambitious policy. In May 1812 he mediated a peace between Russia and Turkey, so as to enable Russia to use all her forces against France (peace of Bucharest); and on the 18th of July, at Örebro, peace was also concluded between Great Britain on one side and Russia and Sweden on the other. These two treaties were, in effect, the corner-stones of a fresh coalition against Napoleon, and were confirmed on the outbreak of the Franco-Russian War by a conference between Alexander and Charles John at Åbo on the 30th of August 1812, when the tsar undertook to place an army corps of 35,000 men at the disposal of the Swedish crown prince for the conquest of Norway.

The treaty of Åbo, and indeed the whole of Charles John's foreign policy in 1812, provoked violent and justifiable criticism among the better class of politicians in Sweden. The immorality of indemnifying Sweden at the expense of a weaker friendly power was obvious; and, while Finland was now definitively sacrificed, Norway had still to be won. Moreover, Great Britain and Russia very properly insisted that Charles John's first duty was to the anti-Napoleonic coalition, the former power vigorously objecting to the expenditure of her subsidies on the nefarious Norwegian adventure before the common enemy had been crushed. Only on his very ungracious compliance did Great Britian also promise to countenance the union of Norway and Sweden (treaty of Stockholm, March 3, 1813); and, on the 23rd of April, Russia gave her guarantee to the same effect. The Swedish crown prince rendered several important services to the allies during the campaign of 1813 (see CHARLES XIV., king of Sweden); but, after Leipzig, he went his own way, determined at all hazards to cripple Denmark and secure Norway.

How this "job" was managed contrary to the dearest wishes of the Norwegians themselves, and how, finally (Nov. 14, 1814), Norway as a free and independent kingdom was united to Sweden under a common king, is elsewhere described (see DENMARK; NORWAY; CHARLES XIV., king of Sweden; CHRISTIAN VIII., king of Denmark).

Union with Norway.

Charles XIII. died on the 5th of February 1818, and was succeeded by Bernadotte under the title of Charles XIV. John. The new king devoted himself to the promotion of the material development of the country, the Göta canal absorbing the greater portion of the twenty-four millions of dalers voted for the purpose. The external debt of Sweden was gradually extinguished, the internal debt considerably reduced, and the budget showed an average annual surplus of 700,000 dalers. With returning prosperity the necessity for internal reform became urgent in Sweden. The antiquated Riksdag, where the privileged estates predominated, while the cultivated middle class was practically unrepresented, had become an insuperable obstacle to all free development; but, though the Riksdag of 1840 itself raised the question, the king and the aristocracy refused to entertain it. Yet the reign of Charles XIV. was, on the whole, most beneficial to Sweden; and, if there was much just cause for complaint, his great services to his adopted country were generally acknowledged. Abroad he maintained a policy of peace based mainly on a good understanding with Russia.

Charles XIV., 1818–1844.

Charles XIV.'s son and successor King Oscar I. was much more liberally inclined. Shortly after his accession (March 4, 1844) he laid several projects of reform before the Riksdag; but the estates would do little more than abolish the obsolete marriage and inheritance laws and a few commercial monopolies. As the financial situation necessitated a large increase of taxation, there was much popular discontent, which culminated in riots in the streets of Stockholm (March 1848). Yet, when fresh proposals for parliamentary reform were laid before the Riksdag in 1849, they were again rejected by three out of the four estates. As regards foreign politics, Oscar I. was strongly anti-German. On the outbreak of the Dano-Prussian War of 1848–49, Sweden sympathized warmly with Denmark. Hundreds of Swedish volunteers hastened to Schleswig-Holstein. The Riksdag voted 2,000,000 dalers for additional armaments. It was Sweden, too, who mediated the truce of Malmö (Aug. 26, 1848), which

Oscar I., 1844–1859.

helped Denmark out of her difficulties. During the Crimean War Sweden remained neutral, although public opinion was decidedly anti-Russian, and sundry politicians regarded the conjuncture as favourable for regaining Finland.

Charles XV., 1859–1872.

Oscar I. was succeeded (July 8, 1859) by his son, Charles XV. (*q.v.*), who had already acted as regent during his father's illnesses. He succeeded, with the invaluable assistance of the minister of justice, Baron Louis Gerhard de Geer (*q.v.*), in at last accomplishing the much-needed reform of the constitution. The way had been prepared in 1860 by a sweeping measure of municipal reform; and, in January 1863, the government brought in a reform bill by the terms of which the Riksdag was henceforth to consist of two chambers, the Upper House being a sort of aristocratic senate, while the members of the Lower House were to be elected triennially by popular suffrage. The new constitution was accepted by all four estates in 1865 and promulgated on the 22nd of January 1866. On the 1st of September 1866, the first elections under the new system were held; and on the 19th of January 1867, the new Riksdag met for the first time. With this one great reform Charles XV. had to be content; in all other directions he was hampered, more or less, by his own creation. The Riksdag refused to sanction his favourite project of a reform of the Swedish army on the Prussian model, for which he laboured all his life, partly from motives of economy, partly from an apprehension of the king's martial tendencies. In 1864 Charles XV. had endeavoured to form an anti-Prussian league with Denmark; and after the defeat of Denmark he projected a Scandinavian union, in order, with the help of France, to oppose Prussian predominance in the north—a policy which naturally collapsed with the overthrow of the French Empire in 1870. He died on the 18th of September 1872, and was succeeded by his brother, the duke of Gothland, who reigned as Oscar II. (R. N. B.)

Constitutional Reform, 1866.

Oscar II., 1872–1907.

The economic condition of Sweden, owing to the progress in material prosperity which had taken place in the country as the result of the Franco-German War, was at the accession of Oscar II. to the throne on the 18th of September 1872 fairly satisfactory. Politically, however, the outlook was not so favourable. In their results, the reforms inaugurated during the preceding reign did not answer expectations. Within three years of the introduction of the new electoral laws De Geer's ministry had forfeited much of its former popularity, and had been forced to resign. In the vital matter of national defence no common understanding had been arrived at, and during the conflicts which had raged round this question, the two chambers had come into frequent collision and paralysed the action of the government. The peasant proprietors, who, under the name of the "Landtmanna" party,[1] formed a compact majority in the Second Chamber, pursued a consistent policy of class interests in the matter of the taxes and burdens that had, as they urged, so long oppressed the Swedish peasantry; and consequently when a bill was introduced for superseding the old system of army organization by general compulsory service, they demanded as a condition of its acceptance that the military burdens should be more evenly distributed in the country, and that the taxes, which they regarded as a burden under which they had wrongfully groaned for centuries, should be abolished. In these circumstances, the "Landtmanna" party in the Riksdag, who desired the lightening of the military burden, joined those who desired the abolition of landlordism, and formed a compact and predominant majority in the Second Chamber, while the burgher and Liberal parties were reduced to an impotent "intelligence" minority. This majority in the Lower Chamber was at once attacked by another compact majority in the Upper, who on their side maintained that the hated land taxes were only a kind of rent-charge on land, were incidental to it and in no way weighed upon the owners, and, moreover, that its abolition would be quite unwarrantable, as it was one of the surest sources of revenue to the state. On the other hand, the First Chamber refused to listen to any abolition of the old military system, so long as the defence of the country had not been placed upon a secure basis by the adoption of general compulsory military service. The government stood midway between these conflicting majorities in the chambers, without support in either.

[1] The Swedish "Landtmanna" party was formed in 1867. It consisted mostly of the larger and smaller peasant proprietors, who at the time of the old "Standers Riksdag" were always opposed to the nobility and the clergy. The object of the party was to bring about a fusion between the representatives of the large landed proprietors and the regular peasant proprietors, to support the interests of landed proprietors in general against those of the town representatives, and to resist Crown interference in the administration of local affairs.

The Party Compromise of 1874.

Such was the state of affairs when Oscar II., surrounded by his late brother's advisers, began his reign. One of his first cares was to increase the strength of his navy, but in consequence of the continued antagonism of the political parties, he was unable to effect much. In the first Riksdag, however, the so-called "compromise," which afterwards played such an important part in Swedish political life, came into existence. It originated in the small "Scania" party in the Upper House, and was devised to establish a *modus vivendi* between the conflicting parties, *i.e.* the champions of national defence and those who demanded a lightening of the burdens of taxation. The king himself perceived in the compromise a means of solving the conflicting questions, and warmly approved it. He persuaded his ministers to constitute a special inquiry into the proposed abolition of land taxes, and in the address with which he opened the Riksdag of 1875 laid particular stress upon the necessity of giving attention to the settlement of these two burning questions, and in 1880 again came forward with a new proposal for increasing the number of years of service with the militia. This motion having been rejected, De Geer resigned, and was succeeded by Count Arvid Posse. The new prime minister endeavoured to solve the question of defence in accordance with the views of the "Landtmanna" party. Three parliamentary committees had prepared schemes for a remission of the land taxes, for a new system of taxation, for a reorganization of the army based on a *stammtrupp* (regular army), by the enlistment of hired soldiers, and for naval reforms. In this last connexion the most suitable types of vessels for coast defence as for offence were determined upon. But Count Posse, deserted by his own party over the army bill, resigned, and was succeeded on the 16th of May 1884 by Oscar Themptauder, who had been minister of finance in the previous cabinet. The new premier succeeded in persuading the Riksdag to pass a bill increasing the period of service with the colours in the army to six years and that in the militia to forty-two days, and as a set-off a remission of 30% on the land taxes.

Protectionist Movement.

Influenced by the economic reaction which took place in 1879 in consequence of the state of affairs in Germany, where Prince Bismarck had introduced the protectionist system, a protectionist party had been formed, which tried to gain adherents in the Riksdag. It is true that in the Riksdag of 1882 the commercial treaty with France was renewed, but since 1885 the protectionist party was prepared to begin the combat, and a duty on corn, which had been proposed in the Riksdag of the same year, was rejected by only a slight majority. During the period of the unusually low price of corn of 1886, which greatly affected the Swedish farmers, protection gained ground to such an extent that its final triumph was considered as certain within a short time. During the Riksdag of the same year, however, the premier, Themptauder, emphatically declared himself against the protectionist party, and while the parties in the Second Chamber were equal in number, the proposed tax on corn was rejected in the First Chamber. In the Riksdag of 1887 there was a majority for protection in the Second Chamber, and in the first the majority against the tax was so small that the tax on corn would have triumphed in a combined meeting of the two chambers. The government, availing itself of its formal right not to dissolve the chamber in which it had the support of a majority, therefore dissolved only the Second Chamber (March 1887).

The new Riksdag assembled in May with a free trade majority in the Second Chamber, but nothing in connexion with the great question of customs was settled. In the meantime, the powerful majority in the Second Chamber split into two groups—the new "Landtmanna" party, which approved protection in the interests of agricultural classes; and a somewhat smaller group, the old "Landtmanna" party, which favoured free trade.

The victory of the free traders was not, however, destined to be of long duration, as the protectionists obtained a majority in both chambers in the next Riksdag (1888). To the First Chamber protectionists were almost exclusively elected, and in the Second all the twenty-two members for Stockholm were disqualified, owing to one of their number not having paid his taxes a few years previously, which prevented his being eligible. Instead, then, of twenty-two free traders representing the majority of the Stockholm electors, twenty-two protectionists, representing the minority, were elected, and Stockholm was thus represented in the Riksdag by the choice of a minority in the capital. This singular way of electing members for the principal city in the kingdom could not fail further to irritate the parties. One result of the Stockholm election came at a convenient time for the Themptauder ministry. The financial affairs of the country were found to be in a most unsatisfactory state. In spite of reduced expenses, a highly estimated revenue, and the contemplated raising of taxes, there was a deficit, for the payment or discharge of which the government would be obliged to demand supplementary supplies. The Themptauder ministry resigned. The king retained, however, for a time several members of the ministry, but it was difficult to find a premier who would be able, during the transition from one system to another, to command sufficient authority to control the parties. At last Baron Gillis Bildt, who, while Swedish ambassador in Berlin, had witnessed the introduction by Prince Bismarck of the agrarian protectionist system in Germany, accepted the premiership, and it was under his auspices that the two chambers imposed a series of duties on necessaries of life. The new taxes, together with an increase of the excise duty on spirits, soon brought a surplus into the state coffers. At a council of state (Oct. 12, 1888) the king declared his wishes as to the way in which this surplus should be used. He desired that it should be applied to a fund for insurance and old age pensions for workmen and old people, to the lightening of the municipal taxes by state contributions to the schools and workhouses, to the abolition of the land taxes and of the obligation of keeping a horse and man for military service, and, lastly, to the improvement of the shipping trade; but the Riksdag decided to devote it to other objects, such as the payment of the deficit in the budget, the building of railways and augmentation of their material, as well as to improvements in the defences of the country.

Baron Bildt resigned as soon as the new system seemed settled, making room for Baron Gustav Akerhjelm. The latter, however, also soon resigned, and was succeeded on the 10th of July 1891 by Erik Gustav Boström, a landed proprietor. The protectionist system gained in favour on the expiry of the commercial treaty with France in 1892, as it could now be extended to articles of industry. The elections of 1890, when the metropolis returned free traders and Liberals to the Second Chamber, certainly effected a change in the latter, as the representatives of the towns and the old "Landtmanna" party joined issue and established a free-trade majority in the chamber, but in the combined meetings of the two chambers the compact protectionist majority in the First Chamber turned the scale. The customs duties were, however, altered several times in accordance with market prices and ruling circumstances. Thus in 1892, when the import duty on unground corn was reduced from 2s. 10d. to 1s. 5d., and that on ground corn from 4s. 9d. to 2s. 10d. for 100 kilogrammes, the same duties were also retained for the following year. They were also retained for 1894 at the request of the government, which desired to keep faith with their promise that while the new organization of the army was going on no increase of duties on the necessaries of life should take place. This measure caused much dissatisfaction, and gave rise to a strong agrarian movement, in consequence of which the government, in the beginning of 1895, before the assembling of the Riksdag, made use of its right of raising the two duties on corn just referred to, 3s. 7d. and 7s. 2d., which were afterwards somewhat reduced as far as seed corn for sowing purposes was concerned.

National Defence.

The question of customs duties now settled, that of national defence was taken up afresh, and in the following year the government produced a complete scheme for the abolition of the land tax in the course of ten years, in exchange for a compensation of ninety days' drill for those liable to military service, proposed to retain the old military system of the country and to strengthen the defences of Norrland, and the government bill for a reorganization of the army was accepted by the Riksdag in an extraordinary session. But it was soon perceived that the new plan was unsatisfactory and required recasting, upon which the minister of war, Baron Rappe, resigned, and was succeeded by Colonel von Crustebjorn, who immediately set to work to prepare a complete reorganization of the army, with an increase of the time of active service on the lines of general compulsory service. The Riksdag of 1900, in addition to grants for the fortifications at Boden, in the province of Norrbotten, on the Russian border, and other military objects, voted a considerable grant for an experimental mobilization, which fully exposed the defects and faults of the old system. In the Riksdag of 1901 E. G. Boström resigned, and was succeeded by Admiral F. W. von Otter, who introduced a new bill for the army reorganization, the most important item of which was the increase of the period of training to 365 days. The cost in connexion with the new scheme was expected to amount to 22 millions of kronor. The Riksdag, however, did not accept the new plan in its full extent. The time of drilling was reduced to 240 days for the infantry, to 300 days for the navy, while for the cavalry and artillery the time fixed was 365 days. The plan, thus modified, was then accepted by the government.

Franchise Reform.

After the elections in 1890, the alliance already mentioned between the old "Landtmanna" party and the representatives of the towns had the result that the Liberals in the Second Chamber, to whom the representatives of the towns mostly belonged, were now in a position to decide the policy which the two united parties should follow. In order to prevent this, it was proposed to readjust the number of the members of the Riksdag. The question was only settled in 1894, when a bill was passed fixing the number of the members of the Riksdag in the First Chamber at 150, and in the Second at 230, of which 150 should represent the country districts and 80 the towns. The question of protection being now considered settled, there was no longer any reason for the continued separation of the two "Landtmanna" parties, who at the beginning of the Riksdag of 1895 joined issue and became once more a compact majority in the Second Chamber, as they had been up to the Riksdag of May 1887. The influence of the country representatives was thus re-established in the Second Chamber, but now the demands for the extension of the franchise came more and more to the front, and the premier, Boström, at last felt bound to do something to meet these demands. He accordingly introduced in the Riksdag of 1896 a very moderate bill for the extension of the franchise, which was, nevertheless, rejected by both chambers, all similar proposals by private members meeting the same fate. When at last the bill for the reorganization of the army, together with a considerably increased taxation, was accepted by the Riksdag of 1901, it was generally acknowledged that, in return for the increased taxation, it would only be just to extend the right of taking part in the political life and the legislative work of the country to those of the population who hitherto had been excluded from it. The government eventually laid a proposal for the extension of the franchise before the Riksdag of 1902, the chief feature of which was that the elector should be twenty-five years of age, and that married men over forty years should be entitled to two votes. The Riksdag, however, finally agreed to a proposal by Bishop Billing, a member of the First Chamber, that an address should be presented to the king asking for a full inquiry into the question of extending the franchise for the election of members to the Second Chamber.

In 1897 the Riksdag had received among its members the first socialistic representative in the person of R. H. Brauting, the leader of the Swedish Social Democrats. The Socialists, who had formerly confined their activity to questions affecting the working classes and their wages, took, however, in 1902 an active part in the agitation for the extension of the franchise. Processions of many thousands of workmen were organized, in Stockholm and in other towns of the kingdom, just before the Riksdag began the discussion on the above-mentioned bill of the government, and when the bill was introduced in the chambers a general and well-organized strike took place and continued during the three days the debate on the bill lasted. As this strike was of an exclusively political kind, and was intended to put pressure on the chambers, it was generally disapproved, and failed in its object. The prime minister, Admiral von Otter, resigned shortly after the end of the session, and was succeeded by Boström, the ex-premier, who at the request of the king again assumed office.

Labour Movement.

The relations with Norway during King Oscar's reign had great influence on political life in Sweden, and more than once it seemed as if the union between the two countries was on the point of being wrecked. The dissensions chiefly had their origin in the demand by Norway for separate consuls and foreign ministers, to which reference is made under NORWAY. At last, after vain negotiations and discussions, the Swedish government in 1895 gave notice to Norway that the commercial treaty which till then had existed between the two countries and would lapse in July 1897 would, according to a decision in the Riksdag, cease, and as Norway at the time had raised the customs duties, a considerable diminution in the exports of Sweden to Norway took place. The Swedish minister of foreign affairs, Count Lewenhaupt, who was considered as too friendly disposed towards the Norwegians, resigned, and was replaced by Count Ludvig Douglas, who represented the opinion of the majority in the First Chamber. When, however, the Norwegian Storthing, for the third time, passed a bill for a national or "pure" flag, which King Oscar eventually sanctioned, Count Douglas resigned in his turn and was succeeded by the Swedish minister at Berlin, Lagerheim, who managed to pilot the questions of the union into more quiet waters. He succeeded all the better as the new elections to the Riksdag of 1900 showed clearly that the Swedish people was not inclined to follow the ultra-conservative or so-called "patriotic" party, which resulted in the resignation of the two leaders of that party, Professor Oscar Alin and Count Marschal Patrick Reutersvard as members of the First Chamber. On the other hand, ex-Professor E. Carlson, of the High School of Gothenburg, succeeded in forming a party of Liberals and Radicals to the number of about 90 members, who, besides being in favour of the extension of the franchise, advocated the full equality of Norway with Sweden in the management of foreign affairs. (O. H. D.)

Relations with Norway.

The state of quietude which for some time prevailed with regard to the relations with Norway was not, however, to be of long duration. The question of separate consuls for Norway soon came up again. In 1902 the Swedish government proposed that negotiations in this matter should be opened with the Norwegian government, and that a joint committee, consisting of representatives from both countries, should be appointed to consider the question of a separate consular service without in any way interfering with the existing administration of the diplomatic affairs of the two countries. The result of the negotiations was published in a so-called "communiqué," dated the 24th of March 1903, in which, among other things, it was proposed that the relations of the separate consuls to the joint ministry of foreign affairs and the embassies should be arranged by identical laws, which could not be altered or repealed without the consent of the governments of the two countries. The proposal for these identical laws, which the Norwegian government in May 1904 submitted, did not meet with the approval of the Swedish government. The latter in their reply proposed that the Swedish foreign minister should have such control over the Norwegian consuls as to prevent the latter from exceeding their authority.[1] This proposal, however, the Norwegian government found unacceptable, and explained that, if such control were insisted upon, all further negotiations would be purposeless. They maintained that the Swedish demands were incompatible with the sovereignty of Norway, as the foreign minister was a Swede and the proposed Norwegian consular service, as a Norwegian institution, could not be placed under a foreign authority. A new proposal by the Swedish government was likewise rejected, and in February 1905 the Norwegians broke off the negotiations. Notwithstanding this an agreement did not appear to be out of the question. All efforts to solve the consular question by itself had failed, but it was considered that an attempt might be made to establish separate consuls in combination with a joint administration of diplomatic affairs on a full unionistic basis. Crown Prince Gustaf, who during the illness of King Oscar was appointed regent, took the initiative of renewing the negotiations between the two countries, and on the 5th of April in a combined Swedish and Norwegian council of state made a proposal for a reform both of the administration of diplomatic affairs and of the consular service on the basis of full equality between the two kingdoms, with the express reservation, however, of a joint foreign minister—Swedish or Norwegian—as a condition for the existence of the union. This proposal was approved of by the Swedish Riksdag on the 3rd of May 1905. In order that no obstacles should be placed in the way for renewed negotiations, Mr Boström, the prime minister, resigned and was succeeded by Mr Ramstedt. The proposed negotiations were not, however, renewed.

The Dissolution of the Union with Norway.

On the 23rd of May the Norwegian Storthing passed the government's proposal for the establishment of separate Norwegian consuls, and as King Oscar, who again had resumed the reins of government, made use of his constitutional right to veto the bill, the Norwegian ministry tendered their resignation. The king, however, declared he could not now accept their resignation, whereupon the ministry at a sitting of the Norwegian Storthing on the 7th of June placed their resignation in its hands. The Storthing thereupon unanimously adopted a resolution stating that, as the king had declared himself unable to form a government, the constitutional royal power "ceased to be operative," whereupon the ministers were requested, until further instructions, to exercise the power vested in the king, and as King Oscar thus had ceased to act as "the king of Norway," the union with Sweden was in consequence dissolved.

In Sweden, where they were least of all prepared for the turn things had taken, the action of the Storthing created the greatest surprise and resentment. The king solemnly protested against what had taken place and summoned an extraordinary session of the Riksdag for the 20th of June to consider what measures should be taken with regard to the question of the union, which had arisen suddenly through the revolt of the Norwegians on the 7th of June. The Riksdag declared that it was not opposed to negotiations being entered upon regarding the conditions for the dissolution of the union if the Norwegian Storthing, after a new election, made a proposal for the repeal of the Act of Union between the two countries, or, if a proposal to this effect was made by Norway after the Norwegian people, through a plebiscite, had declared in favour of the dissolution of the union. The Riksdag further resolved that 100 million kroner (about £555,000) should be held in readiness and be available as the Riksdag might decide. On the resignation of the Ramstedt ministry Mr Lundeberg formed a coalition ministry consisting of members of the various parties in the Riksdag, after which the Riksdag was prorogued on the 3rd of August.

The First Extraordinary Riksdag, 1905.

After the plebiscite in Norway on the 13th of August had decided in favour of the dissolution of the union and after the Storthing had requested the Swedish government to co-operate with it for the repeal of the Act of Union, a conference of delegates from both countries was convened at Karlstad on the 31st of August. On the 23rd

The Karlstad Convention.

[1] For further details see NORWAY: *History*.

of September the delegates came to an agreement, the principal points of which were: that such disputes between the two countries which could not be settled by direct diplomatic negotiations, and which did not affect the vital interests of either country, should be referred to the permanent court of arbitration at the Hague, that on either side of the southern frontier a neutral zone of about fifteen kilometres width should be established, and that within eight months the fortifications within the Norwegian part of the zone should be destroyed. Other clauses dealt with the rights of the Laplanders to graze their reindeer alternatively in either country, and with the question of transport of goods across the frontier by rail or other means of communication, so that the traffic should not be hampered by any import or export prohibitions or otherwise.

The Second Extra-ordinary Riksdag.

From the 2nd to the 19th of October the extraordinary Riksdag was again assembled, and eventually approved of the arrangement come to by the delegates at Karlstad with regard to the dissolution of the union as well as the government proposal for the repeal of the Act of Union and the recognition of Norway as an independent state. An alteration in the Swedish flag was also decided upon, by which the mark of union was to be replaced by an azure-blue square. An offer from the Norwegian Storthing to elect a prince of the Swedish royal house as king in Norway was declined by King Oscar, who now on behalf of himself and his successors renounced the right to the Norwegian crown. Mr Lundeberg, who had accepted office only to settle the question of the dissolution of the union, now resigned and was succeeded by a Liberal government with Mr Karl Staaff as prime minister.

The Franchise Question.

The question of the extension of the franchise, which was a burning one, was to be the principal measure of the Staaff government. It brought in a bill for manhood suffrage at elections for the Second Chamber, together with single member constituencies and election on the absolute majority principle. The bill was passed by the Second Chamber on the 15th of May 1906, by 134 to 94 votes, but it was rejected by the First Chamber by 126 to 18. The latter chamber instead passed a bill for manhood suffrage at elections for the Second Chamber, on the condition that the elections for both chambers should take place on the basis of proportional representation. Both chambers thereupon decided to ask the opinion of the king with regard to the simultaneous extension of the franchise to women at elections for the Second Chamber. The government bill having, however, been passed by the Second Chamber, the prime minister proposed to the king that the Riksdag should be dissolved and new elections for the Second Chamber take place in order to hear the opinion of the country, but as the king did not approve of this Mr Staaff and his government resigned.

A Conservative government was then formed on the 29th of May by Mr Lindman, whose principal task was to find a solution of the suffrage question which both chambers could accept. A government bill was introduced, proposing the settlement of the question on the basis of the bill carried by the First Chamber in the Riksdag of the preceding year. A compromise, approved of by the government, was adopted by the First Chamber on the 14th of May 1907 by 110 votes against 29 and in the Second Chamber by 128 against 98. By this act proportional representation was established for both chambers, together with universal manhood suffrage at elections for the Second Chamber, a reduction of the qualifications for eligibility for the First Chamber and a reduction of the electoral term of this chamber from nine to six years, and finally payment of members of the First Chamber, who hitherto had not received any such emolument.

King Oscar II. died on the 9th of December 1907, sincerely regretted by his people, and was succeeded as king of Sweden by his eldest son, Prince Gustaf. During King Oscar's reign many important social reforms were carried out by the legislature, and the country developed in all directions. In the Riksdag of 1884 a new patent law was adopted, the age at which women should be held to attain their majority was fixed at twenty-one years and the barbarous prison punishment of "bread and water" abolished. In order to meet the cost of the new army organization the Riksdag of 1902 increased the revenue by progressive taxation, but only for one year. Bills for the improvement of the social conditions of the people and in the interests of the working classes were also passed. During the five years 1884–1889 a committee was occupied with the question of workmen's insurance, and thrice the government made proposals for its settlement, on the last occasion adopting the principle of invalidity as a common basis for insurance against accidents, illness or old age. The Riksdag, however, delayed coming to a decision, and contented itself by earmarking money for an insurance fund. At last the Riksdag of 1901 accepted a Bill for insurance against accidents which also extended to agricultural labourers, in connexion with the establishment of a state institution for insurance. The bill for protection against accidents, as well as for the limitation of working hours for women and children, was passed, together with one for the appointment of special factory inspectors. When in 1897 King Oscar celebrated his jubilee of twenty-five years as king, the exhibition which had been organized in Stockholm offered a convincing proof of the progress the country had made in every direction.

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SWEDISH LITERATURE

Swedish literature, as distinguished from compositions in the common *norraena tunga* of old Scandinavia, cannot be said to exist earlier than the 13th century. Nor until the period of the Reformation was its development in any degree rapid or copious. The oldest form in which Swedish exists as a written language (see SCANDINAVIAN LANGUAGE) is the series of manuscripts known as *Landskapslagarne*, or "The Common Laws." These are supposed to be the relics of a still earlier age, and it is hardly believed that we even possess the first that was put down in writing. The most important and the most ancient of these codes is the "Elder West Göta Law," reduced to its present form by the law-man Eskil about 1230. Another of great interest is Magnus Eriksson's "General Common Law," which was written in 1347. These ancient codes have been collected and edited by the learned jurist, K. J. Schlyter (1795–1888) as *Corpus juris Sveo-Gotorum antiqui* (4 vols., 1827–1869). The chief ornament of medieval Swedish literature is *Um styrilse kununga ok höfdinga* ("On the Conduct of Kings and Princes"), first printed by command of Gustavus II. Adolphus, in 1634. The writer is not known; it has been conjecturally dated 1325. It is a handbook of moral and political teaching, expressed in terse and vigorous language. St Bridget, or Birgitta (1303–1373), an historical figure of extraordinary interest, has left her name attached to several important religious works, in particular to a collection of *Uppenbarelser* ("Revelations"), in which her visions and ecstatic meditations are recorded, and a version, the first into Swedish, of the five books of Moses. This latter was undertaken, at her desire, by her father-confessor Mattias (d. 1350), a priest at Linköping. The translation of the Bible was continued a century later by a monk named Johannes Budde (d. 1484).

In verse the earliest Swedish productions were probably the folk-song.[1] The age of these, however, has been commonly exaggerated. It is doubtful whether any still exist which are as old, in their present form, as the 13th century. The bulk are now attributed to the 15th, and many are doubtless much later still. The last, such as "Axel och Valborg," "Liten Karin," "Kämpen Grimborg," and "Habor och Signild," deal with the adventures of romantic medieval romance. Almost the only positive clue we hold to the date of these poems is the fact that one of the most characteristic of them, "Engelbrekt," was written by Thomas, bishop of Strengnäs, who died in 1443. Thomas, who left other poetical pieces, is usually called the first Swedish poet. There are three rhyming chronicles in medieval Swedish, all anonymous. The earliest, *Erikskronikan*,[2] is attributed to 1320; the romance of Karl Magnus, *Nya Karlskrönikan*, describing the period between 1387 and 1452, which is sometimes added to the earlier work, dates from the middle of the 15th century; and the third, *Sturekrönikorna*, was probably written about 1500. The collection of rhymed romances which bears the name of *Queen Euphemia's Songs* must have been written before the death of the Norwegian queen in 1312. They are versions of three medieval stories taken from French and German sources, and dealt with the Chevalier au lion, of Chrestien de Troyes, with Duke Frederick of Normandy, and with Flores and Blancheflor. They possess very slight poetic merit in their Swedish form. A little later the romance of *King Alexander*[3] was translated by, or at the command of, Bo Jonsson Grip; this is more meritorious. Bishop Thomas, who died in 1443, wrote many political songs; and a number of narrative poems date from the close of the century. A brilliant and pathetic relic of the close of the medieval period exists in the *Love Letters* addressed in 1498 by Ingrid Persdotter, a nun of Vadstena, to the young knight Axel Nilsson. The first book printed in the Swedish language appeared in 1495.

The 16th century added but little to Swedish literature, and that little is mostly connected with the newly-founded university of Upsala. The Renaissance scarcely made itself felt in Scandinavia, and even the Reformation failed to waken the genius of the country. Psalms and didactic spiritual poems were the main products of Swedish letters in the 16th century. Two writers, the brothers Petri, sons of a smith at Orebro, take an easy prominence in so barren a period. Olaus Petri (1493–1552) and Laurentius Petri (1499–1573) were Carmelite monks who adopted the Lutheran doctrine while studying at Wittenberg, and came back to Sweden in 1518 as the apostles of the new faith. Olaus, who is one of the noblest figures in Swedish annals, was of the executive rather than the meditative class. He became chancellor to Gustavus Vasa, but his reforming zeal soon brought him into disgrace, and in 1540 he was condemned to death. Two years later he was pardoned, and allowed to resume his preaching in Stockholm. He found time, however, to write a *Swedish Chronicle*, which is the earliest prose history of Sweden, a mystery-play, *Tobiae comedia*, which is the first Swedish drama, and three psalm-books, the best known being published in 1530 under the title of *Några gudhelige vijsor* ("Certain Divine Songs"). His *Chronicle* was based on a number of sources, in the treatment of which he showed a discrimination which makes the work still useful. Laurentius Petri, who was a man of calmer temperament, was archbishop of all Sweden, and edited or superintended the translation of the

The Petri.

[1] *Skanska folkvisor*, edited by E. G. Geijer and A. A. Afzelius (3 vols., Stockholm, 1879).

[2] See Cederschiöld, *Om Erikskrönikan* (1899).

[3] Editions of these chronicles and romances have been issued by the "Svenska Fornskrift Sällskapet" (Stockholm): *Ivan Lejonriddaren* (ed. Stephens), *Hertig Fredrik of Normandie* (ed. Ahlstrand) *Flores och Blancheflor* (ed. G. E. Klemming), Alexander (ed. Klemming), Carl Magnus (ed. Klemming, in *Prosadikter från medeltiden*).

Bible published at Upsala in 1540. He also wrote many psalms. Laurentius Andreae, 1552, had previously prepared a translation of the New Testament, which appeared in 1526. He was a polemical writer of prominence on the side of the Reformers. Finally, Petrus Niger (Peder Svart), bishop of Vesterås (d. 1562), wrote a chronicle of the life of Gustavus I. up to 1533, in excellent prose. The same writer left unpublished a history of the bishops of Vesterås, his predecessors. The latter half of the 16th century is a blank in Swedish literature.

Buraeus.

With the accession of Charles IX., and the consequent development of Swedish greatness, literature began to assert itself in more vigorous forms. The long life of the royal librarian, Johannes Bure or Buraeus (1568–1652), formed a link between the age of the Petri and that of Stjernhjelm. Buraeus studied all the sciences then known to mankind, and confounded them all in a sort of Rabbinical cultus of his own invention, a universal philosophy in a multitude of unreadable volumes.[4] But he was a patient antiquary, and advanced the knowledge of ancient Scandinavian mythology and language very considerably. He awakened curiosity and roused a public sympathy with letters; nor was it without significance that two of the greatest Swedes of the century, Gustavus Adolphus and the poet Stjernhjelm, were his pupils. The reign of Charles IX. saw the rise of secular drama in Sweden. The first comedy was the *Tisbe* of Magnus Olai Asteropherus (d. 1647), a coarse but witty piece on the story of Pyramus and Thisbe, acted by the schoolboys of the college of Arboga in 1610. This play is the *Ralph Roister Doister* of Swedish literature. A greater dramatist was Johannes Messenius (1579–1636), who was the son of a miller near Vadstena and had been carefully educated abroad by the Jesuits. Being discovered plotting against the government during the absence of Gustavus in Russia, he was condemned to imprisonment for life—that is, for twenty years. Before this disaster he had been professor of jurisprudence in Upsala, where his first historical comedy *Disa* was performed in 1611 and the tragedy of *Signill* in 1612. The design of Messenius was to write the history of his country in fifty plays; he completed and produced six. These dramas[5] are not particularly well arranged, but they form a little body of theatrical literature of singular interest and value. Messenius was a genuine poet; the lyrics he introduces have something of the charm of the old ballads. He wrote abundantly in prison; his magnum opus was a history of Sweden in Latin, but he has also left, in Swedish, two important rhyme-chronicles. Messenius was imitated by a little crowd of playwrights. Nikolaus Holgeri Catonius (d. 1655) wrote a fine tragedy on the Trojan War, *Troijenborgh*, in which he excelled Messenius as a dramatist. Andreas Prytz, who died in 1655 as bishop of Linköping, produced several religious chronicle plays from Swedish history. Jacobus Rondeletius (d. 1662) wrote a curious "Christian tragi-comedy" of *Judas redivivus*, which contains some amusing scenes from daily Swedish life. Another good play was an anonymous *Holofernes and Judith* (edited at Upsala, 1895, by O. Sylwan). These plays were all acted by schoolboys and university youths, and when they went out of fashion among these classes the drama in Sweden almost entirely ceased to exist. Two historians of the reign of Charles IX., Erik Göransson Tegel (d. 1636) and Aegidius Girs (d. 1639), deserve mention. The chancellor Magnus Gabriel de la Gardie (1622–1686) did much to promote the study of Swedish antiquities. He founded the College of Antiquities at Upsala in 1667, and bought back the Gothic *Codex argenteus* which he presented to the university library.

Stjernhjelm.

The reign of Gustavus Adolphus was adorned by one great writer, the most considerable in all the early history of Sweden. The title of "the Father of Swedish poetry" has been universally awarded to Göran Lilja, better known by his adopted name of Georg Stjernhjelm (*q.v.*; 1598–1672). Stjernhjelm was a man of almost universal attainment, but it is mainly in verse that he has left his stamp upon

[4] Selections from his writings were edited by G. E. Klemming, (Upsala, 1883–1885).

[5] Edited for a learned society (Upsala, 1886, &c.) by H. Schück.

the literature of his country. He found the language rough and halting, and he moulded it into perfect smoothness and elasticity. His master, Buraeus, had written a few Swedish hexameters by way of experiment. Stjernhjelm took the form and made it national.

The claim of Stjernhjelm to be the first Swedish poet may be contested by a younger man, but a slightly earlier writer, Gustaf Rosenhane (1619–1684), who was a reformer on quite other lines. If Stjernhjelm studied Opitz, Rosenhane took the French poets of the Renaissance for his models, and in 1650 wrote a cycle of one hundred sonnets, the earliest in the language; these were published under the title *Venerid* in 1680. Rosenhane printed in 1658 a "Complaint of the Swedish Language" in thirteen hundred rattling rhyming lines, and in 1682 a collection of eighty songs. He was a metrist of the artistic order, skilful, learned and unimpassioned. His zeal for the improvement of the literature of his country was beyond question. Most of the young poets, however, followed Stjernhjelm rather than Rosenhane. As personal friends and pupils of the former, the brothers Columbus deserve special attention. They were sons of a musician and poet, Jonas Columbus (1586–1663). Each wrote copiously in verse, but Johan (1640–1684), who was professor of poetry at Upsala, almost entirely in Latin, while Samuel (1642–1679), especially in his *Odae sveticae*, showed himself an apt and fervid imitator of the Swedish hexameters of Stjernhjelm, to whom he was at one time secretary, and whose *Hercules* he dramatized. His works were included by P. Hanselli in vol. ii. of *Samlade vitterhets arbeten*, &c.

Rosenhane.

Of a rhyming family of Hjärne, it is enough to mention one member, Urban Hjärne (1641–1724), who introduced the new form of classical tragedy from France, in a species of transition from the masques of Stjernhjelm to the later regular rhymed dramas. His best play was a *Rosimunda*. Lars Johansson (1642–1674), who called himself "Lucidor the Unfortunate," has been the subject of a whole tissue of romance, most of which is fabulous. It is true, however, that he was stabbed, like Marlowe, in a midnight brawl at a tavern. His poems were posthumously collected as *Flowers of Helicon, Plucked and Distributed on various occasions by Lucidor the Unfortunate*. Stripped of the myth which had attracted so much attention to his name, Lucidor proves to be an occasional rhymester of a very low order. Haquin Spegel (1645–1714), the famous archbishop of Upsala, wrote a long didactic epic in alexandrines, *God's Labour and Rest*, with an introductory ode to the Deity in rhymed hexameters. He was also a good writer of hymns. Another ecclesiastic, the bishop of Skara, Jesper Svedberg (1653–1735), wrote sacred verses, but is better remembered as the father of Swedenborg. Peter Lagerlöf (1648–1699) cultivated a pastoral vein in his ingenious lyrics *Elisandra* and *Lycillis*; he was professor of poetry, that is to say, of the art of writing Latin verses, at Upsala. Olof Wexionius (1656–1690?) published his *Sinne-Afvel*, a collection of graceful miscellaneous pieces, in 1684, in an edition of only 100 copies. Its existence was presently forgotten, and the name of Wexionius had dropped out of the history of literature, when Hanselli recovered a copy and reprinted its contents in 1863.

Dahlstjerna.

We have hitherto considered only the followers of Stjernhjelm; we have now to speak of an important writer who followed in the footsteps of Rosenhane. Gunno Eurelius, afterwards ennobled with the name of Dahlstjerna (*q.v.*; 1661–1709), early showed an interest in the poetry of Italy. In 1690 he translated Guarini's *Pastor Fido*, and in or just after 1697 published, in a folio volume without a date, his *Kunga-Skald*, the first original poem in *ottava rima* produced in Swedish. This is a bombastic and vainglorious epic in honour of Charles XI., whom Eurelius adored; it is not, however, without great merits, richness of language, flowing metre, and the breadth of a genuine poetic enthusiasm. He published a little collection of lamentable sonnets when his great master died. Johan Paulinus Liljenstedt (1655–1732), a Finn, was a graceful imitator of Ronsard and Guarini. Johan Runius (1679–1713), called the "Prince of Poets," published a collection entitled *Dudaim*, in which there is nothing to praise, and with him the generation of the 17th century closes. Talent had been shown by certain individuals, but no healthy school of Swedish poetry had been founded, and the latest imitators of Stjernhjelm had lost every vestige of taste and independence.

Rudbeck.

In prose the 17th century produced but little of importance in Sweden. Gustavus Adolphus (1594–1632) was the most polished writer of its earlier half, and his speeches take an important place in the development of the language. The most original mind of the next age was Olof Rudbeck (1630–1702), the famous author of *Atland eller Manhem*. He spent nearly all his life in Upsala, building anatomical laboratories, conducting musical concerts, laying out botanical gardens, arranging medical lecture rooms—in a word, expending ceaseless energy on the practical improvement of the university. He was a genius in all the known branches of learning; at twenty-three his physiological discoveries had made him famous throughout Europe. His *Atland* (or *Atlantika*) appeared in four folio volumes, in Latin and Swedish, in 1675–1698; it was an attempt to summon all the authority of the past, all the sages of Greece and the bards of Iceland, to prove the inherent and indisputable greatness of the Swedish nation, in which the fabulous Atlantis had been at last discovered. It was the literary expression of the majesty of Charles XI., and of his autocratical dreams for the destiny of Sweden. From another point of view it is a monstrous hoard or cairn of rough-hewn antiquarian learning, now often praised, sometimes quoted from, and never read. Olof Verelius (1618–1682) had led the way for Rudbeck, by his translations of Icelandic sagas, a work which was carried on with greater intelligence by Johan Peringskjöld (1654–1720), the editor of the *Heimskringla* (1697), and J. Hadorph (1630–1693). The French philosopher Descartes, who died at Christina's court at Stockholm in 1650, found his chief, though posthumous, disciple in Andreas Rydelius (1671–1738), bishop of Lund, who was the master of Dalin, and thus connects us with the next epoch. His chief work, *Nödiga förnuftsöfningar . . .* (5 vols.) appeared in 1718. Charles XII., under whose special patronage Rydelius wrote, was himself a metaphysician and physiologist of merit.

A much more brilliant period followed the death of Charles XII. The influence of France and England took the place of that of Germany and Italy. The taste of Louis XIV., tempered by the study of Addison and Pope, gave its tone to the academical court of Queen Louise Ulrica, who founded in 1758 the academy of literature, which developed later into the academy of literature, history and antiquities.

Dalin.

Sweden became completely a slave to the periwigs of literature, to the unities and graces of classical France. Nevertheless this was a period of great intellectual stimulus and activity, and Swedish literature took a solid shape for the first time. This Augustan period in Sweden closed somewhat abruptly about 1765. Two writers in verse connect it with the school of the preceding century. Jacob Frese (1692?–1728?), a Finn, whose poems were published in 1726, was an elegiacal writer of much grace, who foreshadowed the idyllic manner of Creutz. Atterbom pronounces Frese the best Swedish poet between Stjernhjelm and Dalin. Samuel von Triewald (1688–1743) played a very imperfect Dryden to Dalin's Pope. He was the first Swedish satirist, and introduced Boileau to his countrymen. His *Satire upon our Stupid Poets* may still be read with entertainment.[1] Both in verse and prose Olof von Dalin (*q.v.*; 1708–1763) takes a higher place than any writer since Stjernhjelm. He was inspired by the study of his great English contemporaries. His *Swedish Argus* (1733–1734) was modelled on Addison's *Spectator*, his *Thoughts about Critics* (1736) on Pope's *Essay on Criticism*, his *Tale of a Horse* on Swift's *Tale of a Tub*. Dalin's style,

[1] The works of the chief writers between Sternhjelm and Dalin were edited by P. Hanselli (Upsala, 1856, &c.) as *Samlade vitterhets-arbeten-af svenska författare*.

whether in prose or verse, was of a finished elegance. As a prose writer Dalin is chiefly memorable for his *History of the Swedish Kingdom* (4 vols., 1746–1762). His great epic, *Swedish Freedom* (1742) was written in alexandrines of far greater smoothness and vigour than had previously been attempted. When in 1737 the new Royal Swedish Theatre was opened, Dalin led the way to a new school of dramatists with his *Brynhilda*, a regular tragedy in the style of Crébillon *père*. In his comedy of *The Envious Man* he introduced the manner of Molière, or more properly that of Holberg. His songs, his satires, his occasional pieces, without displaying any real originality, show Dalin's tact and skill as a workman with the pen. He stole from England and France, but with the plagiarism of a man of genius; and his multifarious labours raised Sweden to a level with the other literary countries of Europe. They formed a basis upon which more national and more scrupulous writers could build their various structures. A foreign critic, especially an English one, will never be able to give Dalin so much credit as the Swedes do; but he was certainly an unsurpassable master of *pastiche*. His works were collected in 6 vols., 1767.

Fru Nordenflycht.

The only poet of importance who contested the laurels of Dalin was a woman. Hedvig Charlotta Nordenflycht (1718–1763) was the centre of a society which took the name of *Tankebyggare Orden* and ventured to rival that which Queen Louise Ulrica created and Dalin adorned. Both groups were classical in taste, both worshipped the new lights in England and France. Fru Nordenflycht wrote with facility and grace; her collection of lyrics, *The Sorrowing Turtledove* (1743), in spite of its affectation, enjoyed and merited a great success; it was the expression of a deep and genuine sorrow—the death of her husband after a very brief and happy married life. It was in 1744 that she settled in Stockholm and opened her famous literary salon. She was called "The Swedish Sappho," and scandal has been needlessly busy in giving point to the allusion. It was to Fru Nordenflycht's credit that she discovered and encouraged the talent of two very distinguished poets younger than herself, Creutz and Gyllenborg, who published volumes of poetry in collaboration.

Creutz.

Count Gustaf Philip Creutz (*q.v.*; 1731–1785) was a Finlander who achieved an extraordinary success with his idyllic poems, and in particular with the beautiful pastoral of *Atis och Camilla*, long the most popular of all Swedish poems. His friend Count Gustaf Fredrik

Gyllenborg.

Gyllenborg (1731–1808) was a less accomplished poet, less delicate and touching, more rhetorical and artificial. His epic *Tåget öfver Bält* ("The Expedition across the Belt") (1785) is an imitation, in twelve books, of Voltaire's *Henriade*, and deals with the prowess of Charles X. He wrote fables, allegories, satires, and a successful comedy of manners, *The Swedish Fop*. He outlived his chief contemporaries so long that the new generation addressed him as "Father Gyllenborg." Anders Odel (1718–1773) wrote in 1739 the famous "Song of Malcolm Sinclair," the *Sinclairsvisa*. The writers of verse in this period were also exceedingly numerous.

Prose Writers.

In prose, as was to be expected, the first half of the 18th century was rich in Sweden as elsewhere. The first Swedish novelist was Jakob Henrik Mörk (1714–1763). His romances have some likeness to those of Richardson; they are moral, long-winded, and slow in evolution, but written in an exquisite style, and with much knowledge of human nature. *Adalrik och Göthilda*, which went on appearing from 1742 to 1745, is the best known; it was followed, between 1748 and 1758, by *Thecla*. Jakob Wallenberg (1746–1778) described a voyage he took to the East Indies and China under the very odd title of *Min son på galejan* ("My Son at the Galleys"), a work full of humour and originality.

Johan Ihre (1707–1780), a professor at Upsala, edited the *Codex argenteus* of Ulfilas, and produced the valuable *Svenskt Dialect Lexicon* (1766) based on an earlier learned work, the *Dialectologia* of Archbishop Erik Benzelius (d. 1743). He settled for some time at Oxford. Ihre's masterpiece is the *Glossarium sueogothicum* (1769), a historical dictionary with many valuable examples from the ancient monuments of the language. In doing this he was assisted by the labours of two other grammarians, Sven Hof (d. 1786) and Abraham Sahlstedt (d. 1776). The chief historians were Sven Lagerbring (1707–1787), author of a still valuable history of Sweden down to 1457 (*Svea Rikes historia*, 4 vols., 1769–1783); Olof Celsius (1716–1794), bishop of Lund, who wrote histories of Gustavus I. (1746–1753) and of Eric XIV. (1774); and Karl Gustaf Tessin (1695–1770) who wrote on politics and on aesthetics. Tessin's *Old Man's Letters to a young Prince* were addressed to his pupil, afterwards Gustavus III. Count Anders Johan von Höpken (1712–1789), the friend of Louise Ulrica, was a master of rhetorical compliment in addresses and funeral orations.

In spite of all the encouragement of the court, drama did not flourish in Sweden. Among the tragic writers of the age we may mention Dalin, Gyllenborg, and Erik Wrangel (1686–1765). In comedy Reinhold Gustaf Modée (d. 1752) wrote three good plays in rivalry of Holberg.

In science Linnaeus, or Karl von Linné (1707–1778), was the name of greatest genius in the whole century; but he wrote almost entirely in Latin. The two great Swedish chemists, Torbern Olof Bergman (1735–1784) and Karl Vilhelm Scheele (1742–1786), flourished at this time. In pathology a great name was left by Nils Rosén von Rosenstein (1706–1773), in navigation by Admiral Fredrik Henrik af Chapman (d. 1808), in philology by Karl Aurivillius (d. 1786). But these and other distinguished savants whose names might be enumerated scarcely belong to the history of Swedish literature. The same may be said about that marvellous and many-sided genius, Emanuel Swedenborg (1688–1772), who, though the son of a Swedish poet, preferred to prophesy to the world in Latin.

The Gustavian period.

What is called the Gustavian period is supposed to commence with the reign of Gustavus III. in 1771 and to close with the abdication of Gustavus IV. in 1809. This period of less than forty years was particularly rich in literary talent, and the taste of the people in literary matters widened to a remarkable extent. Journalism began to develop; the Swedish Academy was founded; the drama first learned to flourish in Stockholm; and literature began to take a characteristically national shape. This fruitful period naturally divides itself into two divisions, equivalent to the reigns of the two kings. The royal personages of Sweden have commonly been protectors of literature; they have strangely often been able men of letters themselves. Gustavus III. (1746–1792), the founder of the Swedish Academy and of the Swedish theatre, was himself a playwright of no mean ability. One of his prose dramas, *Siri Brahe och Johan Gyllenstjerna*, held the stage for many years. But his best work was his national drama of *Gustaf Vasa* (1783), written by the king in prose, and afterwards versified by Kellgren. In 1773 the king opened the national theatre in Stockholm, and on that occasion an opera of *Thetis och Pelée* was performed, written by himself. In 1786 Gustavus created the Swedish Academy, on the lines of the French Academy, but with eighteen members instead of forty. The first list of immortals, which included the survivors of a previous age and such young celebrities as Kellgren and Leopold, embraced all that was most brilliant in the best society of Stockholm; the king himself presided, and won the first prize for an oration. The works of Gustavus III. in six volumes were printed at Stockholm in 1802–1806.

Bellman.

The principal writers of the reign of Gustavus III. bear the name of the academical school. But Karl Mikael Bellman (*q.v.*; 1740–1795), the most original and one of the most able of all Swedish writers, an improvisatore of the first order, had nothing academical in his composition. The riot of his dithyrambic hymns sounded a strange note of nature amid the conventional music of the Gustavians. Of the academical poets Johan Gabriel Oxenstjerna (1750–1818), the nephew of Gyllenborg, was a descriptive idyllist of grace.

He translated *Paradise Lost.* A writer of far more power and versatility was Johan Henrik Kellgren (*q.v.*; 1751–1795), the leader of taste in his time.

Kellgren.

He was the first writer of the end of the century in Sweden, and the second undoubtedly was Karl Gustaf af Leopold[1] (1756–1829), "the blind seer Tiresias-Leopold," who lived on to represent the old school in the midst of romantic times.

Leopold.

Leopold attracted the notice of Gustavus III. by a volume of *Erotic Odes* (1785). The king gave him a pension and rooms in the palace, admitting him on intimate terms. He was not equal to Kellgren in general poetical ability, but he is great in didactic and satiric writing. He wrote a satire, the *Enebomiad,* against a certain luckless Per Enebom, and a classic tragedy of *Virginia.* Gudmund Göran Adlerbeth (1751–1818) made translations from the classics and from the Norse, and was the author of a successful tragic opera, *Cora och Alonzo* (1782). Anna Maria Lenngren (1754–1817) was a very popular sentimental writer of graceful domestic verse, chiefly between 1792 and 1798. She was less French and more national than most of her contemporaries; she is a Swedish Mrs Hemans. Much of her work appeared anonymously, and was generally attributed to her contemporaries Kellgren and Leopold.

Two writers of the academic period, besides Bellman, and a generation later than he, kept apart, and served to lead up to the romantic revival.

Lidner.

Bengt Lidner (1759–1793), a melancholy and professedly elegiacal writer, had analogies with Novalis. He interrupted his studies at the university by a voyage to the East Indies, and only returned to Stockholm after many adventures. In spite of the patronage of Gustavus III. he continued to lead a disordered, wandering life, and died in poverty. A short narrative poem, *The Death of the Countess Spastara* (1783), has retained its popularity. Lidner was a genuine poet, and his lack of durable success must be set down to faults of character, not to lack of inspiration. His poems appeared in 1788. Thomas Thorild (1759–1808) was a much stronger nature, and led the revolt against prevailing taste with far more vigour.

Thorild.

But he is an irregular and inartistic versifier, and it is mainly as a prose writer, and especially as a very original and courageous critic, that he is now mainly remembered. He settled in Germany and died as a professor in Greifswald. Karl August Ehrensvärd (1745–1800) may be mentioned here as a critic whose aims somewhat resembled those of Thorild. The creation of the Academy led to a great production of aesthetic and philosophical writing. Among critics of taste may be mentioned Nils Rosén von Rosenstein (1752–1824); the rhetorical bishop of Linköping, Magnus Lehnberg (1758–1808); and Count Georg Adlersparre (1760–1809). Rosén von Rosenstein embraced the principles of the encyclopaedists while he was attached to the Swedish embassy in Paris. On his return to Sweden he became tutor to the crown prince, and held in succession a number of important offices. As the first secretary of the Swedish Academy he exercised great influence over Swedish literature and thought. His prose writings, which include prefaces to the works of Kellgren and Lidner, and an eloquent argument against Rousseau's theory of the injurious influence of art and letters, rank with the best of the period. Kellgren and Leopold were both of them important prose writers.

The excellent lyrical poet Frans Mikael Franzén (*q.v.*; 1772–1847) and a belated academician Johan David Valerius (1776–1852), fill up the space between the Gustavian period and the domination of romantic ideas from Germany.

Hammarsköld.

It was Lorenzo Hammarsköld (1785–1827) who in 1803 introduced the views of Tieck and Schelling by founding the society in Upsala called "Vitterhetens Vänner," and by numerous critical essays. His chief work was *Svenska vitterheten* (1818, &c.) a history of Swedish literature. Hammarsköld's society was succeeded in 1807 by the famous "Aurora förbundet," founded by two youths of genius, Per Daniel Amadeus Atterbom (1790–1855) and Vilhelm Fredrik Palmblad (1788–1852).

Atterbom.

These young men had at first to endure bitter opposition and ridicule from the academic writers then in power, but they supported this with cheerfulness, and answered back in their magazines *Polyfem* and *Fosforos* (1810–1813). They were named "Fosforisterna" ("Phosphorists") from the latter. Another principal member of the school was Karl Frederik Dahlgren (*q.v.*; 1791–1844), a humorist who owed much to the example of Bellman. Fru Julia Nyberg (1785–1854), under the title of Euphrosyne, was their tenth Muse, and wrote agreeable lyrics. Among the Phosphorists Atterbom was the man of most genius. On the side of the Academy they were vigorously attacked by Per Adam Wallmark (1777–1858), to whom they replied in a satire which was the joint work of several of the romanticists, *Markall's Sleepless Nights.* One of the innovators, Atterbom, eventually forced the doors of the Academy itself.

In 1811 certain young men in Stockholm founded a society for the elevation of society by means of the study of Scandinavian antiquity.

Gothic Society.

This was the Gothic Society, which began to issue the magazine called *Iduna* as its organ. Of its patriotic editors the most prominent was Erik Gustaf Geijer (*q.v.*; 1783–1847), but he was presently joined by a young man slightly older than himself, Esaias Tegnér (*q.v.*; 1782–1846), afterwards bishop of Vexiö, the greatest of Swedish writers.

Geijer.

Tegnér.

Even more enthusiastic than either in pushing to its last extreme the worship of ancient myths and manners was Per Henrik Ling (1776–1839), now better remembered as the father of gymnastic science than as a poet. The Gothic Society eventually included certain younger men than these—Arvid August Afzelius (1785–1871), the first editor of the Swedish folk-songs; Gustaf Vilhelm Gumaelius (1789–1877), who has been somewhat pretentiously styled "The Swedish Walter Scott," author of the historical novel of *Tord Bonde*; Baron Bernhard von Beskow (*q.v.*; 1796–1868), lyrist and dramatist; and Karl August Nicander (1799–1839), a lyric poet who approached the Phosphorists in manner. The two great lights of the Gothic school are Geijer, mainly in prose, and Tegnér, in his splendid and copious verse. Johan Olof Wallin (1779–1839) may be mentioned in the same category, although he is really distinct from all the schools.

Wallin.

He was archbishop of Upsala, and in 1819 he published the national hymn-book of Sweden; of the hymns in this collection, 126 are written by Wallin himself.

From 1810 to 1840 was the blossoming-time in Swedish poetry, and there were several writers of distinguished merit who could not be included in either of the groups enumerated above.

Stagnelius.

Second only to Tegnér in genius, the brief life and mysterious death of Erik Johan Stagnelius (1793–1823) have given a romantic interest to all that is connected with his name. His first publication was the epic of *Vladimir the Great* (1817); to this succeeded the romantic poem *Blanda.* His singular dramas, *The Bacchantes* (1822), *Sigurd Ring,* which was posthumous, and *The Martyrs* (1821), are esteemed by many critics to be his most original productions. His mystical lyrics, entitled *Liljor i Saron* ("Lilies in Sharon"; 1820), and his sonnets, which are the best in Swedish, may be recommended as among the most delicate products of the Scandinavian mind. Stagnelius has been compared, and not improperly, to Shelley.[2] Erik Sjöberg, who called himself "Vitalis" (1794–1828), was another gifted poet whose career was short and wretched.

Sjöberg.

A volume of his poems appeared in 1820; they are few in number and all brief. His work divides itself into two classes—the one profoundly melancholy, the other witty or boisterous. Two humorous poets of the same period who deserve mention are Johan Anders Wadman (1777–1837), an improvisatore of the same class as Bellman, and Christian Erik Fahlcrantz (*q.v.*; 1790–1866).

Among the poets who have been mentioned above, the

[1] His works were edited by C. R. Nyblom (2 vols., 1873).

[2] His collected works were edited by C. Eichhorn (2 vols., Stockholm, 1867–1868). Several of Stagnelius' poems were translated into English by Edmund Gosse 1886).

majority distinguished themselves also in prose. But the period was not one in which Swedish prose shone with any special lustre. The first prosaist of the time was, without question, the novelist, Karl Jonas Ludvig Almqvist, (*q.v.*; 1793–1866), around whose extraordinary personal character and career a mythical romance has already collected (see ALMQVIST). He was encyclopaedic in his range, although his stories preserve most charm; on whatever subject he wrote his style was always exquisite. Fredrik Cederborgh (1784–1835) revived the comic novel in his *Uno von Trasenberg* and *Ottar Tralling*. The historical novels of Gumaelius have already been alluded to. Swedish history supplied themes for the romances of Count Per Georg Sparre (1790–1871) and of Gustaf Henrik Mellin (1803–1876). But all these writers sink before the sustained popularity of the Finnish poet Fredrika Bremer (*q.v.*; 1801–1865), whose stories reached farther into the distant provinces of the world of letters than the writings of any other Swede except Tegnér. She was preceded by Sofia Margareta Zelow, afterwards Baroness von Knorring (1797–1848), who wrote a long series of aristocratic novels.

Almqvist.

Fredrika Bremer.

A polemical writer of great talent was Magnus Jakob Crusenstople (1795–1865), of whose work it has been said that "it is not history and it is not fiction, but something brilliant between the one and the other." As an historian of Swedish literature Per Wieselgren (1800–1877) composed a valuable work, and made other valuable contributions to history and bibliography. In history we meet again with the great name of Geijer, with that of Jonas Hallenberg (1748–1834), and with that of Anders Magnus Strinnholm (1786–1862), whose labours in the field of Swedish history were extremely valuable. Geijer and Strinnholm prepared the way for the most popular of all Swedish historians, Anders Fryxell (1795–1881), whose famous *Berättelser ur svenska historien* appeared in parts during a space of nearly sixty years, and awakened a great interest in Swedish history and legend.

In 1850 the first poet of Sweden, without a rival, was Johan Ludvig Runeberg (*q.v.*; 1804–1877), whose reputation rivals that of Tegnér. Bernhard Elis Malmström (1816–1865), who was a professor of aesthetics at the university of Upsala, was the author of many important books on artistic and literary history, notably a monograph on Franzén. His poetry, although small in volume, gives him a place beside Runeberg. A volume of elegies, *Angelika* (1840), established his fame, and two volumes of poems published in 1845 and 1847 contain a number of ballads, romances and lyrics which keep their hold on Swedish literature. He was an exact and discriminating critic, and inclined to severity in his strictures on the romanticists. The other leading verse-writers were Karl Vilhelm Böttiger (1807–1878), the son-in-law and biographer of Tegnér, who, in addition to his lyrical poetry, chiefly of the sentimental kind, wrote an admirable series of monographs on Swedish men of letters; Johan Börjesson (1790–1866), the last of the Phosphorists, author of various romantic dramas; Vilhelm August Detlof von Braun (1813–1860), a humorous lyrist; "Talis Qualis," whose real name was Karl Vilhelm August Strandberg (1818–1877); Oscar Patrick Sturzen-Becker (1811–1869), better known as "Orvar Odd," a lyrical poet who was also the author of a series of amusing sketches of everyday life; and August Teodor Blanche (1811–1868), the popular dramatist. Blanche produced a number of farces and comedies which were announced as pictures from real life. His pieces abound in comic situations, and some of them, *Magister Bläckstadius* (1844), *Rika Morbror* (1845), *En tragedi i Vimmerby* (1848) and others, maintain their reputation. Fredrik August Dahlgren (1816–1895) gained a great reputation as a dramatist by his national opera, *Vermländingarne* (1846). He is also the author of translations from Shakespeare and Calderon, and of considerable historical works. Other notable plays of the period were the *En Komedi* of J. C. Jolin (1818–1884) and the *Bröllopet på Ulfåsa* (1865) of Frans Hedberg (1828–1908). But Runeberg is the only great poetic name of this period.

Runeberg.

In prose there was not even a Runeberg. The best novelist of the time was Emilie Flygare-Carlén (1807–1892). The art was sustained by Karl Anton Wetterbergh (1804–1889), who called himself "Onkel Adam," by August Blanche the dramatist, and by Marie Sofie Schwartz (1819–1892). Fru Schwartz (née Birat) wrote novels demonstrating the rights of the poor against the rich, of which *The Man of Birth and the Woman of the People* (Eng. trans., 1868) is a good example. Lars Johan Hierta (1801–1872) was the leading journalist, Johan Henrik Thomander, bishop of Lund (1798–1865), the greatest orator, Matthias Alexander Castrén (1813–1852) a prominent man of science, and Karl Gustaf af Forsell (1783–1848), the principal statistician of this not very brilliant period. Elias Lönnrot (*q.v.*; 1802–1884) is distinguished as the Finnish professor who discovered and edited the *Kalevala*.

The most popular poet at the close of the 19th century was the patriotic Finn, Zakris Topelius (*q.v.*; 1818–1898). Of less importance were Karl Herman Sätherberg (1812–1897), a romantic poet who was also a practising physician of distinction; the elegiac poet Johan Nybom (1815–1889); and the poet, novelist, and dramatist Frans Hedberg (d. 1908), who in his old age made many concessions to the modern taste. The posthumous poems of the bishop of Strängnäs, Adam Teodor Strömberg (1820–1889), were collected by Wirsén, and created some sensation. A typical academician was the poet, antiquary and connoisseur, Nils Fredrik Sander (1828–1900). The improvisator of *Gluntarne*, Gunnar Wennerberg (*q.v.*; 1817–1901) survived as a romantic figure of the past. Still older was the poetess Wilhelmina Nordström (1815–1902), long a schoolmistress in Finland. The aesthetic critic and poet, Carl Rupert Nyblom (1832–1907), continued the studies, translations and original pieces which had created him a reputation as one of the most accomplished general writers of Sweden. His wife, Helene Nyblom, was well known as a novelist. A. T. Gellerstedt (b. 1836), an architect of position, was known as a poet of small range but of very fine quality. Among writers of the earlier generation were Achatius Johan Kahl (1794–1888), the biographer of Tegnér; Per Erik Bergfalk (1798–1890), the critic and supporter of Geijer; the distinguished historian and academician, Karl Johan Schlyter (1795–1888) and the historical writers, Fredrik Ferdinand Carlson (1811–1887), Vilhelm Erik Svedelius (1816–1889), and Martin Weibull (1835–1902). The work of King Oscar II. (*q.v.*) himself had given him a worthy place among the intellectuals of the country. But the interest of such veteran reputations is eclipsed by the more modern school.

The serenity of Swedish literature was rudely shaken about 1884 by an incursion of realism and by a stream of novel and violent imaginative impulse. The controversy between the old and the new schools raged so fiercely, and the victory has remained so obviously in the hands of the latter, that it is difficult, especially for a foreigner, to hold the balance perfectly even. It will therefore be best in this brief sketch to say that the leader of the elder school was Viktor Rydberg (*q.v.*; 1828–1895) and that he was ably supported by Carl Snoilsky (*q.v.*; 1841–1904) who at the beginning of the 20th century was the principal living poet of the bygone generation in Sweden. Snoilsky was prominent for the richness of his lyrical style, his cosmopolitan interests and his great width of culture. Carl David af Wirsén (b. 1842) distinguished himself, and made himself very unhappy, by his dogged resistance to every species of renaissance in Swedish thought, or art, or literature. A man of great talent, he was a violent reactionary, and suffered from the consequences of an attitude so unpopular. He found a vehicle for his criticism in the *Post och Inrikes Tidningar*, of which he was editor. He published his *Lyrical Poems* in 1876; *New Lyrical Poems* in 1880; *Songs and Sketches* in 1885.

The Modern Movement.

Four influences may be mentioned as having acted upon young Sweden, and as having combined to release its literature from the old hard-bound conventions. These are English philosophy in the writings of Herbert Spencer, French realism in the practice and the preaching of Zola, Norwegian drama mainly through Ibsen, and Danish criticism in the essays and monographs of Georg Brandes. Unquestionably the greatest name in recent Swedish literature is that of Johan August Strindberg (*q.v.*; b. 1849). His drama of *Master Olof* in 1878 began the revolutionary movement. In 1879 the success of his realistic novel, *The Red Room*, fixed universal attention upon his talent. It was the sensation caused in 1884 by the lawsuit brought against Strindberg's *Married* (a collection of short stories dealing realistically with some of the seamy sides of marriage) which brought to a head the rebellion against the elegant and superficial conventions which were strangling Swedish literature. He affronts every canon of taste, more by a radical absence, it would seem, of the sense of proportion than by any desire to shock. His diatribes against woman suggest a touch of madness, and he was in fact at one time seized with an attack of insanity. He writes like a man whose view is distorted by physical or mental pain. His phraseology and his turns of invention are too empirically pseudoscientific for the simplicity of nature. With all these faults, and in spite of a terrible vulgarity of mind, an absence of humour, and a boundless confidence in the philosophy of Nietzsche, Strindberg is a writer of very remarkable power and unquestionable originality. His mind underwent singular transformations. After devoting himself wholly to realism of the coarsest kind, he began in 1889 his series of mystico-pathological novels about life in the archipelago of Stockholm. This led him to a *culte du moi*, of which the strangest result was an autobiography of crude invective, *A Fool's Confession* (1893), the printing of which in Swedish was forbidden. He rapidly passed on, through books like *Inferno* (1897), the diary of a semi-lunatic, up into the sheer mysticism of *To Damascus* (1898), where he reconciles himself at last to Christianity. His best work is classic in its breadth of style, exquisite in local colour and fidelity to the national characteristics of Sweden.

A curious antidote to the harsh pessimism of Strindberg was offered by the delicate and fantastic temperament of Ola Hansson (b. 1860), whose poems came prominently before the public in 1884, and who, in *Sensitiva amorosa* (1887), preached a gospel of austere self-restraint. Hansson has been as ardent in the idolatry of woman as Strindberg has been in his hostility to the sex. Of those who have worked side by side with Strindberg, the most prominent and active was Gustaf af Geijerstam (b. 1858), in his curious and severely realistic studies of country life in his *Poor People* (1884) and other books. In 1885 he produced a gloomy sketch of student life at Upsala, *Erik Grane*, which made a great sensation. Since then Geijerstam has published more than forty volumes, and has become one of the most popular writers of the north of Europe. A melancholy interest surrounds the name of Victoria Benedictsson (Ernst Ahlgren, 1850–1889), who committed suicide in Copenhagen after achieving marked success with her sketches of humble life in *Från Skåne*, and with the more ambitious works *Money* and *Marianne*. She was perhaps the most original of the many women writers of modern Sweden, and *Money* was hailed by Swedish critics as the most important work of fiction since Strindberg's *Red Room*. Her biography, a most affecting narrative, was published by Ellen Key, and her autobiography by Axel Lundegård (b. 1861), who, after some miscellaneous writing, produced in 1889 a curious novel of analysis called *The Red Prince*, and who, becoming a devout clerical, published a number of popular stories in a neo-romantic manner. In 1898–1900 he produced a historical trilogy, *Struensee*, tracing the career of the minister from his early years as a doctor in Altona to his final downfall. In 1904 appeared the first volume of a second historical trilogy, *The Story of Queen Philippa*. Fru Alfhild Agrell (née Martin), who was born in 1849, produced a series of plays dealing with the woman question, *Rescued* (1883) and others. She also showed great ability as a novelist, among the best of her books being a series of sketches of country life (1884–1887). An historical novelist of unequal powers, but great occasional merit, is Matilda Malling, née Kruse (b. 1864), whose romance about Napoleon (1894) enjoyed a huge success. Tor Hedberg (b. 1861) also began as a decided realist, and turned to a more psychological and idealist treatment of life. His most striking work was *Judas* (1886); he has written some excellent dramas. Late successes in the novel has been those of Hilma Angered-Strandberg (*On the Prairie*, 1898) and Gustaf Janson (*Paradise*, 1900). The most remarkable of the novelists of the latest group is Selma Lagerlöf (b. 1858), who achieved a great success with *Gösta Berlings Saga* in 1891–1892. She employs the Swedish language with an extraordinary richness and variety, and stands in the front rank of Swedish novelists. But perhaps the most cosmopolitan recent novelist of Sweden is Per Hallström (b. 1866), who spent much of his youth in America, and appeared as an imaginative writer first in 1891. He has published volumes of ballads, short stories and sketches, fantastic and humoristic, all admirable in style. His play, *A Venetian Comedy*, enjoyed a substantial success in 1904.

Among the recent lyrical poets of Sweden, the first to adopt the naturalistic manner was Albert Ulrik Bååth (b. 1853), whose earliest poems appeared in 1879. In his rebellion against the sweetness of Swedish convention he proved himself somewhat indifferent to beauty of form, returned to "early national" types of versification, and concentrated his attention on dismal and distressing conditions of life. He is a resolute, but, in his early volumes, harsh and rocky writer. From 1882 onwards Bååth was steadily productive. Karl Alfred Melin (b. 1849) has described in verse the life in the islands of the Stockholm archipelago. Among lyrists who have attracted attention in their various fields are Oskar Levertin (1862–1906) and Emil Kléen (1868–1898). Of these Levertin is the more highly coloured and perfumed, with an almost Oriental richness; Kléen has not been surpassed in the velvety softness of his language. But by far the most original and enjoyable lyrical genius of the later period is that of Gustaf Fröding (b. 1860), whose collection of poems, called *Guitar and Accordion*, humorous, amatory and pathetic, produced a great sensation in 1891. Three other volumes followed in 1894, 1895 and 1897, each displaying to further advantage the versatility and sensuous splendour of Fröding's talent, as well as its somewhat scandalous recklessness. In 1897 he was struck down with insanity, and after three months' confinement in the asylum at Upsala, although he recovered his senses, all his joyousness and wildness had left him. He became gloomily religious, and in a new volume of poems he denounced all that he valued and enjoyed before his conversion. A younger poet is K. G. Ossian-Nilssen (b. 1875), the author of several volumes of vigorous dramatic and satiric verse.

The writer who was exercising most influence in Sweden at the opening of the 20th century was Verner von Heidenstam (b. 1859). He started authorship with a book of verse in 1888, after which time he led a reaction against realism and pessimism, and has turned back to a rich romantic idealism in his novels of *Endymion* (1889) and *Hans Alienus* (1892), and in his stories (1897) of the time of Charles XII. Heidenstam also published interesting volumes of literary criticism, and he is a lyrical poet of very high attainment. Miss Ellen Key (b. 1849), a secularist lecturer of great fervour, became an author in biographical and critical studies of remarkable originality. She is distinguished from Selma Lagerlöf, who is simply an artist, by her exercise of pure intellect; she is a moral leader; she has been called "the Pallas of Sweden." She published in 1897 a biography of the Swedish author, Almqvist; in 1899 she collected her finest essays in the volume called *Thought Pictures*; in 1900 appeared, under the title *Human Beings*, studies of the Brownings and of Goethe; but the finest of Ellen Key's books is *The Century of Childhood* (1901), a philosophical survey of the progress of elementary education in the last hundred years. She exercises a very remarkable power over the minds of the latest generation in Sweden. A polemical essayist of elaborate delicacy of style is Hjalmar Söderberg (b. 1869), who has been influenced by Strindberg and by Anatole

France. His ironic romance, *Martin Birck's Youth*, created a sensation in 1901. Karl Johan Warburg (b. 1852) has done good work both as an essayist and as an historian of literature. But in this latter field by far the most eminent recent name in Swedish literature is that of Professor Johan Henrik Schück (b. 1855), who has made great discoveries in the 16th and 17th centuries, and who has published, besides a good book about Shakespeare, studies in which a profound learning is relieved by elegance of delivery. Warburg and Schück have written an excellent history of Swedish literature down to 1888. The poet Levertin, who was also a distinguished critic, wrote a good book about the Swedish theatre. Drama has rarely flourished in Sweden, but several of the poets mentioned above have written important plays, and, somewhat earlier, the socialistic problem-pieces of Anne Charlotte Edgren-Leffler, duchess of Cajanello (1849–1893), possessed considerable dramatic talent, working under a direct impulse from Ibsen; but her greatest gift was as a novelist. The plays of Harald Johan Molander (1858–1900) have been popular in the theatres of Sweden and Finland since his first success with *Rococo* in 1880. Altogether a remarkable revival of belles-lettres has taken place in Sweden after a long period of inertness and conventionality. It is regrettable, for its own sake, that the Swedish Academy, which in earlier generations had identified itself with the manifestations of original literary genius, has closed its doors to the new writers with an almost vindictive pertinacity.

Swedish Philosophy.—Swedish philosophy proper began in the 17th century with the introduction of Cartesianism. The protagonist of the movement was J. Bilberg (1646–1717), who, in various theses and discussions, defended the new ideas against the scholastic Aristotelianism of the orthodox churchmen. A. Rydelius (1671–1738), an intimate friend of Charles XII., endeavoured to find a common ground for the opposing schools, and the Leibnitzio-Wolffian philosophy was maintained by N. Wallerius (1706–1764). Towards the close of the 18th century, a number of thinkers began to expound the philosophy of the Enlightenment under the influence of English and French ideas—J. H. Kellgren (1751–1795), K. G. af Leopold (1756–1829), T. Thorild (1759–1808), K. A. Ehrensvärd (1745–1800); while the Kantian dialectic was worthily defended by D. Boëthius (1751–1810), whose work paved the way for a great idealistic speculative movement headed by B. Höijer (1767–1812), the poet P. D. A. Atterbom (1790–1855), a follower of Schelling, and J. J. Borelius (b. 1823), the great Swedish exponent of Hegelianism.

All the above thinkers reflected the general development of European thought. There exists, however, a body of thought which is the product of the peculiar genius of the Swedish people, namely, the development of the individual soul in accordance with a coherent social order and a strong religious spirit. This *Personal Philosophy* owes its development to K. J. Boström (*q.v.*), and, though traceable ultimately to Schelling's idealism, received its distinctive character from the investigations of N. F. Biberg (1776–1827), S. Grubbe (1786–1853) and E. G. Geijer (*q.v.*) (1783–1847), all professors at Upsala. Boström's philosophy is logically expressed and based on the one great conception of a spiritual, eternal, immutable Being, whose existence is absolute, above and external to the finite world of time and space. It has for a long time exercised almost unquestioned authority over Swedish thought, religious and philosophical. It is strong in its unequivocal insistence on personal purity and responsibility, and in the uncompromising simplicity of its fundamental principle. Boström wrote little, but his views are to be found in the works of two groups of thinkers. The older group includes S. Ribbing (1816–1899), C. Y. Sahlin (b. 1824), K. Claëson (1827–1859), H. Edfeldt (b. 1836), the editor of Boström's works, A. Nyblaeus (1821–1899) and P. J. H. Leander (b. 1831); the younger writers, less in agreement with one another, but adhering in the main to the same tradition, are E. O. Burman (b. 1845), K. R. Geijer (b. 1849), L. H. Åberg (1851–1895), F. v. Schéele (b. 1853), J. V. A. Norström (b. 1856), of Gothenburg, and P. E. Liljeqvist (b. 1865), of Lund. Of these, Nyblaeus compiled a lucid account of Swedish philosophy from the beginning of the 18th century up to and including Boström; Ribbing (*Platos Ideelära* and *Socratische Studien*) showed how closely Swedish idealism is allied to Greek. P. Wikner (1837–1888) broke away from the Boströmian tradition and followed out a path of his own in a more essentially religious spirit. V. Rydberg (*q.v.*) (1828–1895) closely followed Boström, and in his numerous and varied writings did much to crystallize and extend the principles of idealism. Among prominent modern writers may also be mentioned H. Larsson and A. Herrlin at Lund, and A. Vannerus in Stockholm.

Authorities.—The *Svecia litterata* (1680) of J. Schefferus (1621–1679) is the first serious attempt at a bibliography of Swedish literature. The *Svenska siare och skalder* (Upsala, 1841–1855) contains an admirable series of portraits of Swedish writers up to the end of the reign of Gustavus III.; many of Atterbom's judgments are reversed in the *Grunddragen af Svenska vitterhetens historia* (1866–1868) of B. E. Malmström; and a body of excellent criticism of the subsequent period was supplied by G. Ljunggren in his *Svenska vitterhetens häfder från Gustaf död* (1818–1819; new ed. by Sondén III.'s. 1833), which remains a classic exposition of the views of the romanticists. The history of Swedish letters as it reflects the life of the nation is dealt with by C. R. Nyblom, *Estetiska studier* (Stockholm, 1873–1884). Among general works on the subject, see H. Schück, *Svensk literaturhistoria* (1885, &c.) Schück and Warburg, *Illustrerad Svensk literatur historia* (1896); H. Paul, *Grundriss der germanischen Philologie* (new ed., Strassburg, 1901, &c.). The official handbook of *Sweden* prepared by the Swedish Central Bureau of Statistics for the Paris Exhibition (English ed., Stockholm, 1904); Ph. Schweitzer, *Geschichte der skandinavischen Litteratur*, forming vol. viii. of *Geschichte der Welt Litteratur in Einzeldarstellungen* (Leipzig, 3 pts., 1886–1889); Oscar Levertin, *Svenska Gestalter* 1904. (E. G.)

SWEDENBORG (or Swedberg), **EMANUEL** (1688–1772), Swedish scientist, philosopher and mystic, was born at Stockholm on the 29th of January 1688. His father, Dr Jesper Swedberg, subsequently professor of theology at Upsala and bishop of Skara, was a pious and learned man, who did not escape the charge of heterodoxy, seeing that he placed more emphasis on the cardinal virtues of faith, love and communion with God than on the current dogmas of the Lutheran Church. Having completed his university course at Upsala, in 1710, Swedenborg undertook a European tour, visiting England, Holland, France and Germany, studying especially natural philosophy and writing Latin verses, a collection of which he published in 1710. In 1715 he returned to Upsala, and devoted himself to natural science and various engineering works. From 1716 to 1718 he published a scientific periodical, called *Daedalus hyperboreus*, a record of mechanical and mathematical inventions and discoveries. In 1716 he was introduced to Charles XII., who appointed him assessor-extraordinary on the Swedish board of mines. His reports on smelting and assaying were remarkable for their detail and for the comparisons drawn between Swedish and other methods. Two years later he distinguished himself at the king's siege of Frederikshall by the invention of machines for the transport of boats and galleys overland from Stromstadt to Iddefjord, a distance of 14 m. The same year he published various mathematical and mechanical works. At the death of Charles XII. Queen Ulrica elevated him and his family to the rank of nobility, by which his name was changed from Swedberg to Swedenborg, the "en" corresponding to the German "von." In the Swedish House of Nobles his contributions to political discussion had great influence, and he dealt with such subjects as the currency, the decimal system, the balance of trade and the liquor laws (where he was the pioneer of the Gothenburg system) with marked ability. He strongly opposed a bill for increasing the power of the crown. The next years were devoted to the duties and studies connected with his office, which involved the visitation of the Swedish, Saxon, Bohemian and Austrian mines. In 1724 he was offered the chair of mathematics in the university of Upsala, which he declined, on the ground that it was a mistake for mathematicians to be limited to theory. His inquiring and philosophical mind gradually led him to wider studies. As early as 1721 he was seeking to lay the foundation of a scientific explanation of the universe, when he published his *Prodromus principiorum rerum naturalium*, and had already written his *Principia* in its first form. In 1734 appeared in three volumes (*Opera philosophica et mineralia*, the first volume of which (his *Principia*) contained his view of the first principles of the universe, a curious mechanical and geometrical theory of the origin of things. The other volumes dealt with (*a*) iron and steel, (*b*) copper and brass, their smelting, conversion and assaying, and chemical experiments thereon.

There is no doubt that Swedenborg anticipated many scientific facts and positions that are usually regarded as of much more modern date. It was only towards the end of the 19th century that his voluminous writings began to be properly collected and examined, with the result of proving that there was hardly one department of scientific activity in which he was not far ahead of his time. His work on palaeontology shows him the predecessor of all the Scandinavian geologists, and his contributions in this field alone would have been sufficient to perpetuate his fame. He was also a great physicist and had arrived at the nebular hypothesis theory of the formation of the planets and the sun long before Kant and Laplace. His theory of light and theory of the cosmic atoms were equally astonishing. He wrote a lucid account of the phenomena of phosphorescence, and adduced a molecular magnetic theory which anticipated some of the chief features of the hypothesis of to-day. The great French chemist, Dumas, gives him the credit for the first attempt to establish a system of crystallography. He was the first to employ mercury for the air-pump, and devised a method of determining longitude at sea by observations of the moon among the stars. He suggested the use of experimental tanks for testing the powers of ship models, invented an ear-trumpet for the deaf, improved the common house-stove of his native land, cured smoky chimneys, took a lively interest in machine-guns and even sketched a flying machine.

This flying machine consisted of a light frame covered with strong canvas and provided with two large oars or wings moving on a horizontal axis, and so arranged that the upstroke met with no resistance while the downstroke provided the lifting power. Swedenborg knew that the machine would not fly, but suggested it as a start and was confident that the problem would be solved. He said " It seems easier to talk of such a machine than to put it into actuality, for it requires greater force and less weight than exists in a human body. The science of mechanics might perhaps suggest a means, namely, a strong spiral spring. If these advantages and requisites are observed, perhaps in time to come some one might know how better to utilize our sketch and cause some addition to be made so as to accomplish that which we can only suggest. Yet there are sufficient proofs and examples from nature that such flights can take place without danger, although when the first trials are made you may have to pay for the experience, and not mind an arm or leg."

In 1734 he also published *Prodromus philosophiae ratiocinantis de infinito et causa finali creationis*, which treats of the relation of the finite to the infinite, and of the soul to the body, seeking to establish a nexus in each case as a means of overcoming the difficulty of their relation. From this time he applied himself to the problem of discovering the nature of soul and spirit by means of anatomical studies. In all his researches he acknowledged and contended for the existence and the supremacy of the spiritual and the divine. He travelled in Germany, France and Italy, in quest of the most eminent teachers and the best books dealing with the human frame, and published, as the results of his inquiries among other works, his *Oeconomia regni animalis* (London, 1740–1741) and *Regnum animale* (the Hague, 1744–1745; London, 1745). In no field were Swedenborg's researches more noteworthy than in those of physiological science. In 1901, Professor Max Neuberger of Vienna called attention to certain anticipations of modern views made by Swedenborg in relation to the functions of the brain. The university of Vienna appealed to the Royal Swedish Academy for a complete issue of the scientific treatises, and this resulted in the formation of a committee of experts who have been entrusted with the task. It is clear that Swedenborg showed (150 years before any other scientist) that the motion of the brain was synchronous with the respiration and not with the action of the heart and the circulation of the blood, a discovery the full bearings of which are still far from being realized. He had arrived at the modern conception of the activity of the brain as the combined activity of its individual cells. The cerebral cortex, and, more definitely, the cortical elements (nerve cells), formed the seat of the activity of the soul, and were ordered into departments according to various functions. His views as to the physiological functions of the spinal cord are also in agreement with recent research, and he anticipated many of the pre-eminent offices of the ductless glands which students of the present time are only beginning to discover.

Up to middle age Swedenborg's position was that of a scholar, a scientist, a practical administrator, a legislator, and a man of affairs. But a profound change was coming over him, which led him to leave the domain of physical research for that of psychical and spiritual inquiry. Neither by geometrical, nor physical, nor metaphysical principles had he succeeded in reaching and grasping the infinite and the spiritual, or in elucidating their relation to man and man's organism, though he had caught glimpses of facts and methods which he thought only required confirmation and development. Late in life he wrote to Oetinger that " he was introduced by the Lord first into the natural sciences, and thus prepared, and, indeed, from the year 1710 to 1745, when heaven was opened to him." This latter great event is described by him in a letter to Thomas Hartley, rector of Winwick, as " the opening of his spiritual sight," " the manifestation of the Lord to him in person," " his introduction into the spiritual world." Before his illumination he had been instructed by dreams, and enjoyed extraordinary visions, and heard mysterious conversations. According to his own account, the Lord filled him with His spirit to teach the doctrines of the New Church by the word from Himself; He commissioned him to do this work, opened the sight of his spirit, and so let him into the spiritual world, permitting him to see the heavens and the hells, and to converse with angels and spirits for years; but he never received anything relating to the doctrines of the church from any angel but from the Lord alone while he was reading the word (*True Christian Religion*, No. 779). He elsewhere speaks of his office as principally an opening of the spiritual sense of the word. His friend Robsahm reports, from Swedenborg's own account to him, the circumstances of the first extraordinary revelation of the Lord, when He appeared to him and said, " I am God the Lord, the Creator and Redeemer of the world. I have chosen thee to unfold the spiritual sense of the Holy Scripture. I will Myself dictate to thee what thou shalt write." From that time he gave up all worldly learning and laboured solely to expound spiritual things. In the year 1747, to the great regret of his colleagues, he resigned his post of assessor of the board of mines that he might devote himself to his higher vocation, requesting only to be allowed to receive as a pension the half of his salary. He took up afresh his study of Hebrew, and began his voluminous works on the interpretation of the Scriptures. His life from 1747 was spent alternately in Sweden, Holland and London, in the composition of his works and their publication, till his death, which took place in London on the 29th of March 1772. He was buried in the Swedish church in Princes Square, in the parish of St George's-in-the-East, and on the 7th of April 1908 his remains were removed at the request of the Swedish government to Stockholm.

Swedenborg was a man who won the respect, confidence and love of all who came into contact with him. Though people might disbelieve in his visions, they feared to ridicule them in his presence. Those who talked with him felt that he was truth itself. He never disputed on matters of religion, and if obliged to defend himself, did it with gentleness and in a few words. His manner of life was simple in the extreme; his diet consisted chiefly of bread and milk and large quantities of coffee. He paid no attention to the distinction of day and night, and sometimes lay for days together in a trance, while his servants were often disturbed at night by hearing what he called his conflicts with evil spirits. But his intercourse with spirits was often perfectly calm, in broad daylight, and with all his faculties awake. Three extraordinary instances are produced by his friends and followers in proof of his seership and admission into the unseen world. But there exists no account at first hand of the exact facts, and Swedenborg's own reference to one of these instances admits of another explanation than the supernatural one. Immanuel Kant was struck by them in 1763, but in 1765, after further inquiries, concluded that two of them had " no other foundation than common report (*gemeine Sage*)." See Kehrbach's edition of Kant's *Träume eines Geistersehers* (Leipzig, 1880).

As a theologian Swedenborg never attempted to preach or to found a sect. He believed that members of all the churches could belong to the New Church without forming a separate organization. His theological writings roughly fall into four groups: (1) books of spiritual philosophy, including *The Divine Love and Wisdom*, *The Divine Providence*, *The Intercourse between the Soul and the Body*, *Conjugial Love*; (2) Expository, including *Arcana Celestia* (giving the spiritual sense of Genesis and Exodus), *The Apocalypse Revealed*, *The Apocalypse Explained*; (3) Doctrinal, including *The New Jerusalem and its Heavenly Doctrines*, *The Four Chief Doctrines*, *The Doctrine of Charity*, *The True Christian Religion*, *Canons of the New Church*; (4) Eschatological, including *Heaven and Hell*, and *The Last Judgment*. About forty volumes are available in English, and many have been translated into most of the European languages as well as into Arabic, Hindi and Japanese.

Swedenborg's theosophic system is most briefly and comprehensively presented in his *Divine Love and Wisdom.* The point of view from which God must be regarded is that of His being the Divine Man. His *esse* is infinite love; His manifestation, form or body is infinite wisdom. Divine love is the self-subsisting life of the universe. From God emanates a divine sphere, which appears in the spiritual world as a sun, and from this spiritual sun again proceeds the sun of the natural world. The spiritual sun is the source of love and intelligence, or life, and the natural sun the source of nature or the receptacles of life; the first is alive, the second dead. The two worlds of nature and spirit are perfectly distinct, but they are intimately related by analogous substances, laws and forces. Each has its atmospheres, waters and earths, but in the one they are natural and in the other spiritual. In God there are three infinite and uncreated "degrees" of being, and in man and all things corresponding three degrees, finite and created. They are love, wisdom, use; or end, cause and effect. The final ends of all things are in the Divine Mind, the causes of all things in the spiritual world, and their effects in the natural world. By a love of each degree man comes into conjunction with them and the worlds of nature, spirit and God. The end of creation is that man may have this conjunction and become the image of his Creator and creation. In man are two receptacles for God—the will for divine love and the understanding for divine wisdom—that love and wisdom flowing into both so that they become human. Before the fall this influx was free and unhindered, and the conjunction of man with God and the creation complete, but from that time the connexion was interrupted and God had to interpose by successive dispensations. At last the power and influence of the spirits of darkness, with whom man associates himself by his sin, became so great that the existence of the human race was threatened, and Jehovah was necessitated to descend into nature to restore the connexion between Himself and man. He could not come in His unveiled divinity, for the "hells" would have then perished, whom he did not seek to destroy but only to subjugate. Another purpose of Jehovah's incarnation was the manifestation of His divine love more fully than ever before. Swedenborg wholly rejects the orthodox doctrine of atonement; and the unity of God, as opposed to his idea of the trinity of the church, is an essential feature of his teaching. Another distinctive feature is that Jehovah did not go back to heaven without leaving behind him a visible representative of Himself in the word of the Scripture. This word is an eternal incarnation, with its threefold sense—natural, spiritual, celestial. And Swedenborg is the divinely commissioned expounder of this threefold sense of the word, and so the founder of the New Church, the paraclete of the last dispensation. That he might perceive and understand the spiritual and the celestial senses of the word he enjoyed immediate revelation from the Lord, was admitted into the angelic world, and had committed to him the key of "correspondences" with which to unlock the divine treasures of wisdom. Swedenborg claimed also to have learnt by his admission into the spiritual world the true states of men in the next life, the scenery and occupations of heaven and hell, the true doctrine of Providence, the origin of evil, the sanctity and perpetuity of marriage and to have been a witness of the "last judgment," or the second coming of the Lord, which is a contemporary event. "All religion," he said, "has relation to life, and the life of religion is to do good." "The kingdom of Heaven is a kingdom of uses." He exercised a great influence over S. T. Coleridge, Robert and Elizabeth Browning, Coventry Patmore, Henry Ward Beecher and Thomas Carlyle. And the attention of modern psychologists is now being drawn to his doctrine of the relation of the elements of the universe to the membranes of the body.

Swedenborgianism, as professed by Swedenborg's followers, is based on the belief of Swedenborg's claims to have witnessed the last judgment, or the second advent of the Lord, with the inauguration of the New Church, through the new system of doctrine promulgated by him and derived from the Scriptures, into the true sense of which he was the first to be introduced. The "doctrines" of the New Church as given in the *Liturgy* (which also contains the "Creed" and "Articles of Faith") are as follows:—

1. That there is one God, in whom there is a Divine Trinity; and that He is the Lord Jesus Christ.
2. That a saving faith is to believe on Him.
3. That evils are to be shunned, because they are of the devil and from the devil.
4. That good actions are to be done, because they are of God and from God.
5. That these are to be done by a man as from himself; but that it ought to be believed that they are done from the Lord with him and by him.

Swedenborgians now constitute a widely spread and considerable society, with a regularly constituted ecclesiastical organization and a zealous missionary activity (see New Jerusalem Church).

See R. L. Tafel, *Documents concerning the Life and Character of Swedenborg*, collected, translated and annotated (3 vols., Swedenborg Society, 1875–1877); J. Hyde, *A Bibliography of the Works of Emanuel Swedenborg* (743 pp., Swedenborg Society). Of English lives the principal are those by J. J. G. Wilkinson (London, 1849); E. Paxton Hood (London, 1854); William White (1856, rewritten in 1867 and in 1868); G. Trobridge (London, 1907); also *Emanuel Swedenborg, the Spiritual Columbus, a Sketch*, by U. S. E. (2nd ed., London, 1877). Some of his writings, *e.g. The Divine Providence* and *Heaven and Hell* have been published in popular editions. A useful handbook of Swedenborg's theology is the *Compendium of the Theological Writings of Emanuel Swedenborg* by the Rev. Samuel Warren (London, 1885). Summaries of his system and writings are given in all the above biographies, also in Edmund Swift, *Manual of the Doctrines of the New Church* (London, 1885); and T. Parsons, *Outlines of Swedenborg's Religion and Philosophy*. Important critiques from independent points of view are "The Mystic," in R. W. Emerson's *Representative Men* (1850); Kant's *Träume eines Geistersehers* (1766; the best edition by Kehrbach, Leipzig, 1880); J. G. Herder's "Emanuel Swedenborg," in his *Adrastea* (*Werke zur Phil. und Gesch.*, xii. 110–125); J. J. von Goerres's *Emanuel Swedenborg, seine Visionen und sein Verhältniss zur Kirche* (1827); A. Dorner's *Geschichte der protestantischen Theologie*, pp. 662–667 (Munich, 1867). See also *Transactions of the International Swedenborg Congress* (London, 1910), summarized in *The New Church Magazine* (August, 1910). (A. J. G.)

SWEETBREAD, a popular term for certain glands of animals, particularly when used as articles of food; these are usually the pancreas, the "stomach-sweetbread" of butchers, and the thymus, or "breast sweetbread." The term is also sometimes used to include the salivary and lymphatic glands (see Ductless Glands, Pancreas and Lymphatic System).

SWEET POTATO. This plant, known botanically as *Ipomaea batatas* (formerly as *Convolvulus batatas*), and a member of the natural order Convolvulaceae, is generally cultivated in most tropical countries for the sake of its tuberous root, which is an article of diet greatly in request. It is a climbing perennial with entire or palmately-lobed leaves very variable in shape borne on slender twining stems. The flowers are borne on long stalks in loose clusters or cymes, and have a white or rosy funnel-shaped corolla like that of the common bindweed of English hedges. The edible portion is the root, which dilates into large club-shaped masses filled with starch. It is ill suited to the climate of the United Kingdom, but in tropical countries it is as valuable as the potato is in higher latitudes. The plant is not known in a truly wild state, nor has its origin been ascertained. A. de Candolle concludes that it is in all probability of American origin, where it has been cultivated from prehistoric times by the aborigines. It is mentioned by Gerard as the "potato," or "potatus" or "potades," in contradistinction to the "potatoes" of Virginia (*Solanum tuberosum*). He grew it in his garden, but the climate was not warm enough to allow it to flower, and in winter it perished and rotted. But as the appellation "common" is applied to them the roots must have been introduced commonly. Gerard tells us he bought those that he planted at "the Exchange in London," and he gives an interesting account of the uses to which they were put, the manner in which they were prepared as "sweetmeats," and the invigorating properties assigned to them. The allusions in the *Merry Wives of Windsor* and other of Shakespeare's plays in all probability refer to this plant, and not to what we now call the "potato." The plants require a warm sunny climate, long season, and a liberal supply of water during the growing season. For an account of the cultivation in North America, where large quantities are grown in the Southern states, see L. H. Bailey, *Cyclopaedia of American Horticulture* (1902). Sir George Watt, *Dictionary of the Economic Products of India* (1890), gives an account of its cultivation in India, where some confusion has arisen by the use of the name batatas for the yam (*q.v.*); the author suggests that the introduction of the sweet potato into India is comparatively recent.

SWEET-SOP, or Sugar Apple, botanical name *Anona squamosa*, a small tree or shrub with thin oblong-ovate leaves, solitary greenish flowers and a yellowish-green fruit, like a shortened pine cone in shape with a tubercle corresponding to each of the carpels from the aggregation of which it has been formed. The fruit is 3 to 4 in. in diameter and contains a sweet creamy-yellow custard-like pulp. It is a native of the West Indies and tropical America; it is much prized as a fruit, and has been widely introduced into the eastern hemisphere.

Another species, *A. muricala*, is the sour-sop, a small evergreen tree bearing a larger dark-green fruit, 6 to 8 in. long and 1 to 5 lb in weight, oblong or bluntly conical in shape, with a rough spiny skin and containing a soft white juicy subacid pulp with a flavour of turpentine. It is a popular fruit in the West Indies, where it is native, and is grown with special excellence in Porto Rico. A drink is made from the juice. *A. reticulata* is the custard apple (*q.v.*) and *A. palustris* the alligator apple.

SWELLENDAM, a town of South Africa, Cape province, in the valley of the Breede River, 192 m. by rail E. by S. of Cape Town. Pop. (1904), 2406, of whom 1139 were white. Swellendam is one of the older Dutch settlements in the Cape, dating from 1745, and was named after Hendrik Swellengrebel (then governor of the Cape) and his wife, whose maiden name was Damme. Early in 1795 the burghers of the town and district rose in revolt against the Dutch East India Company, proclaimed a "free republic," and elected a so-styled national assembly. At the same time the burghers of Graaff Reinet also rebelled against the Cape authorities, who were powerless to suppress the insurrectionary movement. One of the claims of the "free republic" was "the absolute and unconditional slavery of all Hottentots and Bushmen." In September of that year Cape Town surrendered to the British and the "National" party at Swellendam quietly accepted British rule.

The town is a trading centre of some importance, and in the surrounding district are large sheep and ostrich farms. The neighbourhood is noted for its abundance of everlasting flowers.

SWETCHINE, MADAME (1782–1857), Russian mystic, whose maiden name was Soymanof, was born in Moscow, and under the influence of Joseph de Maistre became a member of the Roman Catholic Church in 1815. In the following year she settled in Paris where, until her death, she maintained a famous salon remarkable no less for its high courtesy and intellectual brilliance than for its religious atmosphere. Though not physically beautiful she had a personality of rare spiritual charm, nurtured in the private chapel of her house. Her husband, General Swetchine, was 25 years her senior. Her *Life and Works* (of which the best known are "Old Age" and "Resignation") were published by M. de Falloux (2 vols., 1860) and her *Letters* by the same editor (2 vols., 1861).

See Sainte-Beuve, *Nouveaux lundis*, vol. i.; and E. Scherer, *Études sur la littérature contemporaine*, vol. i.

SWEYN I., King of Denmark (–1014), son of Harold Bluetooth, the christianizer of Denmark, by his peasant mistress Aesa, according to the Jomsvikinga Saga, though more probably his mother was Queen Gunild, Harold's consort. The lad was a born champion and buccaneer. His first military expedition, in alliance with the celebrated Jomsborg Viking, Palnatoke, was against his own father, who perished during the struggle (*c.* 986). Six years later he conducted a large fleet of warships to England, which did infinite damage, but failed to capture London. During his absence, Denmark was temporarily occupied by the Swedish king, Eric Sersel, on whose death (*c.* 994) Sweyn recovered his patrimony. About the same time he repudiated his first wife Gunild, daughter of duke Mieszko of Poland, and married King Eric's widow, Sigrid. This lady was a fanatical pagan of a disquieting strength of character. Two viceroys, earlier wooers, were burned to death by her orders for their impertinence, and she refused the hand of Olaf Trygvessön, king of Norway, rather than submit to baptism, whereupon the indignant monarch struck her on the mouth with his gauntlet and told her she was a worse pagan than any dog. Shortly afterwards she married Sweyn, and easily persuaded her warlike husband to unite with Olaf, king of Sweden, against Olaf Trygvessön, who fell in the famous sea-fight off Svolde (1000) on the west coast of Rügen, after a heroic resistance immortalized by the sagas, whereupon the confederates divided his kingdom between them. After his first English expedition Sweyn was content to blackmail England instead of ravaging it, till the ruthless massacre of the Danes on St Brice's day, the 3rd of November 1002, by Ethelred the Unready (Sweyn's sister was among the victims) brought the Danish king to Exeter (1003). During each of the following eleven years, the Danes, materially assisted by the universal and shameless disloyalty of the Saxon ealdormen, systematically ravaged England, and from 991 to 1014 the wretched land is said to have paid its invaders in ransoms alone £158,000. Sweyn died suddenly at Gainsborough on the 13th of February 1014. The data relating to his whole history are scanty and obscure, and his memory has suffered materially from the fact that the chief chroniclers of his deeds and misdeeds were ecclesiastics. It was certainly unfortunate that he began life by attacking his own father. It is undeniable that his favourite wife was the most stiff-necked pagan of her day. His most remarkable exploit, Svolde, was certainly won at the expense of Christianity, resulting, as it did, in the death of the saintly Olaf. Small wonder, then, if Adam of Bremen, and the monkish annalists who follow him, describe Sweyn as a grim and bloody semi-pagan, perpetually warring against Christian states. But there is another side to the picture. Viking though he was, Sweyn was certainly a Christian viking. We know that he built churches; that he invited English bishops to settle in Denmark (notably Godibald, who did good work in Scania); that on his death-bed he earnestly commended the Christian cause to his son Canute. He was cruel to his enemies no doubt, but he never forgot a benefit. Thus he rewarded the patriotism of the Danish ladies who sacrificed all their jewels to pay the heavy ransom exacted from him by his captors, the Jomsborg pirates, by enacting a law whereby women were henceforth to inherit landed property in the same way as their male relatives. Of his valour as a captain and his capacity as an administrator there can be no question. His comrades adored him for his liberality, and the frequent visits of Icelandic skalder to his court testify to a love of poetry on his part, indeed one of his own strophes has come down to us. As to his personal appearance we only know that he had a long cleft beard, whence his nickname of *Tiugeskaeg* or Fork-Beard.

See *Danmarks riges historie. Oldtiden og den ældre middelalder*, pp. 364–381 (Copenhagen, 1897–1905). (R. N. B.)

SWIFT, JONATHAN (1667–1745), dean of St Patrick's, Dublin, British satirist, was born at No. 7 Hoey's Court, Dublin, on the 30th of November 1667, a few months after the death of his father, Jonathan Swift (1640–1667), who married about 1664 Abigaile Erick, of an old Leicestershire family. He was taken over to England as an infant and nursed at Whitehaven, whence he returned to Ireland in his fourth year. His grandfather, Thomas Swift, vicar of Goodrich near Ross, appears to have been a doughty member of the church militant, who lost his possessions by taking the losing side in the Civil War and died in 1658 before the restoration could bring him redress. He married Elizabeth, niece of Sir Erasmus Dryden, the poet's grandfather. Hence the familiarity of the poet's well-known "cooling-card" to the budding genius of his kinsman Jonathan: "Cousin Swift, you will never be a poet." The young Jonathan was educated mainly at the charges of his uncle Godwin, a Tipperary official, who was thought to dole out his help in a somewhat grudging manner. In fact the apparently prosperous relative was the victim of unfortunate speculations, and chose rather to be reproached with avarice than with imprudence. The youth was resentful of what he regarded as curmudgeonly treatment, a bitterness became ingrained and began to corrode his whole nature; and although he came in time to grasp the real state of the case he never mentioned his uncle with kindness or regard. At six he went to Kilkenny School, where Congreve was a schoolfellow; at fourteen he entered pensioner at Trinity College, Dublin, where he seems to have neglected his opportunities. He was referred in natural philosophy, including mathematics, and obtained his degree only by a special but by no means infrequent act of indulgence. The patronage of his uncle galled him: he was dull and unhappy. We find in Swift few signs of precocious genius. As with Goldsmith, and so many other men who have become artists of the pen, college proved a stepmother to him.

In 1688 the rich uncle, whose supposed riches had dwindled so much that at his death he was almost insolvent, died, having decayed, it would seem, not less in mind than in body and estate, and Swift sought counsel of his mother at Leicester. After a brief residence with his mother, who was needlessly alarmed at the idea of her son falling a victim to some casual coquette, Swift towards the close of 1689 entered upon an engagement as secretary to Sir William Temple, whose wife (Dorothy Osborne) was distantly related to Mrs Swift. It was at Moor Park, near Farnham, the residence to which Temple had retired to cultivate apricots after the rapid decline of his influence during the critical period of Charles II.'s reign (1679–1681), that Swift's acquaintance with Esther Johnson, the "Stella" of the famous *Journal*, was begun. Stella's mother was living at Moor Park, as servant or *dame de compagnie* of Temple's strong-minded sister, Lady Giffard. Swift was twenty-two and Esther eight years old at the time, and a curious friendship sprang up between them. He taught the little girl how to write and gave her advice in reading. On his arrival at Moor Park, Swift was, in his own words, a raw, inexperienced youth, and his duties were merely those of account-keeper and amanuensis: his ability gradually won him the confidence of his employer, and he was entrusted with some important missions. He was introduced to William III. during that monarch's visit to Sir William's, and on one occasion accompanied the king in his walks round the grounds. In 1693 Temple sent him to try and convince the king of the inevitable necessity of triennial parliaments. William remained unconvinced and Swift's vanity received a useful lesson. The king had previously taught him "how to cut asparagus after the Dutch fashion." Next year, however, Swift (who had in the meantime obtained the degree of M.A. *ad eundem* at Oxford) quitted Temple, who had, he considered, delayed too long in obtaining him preferment. A certificate of conduct while under Temple's roof was required by all the Irish bishops he consulted before they would proceed in the matter of his ordination, and after five months' delay, caused by wounded pride, Swift had to kiss the rod and solicit in obsequious terms the favour of a testimonial from his discarded patron. Forgiveness was easy to a man of Temple's elevation and temperament, and he not only despatched the necessary recommendation but added a personal request which obtained for Swift the small prebend of Kilroot near Belfast (January 1695), where the new incumbent carried on a premature flirtation with a Miss Jane Waring, whom he called "Varina." In the spring of 1696 he asked the reluctant Varina to wait until he was in a position to marry. Just four years later he wrote to her in terms of such calculated harshness and imposed such conditions as to make further intercourse virtually impossible.

In the meantime he had grown tired of Irish life and was glad to accept Temple's proposal for his return to Moor Park, where he continued until Temple's death in January 1699. During this period he wrote much and burned most of what he had written. He read and learned even more than he wrote. Moor Park took him away from brooding and glooming in Ireland and brought him into the corridor of contemporary history, an intimate acquaintance with which became the chief passion of Swift's life. His *Pindaric Odes*, written at this period or earlier, in the manner of Cowley, indicate the rudiments of a real satirist, but a satirist struggling with a most uncongenial form of expression. Of more importance was his first essay in satiric prose which arose directly from the position which he occupied as domestic author in the Temple household. Sir William had in 1692 published his *Essay upon Ancient and Modern Learning*, transplanting to England a controversy begun in France by Fontenelle. Incidentally Temple had cited the letters of Phalaris as evidence of the superiority of the Ancients over the Moderns. Temple's praise of Phalaris led to an Oxford edition of the *Epistles* nominally edited by Charles Boyle. While this was preparing, William Wotton, in 1694, wrote his *Reflections upon Ancient and Modern Learning*, traversing Temple's general conclusions. Swift's *Battle of the Books* was written in 1697 expressly to refute this. Boyle's *Vindication* and Bentley's refutation of the authenticity of Phalaris came later. Swift's aim was limited to co-operation in what was then deemed the well-deserved putting down of Bentley by Boyle, with a view to which he represented Bentley and Wotton as the representatives of modern pedantry, transfixed by Boyle in a suit of armour given him by the gods as the representative of the "two noblest of things, sweetness and light." The satire remained unpublished until 1704, when it was issued along with *The Tale of a Tub*. Next year Wotton declared that Swift had borrowed his *Combat des livres* from the *Histoire poëtique de la guerre nouvellement déclarée entre les anciens et les modernes* (Paris, 1688). He might have derived the idea of a battle from the French title, but the resemblances and parallels between the two books are slight. Swift was manifestly extremely imperfectly acquainted with the facts of the case at issue. Such data as he displays may well have been derived from no authority more recondite than Temple's own essay.

In addition to £100, Temple left to Swift the trust and profit of publishing his posthumous writings. Five volumes appeared in 1700, 1703 and 1709. The resulting profit was small, and Swift's editorial duties brought him into acrimonious relation with Lady Giffard. The dedication to King William was to have procured Swift an English prebend, but this miscarried owing to the negligence or indifference of Henry Sidney, earl of Romney. Swift then accepted an offer from Lord Berkeley, who in the summer of 1699 was appointed one of the lords justices of Ireland. Swift was to be his chaplain and secretary, but upon reaching Ireland Berkeley gave the secretaryship to a Mr Bushe, who had persuaded him that it was an unfit post for a clergyman. The rich deanery of Derry then became vacant and Swift applied for it. The secretary had already accepted a bribe, but Swift was informed that he might still have the place for £1000. With bitter indignation Swift denounced the simony and threw up his chaplaincy, but he was ultimately reconciled to Berkeley by the presentation to the rectory of Agher in Meath with the united vicarages of Laracor and Rathbeggan, to which was added the prebend of Dunlavin in St Patrick's—the total value being about £230 a year. He was now often in Dublin, at most twenty miles distant, and through Lady Berkeley and her daughters he became the familiar and chartered satirist of the fashionable society there. At Laracor, near Trim, Swift rebuilt the parsonage, made a fish-pond, and planted a garden with poplars and willows, bordering a canal. His congregation consisted of about fifteen persons, "most of them gentle and all of them simple." He read prayers on Wednesdays and Fridays to himself and his clerk, beginning the exhortation "Dearly beloved Roger, the Scripture moveth you and me in sundry places." But he soon began to grow tired of Ireland again and to pay visits in Leicester and London. The author of the *Tale of a Tub*, which he had had by him since 1696 or 1698, must have felt conscious of powers capable of far more effective exercise than reading-desk or pulpit at Laracor could supply; and his resolution to exchange divinity for politics must appear fully justified by the result. The *Discourse on the Dissensions in Athens and Rome* (September 1701), written to repel the tactics of the Tory commons in their attack on the Partition Treaties "without humour and without satire," and intended as a dissuasive from the pending impeachment of Somers, Orford, Halifax and Portland, received the honour, extraordinary for the maiden publication of a young politician, of being generally attributed to Somers himself or to Burnet, the latter of whom found a public disavowal necessary. In April or May 1704 appeared a more remarkable work. Clearness, cogency, masculine simplicity of diction, are conspicuous in the pamphlet, but true creative power told the *Tale of a Tub*. "Good God! what a genius I had when I wrote that book!" was his own exclamation in his latter years. It is, indeed, if not the most amusing of Swift's satirical works, the most strikingly original, and the one in which the compass of his powers is most fully displayed. In his kindred productions he relies mainly upon a single element of the humorous—logical sequence and unruffled gravity bridling in an otherwise frantic absurdity, and investing it with an air of sense. In the *Tale of a Tub* he lashes out in all directions. The humour, if less cogent and cumulative, is richer and more varied; the invention, too, is more daringly original and more completely out of the reach of ordinary faculties. The supernatural coats and the quintessential loaf may be paralleled but cannot be surpassed; and the book is throughout a mine of suggestiveness, as, for example, in the anticipation of Carlyle's clothes philosophy within the compass of a few lines. At the same time it wants unity and coherence, it attains no conclusion, and the author abuses his digressive method of composition and his convenient fiction of hiatuses in the original manuscript. The charges it occasioned of profanity and irreverence were natural, but groundless. There is nothing in the book inconsistent with Swift's professed and real character as a sturdy Church of England parson, who accepted the doctrines of his Church as an essential constituent of the social order around him, battled for them with the fidelity of a soldier defending his colours, and held it no part of his duty to understand, interpret, or assimilate them.

In February 1701 Swift took his D.D. degree at Dublin, and before the close of the year he had taken a step destined to exercise a most important influence on his life, by inviting two ladies to Laracor. Esther, daughter of a merchant named Edward Johnson, a dependant, and legatee to a small amount, of Sir William Temple's (born in March 1680), whose acquaintance he had made at Moor Park in 1689, and whom he has immortalized as "Stella,"[1] came over with her companion Rebecca Dingley, a poor relative of the Temple family, and was soon permanently domiciled in his neighbourhood. The melancholy tale of Swift's attachment will be more conveniently narrated in another place, and is only alluded to here for the sake of chronology. Meanwhile the sphere of his intimacies was rapidly widening. He had been in England for three years together, 1701 to 1704, and counted Pope, Steele and Addison among his friends. The success of his pamphlet gained him ready access to all Whig circles; but already his confidence in that party was shaken, and he was beginning to meditate that change of sides which has drawn down upon him so much but such unjustifiable obloquy. The true state of the case may easily be collected from his next publications—*The Sentiments of a Church of England Man*, and *On the Reasonableness of a Test* (1708). The vital differences among the friends of the Hanover succession were not political, but ecclesiastical. From this point of view Swift's sympathies were entirely with the Tories. As a minister of the Church he felt his duty and his interest equally concerned in the support of her cause; nor could he fail to discover the inevitable tendency of Whig doctrines, whatever caresses individual Whigs might bestow on individual clergymen, to abase the Establishment as a corporation. He sincerely believed that the ultimate purpose of freethinkers was to escape from moral restraints, and he had an unreasoning antipathy to Scotch Presbyterians and English Dissenters. If Whiggism could be proved to entail Dissent, he was prepared to abandon it. One of his pamphlets, written about this time, contains his recipe for the promotion of religion, and is of itself a sufficient testimony to the extreme materialism of his views. Censorships and penalties are among the means he recommends. His pen was exerted to better purpose in the most consummate example of his irony, the *Argument to prove that the abolishing of Christianity in England may, as things now stand, be attended with some inconveniencies* (1708). About this time, too (November 1707), he produced his best narrative poem, *Baucis and Philemon*, while the next few months witnessed one of the most amusing hoaxes ever perpetrated against the quackery of astrologers. In his *Almanac* for 1707 a Protestant alarmist and plot vaticinator styled John Partridge warned customers against rivals and impostors. This notice attracted Swift's attention, and in January 1708 he issued predictions for the ensuing year by Isaac Bickerstaff, written to prevent the people of England being imposed upon by vulgar almanac makers. In this brochure he predicts solemnly that on the 29th of March at 11 o'clock at night Partridge the almanac maker should infallibly die of a raging fever. On the 30th of March he issued a letter confirming Partridge's sad fate. Grub Street elegies on the almanac maker were hawked about London. Partridge was widely deplored in obituary notices and his name was struck off the rolls at Stationers' Hall. The poor man was obliged to issue a special almanac to assure his clients and the public that he was not dead: he was fatuous enough to add that he was not only alive at the time of writing, but that he was also demonstrably alive on the day when the knave Bickerstaff (a name borrowed by Swift from a sign in Long Acre) asserted that he died of fever. This elicited Swift's most amusing *Vindication of Isaac Bickerstaff Esq.* in April 1709. The laughter thus provoked extinguished the *Predictions* for three years, and in 1715 Partridge died in fact; but the episode left a permanent trace in classic literature, for when in 1709 Steele was to start the *Tatler*, it occurred to him that he could secure the public ear in no surer way than by adopting the name of Bickerstaff.

From February 1708 to April 1709 Swift was in London, urging upon the Godolphin administration the claims of the Irish clergy to the first-fruits and twentieths ("Queen Anne's Bounty"), which brought in about £2500 a year, already granted to their brethren in England.[2] His having been selected for such a commission shows that he was not yet regarded as a deserter from the Whigs, although the ill success of his representations probably helped to make him one. By November 1710 he was again domiciled in London, and writing his *Journal to Stella*, that unique exemplar of a giant's playfulness, "which was written for one person's private pleasure and has had indestructible attractiveness for every one since." In the first pages of this marvellously minute record of a busy life we find him depicting the decline of Whig credit and complaining of the cold reception accorded him by Godolphin, whose penetration had doubtless detected the precariousness of his allegiance. Within a few weeks he had become the lampooner of the fallen treasurer, the bosom friend of Oxford and Bolingbroke, and the writer of the *Examiner*, a journal established as the exponent of Tory views (November 1710). He was now a power in the state, the intimate friend and recognized equal of the first writers of the day, the associate of ministers on a footing of perfect cordiality and familiarity. "We were determined to have you," said Bolingbroke to him afterwards; "you were the only one we were afraid of." He gained his point respecting the Irish endowments; and, by his own account, his credit procured the fortune of more than forty deserving or undeserving clients. The envious but graphic description of his demeanour conveyed to us by Bishop Kennet attests the real dignity of his position no less than the airs he thought fit to assume in consequence. The cheerful, almost jovial, tone of his letters to Stella evinces his full contentment, nor was he one to be moved to gratitude for small mercies. He had it, in fact, fully in his own power to determine his relations with the ministry, and he would be satisfied with nothing short of familiar and ostentatious equality. His advent marks a new era in English political life, the age of public opinion, created indeed by the circumstances of the time, but powerfully fostered and accelerated by him. By a strange but not infrequent irony of fate the most imperious and despotic spirit of his day laboured to enthrone a power which, had he himself been in authority, he would have utterly detested and despised. For a brief time he seemed to resume the whole power of the English press in his own pen and to guide public opinion as he would. His services to his party as writer of the *Examiner*, which he quitted in July 1711, were even surpassed by those which he rendered as the author of telling pamphlets, among which *The Conduct of the Allies and of the Late Ministry, in beginning and carrying on the Present War, and Remarks on the Barrier Treaty* (November and December 1711) hold the first rank. In truth, however, he was lifted by the wave he seemed to command. Surfeited with glory,

[1] The name "Stella" is simply a translation of Esther. Swift may have learned that Esther means "star" from the *Elementa linguae persicae* of John Greaves or from some Persian scholar; but he is more likely to have seen the etymology in the form given from Jewish sources in Buxtorf's *Lexicon*, where the interpretation takes the more suggestive form "Stella Veneris."

[2] The grant of the first-fruits was to be made contingent on a concession from the Irish clergy in the shape of the abolition of the sacramental test. This Swift would not agree to. He ultimately won his point from Harley, and his success marks his open rupture with the Whigs.

which it began, after Malplaquet, to think might be purchased at too heavy a cost, the nation wanted a convenient excuse for relinquishing a burdensome war, which the great military genius of the age was suspected of prolonging to fill his pockets. The Whigs had been long in office. The High Church party had derived great strength from the Sacheverell trial. Swift did not bring about the revolution with which, notwithstanding, he associated his name. There seems no reason to suppose that he was consulted respecting the great Tory strokes of the creation of the twelve new peers and the dismissal of Marlborough (December 1711), but they would hardly have been ventured upon if *The Conduct of the Allies* and the *Examiners* had not prepared the way. A scarcely less important service was rendered to the ministry by his *Letter to the October Club*, artfully composed to soothe the impatience of Harley's extreme followers. He had every claim to the highest preferment that ministers could give him, but his own pride and prejudice in high places stood in his way.

Generous men like Oxford and Bolingbroke cannot have been unwilling to reward so serviceable a friend, especially when their own interest lay in keeping him in England. Harley by this time was losing influence and was becoming chronically incapable of any sustained effort. Swift was naturally a little sore at seeing the see of Hereford slipping through his fingers. He had already lost Waterford owing to the prejudice against making the author of the *Tale of a Tub* a bishop, and he still had formidable antagonists in the archbishop of York, whom he had scandalized, and the duchess of Somerset, whom he had satirized. Anne was particularly amenable to the influence of priestly and female favourites, and it must be considered a proof of the strong interest made for Swift that she was eventually persuaded to appoint him to the deanery of St Patrick's, Dublin, vacant by the removal of Bishop Sterne to Dromore. It is to his honour that he never speaks of the queen with resentment or bitterness. In June 1713 he set out to take possession of his dignity, and encountered a very cold reception from the Dublin public. The dissensions between the chiefs of his party speedily recalled him to England. He found affairs in a desperate condition. The queen's demise was evidently at hand, and the same instinctive good sense which had ranged the nation on the side of the Tories, when Tories alone could terminate a fatiguing war, rendered it Whig when Tories manifestly could not be trusted to maintain the Protestant succession. In any event the occupants of office could merely have had the choice of risking their heads in an attempt to exclude the elector of Hanover, or of waiting patiently till he should come and eject them from their posts; yet they might have remained formidable could they have remained united. To the indignation with which he regarded Oxford's refusal to advance him in the peerage the active St John added an old disgust at the treasurer's pedantic and dilatory formalism, as well as his evident propensity, while leaving his colleague the fatigues, to engross for himself the chief credit of the administration. Their schemes of policy diverged as widely as their characters: Bolingbroke's brain teemed with the wildest plans, which Oxford might have more effectually discountenanced had he been prepared with anything in their place. Swift's endeavours after an accommodation were as fruitless as unremitting. His mortification was little likely to temper the habitual virulence of his pen, which rarely produced anything more acrimonious than the attacks he at this period directed against Burnet and his former friend Steele. One of his pamphlets against the latter (*The Public Spirit of the Whigs set forth in their Generous Encouragement of the Author of the Crisis*, 1714) was near involving him in a prosecution, some invectives against the Scottish peers having proved so exasperating to Argyll and others that they repaired to the queen to demand the punishment of the author, of whose identity there could be no doubt, although, like all Swift's writings, except the *Proposal for the Extension of Religion*, the pamphlet had been published anonymously. The immediate withdrawal of the offensive passage, and a sham prosecution instituted against the printer, extricated Swift from his danger.

Meanwhile the crisis had arrived, and the discord of Oxford and Bolingbroke had become patent to all the nation. Foreseeing, as is probable, the impending fall of the former, Swift retired to Upper Letcombe, in Berkshire, and there spent some weeks in the strictest seclusion. This leisure was occupied in the composition of his remarkable pamphlet, *Some Free Thoughts on the Present State of Affairs*, which indicates his complete conversion to the bold policy of Bolingbroke. The utter exclusion of Whigs as well as Dissenters from office, the remodelling of the army, the imposition of the most rigid restraints on the heir to the throne—such were the measures which, by recommending, Swift tacitly admitted to be necessary to the triumph of his party. If he were serious, it can only be said that the desperation of his circumstances had momentarily troubled the lucidity of his understanding; if the pamphlet were merely intended as a feeler after public opinion, it is surprising that he did not perceive how irretrievably he was ruining his friends in the eyes of all moderate men. Bolingbroke's daring spirit, however, recoiled from no extreme, and, fortunately for Swift, he added so much of his own to the latter's MS. that the production was first delayed and then, upon the news of Anne's death, immediately suppressed. This incident but just anticipated the revolution which, after Bolingbroke had enjoyed a three days' triumph over Oxford, drove him into exile and prostrated his party, but enabled Swift to perform the noblest action of his life. Almost the first acts of Bolingbroke's ephemeral premiership were to order him a thousand pounds from the exchequer and despatch him the most flattering invitations. The same post brought a letter from Oxford, soliciting Swift's company in his retirement; and, to the latter's immortal honour, he hesitated not an instant in preferring the solace of his friend to the offers of St John. When, a few days afterwards, Oxford was in prison and in danger of his life, Swift begged to share his captivity; and it was only on the offer being declined that he finally directed his steps towards Ireland, where he was very ill received. The draft on the exchequer was intercepted by the queen's death.

These four busy years of Swift's London life had not been entirely engrossed by politics. First as the associate of Steele, with whom he quarrelled, and of Addison, whose esteem for him survived all differences, afterwards as the intimate comrade of Pope and Arbuthnot, the friend of Congreve and Atterbury, Parnell and Gay, he entered deeply into the literary life of the period. He was treasurer and a leading member of the Brothers, a society of wits and statesmen which recalls the days of Horace and Maecenas. He promoted the subscription for Pope's *Homer*, contributed some numbers to the *Tatler*, *Spectator*, and *Intelligencer*, and joined with Pope and Arbuthnot in establishing the Scriblerus Club, writing *Martinus Scriblerus*, his share in which can have been but small, as well as *John Bull*, where the chapter recommending the education of all blue-eyed children in depravity for the public good must surely be his. His miscellanies, in some of which his satire made the nearest approach perhaps ever made to the methods of physical force, such as *A Meditation upon a Broomstick*, and the poems *Sid Hamet's Rod*, *The City Shower*, *The Windsor Prophecy*, *The Prediction of Merlin*, and *The History of Vanbrugh's House*, belong to this period. A more laboured work, his *Proposal for Correcting, Improving and Ascertaining the English Tongue* (1712), in a letter to Harley, suggesting the regulation of the English language by an academy, is chiefly remarkable as a proof of the deference paid to French taste by the most original English writer of his day. His *History of the Four Last Years of the Reign of Queen Anne* is not on a level with his other political writings. To sum up the incidents of this eventful period of his life, it was during it that he lost his mother, always loved and dutifully honoured, by death; his sister had been estranged from him some years before by an imprudent marriage, which, though making her a liberal allowance, he never forgave.

The change from London to Dublin can seldom be an agreeable one. To Swift it meant for the time the fall from unique authority to absolute insignificance. All share in the administration of even Irish affairs was denied him; every politician shunned him; and his society hardly included a single author or wit. He "continued in the greatest privacy" and "began to think of death." At a later period he talked of "dying of rage, like a poisoned rat in a hole"; for some time, however, he was buoyed up by feeble hopes of a restoration to England. So late as 1726 he was in England making overtures to Walpole, but he had no claim on ministerial goodwill, and as an opponent he had by that time done his worst. By an especial cruelty of fate, what should have been the comfort became the bane of his existence. We have already mentioned his invitation of Esther Johnson and Mrs Dingley to Ireland. Both before and after his elevation to the deanery of St Patrick's these ladies continued to reside near him, and superintended his household during his absence in London. He had offered no obstacle in 1704 to a match proposed for Stella to Dr William Tisdall of Dublin, and, with his evident delight in the society of the dark-haired, bright-eyed, witty beauty—a model, if we may take his word, of all that woman should be—it seemed unaccountable that he did not secure it to himself by the expedient of matrimony. A constitutional infirmity has been suggested as the reason, and the conjecture derives support from several peculiarities in his writings. But, whatever the cause, his conduct proved none the less the fatal embitterment of his life and Stella's and yet another's. He had always been unlucky in his relations with the fair sex. In 1695 he had idealized "Varina." Varina was avenged by Vanessa, who pursued Swift to far other purpose. Esther Vanhomrigh (b. February 14, 1690), the daughter of a Dublin merchant of Dutch origin, who died in 1703 leaving £16,000, had become known to Swift at the height of his political influence. He lodged close to her mother, was introduced to the family by Sir A. Fountaine in 1708 and became an intimate of the house. Vanessa insensibly became his pupil, and he insensibly became the object of her impassioned affection. Her letters reveal a spirit full of ardour and enthusiasm, and warped by that perverse bent which leads so many women to prefer a tyrant to a companion. Swift, on the other hand, was devoid of passion. Of friendship, even of tender regard, he was fully capable, but not of love. The spiritual realm, whether in divine or earthly things, was a region closed to him, where he had never set foot. As a friend he must have greatly preferred Stella to Vanessa. Marriage was out of the question with him, and, judged in the light of Stella's dignity and womanliness, this ardent and unreasoning display of passion was beyond comprehension. But Vanessa assailed him on a very weak side. The strongest of all his instincts was the thirst for imperious domination. Vanessa hugged the fetters to which Stella merely submitted. Flattered to excess by her surrender, yet conscious of his binding obligations and his real preference, he could neither discard the one beauty nor desert the other. It is humiliating to human strength and consoling to human weakness to find the Titan behaving like the least resolute of mortals, seeking refuge in temporizing, in evasion, in fortuitious circumstance. He no doubt trusted that his removal to Dublin would bring relief, but here again his evil star interposed. Vanessa's mother died (1714), and she followed him to Ireland, taking up her abode at Celbridge within ten miles of Dublin. Unable to marry Stella without destroying Vanessa, or to openly welcome Vanessa without destroying Stella, he was thus involved in the most miserable embarrassment; he continued to temporize. Had the solution of marriage been open Stella would undoubtedly have been Swift's choice. Some mysterious obstacle intervened. It was rumoured at the time that Stella was the natural daughter of Temple, and Swift himself at times seems to have been doubtful as to his own paternity. There is naturally no evidence for such reports, which may have been fabrications of the anti-deanery faction in Dublin. From the same source sprang the report of Swift's marriage to Stella by Bishop Ashe in the deanery garden at Clogher in the summer of 1716. The ceremony, it is suggested, may have been extorted by the jealousy of Stella and have been accompanied by the express condition on Swift's side that the marriage was never to be avowed. The evidence is by no means complete and has never been exhaustively reviewed. John Lyon, Swift's constant attendant from 1735 onwards, disbelieved the story. It was accepted by the early biographers, Deane Swift, Orrery, Delany and Sheridan; also by Johnson, Scott, Dr Garnett, Craik, Dr Bernard and others. The arguments against the marriage were first marshalled by Monck Mason in his *History of St Patrick's*, and the conjecture, though plausible, has failed to convince Forster, Stephen, Aitken, Hill, Lane Poole and Churton Collins. Never more than a nominal wife at most, the unfortunate Stella commonly passed for his mistress till the day of her death (in her will she writes herself *spinster*), bearing her doom with uncomplaining resignation, and consoled in some degree by unquestionable proofs of the permanence of his love, if his feeling for her deserves the name. Meanwhile his efforts were directed to soothe Miss Vanhomrigh, to whom he addressed *Cadenus* [*Decanus*] *and Vanessa*, the history of their attachment and the best example of his serious poetry, and for whom he sought to provide honourably in marriage, without either succeeding in his immediate aim or in thereby opening her eyes to the hopelessness of her passion. In 1720, on what occasion is uncertain, he began to pay her regular visits. Sir Walter Scott found the Abbey garden at Celbridge still full of laurels, several of which she was accustomed to plant whenever she expected Swift, and the table at which they had been used to sit was still shown. But the catastrophe of her tragedy was at hand. Worn out with his evasions, she at last (1723) took the desperate step of writing to Stella or, according to another account, to Swift himself, demanding to know the nature of the connexion with him, and this terminated the melancholy history as with a clap of thunder. Stella sent her rival's letter to Swift, and retired to a friend's house. Swift rode down to Marley Abbey with a terrible countenance, petrified Vanessa by his frown, and departed without a word, flinging down a packet which only contained her own letter to Stella. Vanessa died within a few weeks. She left the poem and correspondence for publication. The former appeared immediately, the latter was suppressed until it was published by Sir Walter Scott.

Five years afterwards Stella followed Vanessa to the grave. The grief which the gradual decay of her health evidently occasioned Swift is sufficient proof of the sincerity of his attachment, as he understood it. It is a just remark of Thackeray's that he everywhere half-consciously recognizes her as his better angel, and dwells on her wit and her tenderness with a fondness he never exhibits for any other topic. On the 28th of January 1728, she died, and her wretched lover sat down the same night to record her virtues in language of unsurpassed simplicity, but to us who know the story more significantly for what it conceals than for what it tells. A lock of her hair is preserved, with the inscription in Swift's handwriting, most affecting in its apparent cynicism, "Only a woman's hair!" "Only a woman's hair," comments Thackeray; "only love, only fidelity, purity, innocence, beauty, only the tenderest heart in the world stricken and wounded, and passed away out of reach of pangs of hope deferred, love insulted and pitiless-desertion; only that lock of hair left, and memory, and remorse, for the guilty, lonely wretch, shuddering over the grave of his victim." The more unanswerable this tremendous indictment appears upon the evidence the greater the probability that the evidence is incomplete. *Tout comprendre c'est tout pardonner.*

Between the death of Vanessa and the death of Stella came the greatest political and the greatest literary triumph of Swift's life. He had fled to Ireland a broken man, to all appearance politically extinct; a few years were to raise him once more to the summit of popularity, though power was for ever denied him. Consciously or unconsciously he first taught the Irish to rely upon themselves and for many generations his name was the most universally popular in the country. With his fierce hatred of what he recognized as injustice, it was impossible that he should not feel exasperated at the gross misgovernment of Ireland for the supposed benefit of England, the systematic exclusion of Irishmen from places of honour and profit, the spoliation of the country by absentee landlords, the deliberate discouragement of Irish trade and manufactures. An Irish patriot in the strict sense of the term he was not; he was proud of being an Englishman, who had been accidentally "dropped in Ireland"; he looked upon the indigenous population as conquered savages; but his pride and sense of equity alike revolted against the stay-at-home Englishmen's contemptuous treatment of their own garrison, and he delighted in finding a point in which the triumphant faction was still vulnerable. His *Proposal for the Universal Use of Irish Manufactures*, published anonymously in 1720, urging the Irish to disuse English goods, became the subject of a prosecution, which at length had to be dropped. A greater opportunity was at hand. One of the chief wants of Ireland in that day, and for many a day afterwards, was that of small currency adapted to the daily transactions of life. Questions of coinage occupy a large part of the correspondence of the primate, Archbishop Boulter, whose anxiety to deal rightly with the matter is evidently very real and conscientious. There is no reason to think that the English ministry wished otherwise; but secret influences were at work, and a patent for supplying Ireland with a coinage of copper halfpence was accorded to William Wood on such terms that the profit accruing from the difference between the intrinsic and the nominal value of the coins, about 40%, was mainly divided between him and George I.'s favourite duchess of Kendal, by whose influence Wood had obtained the privilege. Swift now had his opportunity, and the famous six letters signed M. B. Drapier (April to Dec. 1724) soon set Ireland in a flame. Every effort was used to discover, or rather to obtain legal evidence against, the author, whom, Walpole was assured, it would then have taken ten thousand men to apprehend. None could be procured; the public passion swept everything before it; the patent was cancelled; Wood was compensated by a pension; Swift was raised to a height of popularity which he retained for the rest of his life; and the only real sufferers were the Irish people, who lost a convenience so badly needed that they might well have afforded to connive at Wood's illicit profits. Perhaps, however, it was worth while to teach the English ministry that not everything could be done in Ireland. Swift's pamphlets, written in a style more level with the popular intelligence than even his own ordinary manner, are models alike to the controversialist who aids a good cause and to him who is burdened with a bad one. The former may profit by the study of his marvellous lucidity and vehemence, the latter by his sublime audacity in exaggeration and the sophistry with which he involves the innocent halfpence in the obloquy of the nefarious patentee.

The noise of the *Drapier Letters* had hardly died away when Swift acquired a more durable glory by the publication of *Travels Into Several Remote Nations of the World*, in four parts. By Lemuel Gulliver, first a surgeon and then a captain of several ships (Benjamin Motto, October 1726). The first hint came to him at the meetings of the Scriblerus Club in 1714, and the work was well advanced, it would seem, by 1720. Allusions show that it was circulated privately for a considerable period before its actual (anonymous) publication, on the 28th of October 1726. Pope arranged that Erasmus Lewis should act as literary agent in negotiating the manuscript. Swift was afraid of the reception the book would meet with, especially in political circles. The keenness of the satire on courts, parties and statesmen certainly suggests that it was planned while Swift's disappointments as a public man were still rankling and recent. It is Swift's peculiar good fortune that his book can dispense with the interpretation of which it is nevertheless susceptible, and may be equally enjoyed whether its inner meaning is apprehended or not. It is so true, so entirely based upon the facts of human nature, that the question what particular class of persons supplied the author with his examples of folly or misdoing, however interesting to the commentator, may be neglected by the reader. It is also fortunate for him that in three parts out of the four he should have entirely missed "the chief end I propose to myself, to vex the world rather than divert it." The world, which perhaps ought to have been vexed, chose rather to be diverted; and the great satirist literally strains his power *ut pueris placeat*. Few books have added so much to the innocent mirth of mankind of the first two parts of Gulliver; the misanthropy is quite overpowered by the fun. The third part, equally masterly in composition, is less felicitous in invention; and in the fourth Swift has indeed carried out his design of vexing the world at his own cost. Human nature indignantly rejects her portrait in the Yahoo as a gross libel, and the protest is fully warranted. An intelligence from a superior sphere, bound on a voyage to the earth, might actually have obtained a fair idea of average humanity by a preliminary call at Lilliput or Brobdingnag, but not from a visit to the Yahoos. While *Gulliver* is infinitely the most famous and popular of Swift's works, it exhibits no greater powers of mind than many others. The secret of success, here as elsewhere, is the writer's marvellous imperturbability in paradox, his teeming imagination and his rigid logic. Grant his premises, and all the rest follows; his world may be turned topsy-turvy, but the relative situation of its contents is unchanged. The laborious attempts that have been made, particularly in Germany, to affiliate the *Travels* only serve to bring Swift's essential originality into stronger relief. He had naturally read Lucian and Rabelais—possibly *Crusoe* and the *Arabian Nights*. He had read as a young man the lunary adventure of Bishop Wilkins, Bishop Godwin and Cyrano de Bergerac. He had read contemporary accounts of Peter the Wild Boy, the *History of Sevarambes* by D'Alais (1677) and Foligny's *Journey of Jacques Sadeut to Australia* (1693). He may have read Joshua Barnes's description of a race of "Pygmies" in his *Gerania* of 1675. He copied the account of the storm in the second voyage almost literally from Sturmy's *Compleat Mariner*. Travellers' tales were deliberately embalmed by Swift in the amber of his irony. Something similar was attempted by Raspe in his *Munchausen* sixty years later.

Swift's grave humour and power of enforcing momentous truth by ludicrous exaggeration were next displayed in his *Modest Proposal for Preventing the Children of Poor People from being a Burden to their Parents or the Country*, by fattening and eating them (1729), a parallel to the *Argument against Abolishing Christianity*, and as great a masterpiece of tragic as the latter is of comic irony. The *Directions to Servants* (first published in 1745) in like manner derive their overpowering comic force from the imperturbable solemnity with which all the misdemeanours that domestics can commit are enjoined upon them as duties. The power of minute observation displayed is most remarkable, as also in *Polite Conversation* (written in 1731, published in 1738), a surprising assemblage of the vulgarities and trivialities current in ordinary talk. As in the *Directions*, the satire, though cutting, is good-natured, and the piece shows more animal spirits than usual in Swift's latter years. It was a last flash of gaiety. The attacks of giddiness and deafness to which he had always been liable increased upon him. Already in 1721 he complains that the buzzing in his ears disconcerts and confounds him. After the *Directions* he writes little beyond occasional verses, not seldom indecent and commonly trivial. He sought refuge from inferior society often in nonsense, occasionally in obscenity. An exception must be made in the case of the delightful *Hamilton's Bawn*, and still more of the verses on his own death (1731), one of the most powerful and also one of the saddest of his poems. In *The Legion Club* of 1736 he composed the fiercest of all his verse satires. He hated the Irish parliament for its lethargy and the Irish bishops for their interference. He fiercely opposed Archbishop Boulter's plans for the reform of the Irish currency, but admitted that his real objection was sentimental: the coins should be struck as well as circulated in Ireland. His exertions in repressing robbery and mendicancy were strenuous and successful. His popularity remained as great as ever (he received the freedom of Dublin in 1729), and, when he was menaced by the bully Bettesworth, Dublin rose as one man to defend him. He governed his cathedral with great strictness and conscientiousness, and for years after Stella's death continued to hold a miniature court at the deanery. But his failings of mind were exacerbated by his bodily infirmities; he grew more and more whimsical and capricious, morbidly suspicious and morbidly parsimonius; old friends were estranged or removed by death, and new friends did not come forward in their place. For many years, nevertheless, he maintained a correspondence with Pope and Bolingbroke, and with Arbuthnot and Gay until their deaths, with such warmth as to prove that an ill opinion of mankind had not made him a misanthrope, and that human affection and sympathy were still very necessary to him. The letters become scarcer and scarcer with the decay of his faculties; at last, in 1740, comes one to his kind niece, Mrs Whiteway, of heartrending pathos:—

"I have been very miserable all night, and to-day extremely deaf and full of pain. I am so stupid and confounded that I cannot express the mortification I am under both of body and mind. All I can say is that I am not in torture; but I daily and hourly expect it. Pray let me know how your health is and your family: I hardly understand one word I write. I am sure my days will be very few; few and miserable they must be. I am, for those few days, yours entirely—JONATHAN SWIFT.

"If I do not blunder, it is Saturday, July 26, 1740.

"If I live till Monday I shall hope to see you, perhaps for the last time."

Account book entries continue until 1742.

In March 1742 it was necessary to appoint guardians of Swift's person and estate. In September of the same year his physical malady reached a crisis, from which he emerged a helpless wreck, with faculties paralysed rather than destroyed—"He never talked nonsense or said a foolish thing." The particulars of his case have been investigated by Dr Bucknill and Sir William Wilde, who have proved that he suffered from nothing that could be called mental derangement until the "labyrinthine vertigo" from which he had suffered all his life, and which he erroneously attributed to a surfeit of fruit, produced paralysis, "a symptom of which was the not uncommon one of aphasia, or the automatic utterance of words ungoverned by intention. As a consequence of that paralysis, but not before, the brain, already weakened by senile decay, at length gave way, and Swift sank into the dementia which preceded his death." In other words he retained his reason until in his 74th year he was struck down by a new disease in the form of a localized left-sided apoplexy or cerebral softening. Aphasia due to the local trouble and general decay then progressed rapidly together, and even then at 76, two more years were still to elapse before "he exchanged the sleep of idiocy for the sleep of death." The scene closed on the 19th of October 1745. With what he himself described as a satiric touch, his fortune was bequeathed to found a hospital for idiots and lunatics, now an important institution, as it was in many respects a pioneer bequest. He was interred in his cathedral at midnight on the 22nd of October, in the same coffin as Stella, with the epitaph, written by himself, "Hic depositum est corpus Jonathan Swift, S.T.P., hujus ecclesiae cathedralis decani; ubi saeva indignatio cor ulterius lacerare nequit. Abi, viator, et imitare, si poteris, strenuum pro virili libertatis vindicem."

The stress which Swift thus laid upon his character as an assertor of liberty has hardly been ratified by posterity, which has apparently neglected the patriot for the genius and the wit. Not unreasonably; for if half his patriotism sprang from an instinctive hatred of oppression, the other half was disappointed egotism. He utterly lacked the ideal aspiration which the patriot should possess: his hatred of villany was far more intense than his love of virtue. The same cramping realism clings to him everywhere beyond the domain of politics—in his religion, in his fancies, in his affections. At the same time, it is the secret of his wonderful concentration of power: he realizes everything with such intensity that he cannot fail to be impressive. Except in his unsuccessful essay in history, he never, after the mistake of his first Pindaric attempts, strays beyond his sphere, never attempts what he is not qualified to do, and never fails to do it. His writings have not one literary fault except their occasional looseness of grammar and their frequent indecency. Within certain limits, his imagination and invention are as active as those of the most creative poets. As a master of humour, irony and invective he has no superior; his reasoning powers are no less remarkable within their range, but he never gets beyond the range of an advocate. Few men of so much mental force have had so little genius for speculation, and he is constantly dominated by fierce instincts which he mistakes for reasons. As a man the leading note of his character is the same —strength without elevation. His master passion is imperious pride—the lust of despotic dominion. He would have his superiority acknowledged, and cared little for the rest. Place and profit were comparatively indifferent to him; he declares that he never received a farthing for any of his works except *Gulliver's Travels*, and that only by Pope's management; and he had so little regard for literary fame that he put his name to only one of his writings. Contemptuous of the opinion of his fellows, he hid his virtues, paraded his faults, affected some failings from which he was really exempt, and, since his munificent charity could not be concealed from the recipients, laboured to spoil it by gratuitous surliness. Judged by some passages of his life he would appear a heartless egotist, and yet he was capable of the sincerest friendship and could never dispense with human sympathy. Thus an object of pity as well as awe, he is the most tragic figure in our literature—the only man of his age who could be conceived as affording a groundwork for one of the creations of Shakespeare. "To think of him," says Thackeray, "is like thinking of the ruin of a great empire." Nothing finer or truer could be said.

Swift inoculated the Scriblerus Club with his own hatred of pedantry, cant and circumlocution. His own prose is the acme of incisive force and directness. He uses the vernacular with an economy which no other English writer has rivalled. There is a masculinity about his phrases which makes him as clear to the humblest capacity as they are capable of being made to anyone. Ironist as he is, there is no writer that ever wrote whose meaning is more absolutely unmistakable. He is the grand master of the order of plain speech. His influence, which grew during the 18th century in spite of the depreciation of Dr Johnson, has shared in the eclipse of the Queen Anne wits which began about the time of Jeffrey. Yet as the author of *Gulliver* he is still read all over the world, while in England discipleship to Swift is recognized as one of the surest passports to a prose style. Among those upon whom Swift's influence has been most discernible may be mentioned Chesterfield, Smollett, Cobbett, Hazlitt, Scott, Borrow, Newman, Belloc.

AUTHORITIES.—Among the authorities for Swift's life the first place is still of course occupied by his own writings, especially the fragment of autobiography now at Trinity College, Dublin, and his Correspondence, which still awaits an authoritative annotated edition. The most important portion is contained in the *Journal to Stella*. Twenty-five of these letters on Swift's death became the property of Dr Lyon. Hawkesworth bought them for his 1766 edition of the *Works* and eventually gave them to the British Museum. Forty additional letters were published by Dean Swift in 1768 (of these only No. 1 survives in the British Museum). Sheridan brought out the complete *Journal* in 1784 in a mangled form, but the text has as far as possible been restored by modern editors such as Forster, Rylands and Aitken. A full annotated edition is in course of preparation by H. Spencer Scott. The Vanessa correspondence was used by Sheridan, but first published in full by Sir Walter Scott, and Swift's letters to his friend Knightley Chetwode of Woodbrook between 1714 and 1731, over fifty in number, were first issued by Dr Birkbeck Hill in 1899. The more or less contemporary lives of Swift, most of which contain a certain amount of apocrypha, are those of Lord Orrery (1751); Dr Delany's *Observations on Orrery* (1754); Dean Swift's *Essay upon the Life of Swift* (1755); and Thomas Sheridan's *Life* (of 1785). Dr. Hawkesworth, in the life prefixed to his edition of the *Works* in 1755, adds little of importance. Dr Johnson's *Life* is marred by manifest prejudice. Dr Barrett produced an *Essay upon the Early Life* of some value (in 1808). Six years later came the useful biography of Sir Walter Scott, and (in 1819) appeared the elaborate *Life* by W. Monck Mason in the form of an appendix to his ponderous *History of St Patrick's*. A new epoch of investigation was inaugurated by John Forster, who began a new scrutiny of the accumulated material and published his first volume in 1875. Invaluable in many respects, it exhibited the process as well as the result of biography, and never got beyond 1711. The *Life* by Sir Henry Craik (1882 and reissues) now holds the field. Valuable monographs have been produced by Sir Leslie Stephen (Men of Letters and the Memoirs, in the *Dict. Nat. Biog.*), by Thackeray, in his *English Humourists*, by W. R. Wilde, in his *Closing Years of Dean Swift's*

Life, by Lecky, in his *Leaders of Public Opinion*, by G. P. Moriarty, J. Churton Collins (1893), Max Simon (1893), Henriette Cordelet (1907) and Sophie Shilleto Smith (1910). The anecdotes of Swift related in Spence, *Laetitia Pilkington*, Wilson's *Swiftiana*, Delany's *Autobiography*, &c., though often amusing, can hardly be accepted as authentic.

The collective editions of Dr Hawkesworth (various issues, 1755–1779), T. Sheridan (1785), John Nichols (1801, 1804, 1808), Scott (1814 and 1821) and Roscoe (2 vols., 1849) have been in most respects superseded by the edition in Bohn's Standard Library in fourteen volumes (including the two subsequently issued volumes of *Poems*) (1897–1910); arranged as follows: I. Biog. Introduction by W. E. H. Lecky; *Tale of a Tub*; *Battle of the Books*; *Critical Essay upon the Faculties of the Mind*; *The Bickerstaff Pamphlets*, &c., ed. Temple Scott. II. *Journal to Stella*, ed. F. Ryland (two portraits of Stella). III. and IV. *Writings on Religion and the Church*, ed. Temple Scott. V. *Historical and Political Tracts—English*, ed. Temple Scott. VI. *Historical and Political Tracts—Irish*, ed. Temple Scott. VII. The *Drapier's Letters*, ed. Temple Scott. VIII. and XI. Literary Essays, including *Gulliver's Travels* (ed. G. R. Dennis); *A Proposal for Correcting, Improving and Ascertaining the English Tongue*; *Hints towards an Essay on Conversation*; *Character*; *Directions to Servants*; and *Autobiographical Fragment*, ed. Temple Scott. IX. Contributions to the *Examiner*, *Tatler*, *Spectator*, &c., ed. Temple Scott. X. Historical Writings, including the *Four Last Years*; *Abstract of English History*; and *Remarks on Burnet*, ed. Temple Scott. XII. Essays on the Portraits, &c., Bibliography by W. Spencer Jackson, and Index. Twelve portraits of Swift are included in the work, in addition to two portraits of Stella and one of Vanessa. XIII. and XIV. Poems, ed. W. Ernst Browning.

Translations and editions of *Gulliver's Travels* have been numerous. "Valuable Notes for a Bibliography of Swift" were published by Dr S. Lane Poole in *The Bibliographer* (November 1884).

(R. G.; T. Se.)

SWIFT, a bird so called from the extreme speed of its flight, which apparently exceeds that of any other British species, the *Hirundo apus* of Linnaeus and *Cypselus apus* or *murarius* of modern ornithologists. Swifts were formerly associated with swallows (*q.v.*) in classification, but whilst the latter are true Passeres, it is now established that swifts are Coraciiform birds (see Birds) and the sub-order *Cypseli* has been formed to include them and their nearest allies, the humming-birds. The four toes are all directed forwards, whereas in the Passeres the hallux is directed backwards and by opposing the other three makes the foot a grasping organ. In the swifts, moreover, the middle and outer digits have only three joints and the metatarsi and even the toes may be feathered. Swifts are divided into three sub-families: *Macropteryginae*, the true swifts, of tropical Asia, which form a nest gummed by saliva to branches of trees; *Chaeturinae*, building in rocks or houses, and with an almost world-wide range: it includes *Chaetura palagica*, the "chimney-swallow" of the United States, *Collocalia fuciphaga* which obtained its specific name from the erroneous idea that its edible nests were formed by partly digested seaweed; *Cypselinae*, also world-wide and containing *Cypselus apus*, the common European swift. All the swifts are migratory. Well known as a summer visitor throughout the greater part of Europe, the swift is one of the latest to return from Africa, and its stay in the country of its birth is of the shortest, for it generally disappears from England very early in August, though occasionally to be seen for even two months later.

The swift commonly chooses its nesting-place in holes under the eaves of buildings, but a crevice in the face of a quarry, or even a hollow tree, will serve it with the accommodation it requires. This, indeed, is not much, since every natural function except sleep, oviposition and incubation, is performed on the wing, and the easy evolutions of this bird in the air, where it remains for hours together, are the admiration of all who witness them. Though considerably larger than a swallow, it can be recognized at a distance less by its size than by its peculiar shape. The head scarcely projects from the anterior outline of the pointed wings, which form an almost continuous curve, at right angles to which extend the body and tail, resembling the handle of the crescentic cutting-knife used in several trades, while the wings represent the blade. The mode of flight of the two birds is also unlike, that of the swift being much more steady, and, rapid as it is, ordinarily free from jerks. The whole plumage, except a greyish white patch under the chin, is a sooty black, but glossy above. Though its actual breeding-places are by no means numerous, its extraordinary speed and discursive habits make the swift widely distributed; and throughout England scarcely a summer's day passes without its being seen in most places. A larger species, *C. melba* or *C. alpinus*, with the lower parts dusky white, which has its home in many of the mountainous parts of central and southern Europe, has several times been observed in Britain, and two examples of a species of a very distinct genus *Chaetura*, which has its home in northern Asia, but regularly emigrates thence to Australia, have been obtained in England (*Proc. Zool. Soc.*, 1880, p. 1).

Among other peculiarities the swifts, as long ago described (probably from John Hunter's notes) by Sir E. Home (*Phil. Trans.* 1817, pp. 332 et seq., pl. xvi.), are remarkable for the development of their salivary glands, the secretions of which serve in most species to glue together the materials of which the nests are composed, and in the species of the genus *Collocalia* form almost the whole substance of the structure. These are the "edible" nests so eagerly sought by Chinese epicures as an ingredient for soup. These remarkable nests consist essentially of mucus, secreted by the salivary glands above mentioned, which dries and looks like isinglass. Their marketable value depends on their colour and purity, for they are often intermixed with feathers and other foreign substances. The swifts that construct these "edible" nests form a genus *Collocalia*, with many species; but they inhabit chiefly the islands of the Indian Ocean from the north of Madagascar eastward, as well as many of the tropical islands of the Pacific so far as the Marquesas—one species occurring in the hill-country of India. They breed in caves, to which they resort in great numbers, and occupy them jointly and yet alternately with bats—the mammals being the lodgers by day and the birds by night. (A.N.)

SWIMMING (from "swim," A.S. *swimman*, the root being common in Teutonic languages), the action of self-support and self-propulsion on or in water; though used by analogy of inanimate objects, the term is generally connected with animal progression and specially with the art of self-propulsion on water as practised by man. Natation (the synonym derived from Lat. *natare*) is one of the most useful of the physical acquirements of man. There have been cases in which beginners have demonstrated some ability in the art upon their first immersion in deep water, but generally speaking it is an art which has to be acquired. For many years Great Britain held the supremacy in this particular form of athletics, but continental, Australian and American swimmers have so much improved and have developed such speedy strokes, that the claim can no longer be maintained. English swimmers have, however, the satisfaction of knowing that in a great measure through them has come about the very great interest which is now taken in the teaching of swimming throughout the world, and more particularly on the continent of Europe, where they have made frequent tours and given instructive displays of swimming, life-saving (see Drowning), and water polo (*q.v.*); the latter a water game entirely British in its origin.

The teaching of swimming has been taken up in schools, and where the work is well done it is customary to use a form of land drill so as to impress upon the pupils some idea of the motions which have to be made in order to progress through the water. This drill is the preliminary practice to the teaching of the *breast stroke*. This stroke is about the most useful of all the known forms of swimming, more particularly when any one is thrown overboard in clothes; and though speed swimmers look upon it as obsolete, it is undoubtedly the best for a long-distance swim, such as across the English Channel, or other similar feats. A knowledge of it, as well as of the *back stroke*, is essential to the effective saving of life.

When learning the *breast stroke*, the first thing to avoid is undue haste and rapidity in the movements. It is this fault, probably born of nervousness, which causes many to aver that though eager to do so, they have never been able to learn to swim. Rapid action of the arms only exhausts the learner, whose breathing then becomes hurried and irregular, and as a consequence he fails to preserve the buoyancy necessary for carrying him along the surface. When starting for the first stroke the beginner should draw the elbows nearly to the side, at the same time bringing up the forearm and hands to the front of the chest with the palms of the hands downwards near to the surface of the water, the fingers being extended and closed and the forefingers and thumbs nearly touching. The hands are then pushed forward in front of the body to the full extent of the arms, the palms of the hands are turned slightly outwards, and the arms swept round until in a right angle with the shoulders, when the elbows are dropped and the hands come up in front of the chest for the next stroke. The arms should not be kept rigid, but allowed to work gracefully. As the arms are swept backwards the legs are drawn up, the knees being turned outward to the right and left and the heels nearly touching. The legs are then kicked outward and swept round as the arms are being pushed forward to their fullest extent, a "flip" being given with each of the feet, which must be kept loose at the ankles and in the same position as when standing. All beginners have the great fault of trying to make the limbs too rigid, thereby causing stiffness and possibly cramp. Another difficulty with them is the question of breathing, but if the learner will remember to inhale when making each backward sweep of the arms, much of the difficulty usually experienced at the start will be overcome. Expiration should be carried out during the other portion of each stroke. The important thing is to keep the body as level along the surface as possible, and at the same time get regular and natural breathing. The holding of the breath for two or three strokes will exhaust the beginner more than anything else.

A knowledge of the *back stroke* can easily be acquired by those who are able to swim on the breast, for the leg action is very similar and the principles relating to the use of the arms are almost the same. The arms, instead of being moved through the water, are lifted in the air and carried out to beyond the head with the palms upwards. The palms are then slightly turned and the arms swept round. Just as this action is being made the legs are drawn up as in the breast stroke, the body being allowed to travel on with the force of the kick as the arms are extended beyond the head. The great difficulty that a back swimmer has to contend with in open water is that of steering, and the best way to overcome it is to take an object for a guide before starting and hold the head slightly to the side so as to steer by it.

At one time the *side stroke* was the great racing stroke; the body being placed on the side, the upper arm worked from the head to the upper side of the body, the lower arm taken downwards through the water to the underside of the body and a scissor-like kick made with the legs; but this has now been generally given up in favour of the *over-arm, trudgen* and *crawl strokes*.

In the *over-arm* stroke the body is usually turned on the right side.. At the start the lower arm is pulled downwards towards the hips, the fingers being kept closed and the hand flat, so as to present a large surface to the water. When the stroke is finished the hand is turned quickly palm upwards, so that together with the lower part of the arm it cuts the water sideways, the arm being almost bent double. Then, as it is shot forward, the hand is gradually turned from palm upwards to palm downwards, until, when it arrives at its position beyond the head, it is ready for the next stroke. The recovery and the pull ought to be effected as quickly as possible. The upper arm stroke is started when the downward stroke of the under or right arm is finished. It is started in front of the forehead, the arm being slightly bent and the fingers pointing downwards. The hand is pulled past the face and chest with the arm bent at right angles and swept back in front of the body, the arm gradually straightening as it leaves the water opposite the hip. When the hand is opposite the hip it should be brought quickly out of the water and sent forward for the next stroke. When the upper arm is opposite the shoulder in its pull through the water the legs are kicked wide apart and closed again at the moment when the hand leaves the water. The kick is completed and the legs straightened before the left hand is replaced ready for the next stroke. As the legs are opened the upper leg is kicked forward with the knee slightly bent, and the foot kept in its ordinary position. The lower leg is bent double until the heel approaches the thigh, which is brought backwards slightly. In the actual kick the upper leg is sent forward, and as it is straightened vigorously the under leg from the knee downward comes forward to meet it with a vicious kick; the swirl of the feet and closing of the legs drives the body forward. This is what has come to be known in Great Britain as the "Northern Kick," by reason of its first being introduced by Lancashire swimmers.

The *trudgen stroke*, more commonly known as the *trudgeon stroke*, and on the continent of Europe as *Spanish swimming*, was first made prominent in England in 1873 by a swimmer named J. Trudgen, who stated that he had acquired a knowledge of it while in South America. It was, however, known to Clias, a writer on swimming, who described it in 1825 as "The Thrust." Trudgen's speed was so great for his time that swimmers quickly copied his style, and it is from this stroke that the *crawl stroke* has been developed. When swimming Trudgen kept on the chest and lifted the upper part of his body at each stroke out of the water, and at each swing of the arms pulled himself forward, a considerable swirl of the water occurring as each movement was finished. The arms were brought forward sideways, each completing a circle on each side of the body, and the head kept completely above water. Those who copied Trudgen soon found it was less laborious and equally as fast to use a double over-arm stroke with the head and chest well down, and thus have the body supported by the water, using the ordinary over-arm leg kick. At first it was considered a stroke only useful for short distances and for water polo where speed is essential, but the idea was quickly dispelled, and several men, as well as women, have swum as far as fifteen miles with this stroke.

The *crawl stroke* is, like the *trudgen*, an adaptation from native swimmers. It was not generally known in Great Britain until 1902, when Mr Richard Cavill came from Australia to compete in the English championships, but it is said to be common with natives of the South Sea Islands, and from there introduced into Australia about the year 1900. From thence it came to Europe, and there Mr C. M. Daniels, the American amateur champion, made so excellent a study of it that he not only so greatly increased his own pace as to be able to win the English championship, and beat the world's record for a hundred yards, but also introduced various improvements upon it. This stroke is distinct from any other form of swimming: the legs from the knee upwards are kept in line with the body and almost closed; there is no opening of the legs or drawing up of the knees as for the breast, back and side strokes. The swimmer lies flat upon his breast on the surface, the lower part of the legs from the knee downward are alternately lifted above the surface up to the middle of the calf and then they are struck down upon the water with the instep with all force possible. This striking is done from an upward to a downward direction, one leg at a time. The arms are used somewhat similarly as in the trudgen stroke, they are bent at the elbows, dipped in just beyond the head and drawn smartly backwards till they come out of the water at the hips. The right arm is dipped in when the left foot strikes downward and vice versa. The result of this movement is that when one or the other of the limbs is pulling or propelling the body through the water at the same moment another limb is being recovered for the next stroke, most of the limbs are recovered through the air, fewer dead or retarding points are produced than in any other stroke, and less resistance is caused in the line of progress. In performing any other stroke most of the limbs are recovered through the water.

One of the most useful accomplishments for a swimmer is that of *floating*, but curiously enough many of them cannot acquire a knowledge of it. It is purely a matter of buoyancy, and requires constant practice before one can become perfect in it. In learning to float the beginner experiences great difficulty in overcoming the tendency of the legs to sink, and if after frequent trials they are still found to sink he should get some one to hold them up or else place them on the steps or behind the rail of the bath, and thus assisted learn to balance the body on the surface. Before doing so he should completely fill his lungs, spread his legs wide, and then lie backwards with the arms extended in a line with the body and beyond the head, with the palms upwards, care being taken to throw as much weight beyond the head as possible. Furthermore he must lie perfectly still and take care not to hollow the back or raise the abdomen above water. One may sink for an instant, but if the breath be held the lips will come above the surface, when easy breathing may be indulged in. Only the face, chest and toes should appear above the surface of the water. If the feet still have a tendency to sink after they have been gently released from the step or rail, more weight should be thrown beyond the head by turning it well back and lifting the hands out of the water, which will raise the feet. A knowledge of floating is of good service to those attempting to save life and is also essential to those desirous of making a study of the many tricks and scientific feats which are performed by swimmers.

The usual method of entering the water is by what is known as *diving*; some think that it should be termed "springing." The best method of learning to dive is to stand on the side of the bath or on the bank of the river, and then stoop down until the body is nearly double, stretch out the arms in front of the head, sink the head between them and gradually fall over into the water. The ability to enter the water head first will then soon be acquired. To begin, the legs should be placed together and the body kept erect, then a few short inspirations should be made and the lungs cleared and inflated, the arms should be swung from the front and a spring made from the diving base. As the feet leave the base they should be thrown upwards, the body straightened and the head placed between the arms, which should be kept at full stretch beyond the head, with the hands palm downwards and the thumbs touching so as to act as a cut-water. Immediately the body has entered the water, the hands should be turned upwards and the body will then come to the surface at once. In *high diving* a leap is made into mid-air, the body straightened almost to horizontal level, the arms and head then declined towards the water and the legs brought up. This action causes the body to shoot towards the water at a proper angle and the dive is thereby made clean and effective. A useful accomplishment is that known as *surface diving*, because it enables you to find and bring an object to the surface. The correct method of performing it is to first swim a few yards on the surface with the breast stroke, take a breath, then suddenly depress the head, look downwards, elevate the body at the hips, and at the same time make a powerful stroke with the legs and an upward stroke with the hands. The impetus thus obtained will suffice to take the swimmer to the bottom in 10 ft. of water. Once under the surface it is only necessary to keep the head depressed and swim by means of the breast stroke in order to find the object of search. When about to rise to the surface, the head should be turned backwards with the eyes upwards, and a vigorous stroke made with arms and legs. *Plunging* is not very generally practised, though there is a championship for it. A plunge is a standing dive made head first from a firm take off, free from spring. The body must be kept motionless face downwards, no progressive movement must be imparted other than the action of the dive. The plunge terminates when the plunger raises his face above the surface of the water. With the idea of preventing long tests without breathing, it was deemed in 1893 advisable by the swimming association to impose a time limit of one minute in all competitions. Yet even with this time limit, over 80 ft. has been plunged. In Sweden and Germany skilled forms of acrobatic and gymnastic diving have been more largely practised than in England, and as a consequence diving in those countries is in a much higher state of perfection than in England, though even in England great improvement has been made owing to a large influx of Swedish teachers.

Most of the principal races are decided in *baths*, but there has been a tendency of late years to revert to open water in the summer and also to encourage long-distance swimming. The first public baths in Great Britain were opened by the corporation of Liverpool in 1828 and the Baths and Washhouses Act was passed in 1846, the first of the London parishes to adopt the act being St Martin's in the Fields, who opened baths in Green Street, Leicester Square in 1846. Since then public baths have been erected all over Great Britain and Ireland, and bath swimming has become, by reason of the lack of reasonable open water accommodation, the principal means of the teaching of the young. But open water swimming, and more particularly swimming in the sea, is the best training and practice for those who really love the art, because they are able to swim under normal climatic conditions, instead of in tepid water. Many persons in England bathe in the open all the year round, notably in the Serpentine in London, on the sea-coast and in various inland waters.

When bathing in the open, care has to be taken to avoid weeds or undercurrents. In the event of accidentally getting hold of a bed of weeds, the swimmer should cease kicking and work with the arms, and the current will then take him through. If he tries to swim the weeds will entangle his legs and put him in an awkward plight. If he be carried away by a current in a river, he should select a spot on either bank and swim diagonally towards it, never minding where he has left his clothes. When in the sea, the conditions are not always the same, though the general rule of swimming diagonally for shore also applies. For sea bathing, however, it is far better, no matter how good a swimmer one may be, to have a boat in attendance. Before bathing in any strange place, the swimmer should make himself acquainted with the currents and the direction of the tide. When the tide is going out the course should be made along the coast, close in shore. In a rough sea the swimmer should not attempt to breast the waves, but as each wave rises he should swim through, thereby saving himself from buffeting, which if long continued would cause insensibility or else great waste of physical power. When using a boat for bathing the best way is to dive from the stern, to which some steps or a rope ladder should be fixed, in order to aid the swimmer when getting in again. Failing these being at hand, the best way is to lay hold of the stern with both hands and then, making a hard rising kick, raise the body till it rests on the edge of the hips. Then smartly slip the hands a little forward, turn to a sitting position and enter the boat.

Speed swimming *records* are so frequently altered, that students had best obtain the Amateur Swimming Association's Annual Handbook, in which are detailed the accepted records up to date. The improvement in speed has been most remarkable. In 1877 the mile amateur record was 29 m. $25\frac{1}{2}$ secs.; and that stood until 1892. The record in 1907 was 24 m. $42\frac{3}{5}$ secs. made by Mr D. Billington. The hundred yards record has been similarly reduced. In 1878 it was 1 m. $16\frac{3}{4}$ secs.; in 1888 it had been lowered by Mr J. Nuttall to 1 m. $6\frac{1}{4}$ secs.; and in 1907 Mr C. M. Daniels, of America, created a world's record of $55\frac{2}{5}$ secs. The records over intermediate distances have also been considerably lowered and many long-distance swimming records have from time to time been created. One of the most remarkable of these long-distance swims is the race which is known as the "Swim through London," from Richmond lock and weir to Blackfriars, which was instituted in 1907 and won by Mr J. A. Jarvis of Leicester, in 3 hours 24 minutes $6\frac{4}{5}$ secs. In this event 34 started, and 21 finished the distance, which goes to show that much attention is being devoted to long-distance trials; in this event Miss Lilian M. Smith finished fourteenth. Much interest has centred in attempts to swim across the English Channel; Captain Webb, D. Dalton and F. Cavill, all claim to have done it, but only the swim of Captain Webb has been accepted as genuine. The first recorded attempt was made on the 24th of August 1872 by J. B. Johnson, who started from Dover, but remained in the water only 65 minutes. It was on the 12th of August 1875 that Captain Matthew Webb made his first attempt. He started from Dover and remained in the water 6 hours 49 m., when the weather became too rough for him to continue. It is estimated that he was about $13\frac{1}{2}$ m.

across when he had to give up. On the 24th–25th of August 1875, he swam across the English Channel, diving from the Admiralty Pier, Dover, and touching Calais sands, France, after swimming for 21 hours 45 m. It is the greatest swim ever recorded, and at the time of the accomplishment created a great sensation in England. Since this great achievement, numerous unsuccessful attempts have been made, the best being those of Montague Holbein, Jabez Wolff and T. W. Burgess, and their efforts created an interest in long-distance swimming in all parts of the world, which has resulted in the accomplishment of trials and tests once thought impossible.

BIBLIOGRAPHY.—The literature of the subject of swimming is considerable; the most useful work of general reference is *Swimming*, by Ralph Thomas (London, 1904), with bibliography. Other chief works on the technic of swimming that may be mentioned are: Thevenot, *The Art of Swimming* (London, 1789); Steedman, *Manual of Swimming* (Melbourne, 1867); W. Wilson, *The Swimming Instructor* (London, 1883); A. Sinclair and W. Henry, *Swimming* (Badminton Library, London, 1893); C. M. Daniels, *How to Swim and Save Life* (Spalding's Library, London, 1907). (W. Hy.)

SWINBURNE, ALGERNON CHARLES (1837–1909), English poet and critic, was born in London on the 5th of April 1837. He was the son of Admiral Charles Henry Swinburne (of an old Northumbrian family) and of Lady Jane Henrietta, a daughter of George, 3rd earl of Ashburnham. It may almost be said to have been by accident that Swinburne owned London for his birthplace, since he was removed from it immediately, and always felt a cordial dislike for the surroundings and influences of life in the heart of a great city. His own childhood was spent in a very different environment. His grandfather, Sir John Edward Swinburne, bart., owned an estate in Northumberland, and his father, the admiral, bought a beautiful spot between Ventnor and Niton in the Isle of Wight, called East Dene, together with a strip of undercliff known as the Landslip. The two homes were in a sense amalgamated. Sir Edward used to spend half the year in the Isle of Wight, and the admiral's family shared his northern home for the other half; so that the poet's earliest recollections took the form of strangely contrasted emotions, inspired on the one hand by the bleak north, and on the other by the luxuriant and tepid south. Of the two, the influences of the island are, perhaps naturally, the stronger in his poetry; and many of his most beautiful pieces were actually written at the Orchard, an exquisite spot by Niton Bay, which belonged to relatives of the poet, and at which he was a constant visitor.

After some years of private tuition, Swinburne was sent to Eton, where he remained for five years, proceeding to Balliol College, Oxford, in 1857. He was three years at the University, but left without taking a degree. Clearly he must have cultivated while there his passionate and altogether unacademic love for the literature of Greece; but his undergraduate career was unattended by university successes, beyond the Taylorian prize for French and Italian, which he gained in 1858. He contributed to the "Undergraduate Papers," published during his first year, under the editorship of John Nichol, and he wrote a good deal of poetry from time to time, but his name was probably regarded without much favour by the college authorities. He took a second class in classical moderations in 1858, but his name does not occur in any of the "Final" honour schools. He left Oxford in 1860, and in the same year published those remarkable dramas, *The Queen Mother* and *Rosamond*, which, despite a certain rigidity of style, must be considered a wonderful performance for so young a poet, being fuller of dramatic energy than most of his later plays, and rich in really magnificent blank verse. The volume was scarcely noticed at the time, but it attracted the attention of one or two literary judges, and was by them regarded as a first appearance of uncommon promise.

It is a mistake to say, as most biographers do, that Swinburne, after leaving Oxford, spent some time in Italy with Walter Savage Landor. The facts are quite otherwise. The Swinburne family went for a few weeks to Italy, where the poet's mother, Lady Jane, had been educated, and among other places they visited Fiesole, where Landor was then living in the house that had been arranged for him by the kindness of the Brownings. Swinburne was a great admirer of Landor, and, knowing that he was likely to be in the same town with him, had provided himself with an introduction from his friend, Richard Monckton Milnes. Landor and Swinburne met and conversed, with great interest and mutual esteem; but the meetings were not for more than an hour at a time, nor did they exceed four or five in number. Swinburne never lived in Italy for any length of time. In 1865 appeared the lyrical tragedy of *Atalanta in Calydon*, followed in the next year by the famous *Poems and Ballads*, and with them the poet took the public gaze, and began to enjoy at once a vogue that may almost be likened to the vogue of Byron. His sudden and imperative attraction did not, it is true, extend, like Byron's, to the unliterary; but among lovers of poetry it was sweeping, permeating and sincere. The *Poems and Ballads* were vehemently attacked, but *Dolores* and *Faustine* were on everyone's lips: as a poet of the time has said, "We all went about chanting to one another these new, astonishing melodies." *Chastelard*, which appeared between *Atalanta* and *Poems and Ballads*, enjoyed perhaps less unstinted attention; but it is not too much to say that by the close of his thirtieth year, in spite of hostility and detraction, Swinburne had not only placed himself in the highest rank of contemporary poets, but had even established himself as leader of a choir of singers to whom he was at once master and prophet.

Meanwhile, his private life was disturbed by troublous influences. A favourite sister died at East Dene, and was buried in the little shady churchyard of Bonchurch. Her loss overwhelmed the poet's father with grief, and he could no longer tolerate the house that was so full of tender memories. So the family moved to Holmwood, in the Thames Valley, near Reading, and the poet, being now within sound of the London literary world, grew anxious to mix in the company of the small body of men who shared his sympathies and tastes. Rooms were found for him in North Crescent, off Oxford Street, and he was drawn into the vortex of London life. The Pre-Raphaelite movement was in full swing, and for the next few years he was involved in a rush of fresh emotions and rapidly changing loyalties. It is indeed necessary to any appreciation of Swinburne's genius that one should understand that his inspiration was almost invariably derivative. His first book is deliberately Shakespearian in design and expression; the *Atalanta*, of course, is equally deliberate in its pursuit of the Hellenic spirit. Then, with a wider swing of the pendulum, he recedes, in *Poems and Ballads*, to the example of Baudelaire and of the Pre-Raphaelites themselves; with the *Song of Italy* (1867) he is drawing towards the revolt of Mazzini; by the time *Songs before Sunrise* are completed (in 1871) he is altogether under the influence of Victor Hugo, while Rome has become to him "first name of the world's names." But, if Swinburne's inspiration was derivative, his manner was in no sense imitative; he brought to poetry a spirit entirely his own, and a method even more individual than his spirit. In summing up his work we shall seek to indicate wherein his originality and his service to poetry has lain; meanwhile, it is well to distinguish clearly between the influences which touched him and the original, personal fashion in which he assumed those influences, and made them his own. The spirit of Swinburne's muse was always a spirit of revolution. In *Poems and Ballads* the revolt is against moral conventions and restraints; in *Songs before Sunrise* the arena of the contest is no longer the sensual sphere, but the political and the ecclesiastical. The detestation of kings and priests, which marked so much of the work of his maturity, is now in full swing, and Swinburne's language is sometimes tinged with extravagance and an almost virulent animosity. With *Bothwell* (1874) he returned to drama and the story of Mary Stuart. The play has fine scenes and is burning with poetry, but its length not only precludes patient enjoyment, but transcends all possibilities of harmonious unity. *Erechtheus* (1876) was a return to the Greek inspiration of *Atalanta*; and then in the second series of *Poems and Ballads* (1878) the French influence is seen to be at work, and Victor Hugo begins to hold alone the place possessed, at different times, by Baudelaire and Mazzini. At this time Swinburne's energy was at fever height; in 1879 he published his eloquent *Study of Shakespeare*, and in 1880 no fewer than three volumes, *The Modern Heptalogia*, a brilliant anonymous essay in parody, *Songs of the Springtides*, and *Studies in Song*. It was shortly after this date that Swinburne's friendship for Theodore Watts-Dunton (then Theodore Watts) grew into one of almost more than brotherly intimacy. After 1880 Swinburne's life remained without disturbing event, devoted entirely to the pursuit of literature in peace and leisure. The conclusion of the Elizabethan trilogy, *Mary Stuart*, was published in 1881, and in the following year *Tristram of Lyonesse*, a wonderfully individual contribution to the modern treatment of the Arthurian legend, in which the heroic couplet is made to assume opulent, romantic cadences of which it had hitherto seemed incapable. Among the publications of the next few years must be mentioned *A Century of Roundels*, 1883; *A Midsummer Holiday*, 1884; and *Miscellanies*, 1886. The current of his poetry, indeed, continued unchecked; and though it would be vain to pretend that he added greatly either to the range of his subjects or to the fecundity of his versification, it is at least true that his melody was unbroken, and his magnificent torrent of words inexhaustible. His *Marino Faliero* (1885) and *Locrine* (1887) have passages of power and intensity unsurpassed in any of his earlier work, and the rich metrical effects of *Astrophel* (1894) and *The Tale of Balin* (1896) are inferior in music and range to none but his own masterpieces. In 1899 appeared his *Rosamund, Queen of the Lombards*; in 1908 his *Duke of Gardia*; and in 1904 was begun the publication of a collected edition of his Poems and Dramas in eleven volumes.

Besides this wealth of poetry, Swinburne was active as a critic, and several volumes of fine impassioned prose testify to the variety and fluctuation of his literary allegiances. His *Note on Charlotte Brontë* (1877) must be read by every student of its subject; the *Study of Shakespeare* (1880)—followed in 1909 by *The Age of Shakespeare*—is full of vigorous and arresting thought, and many of his scattered essays are rich in suggestion and appreciation. His studies of Elizabethan literature are, indeed, full of "the noble tribute of praise," and no contemporary critic did so much to revive an interest in that wonderful period of dramatic recrudescence, the side-issues of which have been generally somewhat obscured by the pervading and dominating genius of Shakespeare. Where his enthusiasm was heart-whole, Swinburne's appreciation was stimulating and infectious, but the very qualities which give his poetry its unique charm and character were antipathetic to his success as a critic. He had very little capacity for cool and reasoned judgment, and his criticism is often a tangled thicket of prejudices and predilections. He was, of course, a master of the phrase; and it never happened that he touched a subject without illuminating it with some lightning-flash of genius, some vivid penetrating suggestion that outflames its shadowy and confused environment. But no one of his studies is satisfactory as a whole; the faculty for sustained exercise of the judgment was denied him, and even his best appreciations are disfigured by error in taste and proportion. On the other hand, when he is aroused to literary indignation the avalanche of his invective sweeps before it judgment, taste and dignity. His dislikes have all the superlative violence of his affections, and while both alike present points of great interest to the analyst, revealing as they do a rich, varied and fearless individuality, the criticism which his hatreds evoke is seldom a safe guide. His prose work also includes an early novel of some interest, *Love's Cross-currents*, disinterred from a defunct weekly, the *Tatler*, and revised for publication in 1905.

Whatever may be said in criticism of Swinburne's prose, there is at least no question of the quality of his poetry, or of its important position in the evolution of English literary form. To treat first of its technique, it may safely be said to have revolutionized the whole system of metrical expression. It found English poetry bound in the bondage of the iambic; it left it revelling in the freedom of the choriambus, the dactyl and the anapaest. Entirely new effects; a richness of orchestration resembling the harmony of a band of many instruments; the thunder of the waves, and the lisp of leaves in the wind; these, and a score other astonishing poetic developments were allied in his poetry to a mastery of language and an overwhelming impulse towards beauty of form and exquisiteness of imagination. In *Tristram of Lyonesse* the heroic couplet underwent a complete metamorphosis. No longer wedded to antithesis and a sharp caesura, it grew into a rich melodious measure, capable of an infinite variety of notes and harmonies, palpitating, intense. The service which Swinburne rendered to the English language as a vehicle for lyrical effect is simply incalculable. He revolutionized the entire scheme of English prosody. Nor was his singular vogue due only to this extraordinary metrical ingenuity. The effect of his artistic personality was in itself intoxicating, even delirious. He was the poet of youth insurgent against all the restraints of conventionality and custom. The young lover of poetry, when first he encounters Swinburne's influence, is almost bound to be swept away by it; the wild, extravagant licence, the apparent sincerity, the vigour and the verve, cry directly to the aspirations of youth like a clarion in the wilderness. But, while this is inevitable, it is also true that the critical lover of poetry outgrows an unquestioning allegiance to the Swinburnian mood more quickly than any other of the diverse emotions aroused by the study of the great poets. It is not that what has been called his "pan-anthropism"—his universal worship of the holy spirit of man—is in itself an unsound philosophy; there have been many creeds founded on such a basis which have impregnably withstood the attacks of criticism. But the unsoundness of Swinburne's philosophy lies in the fact that it celebrates the spirit of man engaged in a defiant rebellion that leads nowhere; and that as a "criticism of life" it has neither finality nor a sufficiently high seriousness of purpose. Walt Whitman preaches very much the same gospel of the "body electric" and the glory of human nature; but Whitman's attitude is far saner, far more satisfying than Swinburne's, for it is concerned with the human spirit realizing itself in accordance with the unchangeable laws of nature; while Swinburne's enthusiasm is, more often than not, directed to a spiritual revolution which sets the laws of nature at defiance. It is impossible to acquit his poetry entirely of the charge of an animalism which wars against the higher issues of the spirit—an animalism sometimes of love, sometimes of hatred, but, in both extremes, out of centre and harmony.

Yet, when everything has been said that can be said against the unaesthetic violences of the poet's excesses, his service to contemporary poetry outweighed all disadvantages. No one did more to free English literature from the shackles of formalism; no one, among his contemporaries, pursued the poetic calling with so sincere and resplendent an allegiance to the claims of absolute and unadulterated poetry. Some English poets have turned preachers; others have been seduced by the attractions of philosophy; but Swinburne always remained an artist absorbed in a lyrical ecstasy, a singer and not a seer. When the history of Victorian poetry comes to be written, it will be found that his personality was, in its due perspective, among the most potent of his time; and as an artistic influence it will be pronounced both inspiring and beneficent. The topics that he touched were often ephemeral; the causes that he celebrated will, many of them, wither and desiccate; but the magnificent freedom and lyrical resource which he introduced into the language will enlarge its borders and extend its sway so long as English poetry survives.

On the 10th of April 1909, after a short attack of influenza followed by pneumonia, the great poet died at the house on Putney Hill, "The Pines," where with Mr Watts-Dunton he had lived for many years. He was buried at Bonchurch, Isle of Wight. (E. G.)

SWINDON, a market town and municipal borough in the Cricklade parliamentary division of Wiltshire, England, $77\frac{1}{4}$ m. W. of London by the Great Western railway. Pop. (1891), 33,001; (1901), 45,006. It has two parts, New and Old. The new town grew up around the vast locomotive and wagon works of the Great Western railway, and is an important junction on that system with a separate station on the Midland and South-Western Junction railway. It arose rapidly on a strip of waste land, and churches and chapels were built for the workmen, whose numbers soon exceeded 10,000. Each man contributes to a medical fund which maintains the fever, accident and general hospitals, providing also laundries and baths. There are a mechanics' institute, containing a large library, theatre, reading-rooms and lecture-hall. The company owns a park with football and cricket grounds. An aisle of St Saviour's Church, dedicated in 1905, was built by the priest and congregation with their own hands. The picturesque old town stands on a hill overlooking the Gloucestershire borders, the White Horse Vale and Lambourn Down in Berkshire, and the great chalk uplands of Marlborough; while the camps of Blunsdon, Ringsbury, Barbury and Badbury are all visible. Here the chief buildings are the church, town-hall, market-hall and corn exchange. Old Swindon received the right of holding a fair from Charles I. Coate Reservoir, less than 2 m. south-east, is a broad lake which supplies a branch of the Berks and Wilts Canal. Its shores are beautifully wooded, and it abounds with fish. Swindon is governed by a mayor, 12 aldermen and 36 councillors. Area, 4265 acres.

SWINE, a name properly applicable to the domesticated pig (*Sus scrofa*), but also including its wild relatives. As stated in the article ARTIODACTYLA, these animals typify the family Suidae, which, with the Hippopotamidae, constitute the section Suina, a group of equal rank with the Pecora. The Suidae are divisible into the true Old World swine (Suinae) and the American peccaries (Dicotylinae). Of the former the leading characteristics are as follows: an elongated mobile snout, with an expanded, truncated, nearly naked, flat, oval terminal surface in which the nostrils are placed. Feet narrow, with four completely developed toes on each. Hoofs of the two middle toes with their contiguous surfaces flattened. The outer toes not reaching to the ground in the ordinary walking position. Teeth variable in number, owing to the suppression in some forms of an upper incisor and one or more premolars.

In the typical genus *Sus*, as exemplified by domesticated pigs (see PIG) and the wild boar (see BOAR), the dentition is $i.\frac{3}{3}$, $c.\frac{1}{1}$, $p.\frac{4}{4}$, $m.\frac{3}{3}$; total 44; the upper incisors diminishing rapidly in size from the first to the third, and the lower incisors long, narrow, closely approximated, and almost horizontal in position, their tips inclining towards the middle line, the second slightly larger than the first, the third much smaller. The tusks or canines are strongly developed, with

FIG. 1.—Dentition of Boar (*Sus scrofa*).

persistent roots and a partial enamel covering, those of the upper jaw not having the usual downward direction, but curving outwards, upwards and finally inwards, while those of the lower jaw are directed upwards and outwards with a gentle backward curve, their hinder edges working and wearing against the front edges of the upper pair. The tusks appear externally to the mouth, the form of the upper lip being modified to allow of their protrusion, but are much less developed in females than in males. The teeth of the molar series gradually increase in size and complexity from first to last, and are arranged in contiguous series, except that the first lower premolar is separated by an interval from the second. First and second upper premolars with compressed crowns and two roots; and the third and fourth with an inner lobe of the crown, and an additional pair of roots. The first and second molars have quadrate crowns, with four principal obtuse conical cusps, around which numerous accessory cusps are clustered. The crown of the third molar is nearly as long as those of the first and second together, having, in addition to the four principal lobes, a large posterior heel, composed of clustered conical cusps, and supported by additional roots. The lower molars resemble generally those of the upper jaw, but are narrower. Milk dentition: $i.\frac{3}{3}$, $c.\frac{1}{1}$, $m.\frac{3}{3}$; total 28—the first permanent premolar having no predecessor. The third incisor in both upper and lower jaws is large, developed before the others, with much the size, form and direction of the canine. Vertebrae: C. 7, D. 13–14, L. 6, S. 4, Ca. 20–24. The hairy covering of the body varies under different conditions of climate, but when best developed, as in the European wild boar, consists of long stiff bristles, abundant on the back and sides, and of a close softer curling under-coat.

All the typical swine are further characterized by the fact that the young are longitudinally striped with bands of dark brown and some paler tint; this striped coat disappearing in the course of a few months. On the other hand, this peculiar marking is rarely seen in domestic pigs in any part of the world, although it has been occasionally observed. It is stated by Darwin that the pigs which have run wild in Jamaica and New Granada have resumed this aboriginal character, and produce longitudinally striped young; these being the descendants of domestic animals introduced from Europe since the Spanish conquest, as before that time there were no true pigs in the New World. Another character by which the European domesticated pig differs from any of the wild species is the concave outline of the frontal region of the skull.

In the wild boar (*Sus scrofa*) the upper or hinder surface of the lower tusk, which has no enamel, inclines obliquely outwards and is broader than the outer surface. The distributional area

FIG. 2.—Wild Boar and Young (*Sus scrofa*).

of this species includes northern Africa, Europe and central and northern Asia as far as Amurland. Whether the Nubian *S. senarensis* is really distinct, seems doubtful. To the same group belongs the Indian *S. cristatus*, distinguished by the more pronounced development of the crest of long hairs on the nape of the neck, and closely related to the next species. The third species is the banded pig *S. vittatus*, of Sumatra, characterized by having a broad reddish or whitish band running from the middle of the snout along the upper lip to disappear on the side of the neck; the skull being short and high, with the facial portion of the lachrymal bone small. Races of this type are also met with in Java, Cochin-China and Formosa; the pig from the latter island having been named *S. täivanus*. Near akin is the Japanese *S. leucomystax* and the small Andamanese *S. andamanensis*. Whether the New Guinea *S. papuensis* and *S. niger* are really indigenous members of this group or modified descendants of European tame pigs is doubtful; although the general character of the Papuan fauna supports the idea that they are introduced.

A second group is typified by the warty pig, *S. verrucosus*, of Java, in which the hinder or upper unenamelled surface of the lower tusk is narrower than the outer, concave, and set nearly in the long axis of the skull. The skull itself is elongated, with comparatively simple and primitive molars, the latter being relatively short. There are also three small warts on each side of the face, the largest of which is just below the eye and carries long bristles. The small *S. celebensis* of Celebes and *S. philippinensis* are probably only varieties of this species. The bearded pig *S. barbatus* (=*longirostris*) of Borneo is a very distinct member of this group, distinguished by the great elongation of the skull, and the presence of a tuft of long hair near the muzzle. In Sumatra it is represented by the subspecies *S. b. öi*, and in south-west Borneo by *S. b. gargantua*.

Some doubt exists whether the pygmy hog of the Nepal Terai, which is not much larger than a hare, is best regarded as a member of the typical genus, under the name of *Sus salvanius* or as representing a genus by itself, with the title *Porcula salvania*.

Similar doubts have also been entertained with regard to the African bush-pigs or river-hogs, but from geographical considerations alone these are but regarded as representing a separate genus, *Potamochoerus*, although they are nearly allied to the *verrucosus* group of *Sus*. They are specially distinguished by the great development of the anterior half of the zygomatic arch of the skull, and by the presence in the boars of a horny protuberance of the skin in front of each eye, which overlies a tuberosity on the nasal bone; the molars are also small and simple, and the anterior premolars are generally shed at an early stage of life. The group is represented in Madagascar, as well as in Africa south of the Sahara. (See RIVER-HOG.)

The recently discovered *Hylochoerus* of the equatorial forest-districts of Africa comes nearest to the under-mentioned wart-hogs, but the skull is of a much less specialized type, while the upper tusks are much smaller although they have the same general curvature and direction, and the cheek-teeth lack the peculiar characteristics of those of *Phacochoerus*, although they present a certain approximation thereto. On the other hand, resemblance to that genus is shown by the reduction of the upper incisors to a single pair. The skin is clothed with a thick coat of coarse black hair of a bristly nature, but there are a few whitish hairs on the face and in the groin.

In the African wart-hogs (*Phacochoerus*), which take their name from the large warty lobes projecting from each side of the face, the teeth are remarkably modified. The milk-dentition, and even the early condition of the permanent dentition, is formed on the same general type as that of *Sus*, except that certain teeth are absent, the formula being $i\frac{1}{3}$, $c\frac{1}{1}$, $p\frac{3}{2}$, $m\frac{3}{3}$, total 34; but as age advances all the teeth have a tendency to disappear, except the canines and the posterior molars, but these, which in some cases are the only teeth left in the jaws, attain an extraordinary development. The upper canines especially are of great size, and curve outwards, forwards and upwards. Their enamel covering is confined to the apex, and soon wears away. The lower canines are much more slender, but follow the same curve; except on the posterior surface, their crowns are covered with enamel; both pairs of canines are large in the two sexes. The third or last molar tooth of both jaws is of great size, and presents a structure at first sight unlike that of any other mammal, being composed of numerous (22–25) parallel cylinders or columns, each with pulp-cavity, dentine and enamel-covering, and packed together with cement. Examination will, however, show that a modification similar to that which has transformed the comparatively simple molar tooth of the mastodon into the extremely complex grinder of the Indian elephant has served to change the tooth of the common pig into that of *Phacochoerus*. The tubercles which cluster over the surface of the crown of the common pig are elongated and drawn out into the columns of the wart-hog, as the low transverse ridges of the mastodon's tooth become the leaf-like plates of the elephant's molar. (See WART-HOG.)

The last existing representative of the *Suidae* is the babirusa of Celebes, alone representing the genus of the same name, and readily distinguished by the extraordinary size and form of the tusks of the old males. (For the characteristics of this animal see BABIRUSA.)

Extinct Swine.—Species of *Sus* are met with in Pliocene strata of Europe and Asia, the Lower Pliocene *S. erymanthius* of Greece and *S. giganteus* and *S. titan* of India being enormous animals; the last with comparatively simple molars. The European *S. palaeochoerus* and the Indian *S. hysudricus* are smaller forms; the first exhibiting signs of relationship with *Potamochoerus*. In India also occurs *Hippohyus* distinguished by the extremely complicated structure of its molars. In the European Miocene we have *Hyotherium* and *Palaeochoerus*, and in the Upper Oligocene *Propalaeochoerus*, which have square molars without any tendency to a selenodont structure in their cusps. Curiously enough a selenodont type is, however, apparent in those of the imperfectly known Egyptian *Geniohyus* of the Upper Eocene, the earliest species which can be included in the family. Even in this the forward direction of the lower incisors is noticeable. *Choeropotamus* is a European Oligocene genus with bunodont molars which show a conspicuous basal cingulum in the lower dentition; the first premolar is absent. In the European Miocene *Listriodon*, which also occurs in the Indian Tertiaries, the molars have a pair of transverse ridges, like those of the proboscidean *Dinotherium* (*q.v.*); but the genus is believed to be related to the Oligocene *Doliochoerus* and *Choerotherium*, in which these teeth show a more normal type of structure.

For the genus *Elotherium*, of the Lower Miocene and Upper Oligocene of both hemispheres, which is often placed next the Suidae, see ARTIODACTYLA. The American Dicotylinae are noticed under PECCARY. (R. L.*)

SWINEMÜNDE, a port and seaside resort of Germany, in the Prussian province of Pomerania, situated at the east extremity of the island of Usedom, and on the left bank of the river Swine which connects the Stettiner Haff with the Baltic. Pop. (1905), 13,272. It serves as the outer port of Stettin (*q.v.*), 42 m. distant by water, with which, as with Heringsdorf, it has direct railway communication. Its broad unpaved streets and one-storey houses built in the Dutch style give it an almost rustic appearance. although its industries, beyond some fishing, are entirely connected with its shipping. The entrance to the harbour, the best on the Prussian Baltic coast, is protected by two long breakwaters, and is strongly fortified. The grand lighthouse, 216 ft. high, rises beside the new docks on the island of Wollin, on the other side of the narrow Swine. In 1897 the river continuation of the Kaiserfahrt was opened to navigation, and, further, the waterway between the Haff and the Baltic was deepened to 24 ft. in 1900–1901 and in other ways improved. The connexion between Swinemünde and Stettin is kept open in winter by ice breakers. Formerly ships of heavy burden bound for Stettin discharged or lightened their cargo at Swinemünde, but since the recent deepening of the river Oder they can proceed direct to the larger port.

The Swine, the central and shortest passage between the Stettiner Haff and the Baltic Sea, was formerly flanked by the fishing villages of West and East Swine. Towards the beginning of last century it was made navigable for large ships, and Swinemünde, which was founded on the site of West Swine in 1748, was fortified and raised to the dignity of a town by Frederick the Great in 1765.

See Wittenberg, *Swinemünde, Ahlbeck und Heringsdorf* (Linz, 1893).

SWING, DAVID (1830–1894), American clergyman, was born of Alsatian stock in Cincinnati, Ohio, on the 23rd of August 1830. He spent most of his boyhood on a farm and earned his schooling; graduated at Miami University in 1852; studied theology at Lane Seminary; and was principal of the preparatory school at Miami in 1853–1866. He became pastor in 1866 of the Westminster Presbyterian Church (after 1868 the Fourth Church) in Chicago, which was destroyed in the fire of 1871; he then preached in McVicker's theatre until 1874, when a new building was completed. In April 1874 he was tried before the presbytery of Chicago on charges of heresy preferred by Dr Francis Landey Patton, who argued that Professor Swing preached that men were saved by works, that he held a "modal" Trinity, that he did not believe in plenary inspiration, that he unduly countenanced Unitarianism, &c. The presbytery acquitted Dr Swing, who resigned from the presbytery when he learned that the case was to be appealed to the synod. As an action was taken against the church, of which he had remained pastor, he resigned the pastorate, again leased McVicker's theatre (and after 1880 leased Central Music Hall, which was built for the purpose), and in 1875 founded the Central Church, to which many of his former parishioners followed him, and in which he built up a large Sunday school, and established a kindergarten, industrial schools, and other important charities. He died in Chicago on the 3rd of October 1894. He was an excellent preacher, but no theologian. He published *Sermons* (1874), including most of his "heretical" utterances, *Truths for To-day* (2 vols., 1874–1876), *Motives of Life* (1879), and *Club Essays* (1881).

See Joseph F. Newton, *David Swing, Poet-Preacher* (Chicago, 1909).

SWINTON, an urban district in the Rotherham parliamentary division of the West Riding of Yorkshire, England, 10½ m. N.E. of Sheffield, on the Midland, North Eastern and Great Central railways. Pop. (1891), 9705; (1901), 12,217. It is situated at the junction of the Dearne and Dove navigation with the river Don navigation. In the churchyard of St Margaret's church (rebuilt in 1817) two beautiful Norman arches of the old church are preserved. There are collieries, quarries and brickfields in the neighbourhood. There are also flint and glass-bottle works, ironworks (for stoves, grates, fenders and kitchen ranges), and earthenware manufactures. The town was formerly renowned for its Rockingham ware. A free warren was granted to Swinton by Henry II.

SWINTON AND PENDLEBURY, an urban district in the Eccles parliamentary division of Lancashire, England, 5 m. N.W. of Manchester, with stations on the Lancashire & Yorkshire railway. Pop. (1901), 27,005. The church of St Peter, a fine building of stone with a lofty western tower, was erected from the designs of Sir Gilbert Scott in 1869. The Swinton industrial schools, opened in February 1846, are a fine range of buildings of brick with stone facings, surrounded with grounds extending to 20 acres. The manufacture of cotton, and coal-mining are the chief industries. Anciently a large part of Swinton was possessed by the Knights Hospitallers of St John of Jerusalem.

SWITCHBACK, a form of pleasure railway, built over alternate descents and ascents, the train or car first gathering momentum by running down an incline, and surmounting by means of this a lesser ascent. Switchbacks were originally merely an imitation, using cars upon wheels, of the sledge-coasting courses of Russia, and were indeed named by the French *montagnes russes*. They were introduced in Paris in 1816, but soon disappeared in consequence of several serious accidents. About 1880 they again became popular both in Europe and America. A variation of the switchback, though lacking its essential principle of climbing by means of momentum, is the water-chute, an imitation of the Canadian toboggan-slide, in which cars built in the shape of boats glide down steep inclines into artificial lakes at their bases. This is popularly called "shooting the chutes." A further variation is "looping the loop," in which a heavy car on wheels, or a bicycle, starting at a considerable altitude, descends an incline so steep that sufficient momentum is accumulated to carry it completely round a track in the form of a perpendicular loop, in the course of which journey the occupants or rider, while crossing the top of the loop, are actually head downwards. Later it was made even more dangerous by taking out part of the top of the loop, so that the car or bicycle actually passes through the air across the gap.

SWITCH PLANTS, a botanical term for plants, such as broom, with leaves very small or absent, and slender green shoots.

SWITHUN (or SWITHIN), **ST** (d. 862), bishop of Winchester and patron saint of Winchester Cathedral from the 10th to the 16th century. He is scarcely mentioned in any document of his own time. His death is entered in the *Anglo-Saxon Chronicle* under the year 861; and his signature is appended to several charters in Kemble's *Codex diplomaticus*. Of these charters three belong to 833, 838, 860–862. In the first the saint signs as "Swithunus presbyter regis Egberti," in the second as "Swithunus diaconus," and in the third as "Swithunus episcopus." Hence if the second charter be genuine the first must be spurious, and is so marked in Kemble. More than a hundred years later, when Dunstan and Ethelwold of Winchester were inaugurating their church reform, St Swithun was adopted as patron of the restored church at Winchester, formerly dedicated to St Peter and St Paul. His body was transferred from its almost forgotten grave to Ethelwold's new basilica on the 15th of July 971, and according to contemporary writers, numerous miracles preceded and followed the translation.

The revival of St Swithun's fame gave rise to a mass of legendary literature. The so-called *Vitae Swithuni* of Lantfred and Wulstan, written about A.D. 1000, hardly contain any germ of biographical fact; and all that has in later years passed for authentic detail of St Swithun's life is extracted from a biography ascribed to Gotzelin, a monk who came over to England with Hermann, bishop of Salisbury from 1058 to 1078. From this writer, who has perhaps preserved some fragments of genuine tradition, we learn that St Swithun was born in the reign of Egbert, and was ordained priest by Helmstan, bishop of Winchester (838–*c.* 852). His fame reached the king's ears, who appointed him tutor of his son Adulphus (Æthelwulf) and numbered him amongst his chief friends. Under Æthelwulf he was appointed bishop of Winchester, to which see he was consecrated by Archbishop Ceolnoth. In his new office he was remarkable for his piety and his zeal in building new churches or restoring old ones. At his request Æthelwulf gave the tenth of his royal lands to the Church. His humility was such that he made his diocesan journeys on foot; and when he gave a banquet he invited the poor and not the rich. He built near the eastern gate of his cathedral city a bridge whose stone arches were so strongly constructed that in Gotzelin's time they seemed a work "non leviter ruiturus." He died on the 2nd of July 862, and gave orders that he was not to be buried within the church, but outside in "a vile and unworthy place."

William of Malmesbury adds that, as Bishop Alhstan of Sherborne was Æthelwulf's minister for temporal, so St Swithun was for spiritual matters. The same chronicler uses a remarkable phrase in recording the bishop's prayer that his burial might be "ubi et pedibus praetereuntium et stillicidiis ex alto rorantibus esset obnoxius." This expression has been taken as indicating that the well-known weather myth contained in the doggrel lines—

St Swithin's day if thou dost rain
For forty days it will remain;
St Swithin's day if thou be fair
For forty days 'twill rain na mair—

had already, in the 12th century, crystallized round the name of St Swithun; but it is doubtful if the passage lends itself by any straining to this interpretation. James Raine suggested that the legend was derived from the tremendous downpour of rain that occurred, according to the Durham chroniclers, on St Swithun's day, 1315 (*Hist. Dunelm.* pp. xiii. 96–97). Another theory, more plausible, but historically worthless, traces it to a heavy shower by which, on the day of his translation, the saint marked his displeasure towards those who were removing his remains. This story, however, cannot be traced further back than some two or three centuries at the outside, and is at variance with the 10th-century writers, who are all agreed that the translation took place in accordance with the saint's desire as expressed by vision. More probable is John Earle's suggestion that in the legend as now current we have the survival of some pagan or possibly prehistoric day of augury, which has successfully sheltered itself under the protection of an ecclesiastical saint. This view is supported by the fact adduced in *Notes and Queries* (1st series, xii. 137) that in France St Médard (June 8) and St Gervase and St Protais (June 19) are credited with an influence on the weather almost identical with that attributed to St Swithun in England. Similarly we have in Flanders St Godelieve (July 6) and in Germany the Seven Sleepers' Day (June 27). Of other stories connected with St Swithun the two most famous are those of the Winchester egg-woman and Queen Emma's ordeal. The former is to be found in Gotzelin's life (*c.* 1100), the latter in T. Rudborne's *Historia major* (15th century)—a work which is also responsible for the not improbable legend that Swithun accompanied Alfred on his visit to Rome in 856.

The so-called lives of St Swithun written by Wulstan, Lantfred, and perhaps others towards the end of the 10th century may be found in Bollandus's *Acta sanctorum* (July), i. 321–327; Mabillon's *Acta SS. O. B.* vi. 70, &c., vii. 628, &c.; and J. Earle's *Life and Times of St Swithun*, 59, &c. See also William of Malmesbury, *Gest. reg.* i. 150, and *De gest. pont.* 160, 167, 179; Florence of Worcester, i. 168; T. Rudborne ap. Wharton's *Anglia sacra*, i. 287; T. D. Hardy's *Cat. of MSS.* i. 513–517; J. Brand's *Popular Antiquities*; R. Chambers's *Book of Days*; Ethelwulf's *Tithe Charters*, nearly all of which refer to St Swithun in the body of the text, may be studied in Haddon and Stubbs's *Councils*, iii. 636–645; a comparison of the charter on page 642 with Gotzelin's life (ap. Earle, 69) and William of Malmesbury (*Gest. reg.* 150; *De gest. pont.* 160) seems to show that these charters, even if forgeries, date back at least to the 11th century, as well as the story of his being Ethelwulf's "altor et ductor."

SWITZERLAND, a republican country of central Europe, comprising the Swiss Confederation, and bounded N. by the

German Empire, E. by Austria (except where the principality of Liechtenstein intervenes), S. by Italy, and W. by France.

Physical Description.—Switzerland extends between the parallels 45° 49′ 2″ and 47° 48′ 32″ lat. (Greenwich) and the meridians 5° 57′ 26″ and 10° 29′ 40″ long. (Greenwich). It forms an irregular quadrilateral, of which the greatest length from east to west is 226½ m., and the greatest breadth from north to south is nearly 137 m. (136·8). It has, however, no proper physical unity, as it consists of a number of small districts, differing from each other widely in language, religion, ethnology, customs, &c., but bound together in a political alliance, made originally for common defence against a common foe. It is therefore an artificial land, just as its inhabitants form an artificial nation, though nowadays it is becoming more homogeneous in both respects. Its political boundaries thus do not coincide with those of nature. The entire canton of Ticino is south of the Alps, as are the valleys of Simplon (Valais), Mesocco, Bregaglia, Poschiavo and Münster (all in the Grisons); the whole canton of Schaffhausen and part of that of Basel are north of the Rhine, while a large part of the Grisons lies to the east of the Rhine basin, and Porrentruy is far down on the western slope of the Jura. But it is to be noted that all these exceptional cases were outside the limits of the Swiss Confederation up to 1798. Putting them aside, the physical geography of Switzerland may thus be described:—

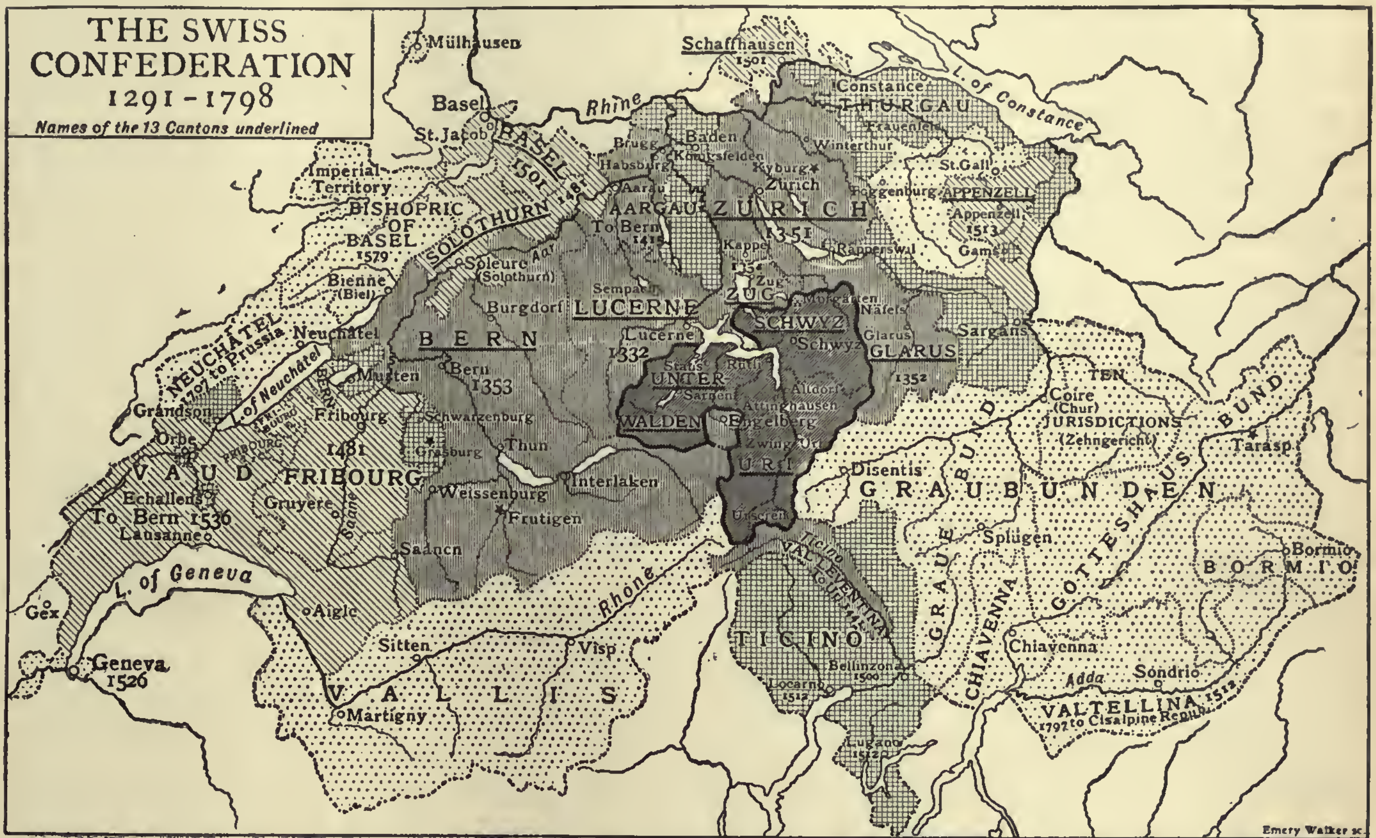
1. On the south runs the main chain of the Alps (*q.v.*), which is joined, at the Mont Dolent (12,543 ft.) in the chain of Mont Blanc, by the lower ranges that rise south of the Lake of Geneva, and which continues partly Swiss till close to the Stelvio Pass on the east.

2. To the north of this main chain there is another great range of mountains (wholly Swiss) only slightly inferior in extent and height, which starts from the hills known as the Jorat range above Lausanne, and culminates in the great snowy summits of the Bernese Oberland and of the Tödi group, before trending to the north near Coire, and, after rising once more in the Säntis group, dies away on the southern shore of the Lake of Constance.

3. The Swiss portion of the main chain of the Alps and this great northern outlier run parallel to each other from the Mont Dolent to near Coire, while for a short distance they actually unite near the Pizzo Rotondo (west of the St Gotthard Pass), parting again near the Oberalp Pass (east of the St Gotthard). Between these two great snowclad ranges flow two of the mightiest European rivers, the Rhone towards the west and the Rhine towards the east, their headwaters being only separated by the tangled mountain mass between the Pizzo Rotondo and the Oberalp Pass, which sends the Reuss towards the north and the Ticino towards the south.

4. To the north of this great northern outlier rises the Jura range (*q.v.*), really a huge spur of the Alps (with which it is connected by the Jorat range), while between the northern outlier and the Jura extends what may be called the plains or "plateau" of Switzerland, consisting all but wholly of the undulating valley of the Aar (below Thun) with its numerous affluents. To that river valley we must add the valley of the Thur (a direct affluent of the Rhine), that lies between the Aar basin and the Rhine basin (the Lake of Constance).

We may thus roughly describe Switzerland (as it exists at the present time) as consisting of three great river valleys (Rhone, Rhine and Aar) with the smaller one of the Thur, which all lie to the north of the main chain of the Alps and include the region between the Alps and the Jura. If we examine matters more carefully we note that the Rhone and Rhine valleys are shut off from that of the Aar (and, of course, of the Thur) by the great northern outlier of the Alps, which consists of the Bernese Oberland and Tödi Alps. Two wide and undulating valleys (Aar and Thur) and two deeply cut trenches (Rhone and Rhine) thus lie on the northern slope of the Alps, to the north and south respectively of the great northern outlier of the Alps. The main chain of the Alps rises in Swiss territory to the height of 15,217 ft. in the loftiest summit or Dufourspitze (wholly Swiss) of Monte Rosa, though the Dom (14,942 ft.), in the Mischabel range, between Zermatt and Saas, is the highest mountain mass which is entirely Swiss. The great northern outlier attains a height of 14,026 ft. in the Finsteraarhorn (Bernese Oberland), while the lowest level (581 ft.) within the Confederation is on the Lago Maggiore. The highest



The 3 original Cantons (Die Urkantone) 1291-1332 — The 8 ancient Cantons 1353-1481 (5 added between 1332 and 1353) — The 13 Cantons 1513-1798 (5 added between 1481 and 1513)

Allied and Protected Districts — Subject Districts — Dates of Confederation, Alliance or Conquest, are shown thus:- 1512

Subject States incorporated with Cantons are indicated by the word To with the date of incorporation:- To Bern 1536 permanently inhabited village in Switzerland is Juf (6998 ft.), at the head of the Avers valley (a tributary of the Hinter Rhine, Grisons), while the lowest is Ascona (666 ft.), on the Lago Maggiore and just south-west of Locarno.

According to the most recent calculations, the total area of Switzerland is 15,951 sq. m. (some 2500 sq. m. less than that of Servia). Of this 11,927·5 sq. m. (or 74·8%) are reckoned as "productive," forests occupying 3,390·9 sq. m. and vineyards 108·7 sq. m., the remainder, or 8427·7 sq. m., consisting of arable and pasture land. Of the "unproductive" area of 4023·5 sq. m (or 25·2%) much consists of lakes and rivers, while glaciers cover 709·7 sq. m. Approximately the Alps occupy one-sixtieth of this area, the Jura about one-tenth, and the "plateau" the rest. Of the entire area the great cantons of the Grisons, Bern and the Valais take up 7411·8 sq. m., or nearly one-half, while if to them be added Vaud, Ticino and St Gall the extent of these six (out of twenty-two) cantons is 10,527·6 sq. m., or almost two-thirds of the area of the Confederation. Not included in the total area of Switzerland are three small "enclaves" (4 sq. m. in all), Büsingen and Verenahof (both in Schaffhausen) belonging to Baden, while Campione (opposite Lugano) is Italian. Switzerland borders on many countries—France west and south-west, Italy south, Austria east (Tirol and Vorarlberg), and Germany north (Bavaria, Württemberg, Baden and Alsace). Switzerland sends its waters to four great river basins (which drain to three different seas) in the following proportions: Rhine basin, 11,159 sq. m.; Rhone basin, 2768 sq. m.; Po basin, 1361 sq. m.; and Inn basin, 663 sq. m.

The thirteen cantons which till 1798 formed the Confederation are all comprised in the Rhine basin, the ten oldest (*i.e.* all before 1500) being within that of the Aar, and it was only after 1798 that certain Romonsch-, French- and Italian-speaking "allies" and subject lands—with their river basins—were tacked on to them.

Most of the great Swiss rivers, being in their origin mere mountain torrents, tend to overflow their banks, and hence much is required and has been done to prevent this by embanking them, and regaining arable land from them. So the Rhine (between Ragatz and the Lake of Constance), the Rhone, the Aar, the Reuss; and in particular we may mention the great work on the Linth (1807–1816) carried out by Hans Konrad Escher, who earned by his success the surname of "Von der Linth," and on the Zihl near the lakes of Neuchâtel and Bienne, while the diversion of the Kander from its junction with the Aar at Thierachern to a channel by which it flows into the Lake of Thun was effected as early as 1714.

There are very many *lakes*, large and small, in Switzerland. The two most extensive, those of Geneva and of Constance, balance each other, as it were, at the south-west and north-east corners of the land. But neither of these is wholly Swiss, this distinction being claimed by the next in size, that of Neuchâtel (92·4 sq. m.), the Lago Maggiore (partly Swiss only) coming next in the list, and being followed by the wholly Swiss lakes of Lucerne and of Zürich. Then come Lugano, Thun, Bienne, Zug, Brienz, Morat, the Walensee, and Sempach ($5\frac{1}{2}$ sq. m.). These fourteen only are over 4 sq. m. in extent. Eleven of them are in the Rhine basin (also in that of the Aar), two (Maggiore and Lugano) in that of the Po, and one (Geneva) in that of the Rhone. There are no large lakes in the Swiss portion of the Inn basin, the most extensive being that of Sils ($1\frac{1}{2}$ sq. m.). Of the smaller lakes those best known to travellers are the Daubensee (near the summit of the Gemmi), the Oeschinensee (at the foot of the Blümlis Alp range) and the Märjelensee, formed by the damming up of the waters of the Great Aletsch glacier by a huge lateral moraine. Alpine tarns are innumerable.

Of the countless *waterfalls* in Switzerland those of the Rhine (near Schaffhausen) have volume but not height, while the reverse is the case in varying degrees with those of the Aar at the Handegg, of the Reichenbach, of Pissevache, and particularly of the Staubbach, a mere thread of water falling clear of a cliff of great height.

There are said to be 1077 *glaciers* in Switzerland, but it is really impossible to estimate the number accurately, as practically all are now in retreat, and it is not easy to say whether an isolated fragment of ice is or is not entitled to rank as an independent glacier. From them flow all the more important Swiss rivers and streams. Yet their distribution is very unequal, for eleven cantons (just one-half of the Confederation) have none. The Valais heads the list with 375 sq. m., then come the Grisons (138·6), Bern (111·3), Uri (44·3), Glarus (13·9) and Ticino (13·1). The five others (Unterwalden, Vaud, St Gall, Schwyz and Appenzell) boast of 13·3 all together. The three longest glaciers in the Alps are all in the great northern outlier (not in the main chain)—the Great Aletsch ($16\frac{1}{2}$ m.), the Fiescher and the Unteraar (each 10 m.). In the main chain the Gorner ($9\frac{1}{4}$ m.) is the longest. Of glaciers covering an area of over 6 sq. m. no fewer than 17 are in Switzerland, as against two each in the French portion of the chain of Mont Blanc and in the Eastern Alps.

Forests cover 21·2% (3390·99 sq. m.) of the total area of Switzerland. Of the six most extensive cantons five are also at the head in the matter of forests: Bern (591 sq. m.), the Grisons (503), Vaud (320), the Valais (297·4) and Ticino (267·2). St Gall (157) ranks in this respect after Zürich (180·8) and Aargau (172), while the only other cantons with over 100 sq. m. are Lucerne (120·4), Fribourg (119) and Soleure (111·3), the lowest place being taken by Geneva (9·9). By far the greater part (67%) of the forest area belongs to the communes or private corporations, while 28·5% is in the hands of private individuals (much of this having become private property in the time of Napoleon I.), but only 4·5% is in the hands of the state, in consequence of the suppression of many monasteries. The communes own 94·3% of the forest area in the Valais, private individuals 78·8% in Lucerne, and the state 16% in Schaffhausen. Schaffhausen and the Jura cantons are the most wooded in proportion to their area, while at the other end of the scale are the towns of Geneva and Basel, and the barren canton of Uri. The great floods of 1834, 1852 and 1868 drew attention to the negligent administration of the forests, considered specially as a protection against damage due to the forces of nature. A forestry department was created in the polytechnic school in Zürich when it was opened in 1855. The Federal Constitution of 1874 (art. 24) handed over to the Confederation the oversight of the forests "in the high mountains," this being interpreted to mean the Alps with their spurs, but not to include the Jura, and a law of 1876 was enacted to carry out this task. In 1897 the limitation mentioned above was struck out, so that the Confederation now has oversight of *all* forests within its territory, a law of 1902 regulating in detail the whole subject. Since 1876 much has been done, either directly by the Confederation or indirectly by subsidizing the efforts of the cantons, to reafforest districts where the trees had been recklessly cut down, and to ensure the proper administration of forests generally.

Geology.—The greater part of Switzerland is occupied by the belts of folded rock which constitute the Alps and the Jura (*q.v.*). The central plain, however, is covered by nearly undisturbed deposits of Oligocene and Miocene age, concealed in many places by glacial, alluvial and other accumulations of later date. Both the Oligocene and the Miocene beds are, for the most part, of fresh-water or brackish-water origin, but the middle of the Miocene series is formed of marine deposits. During this period an arm of the Mediterranean spread up the valley of the Rhone. It reached its maximum extension during the middle portion of the Miocene period, when it appears to have stretched continuously along the outer border of the Alps from the present Golfe du Lion into Austria; but at an earlier and a later date it was represented in Switzerland only by a series of brackish-water lagoons or fresh-water lakes.

Climate.—In Switzerland, where the height above sea-level ranges from 581 ft. (Lago Maggiore) to 15,217 ft. (Monte Rosa), we naturally find very many climates, from the regions of olives, vines, oaks and beeches, pines and firs, to those of the high mountain pastures, rhododendrons, and of eternal snow. It has been reckoned that, while in Italian Switzerland winter lasts only three months, at Glarus (1578 ft.) it lasts four, in the Engadine (5945 to 3406 ft.) six, on the St Gotthard (6936 ft.) eight, on the Great St Bernard (8111 ft.) nine, and on the St Théodule Pass (10,899 ft.) practically always. The highest mean annual temperature (53° F.) in Switzerland is naturally that at Lugano (909 ft.), while at Bevers (5610 ft., Upper Engadine) the lowest mean temperature in winter is −14° F., but the highest in summer is 77° F., an immense difference. At Montreux the annual mean is 50°, at Sion, Basel, Geneva and Coire about 49°, at Zürich 48°, at Bern and Lucerne 47·5°, at St Gall 45°, at Davos 37·5°, at Sils-Maria 34·5°, and on the Great St Bernard 29°. Of course many factors, such as the shape of the ground, the sheltered position of the place, the degree of exposure to sunshine, counterbalance the mere height at which the town is situated.

The snow-clad Alps of course have the heaviest rain- or snow-fall in Switzerland, this being estimated at 89·7 in. per annum. The greatest actually recorded rainfall (87·3 in.) was on the San Bernardino Pass (6769 ft.), while the lowest (21·7 in.) was at Sierre (1767 ft., Valais). At Lugano the average annual rainfall is 65·4 in., on the Great St Bernard 48·7 in., at Lucerne 45·6 in., at Montreux 42·6 in., at Sils-Maria 37 in., at Bern and Davos 36·6 in., and at Basel, Coire and Geneva about 32·7 in. It has been shown by careful observations that the rain- or snow-fall is greatest as we approach the Alps, whether from the north or the south, the flanks of the great ranges and the valleys opening out towards the plains receiving much more rain than the high Alpine valleys enclosed on all sides by lofty ridges. Thunderstorms generally vary in frequency with the amount of rainfall, being most common near the great ranges, and often very local. The floods caused by excessive rainfall are sometimes very destructive, as in 1834, 1852 and 1868, while the same cause leads to landslips, of which the most remarkable have been those of the Rossberg above Goldau (1806), at Evionnaz (1835) and at Elm (1881). The Föhn (*q.v.*) is the most remarkable local wind.

For all these reasons Switzerland has many varieties of climate; and, while, owing to the distribution of the rainfall, the Ticino and

Aar valleys are very fertile, the two great trenches between the main chain and its north outlier, though warm, are less productive, as the water comes from the rivers and not from the skies.

People.—The first estimate of the population of Switzerland with any pretence to accuracy was that of 1817, which put the number at 1,687,900. The first regular census took place in 1836 to 1838, but was therefore not synchronous, while it was also not very systematic—the number was put at 2,190,258. That of 1850 was better organized, while in 1860 the census was declared decennial, a slight alteration being made as to that of 1888 for practical reasons. The following was the number of the population usually resident (the number of those actually present was also taken, but all detailed subdivisions refer only to the residents): in 1850, 2,392,740; in 1860, 2,510,494; in 1870, 2,655,001; in 1880, 2,831,787; in 1888, 2,917,754; and in 1900, 3,315,443. The density per square mile was as follows: 150 in 1850; 157 in 1860; 159 in 1870; 177 in 1880; 182 in 1888; and 207 in 1900. The increase in the whole of the country from 1850 to 1900 was 39%. Thirteen cantons showed an increase lower than this average, the lowest of all being Aargau, Glarus and Lucerne; while in Bern the increase of the towns did not counterbalance the diminution in the country districts. The nine cantons which increased above the average rate did so either owing to special circumstances (*e.g.* the construction of the Simplon railway in the Valais), or because their industries were very flourishing (*e.g.* St Gall), or because they contain great towns (*e.g.* Zürich). The highest rates of increase were shown by Geneva (107% increase) and the half canton of Urban Basel (278% increase). As to the actual distribution of the population, the Alpine regions are the sparsest generally (with the exception of the Outer Rhodes of Appenzell), the Jura region has a much higher ratio, while the densest region of all is the Swiss plateau. The strong attraction of the towns is shown by the facts that between 1850 and 1900 the population of the nineteen largest nearly tripled, while, in 1900, of the 187 "political districts" in Switzerland 41 showed a decrease, and they were all exclusively rural.

The shifting of the population within the country is also proved when we note that in 1900 but 38·5% of the Swiss citizens inhabited their commune of birth, though the proportion was 64% in 1850. If we consider the different cantons, we find that in 1900 31·5% (in 1850 but 26·4%) lived in another commune within their canton of birth, while 18·4% (as against 6·6% in 1850) dwelt in a canton other than their canton of birth. To sum up, in 1850, out of the 25 cantons and half cantons, no fewer than 21 had a majority of citizens living in their commune of birth, while in 1900 the number was but 11, and those all rural cantons. Of the 3164 *communes* (or civil parishes) in Switzerland, only 21 in 1900 had a population exceeding 10,000, while 20 had under 50 inhabitants. If we look at the height of the communes above the sea-level, we find that there were but 3 (with a population of 463 souls) above 1900 metres (2953 ft.), while 68 (with a total population of 188,394) were below 300 metres (984 ft.). The number of inhabited houses rose from 347,327 in 1860 (the number was not taken in 1850) to 434,084 in 1900, while that of separate households mounted from 485,087 in 1850 (528,105 in 1860) to 728,920 in 1900.

The *non-Swiss element* of the population increased from 3% in 1850 to 11·6% in 1900, and its number from 71,570 in 1850 to 383,424 in 1900. The Germans are the most numerous, next in order come Italians, French and Austrians. In 1900 there were 3535 British subjects resident in Switzerland, and 1559 citizens of the United States. Of course most of the non-Swiss are found in the towns, or in rural districts where any great railway line is being constructed.

The *emigration* of Swiss beyond seas was but 1691 in 1877, though it rose in 1883 to 13,502 (the maximum as yet attained). Then the number fell pretty steadily till 1899 (2493), then rose again, and in 1906 was 5296. About 89% go to the United States, and about 6% to the Argentine Republic (mainly from the French-speaking cantons). Bern, Zürich, Ticino, the town of Basel and St Gall are the chief cantons which furnish emigrants.

In the matter of *religion*, the Protestants formed 59·3% in 1850 and 57·8% in 1900, and the Roman Catholics (including the "Christian" or "Old" Catholics, who arose in 1874) 40·6% and 41·6% respectively, while the Jews increased from 1% in 1850 to 4% in 1900—the remainder (other religions or none) being 2% in 1860 (not reckoned separately in 1850) and in 1900. Ten and a half cantons have a majority of Protestants, while in the rest the "Catholics" have the upper hand. The same proportion prevailed in 1850, save that then Geneva had a Protestant majority, whereas in 1870 already the balance had shifted, owing to the number of immigrants from France and Italy.

As to *languages* habitually spoken, Switzerland presents a very variegated picture. By the Federal Constitutions of 1848 (art. 109) and 1874 (art. 116), German, French and Italian are recognized as "national languages," so that debates in the Federal parliament may be carried on in any of the three, while Federal laws, decrees, &c., appear also in the three. The old historical dialects of Romonsch and Ladin (nearly confined to the canton of the Grisons, *q.v.*) enjoy no political recognition by the Confederation, are largely maintained by artificial means in the shape of societies founded for their preservation, and are not even in the majority (which is German) in the Grisons. Of the other 21 cantons, all have a German-speaking majority save 6—French prevails in Fribourg, Vaud, the Valais, Neuchâtel and Geneva, and Italian in Ticino. Since the census of 1880, when detailed inquiries as to language were made for the first time, there has been a certain amount of shifting, as is shown by the following figures. German was spoken by 71·3 of the population in 1880, by 71·4 in 1888 and by 69·8 in 1900; the figures for French are respectively 21·4, 21·8 and 22, and for Italian 5·7, 5·3 and 6·7, while Romonsch fell from 1·4 to 1·3 and 1·2%. "Other languages" were 2, 2 and 3%. Thus in 1900 there were nearly 70% of German-speaking persons, as against nearly 30% who spoke one or other of the Romance tongues. The most interesting cases are the cantons of Fribourg (*q.v.*) and the Valais (*q.v.*), in which French is advancing at the expense of German.

Chief Political Divisions and Towns.—When considering Switzerland it must never be forgotten that, strictly speaking, the only political "divisions" are the 187 "districts" into which the cantons are divided (Bern has 30, Vaud 19 and St Gall 15, no others having over 15). These are administrative districts, created for political purposes. The cantons themselves are not "divisions" but sovereign states, which have formed an alliance for certain purposes, while they are built up out of the 3164 "communes," which are really the political units. Of the 22 cantons,[1] 3 are subdivided—Unterwalden (from before 1291) into Obwalden and Nidwalden, and Appenzell (since 1597) into the Outer Rhodes and the Inner Rhodes, while Basel (since 1833) forms urban Basel (the city) and rural Basel (the country districts). The Swiss political capital is Bern (by virtue of a Federal law of 1848), while the Federal Supreme Tribunal is (since its foundation in 1874) at Lausanne, and the Federal Polytechnic School (since it was opened in 1855) at Zürich.

In 1900 there were 19 towns in Switzerland which had a population exceeding 10,000 souls, all having increased very much within the 50 previous years. The following are the six largest, the figures for 1850 being enclosed within brackets: Zürich, 150,703 (35,483); Basel, 109,161 (27,844); Geneva, 104,796 (42,127), Bern, 64,227 (27,558); Lausanne, 46,732 (17,108), and La Chaux de Fonds, 35,968 (13,659). Thus Geneva was first in 1850, but only third in 1900. Thirteen of these nineteen towns are cantonal capitals, though La Chaux de Fonds, Winterthur, Bienne, Tablat (practically a suburb of St Gall), Le Locle and Vevey are not, while no fewer than twelve cantonal capitals (Sion, Bellinzona, Aarau, Altdorf, Schwyz, Frauenfeld, Glarus, Liestal, Sarnen, Stans, Appenzell and Zug) are below this limit. It is reckoned that while the 19 Swiss towns having over 10,000 inhabitants had in 1850 a population of 255,722, that number had swollen in 1900 to 742,205.

Communications.—The carriage roads of Switzerland were much improved and increased in number after a strong Federal government was set up in 1848, for it largely subsidized cantonal undertakings. In the course of the 19th century many splendid roads were carried over the Alpine passes, whether within or leading from Swiss territory; in the latter case with financial aid from Italy (or till 1859 Austria, as the mistress of the Milanese). The earliest in date was that over the Simplon (1800–1807), while others were opened respectively over the Furka (7992 ft.) in 1867, to the top of the Great St Bernard (8111 ft.) in 1893, over the Grimsel (7100 ft.) in 1895, and over the Klausen Pass (6404 ft.) in 1900. The highest carriage road entirely within Switzerland is that over the Umbrail Pass (8242 ft.), opened in 1901, and leading from the Swiss upper Münster valley to close to the Stelvio.

The first Swiss lake over which a steamer plied regularly was that of Geneva (1823), followed by Constance (1824), Lago Maggiore (1826), Neuchâtel (1827), Thun (1835), Lucerne (1835) and

[1] The cantons are—Aargau, Appenzell, Basel, Bern, Fribourg, Geneva, Glarus, Grisons, Lucerne, Neuchâtel, St Gall, Schaffhausen, Schwyz, Soleure, Thurgau, Ticino, Unterwalden, Uri, Valais, Vaud, Zug, Zürich (see separate articles).

Brienz (1839). The first railway opened within Switzerland was that (14 m. long) from Zürich to Baden in Aargau (1847), though the Swiss bit of that from Basel to Strassburg had been opened in 1844. From 1852 to 1872 the cantons granted concessions for the building of railways to private companies, but from 1872 onwards the conditions were other and the lines were constructed under Federal supervision. In the 'fifties and 'sixties many lines were built, but not always according to sound financial principles, so that in 1878 the great "National Railway" became bankrupt. Hence the idea of the state purchase of the chief lines made considerable progress, so that in 1898 such a scheme was accepted by the Swiss people. Accordingly in 1901 most of the great lines became Federal railways, and the Jura-Simplon in 1903, while the Gotthard line became Federal in 1909. This state ownership only applies to the main lines, not to the secondary lines or to the mountain cog-wheel railways (of which the first was that from Vitznau up the Rigi, 1871) now so widespread throughout the country. The highest point as yet attained in Switzerland by a mountain railway is the Eismeer station (10,371 ft.) of the line towards the Jungfrau. Many tunnels have been pierced through the Swiss Alps, such as the St Gotthard (1882), the Albula (1903) and the Simplon (1906). The highest line carried over a Swiss pass is that over the Little Scheidegg (6772 ft.).

Industries.—a. Of the Land. If we look at the annual turnover there is no doubt that the principal Swiss industry is that of the entertainment of foreign visitors, for its gross receipts are larger than those of any other branch. It appears from the official statistics that in 1905 its gross receipts amounted to rather over £7,500,000 (as against about £4,500,000 in 1894, and rather over £2,000,000 in 1880), the net profit being nearly £1,500,000 (as against £656,000 and nearly £300,000 respectively), while in 1905 the capital invested in this industry was rather over £31,000,000 (as against £20,750,000 and £12,750,000 respectively). In 1905 there were in Switzerland 1924 hotels (of which 402 were in Bern and 358 in the Grisons) specially built for the accommodation of foreign visitors, containing 124,068 beds, and employing 33,480 servants (the numbers for 1894 and 1880 are 1693 and 1002, 88,634 and 58,137, and 23,997 and 16,022 respectively). Part of this increase is due to the fashion of visiting Switzerland in winter for skating, tobogganing, skiing, &c.

Of the actual "productive" soil about two-thirds is devoted to arable or pasturage purposes, but the latter branch is by far the more important, occupying about 83% of this two-thirds, for Switzerland is much more a pastoral than an agricultural country. In 1906 the number of cattle was officially put at 1,497,904 (as against 1,340,375 in 1901 and 993,291 in 1866). In summer they are supported on the numerous mountain pastures or "alps" (see ALPS, 2), which number 4778, and are of an estimated capital value of rather over £3,000,000, while in winter they are fed on the hay mown on the lower meadows or purchased from outside. Two main breeds of cattle are found in Switzerland, the dun race (best represented by the cattle of Schwyz) and the dappled race (of which the Simme valley beasts are of the red and white kind, and those of the Gruyère of the black and white variety). The best Swiss cheeses are those of the Emmenthal and of the Gruyère, while the two principal condensed milk factories (Nestlé at Vevey and that at Cham) are now united. It should be noted that the proportion of the land devoted to pastoral pursuits increases, like the rainfall, from the west and north-west to the east and north-east, so that it is highest (nearly 90%) in Appenzell and St Gall. As regards other domestic animals, the number of swine increased from 304,428 in 1866 to 566,974 in 1896 (the maximum recorded), but in 1906 fell to 548,355. The number of goats has remained pretty steady (359,913 in 1906 to 375,482 in 1866, the maximum, 416,323, being attained in 1886), but that of sheep has decreased from 447,001 in 1866 to 209,443 in 1906.

It is stated that but 14% of the "productive" area of Switzerland is corn-growing, this proportion being however doubled in Vaud. Hence for its food supply the country is largely dependent on its imports, the home supply sufficing for 153 days only. Tobacco is grown to a certain extent, especially near Payerne in the Broye valley (Vaud) and in Ticino, while more recently beetroot has been cultivated for the purpose of manufacturing sugar. Fruit and vegetables are made into jams and concentrated foods at Lenzburg and Kemptthal, while *kirschwasser* (cherry brandy) is made in Zug. Forests cover about 28½% of the "productive" area of Switzerland. They are now well cared for, and produce considerable profits.

Vineyards in Switzerland now cover 108·7 sq. m., though the area is steadily decreasing owing to the competition of foreign cheap wines. The only cantons which have over 10% of their area thus planted are Vaud (25%), Ticino (20%), Zürich (17%) and the Valais (10·7%). Among the best Swiss wines are those of La Côte, Lavaux and Yvorne (all in Vaud), and Muscat, Fendant and Vin du Glacier (all in the Valais). Those grown near Neuchâtel, at the northern end of the lake of Zürich, near Baden (Aargau), and along the Swiss bank of the Rhine, are locally much esteemed.

Among the raw mineral products of Switzerland the most important is asphalt, which is worked by an English company in the Val de Travers (Neuchâtel). Various metals (even including gold and silver) exist in Switzerland, but are hardly worked at all, save iron (Delémont), copper (Val d'Anniviers) and argentiferous lead (Lötschenthal). True coal is wholly absent, but lignites occur here and there, and are sometimes worked (*e.g.* at Käpfnach, Zürich). Anthracite is found in the Valais, while peat is worked in many parts. Salt was first found at Bex (Vaud) in 1544, and the mines are still worked. But far more important are the saline deposits along the Rhine, from near Basel to Coblenz (at the junction of the Rhine and the Aar), which were discovered at Schweizerhall in the year 1836, at Kaiseraugst in 1844, at Rheinfelden in 1845 and at Ryburg in 1848. Marble, sandstone and granite are worked in various spots for building purposes. Marl, clay and limestone are also found, and are much used for the manufacture of various kinds of cement. There are said to be 620 mineral springs in Switzerland, the best known being those at Baden in Aargau and at Schinznach (both sulphur), Schuls-Tarasp and St Moritz, Stachelberg, Ragatz and Pfäfers, Leukerbad and Weissenburg. The most important slate quarries are those in the canton of Glarus. The relative importance of the Swiss industries concerned with the land is best shown by the census taken in 1900 as to the occupations of the inhabitants. No fewer than 1,035,010 (about one-third of the total population) were engaged in pastoral or agricultural pursuits, as against 19,334 employed in market gardening, 18,233 in various matters touching the forests, 12,785 in the vineyards and 12,323 in extracting minerals (of these 8004 were employed in stone or marble quarries).

b. Manufactures.—The same census also shows the relative importance of the chief branches of manufacture in Switzerland—textile industries 270,114 (of which 88,457 were in the silk branch and 63,853 in that of cotton), watchmaking 115,617, embroidery 89,558, besides 74,148 engaged in the manufacture of machinery. Eastern Switzerland is the industrial portion of the land, though watchmaking and some minor industries are carried on in the Jura. The textile industries are by far the most important in Switzerland, Zürich and its neighbourhood being the main centre both for silk (this branch was revived by the Protestant exiles from Italy in the 16th century) and cotton, while St Gall, Appenzell and Thurgau are mainly devoted to embroidery, and Basel to the silk ribbon and floss silk departments. The watchmaking industry has been established in Geneva since the end of the 16th century, and spread in the early 18th century to the Neuchâtel portion of the Jura (centre La Chaux de Fonds and Le Locle). Musical boxes are chiefly made at Ste Croix in the Vaud section of the Jura, while Geneva is famous for its jewelry and goldsmiths' work. The growth of the manufacture of machines is much more recent, having originally been a mere adjunct of the textile industry, and developed in order to secure its independence of imports from England. Its centres are in and around Zürich, Winterthur, St Gall and Basel. Among other products and industries are chocolate (Suchard, Cailler, Sprüngli, Tobler, Peter, Maestrani, &c.), shoemaking (Schönenwerd), straw plaiting (Aargau and Gruyère), wood carving (Brienz in the Bernese Oberland since 1825), concentrated soups and meats (Maggi's factory is at Kemptthal near Winterthur), aniline dyes (Basel), aluminium (Neuhausen in Schaffhausen).

Commerce.—Switzerland is naturally adapted for free trade for it depends on the outside world for much of its food-stuffs and the raw materials of its manufactures. After the adoption of the Federal Constitution of 1848, customs duties within the land were abolished, while moderate duties only were levied on imports, the sum increasing as the articles came more or less within the category of luxuries, but being lowest on necessaries of life. Down to 1870 Switzerland was all but entirely on the side of free trade. Since that time it has been becoming more and more protectionist. This change was due in part to the increased tariffs levied in Germany and France, and in part to the strong pressure exercised by certain branches of the Swiss manufacturing industries, while treaties of commerce have been made with divers countries. Hence in 1903 the Swiss people adopted the principle of a greatly increased scale of duties, the detailed tariff of the actual sums levied on the various articles coming into force on the 1st of January 1906. These higher duties were meant to serve as a weapon for obtaining better terms in future commercial treaties, but were finally increased still more at the instigation of certain of the great manufacturers, so that Switzerland became decidedly a protectionist country. In 1901 the receipts from the customs duties were about £1,858,000, while in 1905 they were £2,541,000, and in 1907 rather more (£2,894,000).

Excluding goods in transit, the total value of imports rose from about £36,500,000 in 1895 to about £55,000,000 in 1905, while between the same dates the exports rose from about £26,500,000 to £38,750,000—in other words, the unfavourable balance of trade had increased from £10,000,000 in 1895 to £16,250,000 in 1905.

The increase during the same period in the case of the four great articles of export from Switzerland was as follows: silk from nearly £8,500,000 to rather over £10,000,000, embroideries from nearly £3,000,000 to £5,000,000, watches from £3,500,000 to £5,250,000, and machinery from rather under £1,000,000 to £2,250,000.

Drawn and Engraved by Justus Perthes, Gotha, Germany.

WÜRTTEMBERG
BAVARIA
SCHAFFHSN.
Schaffhausen
THURGAU
Frauenfeld
Winterthur
ZÜRICH
Zürich
Constance
Friedrichshafen
Lindau
Bregenz
Arbon
Romanshorn
Rorschach
Lustenau
Dornbirn
Ravensburg
Kempten
St. Gall
Herisau
APPENZELL
ST. GALL
Feldkirch
Bludenz
SCHWYZ
Schwyz
Einsiedeln
Lake of Lucerne
Nidwalden
GLARUS
Glarus
Ragatz
Chur
URI
GRISONS
Davos Platz
Klosters
Thusis
S. Bernardino
Tirano
Bormio
Chiavenna
Morbegno
Sondrio
Poschiavo
Bellinzona
Locarno
Ascona
Lugano
Mendrisio
Como
TICINO
Intra
Angera
Sesto Calende
Abbreviations:
Aig, Aiguille; Auss, Ausser; B, bg, Berg; bg, burg; br, brn, brunnen; C, Col; C, Can, Canal; C°, Cima; Chap, Chapel; D, Dent; Gl, Glacier; Gd.(es), Grand(es); Gr, Gross; H, Höhe, h, horn; Heinr, Heinrichs; hfn, hofen; hm, heim; Ht, Hinter; Hts, Hauts; J, Joch; k, kopf; kfn, kofen; kl, klein; M, Mt, Mont, Monte; M^a Madonna; Nd, Nieder; Ob, Ober; P, pass, also Pic, Piz; P^a Prima; P° Pizzo; Pte, Ponte; S, See; Sp, Spitze; st, stock; Stat, Station; St Margreth, St Margrethen; th, thal, tal; U, Unt, Unten; Double nn, n, sometimes written thus_m, ñ.

Government.—The Swiss Confederation must be carefully distinguished from the 22 cantons of which it is composed, and which are sovereign states, save in so far as they have given up their rights to the Federal government. These cantons themselves are built up of many political communes, or Gemeinden, or civil parishes, which are the real political units of the country (and not merely local subdivisions); for any one desiring to become naturalized a Swiss must first become (by purchase or grant) a member of a commune, and then, if his burghership of the commune is confirmed by the cantonal authorities, he obtains also, simultaneously, both cantonal and Federal citizenship.

a. Now in Switzerland there are 3164 *political communes* (*municipalités* or *Einwohnergemeinden*). These are composed of all male Swiss citizens over twenty years of age, of good character and resident in the commune for at least three months. The meeting of these persons is called the *assemblée générale* or *Gemeindeversammlung*, while the executive council chosen by it is the *conseil municipal* or *Gemeinderat*, the chief person in the commune (elected by the larger meeting) being termed the *syndic* or *maire*, the *Gemeindepräsident* or the *Gemeindeammann.* This kind of commune includes all Swiss residents (hence the German name) within its territorial limits, and has practically all powers of management of local affairs, including the carrying out of cantonal and Federal laws or decrees, save and except matters relating to the pastures and forests held in common. This class of commune dates only from the time of the Helvetic republic (1798–1802), and its duties were largely increased after the liberal movement of 1830; the care of the highways, the police, the schools, the administration of the poor law being successively handed over to it, so that it became a political body. As regards Swiss citizens belonging to cantons other than that in which they reside, the Federal Constitution of 1848 (art. 41) gave them rights of voting there in cantonal and Federal matters, but not in those relating exclusively to the commune itself. The Federal Constitution of 1874 (art. 43) gives to such persons as those named above (*établis* or *Niedergelassenen*—that is, permanent settlers) all voting rights, Federal, cantonal and communal (save as below), the two last named after a stay of three months. Temporary residents being Swiss citizens (*e.g.* labourers, servants, students, officials not being communal officials) are called *résidents* or *Aufenthalter*, and are in most cantons considered to be as such incapable of voting in communal matters until after a residence of three months, though some cantons require a longer sojourn. Foreign residents are included under this class of *Aufenthalter*.

The *burgher communes* (*communes bourgeoises* or *Bürgergemeinden*), now principally of historical interest, having for the most part gradually merged with the other class of communes, were originally simply the communities that dealt with the management of the "lands subject to common user" or *Allmend* (mainly summer pastures and forests), but gradually obtained, by purchase or otherwise, the manorial rights, the burghers then being themselves the lords of the manor (as at Brixham in Devonshire). But when after the Reformation, owing to the suppression of the monasteries, the care of the poor was imposed by the Federal Diet, in 1551, on the several communes, these naturally aided only their own members, a course which gave rise to a "communal burghership," a system designed to prevent persons from gaining a "settlement" in any commune to which they did not properly belong. Thus all non-burgher residents, permanent or temporary, were excluded from any share in the enjoyment of the lands subject to common user, or in their management, and remained complete outsiders, though paying local rates. With the increased facilities of communication and the rise of a shifting industrial population such restrictions became invidious and unfair, particularly after the introduction, under the Helvetic republic, of a Federal citizenship, superior to cantonal citizenship, and after the communes became more and more burdened with public duties, so that the amount of the rates equalled, if it did not exceed, the sums produced by the "common lands." To avoid some of these inconveniences "political communes" were set up, consisting practically of all Swiss permanent residents. But the relation between these and the old *Bürgergemeinden* (the burghers of which only have rights of user over the common lands) was very delicate, and has been settled (if settled at all) in various fashions. In some cases the older communes simply merged with the newer, the ownership of the common lands thus passing from one to the other class. In other cases the *Bürgergemeinden* still exist as distinct from the "political communes," but solely for purposes (enjoyment, management, &c.) relating to the common lands, and thus form a sort of privileged community inside the larger and now more generally important community. In some cases the common lands have been divided in varying proportions between the two classes of communes, the *Bürgergemeinden* thus continuing to exist solely as regards that part of the common lands which they have retained. In other cases the common lands, whether before or after 1798, have passed into the possession of a small number of the burghers, who form a close corporation, the revenues of which are enjoyed by the members as such, and not as citizens—in short are subject to no public obligations or burdens save rates and taxes.

b. The twenty-two cantons (three are subdivided—Unterwalden, Appenzell and Basel—into two halves) are divided into "administrative districts" (187 in number), which are ruled by prefects, in the French fashion, appointed by the cantonal authorities. These are the true local divisions in the country. Each canton has its own legislature, executive and judiciary. The older cantons have in some cases (Uri, Unterwalden, Appenzell and Glarus) preserved their ancient democratic assemblies (or *Landesgemeinden*), in which each burgher appears in person, and which usually meet once a year, on the last Sunday in April or the first Sunday in May, always (weather permitting) in the open air. These annual assemblies elect annually a sort of standing committee, and also the chief magistrate or *Landammann*, as well as the judiciary. In the other eighteen cantons the legislature (*Gross Rat* or *grand conseil*) is composed of representatives chosen by the cantonal voters in proportion, varying in each canton, to the population. They are thus local parliaments rather than mere county councils. The executive (*Regierungsrat* or *conseil d'état*) is elected everywhere (save Fribourg, the Valais and Vaud) by a popular vote, this plan having gradually superseded election by the cantonal legislature. All the cantons (save Fribourg) have the referendum and initiative, by which the electors can exercise control over their elected representatives. The cantonal judiciary is chosen by the people.

c. In 1848 the *Federal government* was reorganized according to the plan adopted in the United States, at any rate so far as regards the *legislature* (*Bundesversammlung* or *assemblée fédérale*). This is composed of two houses: (1) the *Ständerat* or *conseil des états*, to which each canton, great or small, sends two representatives (generally chosen for varying terms by the people, but, in 1907, still by the cantonal legislature in Bern, Fribourg, Neuchâtel, St Gall, the Valais and Vaud), this house being like the American Senate; (2) the *Nationalrat* or *conseil national*, composed of representatives (at present 167 in number) elected within the cantons in the proportion of 1 to every 20,000 (or fraction over 10,000) of the population, and holding office for three years, before the expiration of which it cannot be dissolved. The two houses are on an absolutely equal footing, and bills are introduced into one or the other simply because of reasons of practical convenience. The Federal parliament meets, at least, once a year, in Bern, the Federal capital. The *Federal executive* (*Bundesrat* or *conseil fédéral*) was set up in 1848 and is composed of seven members, who are elected for three years by the two houses of the Federal legislature, sitting together as a congress, but no two members may belong to the same canton. The Federal parliament annually names the president (*Bundespräsident* or *président de la confédération*) and the vice-president, so that the former is really but the chairman of a committee, and not in any way like the American president. The Federal president always holds the foreign portfolio (the "political department"), the other portfolios being annually redistributed among the other members, but all decisions proceed from the council as a whole. The Federal councillors cannot be at the same time members of either house of the Federal parliament, though they may speak or introduce motions (but not vote) in either house. The *Federal Supreme Court* (*Bundesgericht* or *tribunal fédéral*) was created by the Federal Constitution of 1874 and is (since 1904) composed of 19 full members (plus 9 substitutes), all elected by the two houses of the Federal parliament, sitting together and holding office for six years; the Federal parliament also elects every two years the president and vice-president of the Federal tribunal. Its seat is at Lausanne. Its jurisdiction extends to disputes between the Confederation, the cantons, and private individuals, so far as these differences refer to Federal matters. An appeal lies in some cases (not too clearly distinguished) to the Federal council, and in some to the two houses of the Federal legislature sitting together. As to the referendum and initiative (whether as to the revision of the constitution or as to bills) see REFERENDUM.

It was natural that, as the members of the Swiss Confederation were drawn closer and closer together, there should arise the idea of a *Federal code* as distinguished from the manifold cantonal legal systems. The Federal Constitution of 1874 conferred on the Federal authorities the power to legislate on certain defined legal subjects, and advantage was taken of this to revise and codify the Law of Obligations (1881) and the Law of Bankruptcy (1889). The success of these attempts led to the adoption by the Swiss people (1898) of new constitutional articles, extending the powers of the Federal authorities to the other departments of civil law and also to criminal law. Drafts carefully prepared by commissions of specialists were slowly considered during nearly two years by the two houses of the Federal parliament, which finally adopted the civil code on the 10th of December 1907, and it was expected that by 1912 both a complete Federal civil code and a complete Federal criminal code would come into operation.

Before 1848 there was scarcely such a thing as *Federal finances* for there was no strong central Federal authority. As the power of those authorities increased, so naturally did their expenditure and receipts. In 1849 the receipts were nearly £240,000, as against an expenditure of £260,000. By 1873 each had risen to rather over £1,250,000, while in 1883 they just overtopped £2,000,000 sterling each, and in 1900 the receipts were just over £4,000,000 sterling, as against an expenditure of nearly £4,000,000. The figures for 1907 are £5,750,000 as against just over £5,500,000, and are the highest yet recorded. The funded Federal debt rose from a modest £150,000 in 1849 to rather over £2,000,000 in 1891, and rather over £4,000,000 in 1903, standing in 1905 at £3,250,000.

By the Federal Constitution of 1848 the *post office* was made a Federal attribute, and the first Federal law on the subject was passed in 1849 (postage stamps within the country in 1850, for foreign lands in 1854, and post-cards in 1870), while a Federal law of 1851 extended this privilege to the electric telegraph, so that in 1852 the first line was opened with thirty-four offices. In the Federal Constitution of 1874 both branches are declared to fall within the jurisdiction of the Confederation, while in 1878 this privilege was extended to the newly invented telephone. Inviolability of communications in all three cases is guaranteed.

In 1891 the Swiss people accepted the principle of a *state bank* with a monopoly of note issue. A first scheme was rejected by a popular vote in 1897, but a second was more successful in 1905. The "Swiss National Bank" was actually opened on the 20th of June 1907, its two chief seats being at Zürich and at Bern. It has a capital of £2,000,000 sterling, divided into 100,000 shares. Two-fifths of this capital is reserved to the cantons in proportion to their population in 1900, and two-fifths were taken up by public subscription in June 1906. The remaining fifth was reserved to the existing thirty-six banks in Switzerland (all founded between 1834 and 1900), which have hitherto enjoyed the right of issuing notes. It was stipulated that within three years of the opening of the National Bank all notes issued by these thirty-six banks must be withdrawn, and many had by 1907 taken this course in anticipation.

There is no "established Swiss Church" recognized by the Federal Constitution, but there may be one or more "established churches" in any canton. The Federal Constitution of 1874 guarantees full religious liberty and freedom of worship, not being contrary to morals and the public peace, as well as exemption from any compulsory church rates (arts. 49 and 50). But it repeats, with fresh pricks (art. 51), the provision of the Constitution of 1848 by which the Jesuits and all affiliated religious orders are forbidden to settle in Switzerland, extending this prohibition to any other orders that may endanger the safety of the state or the public peace. It also introduces a new article (No. 52) forbidding the erection of new religious orders or new monasteries or the re-establishment of old ones, and also a new clause (last part of art. 50) by which the erection of new bishoprics on Swiss soil is subject to the approval of the Federal authorities. The Jesuit article was due to the "Sonderbund" War of 1847, and the rest of this exceptional legislation to the "Kulturkampf" which raged in Switzerland in 1872–1874. The Protestants form rather over three-fifths of the population, but have the majority in 10½ of the 22 cantons only. In the German-speaking cantons they are Zwinglians, and in the French-speaking cantons Calvinists, though in neither case of the original and orthodox shade. The Protestants alone are "established" in the Outer Rhodes of Appenzell; while the Romanists alone are "established" in 7½ cantons (Lucerne, Uri, Schwyz, Unterwalden, Zug, Ticino, the Valais, and the Inner Rhodes of Appenzell), but only jointly in the 3 other cantons (Fribourg, St Gall and Soleure) in which they are in a majority. In June 1907 Geneva decided on the complete separation of church and state, and now stands alone in Switzerland in not having any "established church" at all (previously it had two—Protestants and Christian Catholics). In the other 21 cantons, the Protestants and Romanists are jointly "established" in 11½, as are the Protestants and the Christian Catholics in 1½, in which the Christian Catholics take the place of the Romanists. Thus out of the 21 cantons with "established churches" (*Landeskirchen* or *églises nationales*) the Protestants are solely or jointly "established" in 13½, and the Romanists in 19 (not in Bern, Urban Basel and the Outer Rhodes of Appenzell), while the Christian Catholics are recognized in 7 cantons, in two of which (Basel and Neuchâtel) they are also "endowed." The case of Neuchâtel is particularly striking, as it has three "established churches" (Protestants, Romanists and Christian Catholics), while there the Jewish rabbis, as well as the *pasteurs* of the Free Evangelical Church, are exempt from military service. Besides a few parishes in Bern there are also three "Evangelical Free Churches" (*Églises libres*), viz. in Vaud (since 1847), in Geneva (since 1848) and in Neuchâtel (since 1873). The Romanists have five diocesan bishops in Switzerland—Sion (founded in the 4th century), Geneva (4th century, Basel (4th century, but reorganized in 1828), Coire (5th century), Lausanne (6th century), and St Gall (till 1824 part of the bishopric of Constance, and a separate see since 1847). There are besides the sees of Lugano (erected in 1888 for Italian Switzerland—till then in Milan or Como—but united for the present to the see of Basel, though administered by a suffragan bishop) and Bethlehem (a see *in partibus*, annexed in 1840 to the abbacy of St Maurice in the Valais). The Christian Catholics (who resemble the Old Catholics in Germany) split off from the Romanists in 1874 on the question of papal infallibility (in Bern and Geneva politics also played a great part), and since 1876 have had a bishop of their own (consecrated by the German Old Catholic, Bishop Reinkens), who resides in Bern, but bears no diocesan title. The Christian Catholics (who in the census are counted with the Romanists) are strongest in Bern, Soleure and Geneva, while their number in 1906 was estimated variously at from twenty to thirty-four thousand—they have 38 parishes (10 being in French-speaking Switzerland) and some 57 pastors. There are still a few monasteries in Switzerland which have escaped suppression. The principal are the Benedictine houses of Disentis (founded in the 7th century by the Irish monk Sigisbert), Einsiedeln (*q.v.*; 10th century) and Engelberg (*q.v.*; 12th century) as well as the houses of Austin Canons at St Maurice (held by them since 1128, though the house was founded by Benedictines in the 6th century) and on the Great St Bernard (11th century).

Education.—Education of all grades is well cared for in Switzerland, and large sums are annually spent on it by the cantons and the communes, with substantial grants from the Confederation (these last in 1905 were about £224,000), so far as regards primary and higher education. Four classes of educational establishments exist.

a. In the case of the *primary education*, the Confederation has the oversight (Federal Constitution of 1874, art. 27), but the cantons the administration. It is laid down that in the case of the public primary schools four principles must be observed by the cantons: the instruction given must be sufficient, it must be under state (*i.e.* lay) management (ecclesiastics as such can have no share in it), attendance must be compulsory, and the instruction must be gratuitous, while members of all religions must be able to frequent the schools without offence to their belief or consciences (this is interpreted to mean that the general instruction given must be undenominational, while if any denominational instruction is given attendance at it must not be made compulsory). By an amendment to the Federal Constitution adopted in 1902 the Confederation is empowered to make grants in aid in the case of primary schools, while a Federal law of 1903, regulating such grants to be appropriated solely to certain specified purposes, provides that the term "primary schools" shall include continuation schools if attendance is compulsory. The cantons organize primary education in their territories, delegating local arrangements (under the control of a cantonal inspector) to a committee (*Schulkommission*) elected *ad hoc* in each commune, so that it is not a committee of the communal council. The general principles laid down by the Confederation are elaborated into laws by each canton, while the communal councils pass by-laws. Hence there is a great variety in details between canton and canton. The school age varies from 6 to 16 (for younger scholars there are voluntary kindergarten schools or *écoles enfantines*), and attendance during this period is compulsory, it not being possible to obtain exemption by passing a certain standard. Two-thirds of the schools are "mixed"; in the towns, however, boys are often separated from girls. The teachers (who must hold a cantonal certificate of efficiency) are chosen by the Schulkommission from among the candidates who apply for the vacant post, but are elected and paid by the communal council. Religious tests prevail as to teachers, who must declare the religion they profess, and are required to impart the religious instruction in the school, this being compulsory on the children professing the religion that is in the majority in that particular commune—consequently a Protestant teacher would never be appointed in a Romanist school or vice versa. The religious teaching occupies an hour (always at the beginning of the school hours) thrice a week, while special dogmatic instruction is imparted by the pastor, outside the school-house as a rule, or in a room specially set apart therein. The pastor is *ex officio* president of the Schulkommission, while the religious teaching in school is based on a special "school Bible," containing short versions of the chief events in Bible history. The exact curriculum (code) is prescribed by the canton, and also the number of hours during which the school must be open annually, but the precise repartition of these is left to the local Schulkommission. The attendance registers kept by the teachers are submitted to the Schulkommission, which takes measures against truant children or negligent parents by means of a written warning, followed (if need be) by a summons before a court. The treasurer of the Schulkommission receives and distributes the money contributions of the cantons (including the grant in aid from the Confederation) and also of the communes, or of benevolent private individuals. The school hours are as a rule four hours (from 7 a.m. in summer and 8 a.m. in winter) in the morning and (in the winter) three hours in the afternoon, but on two afternoons in the week there is a sewing school for the girls, the boys being then free. There are no regular half-holidays. Private schools are permitted, but receive no financial aid from the outside, while the teacher must hold a certificate of efficiency as in the state schools, must adopt the same curriculum, and is subject to the by-laws made by the Schulkommission. On the other hand he is not bound by any conscience clause and can charge fees. A cantonal inspector examines each school (of either class) annually and reports to the cantonal educational authorities, who point out any deficiencies to the local Schulkommission, which must remedy them. There is no payment by results, nor do the money contributions (from any source) depend on the number of attendances made, though of course they are more or less in proportion to the number of scholars attending that particular school. Some favour the idea of making the primary schools wholly dependent financially on the Confederation. This course has obvious conveniences, but a first attempt was defeated in 1882, and the scheme is still opposed, mainly on the ground that it would seriously impair the principle of cantonal sovereignty, and immensely strengthen the power of the Federal educational authorities. By the law of 1903 the quota of the Federal subvention was fixed at sixpence per head of the resident population of each canton, but in the case of 6½ cantons (the poorer ones) an extra twopence was added.

b. The *secondary schools* are meant on the one side to help those scholars of the primary schools who desire to increase their knowledge though without any idea of going on to higher studies, and on the other to prepare certain students for entrance into the middle schools. The attendance everywhere is optional, save in the city of Basel, where it is compulsory. These schools vary very much from canton to canton. The course of studies extends over two to four years, and students are admitted at ages from ten upwards. The curriculum includes the elements of the classical and modern languages, of mathematics, and of the natural sciences. They receive no Federal subvention, but are supported by the cantons and the communes. In 1905 the cantons contributed £20,000 less than the communes to the total cost of about £234,000.

c. Under the general name of *middle schools* (*Mittelschulen* or *écoles moyennes*) the Swiss include a variety of educational establishments, which fall roughly under two heads:—

1. Technical schools (like those at Bienne and Winterthur) and schools for instruction in various professions (commerce, agriculture, forestry and the training colleges for teachers).
2. Grammar schools, colleges and cantonal schools, which in some cases prepare for the universities and in some cases do not.

The expenses of both classes fall mainly on the cantons (in 1905 about £300,000 to £130,000 from the communes), who for the former class (including certain departments of the second) receive a grant in aid from the Confederation—in 1905 about £84,500.

d. As regards the *higher education* the Federal Constitution of 1874 (art. 27) empowered the Confederation to erect and support, besides the existing Federal Polytechnic School (opened at Zürich in 1855, having been founded by virtue of art. 22 of the Federal Constitution of 1848), a Federal university (this has not yet been done) and other establishments for the higher education (see *c.* 1 above). This clause would seem to authorize the Confederation to make grants in aid of the cantonal universities, but as yet this has not been done, while the cantons are in no hurry to give up their local universities. There are seven full universities in Switzerland—Basel (founded in 1460), Zürich (1833), Bern (1834), Geneva (1873, founded in 1559 as an académie), Fribourg (international Catholic, founded in 1889), Lausanne (1890, founded in 1537 as an académie) and Neuchâtel (existed 1840–1848, refounded in 1866, and raised from the rank of an académie to that of a university in 1909). There is besides a law school at Sion (existed 1807–1810, refounded in 1824). In general they each (save Sion, of course) have four faculties—theology, medicine, law and philosophy. Fribourg and Neuchâtel both lack a medical faculty, while Zürich and Bern have distinct faculties for veterinary medicine, and Zürich a special one for dentistry (in Geneva there is a school of dentistry), while Geneva and Neuchâtel support observatories. The theological faculty is in every case Protestant, save that in Fribourg there is only a Romanist faculty (192 students in 1907), while Bern has both a Protestant faculty and also a Christian Catholic faculty (11 students in 1907), but no Romanist faculty, despite the fact that the Romanists (mainly in the Bernese Jura) form about one-sixth of the population, while there are not very many Christian Catholics. These eight academical institutions were maintained by the cantons at a cost in 1905 of about £155,000, while in the winter session of 1906 the total number of matriculated students (of whom 3784 were non-Swiss) was 6444 (of whom 1904 were women—Fribourg does not receive them), besides 2077 "hearers"—in all 8521. The largest institution was Bern (1626 matriculated students) and the smallest Neuchâtel (163). The Federal Polytechnic School is fixed at Zürich and now comprises seven departments—architecture, engineering, industrial mechanics, industrial chemistry, agriculture and forestry, training of teachers in mathematics, physics and the natural sciences, and military science, besides a department for philosophy and political science. It enjoys a very high reputation and is much frequented by non-Swiss, who in the winter session of 1905–1906 numbered 522 out of the 1325 matriculated students (women are not admitted). In 1905 the cost of the maintenance of the school (which falls entirely upon the Confederation) was about £56,000.

Army.—The Swiss army is a purely militia force, receiving only periodical training (so far as regards men between 20 and 48 years of age), based upon the principle of universal compulsory personal military service. Till 1848 the cantons alone raised, armed, equipped and trained all military units and nominated the officers. By the Federal Constitution of 1848 (art. 20) the Confederation was entrusted with the training of the engineers, the artillery and the cavalry, with the education of instructors for all other arms, and with the higher training of all arms, while it was empowered to found military schools, to organize general military manœuvres, and to supply a part of the war *matériel*. The Confederation, too, was given the supervision of the training of the infantry, as well as the furnishing, the construction and the maintenance of all war *matériel*, which the cantons were bound to supply to the Confederation. The Federal Constitution of 1874 marked an advance on that of 1848 as to the following points. The principle of universal military service and the organization of the Federal army were developed according to the proportion of the population capable of bearing arms (in contradistinction to the 1848 system, art. 19, of fixed contingents in the proportion of 3 to every 100 men of the population of each canton); the entire military training and arming of these men and the cost of their uniform and equipment were taken over by the Confederation, which, too, supervised the military administration of the cantons. The uniform, equipment and weapons of the men were to be free of cost to them, while compensation was due from the Confederation to the families of those killed or permanently injured in the course of their military service, as well as to the invalids themselves. There thus remained to the cantons the raising of all the infantry units and of most of the cavalry and artillery units as well as the nomination of the officers of all arms; all these acts were subject to the supervision of the Confederation and had to be in accordance with Federal laws and regulations. An attempt made in 1895 to extend still further the sphere of action of the Confederation in military matters was rejected by a vote of the Swiss people. Thus the present system rests partly on the 1874 Constitution, and partly on the new military law, passed by the Federal parliament on the 12th of April 1907.

a. The 1874 Constitution forbids the maintenance of any standing army (art. 13), and also (art. 11) the practice (formerly very widespread) of hiring out contingents of mercenary soldiers by the Confederation or the cantons to foreign powers ("military capitulations"). The Federal government can, at or without the request of any canton, repress any disturbances within Switzerland by means of Federal troops, the cantons being bound to allow these free passage over their territory (arts. 16–17). By art. 18 every Swiss male citizen is subject to the obligation of personal military service (the families of those killed or permanently injured in the course of active Federal service as well as the invalids themselves are provided for by the Confederation), and the tax for those exempted is to be fixed by a Federal law, while every recruit receives free of cost his first uniform, equipment and weapons. Art. 16

provides that the Confederation has control of the Federal army and of the war *matériel*, the cantons being only allowed certain defined rights within their respective territories. By art. 20 the limits of the jurisdiction of the Confederation and of the cantons are defined. The Confederation has the sole right of legislation in military matters, but the execution of these laws is in the hands of the cantons, though under Federal supervision, while all branches of military training and arming are handed over to the Confederation; on the other hand, the cantons supply and keep up the equipment and the uniforms of the soldiers, though these expenses are reimbursed by the Confederation according to a certain scale fixed by Federal regulations to be made later on. Art. 21 enacts that, where military considerations do not stand in the way, the military units are to be formed of men of the same canton, but the actual raising of these units and the maintenance of their numbers, as well as the nomination and the promotion of the officers, belong to the cantons, subject to certain general principles to be laid down by the Confederation. Finally, the Confederation has (art. 22) the right of using or acquiring military drill grounds, buildings, &c., belonging to the cantons on payment of moderate compensation according to principles to be laid down in a Federal law. It will thus be seen that the Swiss army is by no means wholly in the hands of the Federal authorities, the cantons still having a large share in its management, though the military department of the Federal executive has the ultimate control and pays most of the military expenses. In fact it has been said in jest that the coat of a soldier belongs to his canton and his rifle to the Confederation.

b. After much discussion and careful consideration of the opinions of many experts, the Federal law of 1907 was enacted, by which more uniformity was introduced into administrative matters and the whole system remodelled, of course according to the general principles formulated in the Federal Constitution of 1874 and summarized under *a*.

The following is a bird's-eye view of the actual organization of the Swiss army. Every Swiss male citizen is bound to render personal military service between the ages of twenty and forty-eight. Certain classes are exempt, such as high Federal officials, clergymen (not being military chaplains), officials of hospitals and prisons, as well as custom-house officials and policemen and officials of public means of communication, but in the latter case only those whose services would be indispensable in time of war, *e.g.* post office, telegraph, telephone, railway and steamer employés (all exempted before 1907)—custom-house men, policemen and the officials last named must have had a first period of training before they are exempt. Those who are totally disqualified for any reason must, till the age of forty, pay an extra tax of 6 francs a head, plus 1½ francs on every 1000 francs of their net property, and 1½ francs on every 100 francs of their net income, the maximum tax that can be levied in any particular case being 3000 francs a year (property under 1000 francs and the first 600 francs of income are free from this tax, which is only levied as to its half in case of the men in the Landwehr): this tax is equally divided between the Confederation and the cantons, its total yield in 1905 being about £171,000. The cantonal authorities muster in certain fixed centres their young men of twenty years, who must appear personally in order to submit themselves at the hands of the Federal officials to a medical examination, a literary examination (reading, arithmetic, elementary Swiss geography and history, and the composition of a short written essay), as well as (since 1905) pass certain elementary gymnastic tests (a long jump of at least 8 ft., lifting at least four times a weight of about 37 lb in both hands at once, and running about 80 yds. in under 14 seconds), different marks being given according to the degree of proficiency in these literary and gymnastic departments. Those falling below a certain standard—bodily, mental or muscular—are exempted, but may be "postponed" for not more than four years, in hopes that before that date the desired standard will be attained. If not totally disqualified (in that case they pay a tax) they may be incorporated not in the territorial army, but in the auxiliary forces (*e.g.* pioneers, hospital, commissariat, intelligence and transport departments). The cantons (under Federal supervision) see that the lads, while still at school, receive a gymnastic training, while the Confederation makes money grants to societies which aim at preparing lads after leaving school for their military service, whether by stimulating bodily training or the practice of rifle shooting, in which case rifles, ammunition and equipment are supplied free—in all these cases the attendance of the lads is purely voluntary. In some cantons the young men, between the ages of eighteen and twenty, are *required* to attend a night school (in order to rub up their school knowledge) for sixty hours a winter for two winters, the teacher being paid by the Confederation and the lads being under military law. Naturally the lads from the large towns and the more prosperous cantons do best in the literary examination and those who belong to gymnastic societies in the gymnastic tests, though sheer bodily untrained strength avails much in the lifting of weights. In 1906 26,808 young men of twenty years of age were examined (this is exclusive of older men then first mustered). Of this number 14,045 (52·4%) were at once enrolled as recruits, 3497 (13%) were "postponed" for one or two years, and 9266 (34·6%) were exempted wholly—these ratios vary but little, for the standard is kept rather high, partly owing to considerations of expense, so that a young fellow of twenty who becomes a "recruit" at once may be taken to be distinctly above the average in bodily and mental qualities. By the new law of 1907 the army is divided into three (not, as previously, four) classes—the *Auszug* or *élite* (men from twenty to thirty-two), the *Landwehr* (men between thirty-three and forty) and the *Landsturm* or *réserve* (men between forty-one and forty-eight). The recruits serve for different periods during their first year according to the arm of the service into which they are incorporated—infantry and engineers sixty-five days, artillery and garrison troops seventy-five days and cavalry ninety days, while those in the auxiliary troops serve but sixty days. Soldiers in the Élite are called out seven times during their term of service for a period of eleven days a year (fourteen days for the artillery and garrison troops), while the Landwehr is only called out once for a training period of eleven days. Cavalry men serve ten years in the Élite (no service in the Landwehr), and during that period are called out eight times for a training period of eleven days a year. Between the ages of twenty and forty each soldier must attain a certain proficiency in marksmanship (at least 30 points out of 90 in 10 shots), while there is an annual inspection (by cantonal officials) of arms, uniform and equipment. The Confederation also makes money grants to rifle societies, which in 1906 numbered 3732, had 220,951 members (all soldiers between twenty and forty must be members), and received Federal grants to the amount of about £13,500. Rifle and uniform become the full property of the soldier after he has completed his full term of service. Officers serve in the Élite till thirty-eight years of age, and in the Landwehr till forty-four (in the case of officers on the staff the service lasts till forty-eight years of age), while they remain in the Landsturm till fifty-two years of age. The Swiss army is made up (according to the new law of 1907) of a staff, composed of all the commanding officers on active service from the rank of major upwards (in this as in all the following cases the actual number is to be fixed by a Federal law), the general staff, the army service corps (post office, telegraph, railways, motor cars, chaplains, police, courts of justice, secretaries, &c., and the auxiliary services), while the soldiers proper are divided into a number of classes—infantry (including sharpshooters and cyclists), cavalry, artillery (including the mountain batteries), engineers (including sappers and railway labourers), garrison troops, the medical, veterinary (veterinary surgeons and farriers), commissariat and transport services (drivers and leaders of laden horses and mules). On the first of January 1907 (still under the old system) the numbers of the Swiss army were as follows: the Élite had 139,514 (of which 104,263 were infantry, 5183 cavalry, 18,544 artillery and 5567 engineers), and the Landwehr 93,163 (including 67,955 infantry, 4378 cavalry, 13,332 artillery and 4313 engineers)—making thus a total of 232,677 men between the ages of twenty and forty-four years of age (17,221 infantry, 9561 cavalry, 31,866 artillery and 9880 engineers). To this total must be added 44,294 men in the armed Landsturm (forty-five to fifty years of age) and 262,138 auxiliary troops (pioneers, workmen in military establishments, medical, commissariat and transport departments, police, firemen, clerks, and men at a military dépôt). The total of the Landsturm and the auxiliary services is 306,432, so that a grand total is 539,109 men (under the old system officers served in the Landwehr till forty-eight, and in the Landsturm till fifty-five). The total expenses of the Swiss army rose from £928,000 in 1896 to £1,400,000 in 1906. Rifles are manufactured in Bern, ammunition at Thun and at Altdorf, uniforms are made in Bern, and the cavalry remount dépôt is at Thun, which is also the chief artillery centre of Switzerland. There is a department for military science at the Federal Polytechnic School at Zürich, one section being meant for students in general, and the other specially for officers. (W. A. B. C.)

History

The Swiss Confederation is made up of twenty-two small states, differing from each other in nearly every point—religious, political, social, industrial, physical and linguistic; yet it forms a nation the patriotism of whose members is universally acknowledged. History alone can supply us with the key to this puzzle; but Swiss history, while thus essential if we could thoroughly grasp the nature of the Confederation, is very intricate and very local. A firm hold on a few guiding principles is therefore most desirable, and of these there are three which we must always bear in mind. (1) The first to be mentioned is *the connexion of Swiss history with that of the Empire.* Swiss history is largely the history of the drawing together of bits of each of the imperial kingdoms (Germany, Italy and Burgundy) for common defence against a common foe—the Habsburgs; and, when this family have secured to themselves the permanent possession of the Empire, the Swiss League little by little wins its independence of the Empire, practically in 1499, formally in 1648. Originally a member of the Empire, the Confederation becomes first an ally, then merely a friend. (2) The second is *the German origin and nature of the Confederation.* Round a German nucleus (the three Forest districts) there gradually gather other German districts; the Confederation is exclusively German (save partially in the case of Fribourg, in which after its admission in 1481 Teutonic influences gradually supplanted the Romance speech); and it is not till 1803 and 1815 that its French- and Italian-speaking "subjects" are raised to political equality with their former masters, and that the Romonsch-speaking Leagues of Raetia (Graubünden) pass from the status of an ally to that of a member of the Confederation. (3) Swiss history is *a study in federalism*. Based on the defensive alliances of 1291 and 1315 between the three Forest districts, the Confederation is enlarged by the admission of other districts and towns, all leagued with the original three members, but not necessarily with each other. Hence great difficulties are encountered in looking after common interests, in maintaining any real union; the Diet was merely an assembly of ambassadors with powers very strictly limited by their instructions, and there was no central executive authority. The Confederation is a *Staatenbund*, or permanent alliance of several small states. After the break-up of the old system in 1798 we see the idea of a *Bundesstaat*, or an organized state with a central legislative, executive and judiciary, work its way to the front, an idea which is gradually realized in the Constitutions of 1848 and 1874. The whole constitutional history of the Confederation is summed up in this transition to a federal state, which, while a single state in its foreign relations, in home matters maintains the more or less absolute independence of its several members.

Swiss history falls naturally into five great divisions: (1) the origins of the Confederation—up to 1291 (for the legendary origin see TELL, WILLIAM); (2) the shaking off dependence on the Habsburgs—up to 1394 (1474); (3) the shaking off dependence on the Empire—up to 1499 (1648); (4) the period of religious divisions and French influence—up to 1814; (5) the construction of an independent state as embodied in the Constitutions of 1848 and 1874.

Early History of the Three Lands.

1. On the 1st of August 1291 the men of the valley of Uri (*homines vallis Uraniae*), the free community of the valley of Schwyz (*universitas vallis de Switz*), and the association of the men of the lower valley or Nidwalden (*communitas hominum intramontanorum vallis inferioris*)—Obwalden or the upper valley is not mentioned in the text, though it is named on the seal appended—formed an Everlasting League for the purpose of self-defence against all who should attack or trouble them, a league which is expressly stated to be a confirmation of a former one (*antiquam confederationis formam juramento vallatam presentibus innovando*). This league was the foundation of the Swiss Confederation.

What were these districts? and why at this particular moment was it necessary for them to form a defensive league? The legal and political conditions of each were very different. (*a*) In 853 Louis the German granted (*inter alia*) all his lands (and the rights annexed to them) situated in the *pagellus Uraniae* to the convent of Sts Felix and Regula in Zürich (the present Fraumünster), of which his daughter Hildegard was the first abbess, and gave to this district the privilege of exemption from all jurisdiction save that of the king (*Reichsfreiheit*), so that though locally within the Zürichgau it was not subject to its count, the king's deputy. The abbey thus became possessed of the greater part of the valley of the Reuss between the present Devil's Bridge and the Lake of Lucerne, for the upper valley (Urseren) belonged at that time to the abbey of Disentis in the Rhine valley, and did not become permanently allied with Uri till 1410. The privileged position of the abbey tenants gradually led the other men of the valley to "commend" themselves to the abbey, whether they were tenants of other lords or free men as in the Schächenthal. The meeting of all the inhabitants of the valley, for purposes connected with the customary cultivation of the soil according to fixed rules and methods, served to prepare them for the enjoyment of full political liberty in later days. The important post of "protector" (*advocatus* or *vogt*) of the abbey was given to one family after another by the emperor as a sign of trust; but when, on the extinction of the house of Zäringen in 1218, the office was granted to the Habsburgs, the protests of the abbey tenants, who feared the rapidly rising power of that family, and perhaps also the desire of the German king to obtain command of the St Gotthard Pass (of which the first authentic mention occurs about 1236, when of course it could only be traversed on foot), led to the recall of the grant in 1231, the valley being thus restored to its original privileged position, and depending immediately on the king. (*b*) In Schwyz (first mentioned in 972) we must distinguish between the districts west and east of Steinen. In the former the land was in the hands of many nobles, amongst whom were the Habsburgs; in the latter there was, at the foot of the Mythen, a free community of men governing themselves and cultivating their land in common; both, however, were politically subject to the king's delegates, the counts of the Zürichgau, who after 1173 were the ever-advancing Habsburgs. But in 1240 the free community of Schwyz obtained from the emperor Frederick II. a charter which removed them from the jurisdiction of the counts, placing them in immediate dependence on the king, like the abbey men of Uri. In a few years, however, the Habsburgs contrived to dispense with this charter in practice. (*c*) In Unterwalden things were very different. The upper valley (Obwalden or Sarnen), like the lower (Nidwalden or Stans), formed part of the Zürichgau, while in both the soil was owned by many ecclesiastical and lay lords, among them being the Habsburgs and the Alsatian abbey of Murbach. Hence in this district there were privileged tenants, but no free community, and no centre of unity, and this explains why Obwalden and Nidwalden won their way upwards so much more slowly than their neighbours in Uri and Schwyz. Thus the early history and legal position of these three districts was very far from being the same. In Uri the Habsburgs, save for a brief space, had absolutely no rights; while in Schwyz, Obwalden and Nidwalden they were also, as counts of the Zürichgau, the representatives of the king.

The League of 1291.

The Habsburgs had been steadily rising for many years from the position of an unimportant family in the Aargau to that of a powerful clan of large landed proprietors in Swabia and Alsace, and had attained a certain political importance as counts of the Zürichgau and Aargau. In one or both qualities the cadet or Laufenburg line, to which the family estates in the Forest districts round the Lake of Lucerne had fallen on the division of the inheritance in 1232, seem to have exercised their legal rights in a harsh manner. In 1240 the free men of Schwyz obtained protection from the emperor, and in 1244 we hear of the castle of New Habsburg, built by the Habsburgs on a promontory jutting out into the lake not far from Lucerne, with the object of enforcing their real or pretended rights. It is therefore not a matter for surprise that when, after the excommunication and deposition of Frederick II. by Innocent IV. at the Council of Lyons in 1245, the head of the cadet line of Habsburg sided with the pope, some of the men of the Forest districts should rally round the emperor. Schwyz joined Sarnen and Lucerne (though Uri and Obwalden supported the pope); the castle of New Habsburg was reduced to its present ruined state; and in 1247 the men of Schwyz, Sarnen and Lucerne were threatened by the pope with excommunication if they persisted in upholding the emperor and defying their hereditary lords the counts of Habsburg. The rapid decline of Frederick's cause soon enabled the Habsburgs to regain their authority in these districts. Yet these obscure risings have an historical interest, for they are the foundation in fact (so far as they have any) of the legendary stories of Habsburg oppression told of and by a later age. After this temporary check the power of the Habsburgs continued to increase rapidly. In 1273 the head of the cadet line sold all his lands and rights in the Forest districts to the head of the elder or Alsatian line, Rudolph, who a few months later was elected to the imperial throne, in virtue of which he acquired for his family in 1282 the duchy of Austria, which now for the first time became connected with the Habsburgs. Rudolph recognized the privileges of Uri but not those of Schwyz; and, as he now united in his own person the characters of emperor, count of the Zürichgau, and landowner in the Forest districts (a name occurring first in the 14th century), such a union of offices might be expected to result in a confusion of rights. On the 16th of April 1291 Rudolph bought from the abbey of Murbach in Alsace (of which he was "advocate") all its rights over the town of Lucerne and the abbey estates in Unterwalden. It thus seemed probable that the other Forest districts would be shut off from their natural means of communication with the outer world by way of the lake. Rudolph's death, on the 15th of July of the same year, cleared the way, and a fortnight later (August 1) the Everlasting League was made between the men of Uri, Schwyz and Nidwalden (the words *et vallis superioris*, *i.e.* Obwalden, were inserted, perhaps between the time of the drawing up of the document, the text of which does not mention Obwalden, and the moment of its sealing on the original seal of Nidwalden) for the purpose of self-defence against a common foe. We do not know the names of the delegates of each valley who concluded the treaty, nor the place where it was made, nor have we any account of the deliberations of which it was the result. The common seal—that great outward sign of the right of a corporate body to act in its own name—appears first in Uri in 1243, in Schwyz in 1281, in Unterwalden not till this very document of 1291; yet, despite the great differences in their political status, they all joined in concluding this League, and confirmed it by their separate seals, thereby laying claim on behalf of their union to an independent existence. Besides promises of aid and assistance in the case of attack, they agree to punish great criminals by their own authority, but advise that, in minor cases and in all civil cases, each man should recognize the "judex" to whom he owes suit, engaging that the Confederates will, in case of need, enforce the decisions of the "judex." At the same time they unanimously refuse to recognize any "judex" who has bought his charge or is a stranger to the valleys. All disputes between the parties to the treaty are, as far as possible, to be settled by a reference to arbiters, a principle which remained in force for over six hundred years. "Judex" is a general term for any local official, especially the chief of the community, whether named by the lord or by the community; and, as earlier in the same year Rudolph had promised the men of Schwyz not to force upon them a "judex" belonging to the class of serfs, we may conjecture from this very decided protest that the chief source of disagreement was in the matter of the jurisdictions of the lord and the free community, and that some recent event in Schwyz led it to insist on the insertion of this provision. It is stipulated also that every man shall be bound to obey his own lord "convenienter," or so far as is fitting and right. The *antiqua confoederatio* mentioned in this document was probably merely an ordinary agreement to preserve the peace in that particular district, made probably during the interregnum (1254–1273) in the Empire.

Morgarten and the League of 1315.

2. In the struggle for the Empire, which extended over the years following the conclusion of the League of 1291, we find that the Confederates supported without exception the anti-Habsburg candidate. On the 16th of October 1291 Uri and Schwyz allied themselves with Zürich, and joined the general rising in Swabia against Albert, the new head of the house of Habsburg. It soon failed, but hopes revived when in 1292 Adolf of Nassau was chosen emperor. In 1297 he confirmed to the free men of Schwyz their charter of 1240, and, strangely enough, confirmed the same charter to Uri, instead of their own of 1231. It is in his reign that we have the first recorded meeting of the "Landsgemeinde" (or legislative assembly) of Schwyz (1294). But in 1298 Albert of Habsburg himself was elected to the Empire. His rule was strict and severe, though not oppressive. He did not indeed confirm the charters of Uri or of Schwyz, but he did not attack the ancient rights of the former, and in the latter he exercised his rights as a landowner and did not abuse his political rights as emperor or as count. In Unterwalden we find that in 1304 the two valleys were joined together under a common administrator (the local deputy of the count)—a great step forward to permanent union. The stories of Albert's tyrannical actions in the Forest districts are not heard of till two centuries later, though no doubt the union of offices in his person was a permanent source of alarm to the Confederation. It was in his time too that the "terrier" (or list of manors and estates, with enumeration of all quit rents, dues, &c., payable by the tenants to their lords) of all the Habsburg possessions in Upper Germany was begun, and it was on the point of being extended to Schwyz and Unterwalden when Albert was murdered (1308) and the election of Henry of Luxemburg roused the free men to resist the officials charged with the survey. Despite his promise to restore to the Habsburgs all rights enjoyed by them under his three predecessors (or maintain them in possession), Henry confirmed, on the 3rd of June 1309, to Uri and Schwyz their charters of 1297, and, for some unknown reason, confirmed to Unterwalden all the liberties granted by his predecessor, though as a matter of fact none had been granted. This charter, and the nomination of one royal bailiff to administer the three districts, had the effect of placing them all (despite historical differences) in an identical political position, and that the most privileged yet given to any of them—the freedom of the free community of Schwyz. A few days later the Confederates made a fresh treaty of alliance with Zürich; and in 1310 the emperor placed certain other inhabitants of Schwyz on the same privileged footing as the free community. The Habsburgs were put off with promises; and, though their request (1311) for an inquiry into their precise rights in Alsace and in the Forest districts was granted, no steps were taken to carry out this investigation. Thus in Henry's time the struggle was between the Empire and the Habsburgs as to the recognition of the rights of the latter, *not* between the Habsburgs and those dependent on them as landlords or counts.

On Henry's death in 1313 the electors hesitated long between Frederick the Handsome of Habsburg and Louis of Bavaria. The men of Schwyz seized this opportunity for making a wanton attack on the great abbey of Einsiedeln, with which they had a long-standing quarrel as to rights of pasture. The abbot caused them to be excommunicated, and Frederick (the choice of the minority of the electors), who was the hereditary "advocate" of the abbey, placed them under the ban of the Empire. Louis, to whom they appealed, removed the ban; on which Frederick issued a decree by which he restored to his family all their rights and possessions in *the three valleys* and Urseren, and charged his brother Leopold with the execution of this order. The Confederates hastily concluded alliances with Glarus, Urseren, Arth and Interlaken to protect themselves from attack on every side. Leopold collected a brilliant army at the Austrian town of Zug in order to attack Schwyz, while a body of troops was to take Unterwalden in the rear by way of the Brünig Pass. On the 15th of November 1315, Leopold with from 15,000 to 20,000 men moved forward along the shore of the Lake of Aegeri, intending to assail the town of Schwyz by climbing the slopes of Morgarten above the south-eastern end of the lake. There they were awaited by the valiant band of the Confederates from 1300 to 1500 strong. The march up the rugged and slippery slope threw the Austrian army into disarray, which became a rout and mad flight when huge boulders and trunks of trees were hurled from above by their foes, who charged down and drove them into the lake. Leopold fled in hot haste to Winterthur, and the attack by the Brünig was driven back by the men of Unterwalden. On the 9th of December 1315 representatives of the victorious highlanders met at Brunnen, on the Lake of Lucerne, not far from Schwyz, and renewed the Everlasting League of 1291. In their main lines the two documents are very similar, the later being chiefly an expansion of the earlier. That of 1315 is in German (in contrast to the 1291 League, which is in Latin), and has one or two striking clauses largely indebted to a decree issued by Zürich on the 24th of July 1291. None of the three districts or their dependents is to recognize a new lord without the consent and counsel of the rest. (This is probably meant to provide for an interregnum in or disputed election to the Empire, possibly for the chance of the election of a Habsburg.) Strict obedience in all lawful matters is to be rendered to the rightful lord in each case, unless he attacks or wrongs any of the Confederates, in which case they are to be free from all obligations. No negotiations, so long as the "Länder" have no lord, are to be entered on with outside powers, save by common agreement of all. Louis solemnly recognized and confirmed the new league in 1316, and in 1318 a truce was concluded between the Confederates and the Habsburgs, who treat with them on equal terms. The lands and rights annexed belonging to the Habsburgs in the Forest districts are fully recognized as they existed in the days of Henry of Luxemburg, and freedom of commerce is granted. But there is not one word about the *political* rights of the Habsburgs as counts of the Zürichgau and Aargau. This distinction gives the key to the whole history of the relations between the Confederates and Habsburgs; the rights of the latter as landowners are fully allowed, and till 1801 they possessed estates within the Confederation; it is their political rights which were always contested by the Swiss, who desired to rule themselves.

The League of Eight Members.

As early as 1320 we find the name "Switzerland" (*Sweicz*) (derived from Schwyz, which had always been the leader in the struggle) applied to the three Forest cantons, and in 1352 extended to the Confederation as a whole. But it was not till after Sempach (1386) that it came into popular use, the historian J. von Müller (1785) fixing the distinction between "Schweiz" (for the country) and "Schwyz" (for the canton), and it did not form the official name of the Confederation till 1803. (Officially in the middle ages and later the Confederation was named "les Ligues de la Haute Allemagne," or, as Commines, late in the 15th century, puts it, "les vieilles Ligues d'Allemagne qu'on appelle Suisses," while from *c.* 1452 onwards the people were called "Swiss"). This is in itself a proof of the great renown which the League won by its victory at Morgarten. Another is that as years go by we find other members admitted to the privileges of the original alliance of the three Forest districts. First to join the League (1332) was the neighbouring town of Lucerne, which had grown up round the monastery of St Leodegar or Leger (whence the place took its name), perhaps a colony, certainly a cell of the great house of Murbach in Alsace, under the rule of which the town remained till its sale in 1291 to the Habsburgs. This act of Lucerne was opposed by the house of Austria, but, despite the decision of certain chosen arbitrators in favour of the Habsburg claims, the town clung to the League with which it was connected by its natural position, and thus brought a new element into the pastoral association of the Forest districts, which now surrounded the entire Lake of Lucerne. Next, in 1351, came the ancient town of Zürich, which in 1218, on the extinction of the house of Zäringen, had become a free imperial city in which the abbess of the Fraumünster (the lady of Uri) had great influence, while in 1336 there had been a great civic revolution, headed by Rudolph Brun, which had raised the members of the craft gilds to a position in the municipal government of equal power with that of the patricians, who, however, did not cease intriguing to regain their lost privileges, so that Brun, after long hesitation, decided to throw in the lot of the town with the League rather than with Austria. In this way the League now advanced from the hilly country to the plains, though the terms of the treaty with Zürich did not bind it so closely to the Confederates as in the other cases (the right of making alliances apart from the League being reserved though the League was to rank before these), and hence rendered it possible for Zürich now and again to incline towards Austria in a fashion which did great hurt to its allies. In 1352 the League was enlarged by the admission of Glarus and Zug. Glarus belonged to the monastery of Säckingen on the Rhine (founded by the Irish monk Fridolin), of which the Habsburgs were "advocates," claiming therefore many rights over the valley, which refused to admit them, and joyfully received the Confederates who came to its aid; but it was placed on a lower footing than the other members of the League, being bound to obey their orders. Three weeks later the town and district of Zug, attacked by the League and abandoned by their Habsburg masters, joined the Confederation, forming a transition link between the civic and rural members of the League. The immediate occasion of the union of these two districts was the war begun by the Austrian duke against Zürich, which was ended by the Brandenburg peace of 1352, by which Glarus and Zug were to be restored to the Habsburgs, who also regained their rights over Lucerne. Zug was won for good by a bold stroke of the men of Schwyz in 1364, but it was not till the day of Näfels (1388) that Glarus recovered its lost freedom. These temporary losses and the treaty made by Brun of Zürich with Austria in 1356 were, however, far outweighed by the entrance into the League in 1353 of the famous town of Bern, which, founded in 1191 by Berthold V. of Zäringen, and endowed with great privileges, had become a free imperial city in 1218 on the extinction of the Zäringen dynasty. Founded for the purpose of bridling the turbulent feudal nobles around, many of whom had become citizens, Bern beat them back at Dornbühl (1298), and made a treaty with the Forest districts as early as 1323. In 1339, at the bloody fight of Laupen, she had broken the power of the nobles for ever, and in 1352 had been forced by a treaty with Austria to take part in the war against Zürich, but soon after the conclusion of peace entered the League as the ally of the three Forest districts, being thus only indirectly joined to Lucerne and Zürich. The special importance of the accession of Bern was that the League now began to spread to the west, and was thus brought into connexion for the first time with the French-speaking land of Savoy. The League thus numbered eight members, the fruits of Morgarten, and no further members were admitted till 1481, after the Burgundian War. But, in order thoroughly to understand the nature of the League, it must be remembered that, while each of the five new members was allied with the original nucleus—the three Forest districts—these five were not directly allied to one another: Lucerne was allied with Zürich and Zug; Zürich with Lucerne, Zug and Glarus; Glarus with Zürich; Zug with Lucerne and Zürich; Bern with no one except the three original members. The circumstances under which each entered the League can alone explain these very intricate relations.

Sempach.

After a short interval of peace the quarrels with Austria broke out afresh; all the members of the League, save the three Forest districts and Glarus, joined (1385) the great union of the south German cities; but their attention was soon called to events nearer home. Lucerne fretted much under the Austrian rule, received many Austrian subjects among her citizens, and refused to pay custom duties to the Austrian bailiff at Rothenburg, on the ground that she had the right of free traffic. An attack on the custom-house at Rothenburg, and the gift of the privileges of burghership to the discontented inhabitants of the little town of Sempach a short way off, so irritated Leopold III. (who then held all the possessions of his house outside Austria) that he collected an army, with the intention of crushing his rebellious town. Lucerne meanwhile had summoned the other members of the League to her aid, and, though Leopold's feint of attacking Zürich caused the troops of the League to march at first in that direction, they discovered their mistake in time to turn back and check his advance on Lucerne. From 1500 to 1600 men of Uri, Schwyz, Unterwalden, and Lucerne opposed the 6000 which made up the Austrian army. The decisive fight took place on the 9th of July 1386, near Sempach, on a bit of sloping meadow-land, cut up by streams and hedges, which forced the Austrian knights to dismount. The great heat of the day, which rendered it impossible to fight in armour, and the furious attacks of the Confederates, finally broke the Austrian line after more than one repulse and turned the day (see WINKELRIED). Leopold, with a large number of his followers, was slain, and the Habsburg power within the borders of the Confederation finally broken. Glarus at once rose in arms against Austria, but it was not till the expiration of the truce made after Sempach that Leopold's brother, Albert of Austria, brought an army against Glarus, and was defeated at Näfels (not far from Glarus) on the 9th of April 1388, by a handful of Glarus and Schwyz men

In 1389 a peace for seven years was made, the Confederates being secured in all their conquests; an attempt made in 1393 by Austria by means of Schöno, the chief magistrate of Zürich and leader of the patrician party, to stir up a fresh attack failed owing to a rising of the burghers, who sympathized with the Confederates, and on the 16th of July 1394 the peace was prolonged for twenty years (and again in 1412 for fifty years), various stipulations being made by which the long struggle of the League against the Habsburgs was finally crowned with success.

Freedom from the Political Claims of the Habsburgs.

By the peace of 1394 Glarus was freed on payment of £200 annually (in 1395 it bought up all the rights of Säckingen); Zug too was released from Austrian rule. Schwyz was given the *advocatia* of the great abbey of Einsiedeln; Lucerne got the Entlebuch (finally in 1405), Sempach and Rothenburg, Bern and Soleure were confirmed in their conquests. Above all, the Confederation as a whole was relieved from the overlordship of the Habsburgs, to whom, however, all their rights and dues as landed proprietors were expressly reserved; Bern, Zürich and Soleure guaranteeing the maintenance of these rights and dues, with power in case of need to call on the other Confederates to support them by arms. Though the house of Habsburg entertained hopes of recovering its former rights, so that technically the treaties of 1389, 1394 and 1412 were but truces, it finally and for ever renounced all its feudal rights and privileges within the Confederation by the "Everlasting Compact" of 1474.

It is probable that Bern did not take any active share in the Sempach War because she was bound by the treaty of peace made with the Austrians in 1368; and Soleure, allied with Bern, was doubtless a party to the treaty of 1394 (though not yet in the League), because of its sufferings in 1382 at the hands of the Kyburg line of the Habsburgs, whose possessions (Thun, Burgdorf, &c.) in 1384 fell into the hands of the two allies.

We may mention here the foray (known as the English or Gugler War) made in 1375 by Enguerrand de Coucy (husband of Isabella, daughter of Edward III. of England) and his freebooters (many of them Englishmen and Welshmen), called "Gugler" from their pointed steel caps, with the object of obtaining possession of certain towns in the Aargau (including Sempach), which he claimed as the dowry of his mother Catherine, daughter of the Leopold who was defeated at Morgarten. He was put to rout in the Entlebuch by the men of Bern, Lucerne, Schwyz and Unterwalden in December 1375. This victory was commemorated with great rejoicings in 1875.

3. The great victory at Sempach not merely vastly increased the fame of the Everlasting League but also enabled it to extend both its influence and its territory. The 15th century is the period when both the League and its several members took the aggressive, and the expansion of their power and lands cannot be better seen than by comparing the state of things at the beginning and at the end of this century. The pastoral highlands of Appenzell (Abbatis Cella) and the town of St Gall had long been trying to throw off the rights exercised over them by the great abbey of St Gall. The Appenzellers, especially, had offered a stubborn resistance, and the abbot's troops had been beaten back by them in 1403 on the heights of Vögelinseck, and again in 1405 in the great fight on the Stoss Pass (which leads up into the highlands), in which the abbot was backed by the duke of Austria. The tales of the heroic defence of Uri Rotach of Appenzell, and of the appearance of a company of Appenzell women disguised as warriors which turned the battle, are told in connexion with this fight, but do not appear till the 17th and 18th centuries, being thus quite unhistorical, so far as our genuine evidence goes. Schwyz had given them some help, and in 1411 Appenzell was placed under the protection of the League (save Bern), with which in the next year the city of St Gall made a similar treaty to last ten years. So too in 1416–1417 several of the "tithings" of the Upper Valais (*i.e.* the upper stretch of the Rhone valley), which in 1388 had beaten the bishop and the nobles in a great fight at Visp, became closely associated with Lucerne, Uri and Unterwalden. It required aid in its final struggle (1418–19) against the great house of Raron, the count-bishop of Sitten (or Sion), and the house of Savoy, which held the Lower Valais—the Forest districts, on the other hand, wishing to secure themselves against Raron and Savoy in their attempt to conquer permanently the Val d'Ossola on the south side of the Simplon Pass. Bern, however, supported its burgher, the lord of Raron, and peace was made in 1420. Such were the first links which bound these lands with the League; but they did not become full members for a long time—Appenzell in 1513, St Gall in 1803, the Valais in 1815.

Struggles in Appenzell, St Gall and the Valais.

Space will not allow us to enumerate all the small conquests made in the first half of the 15th century by every member of the League; suffice it to say that each increased and rounded off its territory, but did not give the conquered lands any political rights, governing them as "subject lands," often very harshly. The same phenomenon of lands which had won their own freedom playing the part of tyrant over other lands which joined them more or less by their voluntary action is seen on a larger scale in the case of the conquest of the Aargau, and in the first attempts to secure a footing south of the Alps.

In 1412 the treaty of 1394 between the League and the Habsburgs had been renewed for fifty years; but when in 1415 Duke Frederick of Austria helped Pope John XXII. to escape from Constance, where the great oecumenical council was then sitting, and the emperor Sigismund placed the duke under the ban of the Empire, summoning all members of the Empire to arm against him, the League hesitated, because of their treaty of 1412, till the emperor declared that all the rights and lands of Austria in the League were forfeited, and that their compact did not release them from their obligations to the Empire. In the name, therefore, of the emperor, and by his special command, the different members of the League overran the extensive Habsburg possessions in the Aargau. The chief share fell to Bern, but certain districts (known as the *Freie Aemter*) were joined together and governed as bailiwicks held in common by all the members of the League (save Uri, busied in the south, and Bern, who had already secured the lion's share of the spoil for herself). This is the first case in which the League as a whole took up the position of rulers over districts which, though guaranteed in the enjoyment of their old rights, were nevertheless politically unfree. As an encouragement and a reward, Sigismund had granted in advance to the League the right of criminal jurisdiction (*haute justice* or *Blutbann*), which points to the fact that they were soon to become independent of the Empire, as they were of Austria.

As the natural policy of Bern was to seek to enlarge its borders at the expense of Austria, and later of Savoy, so we find that Uri, shut off by physical causes from extension in other directions, as steadily turned its eyes towards the south. In 1410 the valley of Urseren was finally joined to Uri; though communications were difficult, and carried on only by means of the "Stiebende Brücke," a wooden bridge suspended by chains over the Reuss, along the side of a great rocky buttress (pierced in 1707 by the tunnel known as the Urnerloch), yet this enlargement of the territory of Uri gave it complete command over the St Gotthard Pass, long commercially important, and now to serve for purposes of war and conquest. Already in 1403 Uri and Obwalden had taken advantage of a quarrel with the duke of Milan as to custom dues at the market of Varese to occupy the long narrow upper Ticino valley on the south of the pass called the Val Leventina; in 1411 the men of the same two lands, exasperated by the insults of the local lords, called on the other members of the League, and all jointly (except Bern) occupied the Val d'Ossola, on the south side of the Simplon Pass. But in 1414 they lost this to Savoy, and, with the object of getting it back, obtained in 1416–1417 the alliance of the men of the Upper Valais, then fighting for freedom, and thus regained (1416) the valley, despite the exertions of the great Milanese general Carmagnola. In 1419 Uri and Obwalden bought from its lord the town and district of Bellinzona. This rapid advance, however, did not approve itself to the duke of Milan, and Carmagnola reoccupied both valleys; the Confederates were not at one with regard to these southern conquests; a small body pressed on in front of the rest, but was cut to pieces at Arbedo near Bellinzona in 1422. A bold attempt in 1425 by a Schwyzer, Peter Rissi by name, to recover the Val d'Ossola caused the Confederates to send a force to rescue these adventurers; but

First Italian Conquests.

the duke of Milan intrigued with the divided Confederates, and finally in 1426, by a payment of a large sum of money and the grant of certain commercial privileges, the Val Leventina, the Val d'Ossola and Bellinzona were formally restored to him. Thus the first attempt of Uri to acquire a footing south of the Alps failed; but a later attempt was successful, leading to the inclusion in the Confederation of what has been called "Italian Switzerland."

The First Civil War.

The original contrasts between the social condition of the different members of the League became more marked when the period of conquest began, and led to quarrels and ill-feeling in the matter of the Aargau and the Italian conquests which a few years later ripened into a civil war, brought about by the dispute as to the succession to the lands of Frederick, count of Toggenburg, the last male representative of his house. Count Frederick's predecessors had greatly extended their domains, so that they took in not only the Toggenburg or upper valley of the Thur, but Uznach, Sargans, the Rhine valley between Feldkirch and Sargans, the Prättigau and the Davos valley. He himself, the last great feudal lord on the left bank of the Rhine, had managed to secure his vast possessions by making treaties with several members of the League, particularly Zürich (1400) and Schwyz (1417)—from 1428 inclining more and more to Schwyz (then ruled by Ital Riding), as he was disgusted with the arrogant behaviour of Stüssi, the burgomaster of Zürich. His death (April 30, 1436) was the signal for the breaking out of strife. The Prättigau and Davos valley formed the League of the Ten Jurisdictions in Raetia (see below), while Frederick's widow sided with Zürich against Schwyz for different portions of the great inheritance which had been promised them. After being twice defeated, Zürich was forced in 1440 to buy peace by certain cessions (the "Höfe") to Schwyz, the general feeling of the Confederates being opposed to Zürich, so that several of them went so far as to send men and arms to Schwyz. Zürich, however, was bitterly disappointed at these defeats, and had recourse to the policy which she had adopted in 1356 and 1393—an alliance with Austria (concluded in 1442), which now held the imperial throne in the person of Frederick III. Though technically within her rights according to the terms on which she had joined the League in 1351, this act of Zürich caused the greatest irritation in the Confederation, and civil war at once broke out, especially when the Habsburg emperor had been solemnly received and acknowledged in Zürich. In 1443 the Zürich troops were completely defeated at St Jakob on the Sihl, close under the walls of the city, Stüssi himself being slain. Next year the city itself was long besieged. Frederick, unable to get help elsewhere, procured from Charles VII. of France the despatch of a body of Armagnac free lances (the Écorcheurs), who came, 30,000 strong, under the dauphin Louis, plundering and harrying the land, till at the very gates of the free imperial city of Basel (which had made a twenty years' alliance with Bern), by the leper house of St Jakob on the Birs (Aug. 26, 1444), the desperate resistance of a small body of Confederates (1200 to 1500), till cut to pieces, checked the advance of the freebooters, who sustained such tremendous losses that, though the victors, they hastily made peace, and returned whence they had come. Several small engagements ensued, Zürich long declining to make peace because the Confederates required, as the result of a solemn arbitration, the abandonment of the Austrian alliance. At length it was concluded in 1450, the Confederates restoring almost all the lands they had won from Zürich. Thus ended the third attempt of Austria to conquer the League by means of Zürich, which used its position as an imperial free city to the harm of the League, and caused the first civil war by which it was distracted.

Constitution of the League, c. 1450.

These fresh proofs of the valour of the Confederates, and of the growing importance of the League, did not fail to produce important results. In 1452 the "Confederates of the Old League of Upper Germany" (as they styled themselves) made their first treaty of alliance with France, a connexion which was destined to exercise so much influence on their history. Round the League there began to gather a new class of allies (known as "Zugewandte Orte," or associated districts), more closely joined to it, or to certain members of it, than by a mere treaty of friendship, yet not being admitted to the rank of a full member of the League. Of these associates three, the abbot (1451) and town of St Gall (1454), and the town of Bienne (Biel), through its alliance (1352) with Bern, were given seats and votes in the Diet, being called *socii*; while others, known as *confoederati*, were not so closely bound to the League, such as the Valais (1416–1417), Schaffhausen (1454), Rottweil (1463), Mühlhausen (1466), (to the class of *confoederati* belonged in later times Neuchâtel 1406–1501), the Three Leagues of Raetia (1497–1498), Geneva (1519–1536), and the bishop of Basel (1579). Appenzell, too, in 1452, rose from the rank of a "protected district" into the class of associates, outside which were certain places "protected" by several members of the League, such as Gersau (1359), the abbey of Engelberg (*c.* 1421), and the town of Rapperswil (1464). The relation of the "associates" to the League may be compared with the ancient practice of "commendation": they were bound to obey orders in declaring war, making alliances, &c.

In 1439 Sigismund succeeded his father Frederick in the Habsburg lands in Alsace, the Thurgau, and Tirol and, being much irritated by the constant encroachments of the Confederates, in particular by the loss of Rapperswil (1458), declared war against them, but fared very badly. In 1460 the Confederates overran the Thurgau and occupied Sargans. Winterthur was only saved by an heroic defence. Hence in 1461 Sigismund had to give up his claims on those lands and renew the peace for fifteen years, while in 1467 he sold Wintherthur to Zürich. Thus the whole line of the Rhine was lost to the Habsburgs, who retained (till 1801) in the territories of the Confederates the Frickthal only. The Thurgovian bailiwicks were governed in common as "subject" lands by all the Confederates except Bern. The touchiness of the now rapidly advancing League was shown by the eagerness with which in 1468 its members took up arms against certain small feudal nobles who were carrying on a harassing guerrilla warfare with their allies Schaffhausen and Mühlhausen. They laid siege to Waldshut, and to buy them off Sigismund in August 1468 engaged to pay 10,000 gulden as damages by the 24th of June 1469; in default of payment the Confederates were to keep for ever the Black Forest, and Waldshut, one of the Black Forest towns on the Rhine. A short time before (1467) the League had made treaties of friendship with Philip the Good, duke of Burgundy, and with the duke of Milan. All was now prepared for the intricate series of intrigues which led up to the Burgundian War—a great epoch in the history of the League, as it created a common national feeling, enormously raised its military reputation, and brought about the close connexion with certain parts of Savoy, which finally (1803–1815) were admitted into the League.

The Burgundian War.

Sigismund did not know where to obtain the sum he had promised to pay. In this strait he turned to Charles the Bold (properly the Rash), duke of Burgundy, who was then beginning his wonderful career, and aiming at restoring the kingdom of Burgundy. For this purpose Charles wished to marry his daughter and heiress to Maximilian, son of the emperor, and first cousin of Sigismund, in order that the emperor might be induced to give him the Burgundian crown. Hence he was ready to meet Sigismund's advances. On the 9th of May 1469 Charles promised to give Sigismund 50,000 florins, receiving as security for repayment Upper Alsace, the Breisgau, the Sundgau, the Black Forest, and the four Black Forest towns on the Rhine (Rheinfelden, Säckingen, Laufenburg and Waldshut), and agreed to give Sigismund aid against the Swiss, if he was attacked by them. It was not unnatural for Sigismund to think of attacking the League, but Charles's engagement to him is quite inconsistent with the friendly agreement made between Burgundy and the League as late as 1467. The emperor then on his side annulled Sigismund's treaty of 1468 with the Swiss, and placed them under the ban of the Empire. Charles committed the mortgaged lands to Peter von Hagenbach, who proceeded to try to establish his master's power there by such harsh measures as to cause the people to rise against him.

The Swiss in these circumstances began to look towards Louis XI. of France, who had confirmed the treaty of friendship made with them by his father in 1452. Sigismund had applied to him early in 1469 to help him in his many troubles, and to give him aid against the Swiss, but Louis had point-blank refused. Anxious to secure their neutrality in case of his war with Charles, he made a treaty with them on the 13th of August 1470 to this effect. All the evidence goes to show that Sigismund was not a tool in the hands of Louis, and that Louis, at least at that time, had no definite intention of involving Charles and the Swiss in a war, but wished only to secure his own flank.

Sigismund in the next few years tried hard to get from Charles the promised aid against the Swiss (the money was paid punctually enough by Charles on his behalf), who put him off with various excuses. Charles on his side, in 1471–1472, tried to make an alliance with the Swiss, his efforts being supported by a party in Bern headed by Adrian von Bubenberg. Probably Charles wished to use both Sigismund and the Swiss to further his own interests, but his shifty policy had the effect of alienating both from him. Sigismund, disgusted with Charles, now inclined towards Louis, whose ally he formally became in the summer of 1473—a change which was the real cause of the emperor's flight from Treves in November 1473, when he had come there expressly to crown Charles. The Confederates on their side were greatly moved by the oppression of their friends and allies in Alsace by Hagenbach, and tried in vain (January 1474) to obtain some redress from his master. Charles's too astute policy had thus lost him both Sigismund and the Swiss. They now looked upon Louis, who, thoroughly aware of Charles's ambition, and fearing that his disappointment at Treves would soon lead to open war, aimed at a master stroke—no less than the reconciliation of Sigismund and the Swiss. This on the face of it seemed impracticable, but common need and Louis's dexterous management brought it to pass, so that on the 30th of March 1474 the Everlasting Compact was signed at Constance, by which Sigismund finally renounced all Austrian claims on the lands of the Confederates, and guaranteed them in quiet enjoyment to them; they, on the other hand, agreed to support him if Charles did not give up the mortgaged lands when the money was paid down. The next day the Swiss joined the league of the Alsatian and Rhine cities, as also did Sigismund. Charles was called on to receive the money contributed by the Alsatian cities, and to restore his lands to Sigismund. He, however, took no steps. Within a week the oppressive bailiff Hagenbach was captured, and a month later (May 9, 1474) he was put to death, Bern alone of the Confederates being represented. On the 9th of October the emperor, acting of course at the instance of Sigismund, ordered them to declare war against Charles, which took place on the 25th of October. Next day Louis formally ratified his alliance with the Confederates, promising money and pensions, the latter to be increased if he did not send men. Throughout these negotiations and later Bern directs Swiss policy, though all the Confederates are not quite agreed. She was specially exposed to attack from Charles and Charles's ally (since 1468) Savoy, and her best chance of extending her territory lay towards the west and south. A forward policy was thus distinctly the best for Bern, and this was the line supported by the French party under Nicholas von Diesbach, Adrian von Bubenberg opposing it, though not with any idea of handing over Bern to Charles. The Forest districts, however, were very suspicious of this movement to the west, by which Bern alone could profit, though the League as a whole might lose; then, too, Uri had in 1440 finally won the Val Leventina, and she and her neighbours favoured a southerly policy—a policy which was crowned with success after the gallant victory won at Giornico in 1478 by a handful of men from Zürich, Lucerne, Uri and Schwyz over 12,000 Milanese troops. Thus Uri first gained a permanent footing south of the Alps, not long before Bern won its first conquests from Savoy.

The war in the west was begun by Bern and her allies (Fribourg, Soleure, &c.) by marauding expeditions across the Jura, in which Héricourt (November 1474) and Blamont (August 1475) were taken, both towns being held of Charles by the "sires" de Neuchâtel, a cadet line of the counts of Montbéliard. It is said that in the former expedition the white cross was borne (for the first time) as the ensign of the Confederates, but not in the other. Meanwhile Yolande, the duchess of Savoy, had, through fear of her brother Louis XI. and hatred of Bern, finally joined Charles and Milan (January 1475), the immediate result of which was the capture, by the Bernese and friends (on the way back from a foray on Pontarlier in the free county of Burgundy or Franche-Comté), of several places in Vaud, notably Grandson and Échallens, both held of Savoy by a member of the house of Chalon, princes of Orange (April 1475), as well as of Orbe and Jougne, held by the same, but under the count of Burgundy. In the summer Bern seized on the Savoyard district of Aigle. Soon after (October–November 1475) the same energetic policy won for her the Savoyard towns of Morat, Avenches, Estavayer and Yverdon; while (September) the Upper Valais, which had conquered all Lower or Savoyard Valais, entered into alliance with Bern for the purpose of opposing Savoy by preventing the arrival of Milanese troops. Alarmed at their success, the emperor and Louis deserted (June–September) the Confederates, who thus, by the influence of Louis and Bernese ambition, saw themselves led on and then abandoned to the wrath of Charles, and very likely to lose their new conquests. They had entered on the war as "helpers" of the emperor, and now became principals in the war against Charles, who raised the siege of Neuss, made an alliance with Edward IV. of England, received the surrender of Lorraine, and hastened across the Jura (February 1476) to the aid of his ally Yolande. On the 21st of February Charles laid siege to the castle of Grandson, and after a week's siege the garrison of Bernese and Fribourgers had to surrender (Oct. 28), while, by way of retaliation for the massacre of the garrison of Estavayer in 1475, of the 412 men two only were spared in order to act as executioners of their comrades. This hideous news met a large body of the Confederates gathered together in great haste to relieve the garrison, and going to their rendezvous at Neuchâtel, where both the count and town had become allies of Bern in 1406. An advance body of Bernese, Fribourgers and Schwyzers, in order to avoid the castle of Vauxmarcus (seized by Charles), on the shore of the Lake of Neuchâtel, and on the direct road from Neuchâtel to Grandson, climbed over a wooded spur to the north, and attacked (March 2) the Burgundian outposts. Charles drew back his force in order to bring down the Swiss to the more level ground where his cavalry could act, but his rear misinterpreted the order, and when the main Swiss force appeared over the spur the Burgundian army was seized with a panic and fled in disorder. The Swiss had gained a glorious victory, and regained their conquest of Grandson, besides capturing very rich spoil in Charles's camp, parts of which are preserved to the present day in various Swiss armouries. Such was the famous battle of Grandson. Charles at once retired to Lausanne, and set about reorganizing his army. He resolved to advance on Bern by way of Morat (or Murten), which was occupied by a Bernese garrison under Adrian von Bubenburg, and laid siege to it on the 9th of June. The Confederates had now put away all jealousy of Bern, and collected a large army. The decisive battle took place on the afternoon of the 22nd of June, after the arrival of the Zürich contingent under Hans Waldmann. English archers were in Charles's army, while with the Swiss was René, the dispossessed duke of Lorraine. After facing each other many hours in the driving rain, a body of Swiss, by outflanking Charles's van, stormed his palisaded camp, and the Burgundians were soon hopelessly beaten, the losses on both sides (a contrast to Grandson) being exceedingly heavy. Vaud was reoccupied by the Swiss (Savoy having overrun it on Charles's advance); but Louis now stepped in and procured the restoration of that region to Savoy, save Grandson, Morat, Orbe and Échallens, which were to be held by the Bernese jointly with the Fribourgers, Aigle by Bern alone —Savoy at the same time renouncing all its claims over Fribourg. Thus French-speaking districts first became permanently connected with the Confederation, hitherto purely German, and the war had been one for the maintenance of recent conquests, rather than purely in defence of Swiss freedom. Charles tried in vain to raise a third army; René recovered Lorraine, and on the 5th of January 1477, under the walls of Nancy, Charles's wide-reaching plans were ended by his defeat and death, many Swiss being with René's troops. The wish of the Bernese to overrun Franche-Comté was opposed by the older members of the Confederation, and finally, in 1479, Louis, by very large payments, secured the abandonment of all claims on that province, which was annexed to the French crown.

Internal Disputes in the League.

These glorious victories really laid the foundation of Swiss nationality; but soon after them the long-standing jealousy between the civic and rural elements in the Confederation nearly broke it up. This had always hindered common action save in the case of certain pressing questions. In 1370, by the "Parsons' ordinance" (Pfaffenbrief), agreed on by all the Confederates except Bern and Glarus, all residents whether clerics or laymen, in the Confederation who were bound by oath to the duke of Austria were to swear faith to the Confederation, and this oath was to rank before any other; no appeal was to lie to any court spiritual or lay (except in matrimonial and purely spiritual questions) outside the limits of the Confederation, and many regulations were laid down as to the suppression of private wars and keeping of the peace on the high roads. Further, in 1393, the "Sempach ordinance" was accepted by all the Confederates and Soleure; this was an attempt to enforce police regulations and to lay down "articles of war" for the organization and discipline of the army of the Confederates, minute regulations being made against plundering—women, monasteries and churches being in particular protected and secured. But save these two documents common action was limited to the meeting of two envoys from each member of the Confederation and one from each of the "socii" in the Diet, the powers of which were greatly limited by the instructions brought by each envoy, thus entailing frequent reference to his government, and included foreign relations, war and peace, and common arrangements as to police, pestilence, customs duties, coinage, &c. The decisions of the majority did not bind the minority save in the case of the affairs of the bailiwicks ruled in common. Thus everything depended on common agreement and good will. But disputes as to the divisions of the lands conquered in the Burgundian War, and the proposal to admit into the League the towns of Fribourg and Soleure, which had rendered such good help in the war, caused the two parties to form separate unions, for by the latter proposal the number of towns would have been made the same as that of the "Länder," which these did not at all approve. Suspended a moment by the campaign in the Val Leventina, these quarrels broke out after the victory of Giornico; and at the Diet of Stans (December 1481), when it seemed probable that the failure of all attempts to come to an understanding would result in the disruption of the League, the mediation of Nicholas von der Flüe (or Bruder Klaus), a holy hermit of Sachseln in Obwalden, though he did not appear at the Diet in person, succeeded in bringing both sides to reason, and the third great ordinance of the League—the "compact of Stans"—was agreed on. By this the promise of mutual aid and assistance was renewed, especially when one member attacked another, and stress was laid on the duty of the several governments to maintain the peace, and not to help the subjects of any other member in case of a rising. The treasure and movables captured in the war were to be equally divided amongst the combatants, but the territories and towns amongst the members of the League. As a practical proof of the reconciliation, on the same day the towns of Fribourg and Soleure were received as full members of the Confederation, united with all the other members, though on less favourable terms than usual, for they were forbidden to make alliances, save with the consent of all or of the greater part of the other members. Both towns had long been allied with Bern, whose influence was greatly increased by their admission. Fribourg, founded in 1178 by Berthold IV. of Zäringen, had on the extinction of that great dynasty (1218) passed successively by inheritance to Kyburg (1218), by purchase to Austria (1277), and by commendation to Savoy (1452); when Savoy gave up its claims in 1477 Fribourg once more became a free imperial city. She had become allied with Bern as early as 1243, but in the 14th and 15th centuries became Romance-speaking, though from 1483 onwards German gained in strength and was the official language till 1798. Soleure (or Solothurn) had been associated with Bern from 1295, but had in vain sought admission into the League in 1411. Both the new members had done much for Bern in the Burgundian War, and it was for their good service that she now procured them this splendid reward, in hopes perhaps of aid on other important and critical occasions.

The compact of Stans strengthened the bonds which joined the members of the Confederation; and the same centralizing tendency is well seen in the attempt (1483–1489) of Hans Waldmann, the burgomaster of Zürich, to assert the rule of his city over the neighbouring country districts, to place all power in the hands of the gilds (whereas by Brun's constitution the patricians had an equal share), to suppress all minor jurisdictions, and to raise a uniform tax. But this idea of concentrating all powers in the hands of the government aroused great resistance, and led to his overthrow and execution. Peter Kistler succeeded (1470) better at Bern in a reform on the same lines, but less sweeping.

Practical Freedom from the Empire.

The early history of each member of the Confederation, and of the Confederation itself, shows that they always professed to belong to the Empire, trying to become immediately dependent on the emperor in order to prevent oppression by middle lords, and to enjoy practical liberty. The Empire itself had now become very much of a shadow; cities and princes were gradually asserting their own independence, sometimes breaking away from it altogether. Now, by the time of the Burgundian War, the Confederation stood in a position analogous to that of a powerful free imperial city. As long as the emperor's nominal rights were not enforced, all went well; but, when Maximilian, in his attempt to reorganize the Empire, erected in 1495 at Worms an imperial chamber which had jurisdiction in all disputes between members of the Empire, the Confederates were very unwilling to obey it—partly because they could maintain peace at home by their own authority, and partly because it interfered with their practical independence. Again, their refusal to join the "Swabian League," formed in 1488 by the lords and cities of South Germany to keep the public peace, gave further offence, as well as their fresh alliances with France. Hence a struggle was inevitable, and the occasion by reason of which it broke out was the seizure by the Tyrolese authorities in 1499 of the Münsterthal, which belonged to the "Gotteshausbund," one of the three leagues which had gradually arisen in Raetia. These were the "Gotteshausbund" in 1367 (taking in all the dependents of the cathedral church at Chur living in the Oberhalbstein and Engadine); the "Ober" or "Grauer Bund" in 1395 and 1424 (taking in the abbey of Disentis and many counts and lords in the Vorder Rhein valley, though its name is not derived, as often stated, from the "grey coats" of the first members, but from "grawen" or "grafen," as so many counts formed part of it); and the "League of the Ten Jurisdictions" (Zehngerichtenbund), which arose in the Prättigau and Davos valley (1436) on the death of Count Frederick of Toggenburg, but which, owing to certain Austrian claims in it, was not quite so free as its neighbours. The first and third of these became allied in 1450, but the formal union of the three dates only from 1524, as documentary proof is wanting of the alleged meeting at Vazerol in 1471, though practically before 1524 they had very much in common. In 1497 the Ober Bund, in 1498 the Gotteshausbund, made a treaty of alliance with the Everlasting League or Swiss Confederation, the Ten Jurisdictions being unable to do more than show sympathy, owing to Austrian claims, which were not bought up till 1649 and 1652. Hence this attack on the Münsterthal was an attack on an "associate" member of the Swiss Confederation, Maximilian being supported by the Swabian League; but its real historical importance is the influence it had on the relations of the Swiss to the Empire. The struggle lasted several months, the chief fight being that in the Calven gorge (above Mals; May 22, 1499), in which Benedict Fontana, a leader of the Gotteshausbund men, performed many heroic deeds before his death. But, both sides being exhausted, peace was made at Basel on the 22nd of September 1499. By this the matters in dispute were referred to arbitration, and the emperor annulled all the decisions of the imperial chamber against the Confederation; but nothing was laid down as to its future relations with the Empire. No further real attempt, however, was made to enforce the rights of the emperor, and the Confederation became a state allied with the Empire, enjoying practical independence, though not formally freed till 1648. Thus, 208 years after the origin of the Confederation in 1291, it had got rid of all Austrian claims (1394 and 1474), as well as all practical subjection to the emperor. But its further advance towards the position of an independent state was long checked by religious divisions within, and by the enormous influence of the French king on its foreign relations.

With the object of strengthening the northern border of the Confederation, two more full members were admitted in 1501—Basel and Schaffhausen—on the same terms as Fribourg and Soleure. The city of Basel had originally been ruled by its bishop, but early in the 14th century it became a free imperial city; before 1501 it had made no permanent alliance with the Confederation, though it had been in continual relations with it. Schaffhausen had grown up round the Benedictine monastery of All Saints, and became in the early 13th century a free imperial city, but was mortgaged to Austria from 1330 to 1415, in which last year the emperor Sigismund declared all Duke Frederick's rights forfeited in consequence of his abetting the flight of Pope John XXII. It bought its freedom in 1418 and became an "associate" of the Confederation in 1454.

The League enlarged to Thirteen Members.

A few years later, in 1513, Appenzell, which in 1411 had become a "protected" district, and in 1452 an "associate" member of the Confederation, was admitted as the thirteenth full member; and this remained the number till the fall of the old Confederation in 1798. Round the three original members had gathered first five others, united with the three, but not necessarily with each other; and then gradually there grew up an outer circle, consisting of five more, allied with all the eight old members, but tied down by certain stringent conditions. Constance, which seemed called by nature to enter the League, kept aloof, owing to a quarrel as to criminal jurisdiction in the Thurgau, pledged to it before the district was conquered by the Confederates.

Conquests in Italy.

In the first years of the 16th century the influence of the Confederates south of the Alps was largely extended. The system of giving pensions, in order to secure the right of enlisting men within the Confederation, and of capitulations, by which the different members supplied troops, was originated by Louis XI. in 1474, and later followed by many other princes. Though a tribute to Swiss valour and courage, this practice had very evil results, of which the first-fruits were seen in the Milanese troubles (1500–1516), of which the following is a summary. Both Charles VIII. (1484) and Louis XII. (1499 for ten years) renewed Louis XI.'s treaty. The French attempts to gain Milan were largely carried on by the help of Swiss mercenaries, some of whom were on the opposite side; and, as brotherly feeling was still too strong to make it possible for them to fight against one another, Lodovico Sforza's Swiss troops shamefully betrayed him to the French at Novara (1500). In 1500, too, the three Forest districts occupied Bellinzona (with the Val Blenio) at the request of its inhabitants, and in 1503 Louis XII. was forced to cede it to them. He, however, often held back the pay of his Swiss troops, and treated them as mere hirelings, so that when the ten years' treaty came to an end Matthew Schinner, bishop of Sitten (or Sion), induced them to join (1510) the pope, Julius II., then engaged in forming the Holy League to expel the French from Italy. But when, after the battle of Ravenna, Louis XII. became all-powerful in Lombardy, 20,000 Swiss poured down into the Milanese and occupied it, Felix Schmid, the burgomaster of Zürich, naming Maximilian (Lodovico's son) duke of Milan, in return for which he ceded to the Confederates Locarno, Val Maggia, Mendrisio and Lugano (1512), while the Raetian Leagues seized Chiavenna, Bormio and the Valtellina. (The former districts, with Bellinzona, the Val Blenio and the Val Leventina, were in 1803 made into the canton of Ticino, the latter were held by Raetia till 1797.) In 1513 the Swiss completely defeated the French at Novara, and in 1515 Pace was sent by Henry VIII. of England to give pensions and get soldiers. Francis I. at once on his accession (1515) began to prepare to win back the Milanese, and, successfully evading the Swiss awaiting his descent from the Alps, beat them in a pitched battle at Marignano near Milan (Sept. 13, 1515), which broke the Swiss power in north Italy, so that in 1516 a peace was made with France—the Valais, the Three Raetian Leagues and both the abbot and town of St Gall being included on the side of the Confederates. Provision was made for the neutrality of either party in case the other became involved in war, and large pensions were promised. This treaty was extended by another in 1521 (to which Zürich, then under Zwingli's influence, would not agree, holding aloof from the French alliance till 1614), by which the French king might, with the consent of the Confederation, enlist any number of men between 6000 and 16,000, paying them fit wages, and the pensions were raised to 3000 francs annually to each member of the Confederation. These two treaties were the starting-point of later French interference with Swiss affairs.

The Reformation.

4. In 1499 the Swiss had practically renounced their allegiance to the emperor, the temporal chief of the world according to medieval theory; and in the 16th century a great number of them did the same by the world's spiritual chief, the pope. The scene of the revolt was Zürich, and the leader Ulrich Zwingli (who settled in Zürich at the very end of 1518). But we cannot understand Zwingli's career unless we remember that he was almost more a political reformer than a religious one. In his former character his policy was threefold. He bitterly opposed the French alliance and the pension and mercenary system, for he had seen its evils with his own eyes when serving as chaplain with the troops in the Milanese in 1512 and 1515. Hence in 1521 his influence kept Zürich back from joining in the treaty with Francis I. Then, too, at the time of the Peasant Revolt (1525), he did what he could to lighten the harsh rule of the city over the neighbouring rural districts, and succeeded in getting serfage abolished. Again he had it greatly at heart to secure for Zürich and Bern the chief power in the Confederation, because of their importance and size; he wished to give them extra votes in the Diet, and would have given them two-thirds of the "common bailiwicks" when these were divided. In his character as a religious reformer we must remember that he was a humanist, and deeply read in classical literature, which accounts for his turning the canonries of the Grossmünster into professorships, reviving the old school of the Carolinum, and relying on the arm of the state to carry out religious changes (see ZWINGLI). After succeeding at two public disputations (both held in 1523) his views rapidly gained ground at Zürich, which long, however, stood quite alone, the other Confederates issuing an appeal to await the decision of the asked-for general council, and proposing to carry out by the arm of the state certain small reforms, while clinging to the old doctrines. Zwingli had to put down the extreme wing of the Reformers—the Anabaptists—by force (1525–1526). Quarrels soon arose as to allowing the new views in the "common bailiwicks." The disputation at Baden (1526) was in favour of the maintainers of the old faith; but that at Bern (1528) resulted in securing for the new views the support of that great town, and so matters began to take another aspect. In 1528 Bern joined the union formed in December 1527 in favour of religious freedom by Zürich and Constance (*Christliches Burgrecht*), and her example was followed by Schaffhausen, St Gall, Basel, Bienne and Mühlhausen (1528–1529). This attempt virtually to break up the League was met in February 1529 by the offensive and defensive alliance made with King Ferdinand of Hungary (brother of the emperor) by the three Forest districts, with Lucerne and Zug, followed (April 1529) by the "Christliche Vereinigung," or union between these five members of the

League. Zürich was greatly moved by this, and, as Zwingli held that for the honour of God war was as necessary as iconoclasm, hostilities seemed imminent; but Bern held back; and the first peace of Kappel was concluded (June 1529), by which the Hungarian alliance was annulled and the principle of "religious parity" (or freedom) was admitted in the case of each member of the League, while in the "common bailiwicks" the majority in each parish was to decide the religion of that parish. This was at once a victory and a check for Zwingli. He tried to make an alliance with the Protestants in Germany, but failed at the meeting at Marburg (October 1529) to come to an agreement with Luther on the subject of the Eucharist, and the division between the Swiss and the German Reformations was stereotyped. Zwingli now developed his views as to the greater weight which Zürich and Bern ought to have in the League. Quarrels, too, went on in the "common bailiwicks," for the members of the League who clung to the old faith had a majority of votes in matters relating to these districts. Zürich tried to cut off supplies of food from reaching the Romanist members (contrary to the wishes of Zwingli), and, on the death of the abbot of St Gall, disregarding the rights of Lucerne, Schwyz and Glarus, who shared with her since 1451 the office of protectors of the abbey, suppressed the monastery, giving the rule of the land and the people to her own officers. Bern in vain tried to moderate this aggressive policy, and the Romanist members of the League indignantly advanced from Zug towards Zürich. Near Kappel, on the 11th of October 1531, the Zürich vanguard under Göldli was (perhaps owing to his treachery) surprised, and despite reinforcements the men of Zürich were beaten, among the slain being Zwingli himself. Another defeat completed the discomfiture of Zürich, and by the second peace of Kappel (November 1531) the principle of "parity" was recognized, not merely in the case of each member of the League and of the "common bailiwicks," but in the latter Romanist minorities in every parish were to have a right to celebrate their own worship. Thus everywhere the rights of a minority were protected from the encroachments of the majority. The "Christliches Burgrecht" was abolished, and Zürich was condemned to pay heavy damages. Bullinger succeeded Zwingli, but this treaty meant that neither side could now try to convert the other wholesale. The League was permanently split into two religious camps: the Romanists, who met at Lucerne, numbered, besides the five already mentioned, Fribourg, Soleure, Appenzell (Inner Rhoden) and the abbot of St Gall (with the Valais and the bishop of Basel), thus commanding sixteen votes (out of twenty-nine) in the Diet; the Evangelicals were Zürich, Bern, Schaffhausen, Appenzell (Ausser Rhoden), Glarus and the towns of St Gall, Basel and Bienne (with Graubünden), who met at Aarau.

Bern had her eyes always fixed upon the Savoyard lands to the south-west, in which she had got a footing in 1475, and now made zeal for religious reforms the excuse for resuming her advance policy. In 1526 Guillaume Farel, a preacher from Dauphiné, had been sent to reform Aigle, Morat and Neuchâtel. In 1532 he came to Geneva, an ancient city of which the rule had long been disputed by the prince-bishop, the burgesses and the house of Savoy, the latter holding the neighbouring districts. She had become in 1519 the ally of Fribourg, in 1526 that of Bern also; and in 1530, by their influence, a peace was made between the contending parties. The religious changes introduced by Farel greatly displeased Fribourg, which abandoned the alliance (1534), and in 1535 the Reformation was firmly planted in the city. The duke of Savoy, however, took up arms against Bern (1536), who overran Gex, Vaud and the independent bishopric of Lausanne, as well as the Chablais to the south of the lake. Geneva was only saved by the unwillingness of the citizens. Bern thus ruled north and south of the lake, and carried matters with a high hand. Shortly after this John Calvin, a refugee from Picardy, was, when passing through Geneva, detained by Farel to aid him, and, after an exile from 1538–1541, owing to opposition of the papal party and of the burghers, who objected to Bernese rule, he was recalled (1541) and set up his wonderful theocratic government in the city, in 1553 burning Servetus, the Unitarian (see CALVIN and SERVETUS), and in 1555 expelling many who upheld municipal liberty, replacing them by French, English, Italians and Spaniards as new burghers, whose names are still frequent in Geneva (*e.g.* Candolle, Mallet, Diodati). His theological views led to disputes with the Zürich Reformers, which were partly settled by the *Consensus Tigurinus* of 1549, and more completely by the *Helvetic Confession* of 1562–1566, which formed the basis of union between the two parties.

Conquest of Vaud by Bern.

By the time of Calvin's death (1564) the old faith had begun to take the offensive; the reforms made by the Council of Trent urged on the Romanists to make an attempt to recover lost ground. Emmanuel Philibert, duke of Savoy, the hero of St Quentin (1557), and one of the greatest generals of the day, with the support of the Romanist members of the League, demanded the restoration of the districts seized by Bern in 1536, and on the 30th of October 1564 the Treaty of Lausanne confirmed the decision of the other Confederates sitting as arbitrators (according to the old constitutional custom). By this treaty Gex, the Genevois and the Chablais were to be given back, while Lausanne, Vevey, Chillon, Villeneuve, Nyon, Avenches and Yverdon were to be kept by Bern, who engaged to maintain the old rights and liberties of Vaud. Thus Bern lost the lands south of the lake, in which St Francis of Sales, the exiled prince-bishop of Geneva (1602–1622), at once proceeded to carry out the restoration of the old faith. In 1555 Bern and Fribourg, as creditors of the debt-laden count, divided the county of Gruyère, thus getting French-speaking subjects. In 1558 Geneva renewed her alliance with Bern, and in 1584 she made one with Zürich. The duke of Savoy made several vain attempts to get hold of Geneva, the last (in 1602) being known as the "escalade."

The Counter-Reformation.

The decrees of the Council of Trent had been accepted fully by the Romanist members of the League, so far as relates to dogma, but not as regards discipline or the relations of church and state, the sovereign rights and jurisdiction of each state being always carefully reserved. The counter-Reformation, however, or reaction in favour of the old faith, was making rapid progress in the Confederation, mainly through the indefatigable exertions of Charles Borromeo, from 1560 to 1584 archbishop of Milan (in which diocese the Italian bailiwicks were included), and nephew of Pius IV., supported at Lucerne by Ludwig Pfyffer, who, having been (1562–1570) the chief of the Swiss mercenaries in the French wars of religion, did so much till his death (1594) to further the religious reaction at home that he was popularly known as the "Swiss king." In 1574 the Jesuits, the great order of the reaction, were established at Lucerne; in 1579 a papal nuncio came to Lucerne; Charles Borromeo founded the "Collegium Helveticum" at Milan for the education of forty-two young Swiss, and the Catholic members of the League made an alliance with the bishop of Basel; in 1581 the Capuchins were introduced to influence the more ignorant classes. Most important of all was the Golden or Borromean League, concluded (Oct. 5, 1586) between the seven Romanist members of the Confederation (Uri, Schwyz, Unterwalden, Lucerne, Zug, Fribourg and Soleure) for the maintenance of the true faith in their territories, each engaging to punish backsliding members and to help each other if attacked by external enemies, notwithstanding any other leagues, old or new. This league marks the final breaking up of the Confederation into two great parties, which greatly hindered its progress. The Romanist members had a majority in the Diet, and were therefore able to refuse admittance to Geneva, Strassburg and Mühlhausen. Another result of these religious differences was the breaking up of Appenzell into two parts (1597), each sending one representative to the Diet—"Inner Rhoden" remaining Romanist, "Ausser Rhoden" adopting the new views. We may compare with this the action of Zürich in 1555, when she received the Protestant exiles (bringing with them the silk-weaving industry) from Locarno and the Italian bailiwicks into her burghership, and Italian names are found there to this day (*e.g.* Orelli, Muralt).

In the Thirty Years' War the Confederation remained neutral, being bound both to Austria (1474) and to France (1516), and neither religious party wishing to give the other an excuse for calling in foreign armies. But the troubles in Raetia threatened entanglements. Austria wished to secure the Münsterthal (belonging to the League of the Ten Jurisdictions), and Spain wanted the command of the passes leading from the Valtellina (conquered by the leagues of Raetia in 1512), the object being to connect the Habsburg lands of Tirol and Milan. In the Valtellina the rule of the Three Raetian Leagues was very harsh, and Spanish intrigues easily brought about the massacre of 1620, by which the valley was won, the Romanist members of the Confederation stopping the troops of Zürich and Bern. In 1622 the Austrians conquered the Prättigau, over which they still had certain feudal rights. French troops regained the Valtellina in 1624, but it was occupied once more in 1629 by the imperial troops, and it was not till 1635 that the French, under Rohan, finally succeeded in holding it. The French, however, wished to keep it permanently; hence new troubles arose, and in 1637 the natives, under George Jenatsch, with Spanish aid drove them out, the Spaniards themselves being forced to resign it in 1639. It was only in 1649 and 1652 that the Austrian rights in the Prättigau were finally bought up by the League of the Ten Jurisdictions, which thus gained its freedom.

In consequence of Ferdinand II.'s edict of restitution (1629), by which the *status quo* of 1552 was re-established—the high-water mark of the counter-Reformation—the abbot of St Gall tried to make some religious changes in his territories, but the protest of Zürich led to the Baden compromise of 1632, by which, in the case of disputes on religious matters arising in the "common bailiwicks," the decision was to be, not by a majority of the cantons, but by means of friendly discussion—a logical application of the doctrine of religious parity—or by arbitration.

But by far the most important event in Swiss history in this age is the formal freeing of the Confederation from the empire.

Formal Freedom from the Empire.

Basel had been admitted a member of the League in 1501, two years after the Confederation had been practically freed from the jurisdiction of the imperial chamber, though the city was included in the new division of the empire into "circles" (1521), which did not take in the older members of the Confederation. Basel, however, refused to admit this jurisdiction; the question was taken up by France and Sweden at the congress of Münster, and formed the subject of a special clause in both the treaties of Westphalia, by which the city of Basel and the other "Helvetiorum cantones" were declared to be "in the possession, or almost in the possession, of entire liberty and exemption from the empire, and *nullatenus* subject to the imperial tribunals." This was intended to mean formal exemption from all obligations to the empire (with which the Confederation was connected hereafter simply as a friend), and to be a definitive settlement of the question. Thus by the events of 1499 and 1648 the Confederation had become an independent European state, which, by the treaty of 1516, stood as regards France in a relation of neutrality.

In 1668, in consequence of Louis XIV.'s temporary occupation of the Franche Comté, an old scheme for settling the number of men to be sent by each member of the Confederation to the joint army, and the appointment of a council of war in war time, that is, an attempt to create a common military organization, was accepted by the Diet, which was to send two deputies to the council, armed with full political powers. This agreement, known as the *Defensionale*, is the only instance of joint and unanimous action in this miserable period of Swiss history, when religious divisions crippled the energy of the Confederation.

Throughout the 17th and 18th centuries the Confederation was practically a dependency of France. In 1614 Zürich for

French Influence, Religious Divisions, and Rise of an Aristocracy.

the first time joined in the treaty, which was renewed in 1663 with special provisions as regards the Protestant Swiss mercenaries in the king's pay and a promise of French neutrality in case of civil war in the League. The Swiss had to stand by while Louis XIV. won Alsace (1648), Franche Comté (1678) and Strassburg (1681). But, as Louis inclined more and more to an anti-Protestant policy, the Protestant members of the League favoured the Dutch military service; and it was through their influence that in 1707 the "states" of the principality of Neuchâtel, on the extinction of the Longueville line of these princes, decided in favour of the king of Prussia (representing the overlords—the house of Chalon-Orange) as against the various French pretenders claiming from the Longueville dynasty by descent or by will. In 1715 the Romanist members of the League, in hopes of retrieving their defeat of 1712 (see below), agreed, while renewing the treaty and capitulations, to put France in the position of the guarantor of their freedom, with rights of interfering in case of attack from within or from without, whether by counsel or arms, while she promised to procure restitution of the lands lost by them in 1712. This last clause was simply the surrender of Swiss independence, and was strongly objected to by the Protestant members of the Confederation, so that in 1777 it was dropped, when all the Confederates made a fresh defensive alliance, wherein their sovereignty and independence were expressly set forth. Thus France had succeeded to the position of the empire with regard to the Confederation, save that her claims were practically asserted and voluntarily admitted.

Between 1648 and 1798 the Confederation was distracted by religious divisions and feelings ran very high. A scheme to set up a central administration fell through in 1655, through jealousy of Bern and Zürich, the proposers. In 1656 a question as to certain religious refugees, who were driven from Schwyz and took refuge at Zürich, brought about the first Villemergen War, in which the Romanists were successful, and procured a clause in the treaty asserting very strongly the absolute sovereignty, in religious as well as in political matters, of each member of the League within its own territories, while in the "common bailiwicks" the Baden arrangement (1632) was to prevail. Later, the attempt of the abbot of St Gall to enforce his rights in the Toggenburg swelled into the second Villemergen War (1712), which turned out very ill for the defeated Romanists. Zürich and Bern were henceforth to hold in severalty Baden, Rapperswil, and part of the "common bailiwicks" of the Aargau, both towns being given a share in the government of the rest, and Bern in that of Thurgau and Rheinthal, from which, as well as from that part of Aargau, she had been carefully excluded in 1415 and 1460. The only thing that prospered was the principle of "religious parity," which was established completely, as regards *both* religions, within each parish in the "common bailiwick."

The Diet had few powers; the Romanists had the majority there; the sovereign rights of each member of the League and the limited mandate of the envoys effectually checked all progress. Zürich, as the leader of the League, managed matters when the Diet was not sitting, but could not enforce her orders. The Confederation was little more than a collection of separate atoms, and it is really marvellous that it did not break up through its own weakness.

In these same two centuries, the chief feature in domestic Swiss politics is the growth of an aristocracy: the power of voting and the power of ruling are placed in the hands of a small class. This is chiefly seen in Bern, Lucerne, Fribourg and Soleure, where there were not the primitive democracies of the Forest districts nor the government by gilds as at Zürich, Basel and Schaffhausen. It was effected by refusing to admit any new burghers, a practice which dates from the middle of the 16th century, and is connected (like the similar movement in the smaller local units of the "communes" in the rural districts) with the question of poor relief after the suppression of the monasteries. Outsiders (Hintersasse or Niedergelassene) had no political rights, however long they might have resided, while the privileges of burghership were strictly hereditary. Further, within the burghers, a small class succeeded in securing the monopoly of all public offices, which was kept up by the practice of co-opting, and was known as the "patriciate." So in Bern, out of 360 burgher families 69 only towards the close of the 18th century formed the ruling oligarchy—and, though to foreigners the government seemed admirably managed, yet the last thing that could be said of it was that it was democratic. In 1749 Samuel Henzi (disgusted at being refused the post of town librarian) made a fruitless attempt to overthrow this oligarchy, like the lawyer, Pierre Fatio at Geneva in 1707. The harsh character of Bernese rule (and the same holds good with reference to Uri and the Val Leventina) was shown in the great strictness with which its subject land Vaud was kept in hand: it was ruled as a conquered land by a benevolent despot, and we can feel no surprise that Major J. D. A. Davel in 1723 tried to free his native land, or that it was in Vaud that the principles of the French Revolution were most eagerly welcomed. Another result of this aristocratic tendency was the way in which the cities despised the neighbouring country districts, and managed gradually to deprive them of their equal political rights and to levy heavy taxes upon them. These and other grievances (the fall in the price of food after the close of the Thirty Years' War, the lowering of the value of the coin, &c.), combined with the presence of many soldiers discharged after the great war, led to the great Peasant Revolt (1653) in the territories of Bern, Soleure, Lucerne and Basel, interesting historically as being the first popular rising since the old days of the 13th and 14th centuries, and because reminiscences of legends connected with those times led to the appearance of the "three Tells," who greatly stirred up the people. The rising was put down at the cost of much bloodshed, but the demands of the peasants were not granted. Yet during this period of political powerlessness a Swiss literature first arises: Conrad Gesner and Giles Tschudi in the 16th century are succeeded by J. J. Scheuchzer, A. von Haller, J. C. Lavater, J. J. Bodmer, H. B. de Saussure, J. J. Rousseau, J. von Müller; the taste for Swiss travel is stimulated by the publication (1793) of the first real Swiss guide-book by J. G. Ebel (*q.v.*), based on the old *Deliciae*; industry throve greatly. The residence of such brilliant foreign writers as Gibbon and Voltaire within or close to the territories of the Confederation helped on this remarkable intellectual revival. Political aspirations were not, however, wholly crushed, and found their centre in the Helvetic Society, founded in 1762 by F. U. Balthasar and others.

Effects of the French Revolution on the Confederation.

The Confederation and France had been closely connected for so long that the outbreak of the French Revolution could not fail to affect the Swiss. The Helvetian Club, founded at Paris in 1790 by several exiled Vaudois and Fribourgers, was the centre from which the new ideas were spread in the western part of the Confederation, and risings directed or stirred up. In 1790 the Lower Valais rose against the oppressive rule of the upper districts; in 1791 Porrentruy defied the prince-bishop of Basel, despite the imperial troops he summoned, and proclaimed (November 1792) the "Rauracian republic," which three months later (1793) became the French department of the Mont Terrible; Geneva was only saved (1792) from France by a force sent from Zürich and Bern; while the massacre of the Swiss guard at the Tuileries on the 10th of August 1792 aroused intense indignation. The rulers, however, unable to enter into the new ideas, contented themselves with suppressing them by force, *e.g.* Zürich in the case of Stäfa (1795). St Gall managed to free itself from its prince-abbot (1795–1797), but the Leagues of Raetia so oppressed their subjects in the Valtellina that in 1797 Bonaparte (after conquering the Milanese from the Austrians) joined them to the Cisalpine republic. The Diet was distracted by party struggles and the fall of the old Confederation was not far distant. The rumours of the vast treasures stored up at Bern, and the desire of securing a bulwark against Austrian attack, specially turned the attention of the directory towards the Confederation; and this was utilized by the heads of the Reform party in the Confederation—Peter Ochs (1752–1821), the burgomaster of Basel, and Frédéric César Laharpe (1754–1838; tutor, 1783–1794, to the later tsar Alexander I.), who had left his home in Vaud through disgust at Bernese oppression, both now wishing for aid from outside in order to free their land from the rule of the oligarchy. Hence, when Laharpe, at the head of some twenty exiles from Vaud and Fribourg, called (Dec. 9, 1797) on the Directory to protect the liberties of Vaud, which, so he said (by a bit of purely apocryphal history), France by the treaty of 1565 was bound to guarantee, his appeal found a ready answer. In February 1798 French troops occupied Mühlhausen and Bienne (Biel), as well as those parts of the lands of the prince-bishop of Basel (St Imier and the Münsterthal) as regards which he had been since 1579 the ally of the Catholic members of the Confederation. Another army entered Vaud (February 1798), when the "Lemanic republic" was proclaimed, and the Diet broke up in dismay without taking any steps to avert the coming storm. Brune and his army occupied Fribourg and Soleure, and, after fierce fighting at Neuenegg, entered (March 5) Bern, deserted by her allies and distracted by quarrels within. With Bern, the stronghold of the aristocratic party, fell the old Confederation. The revolution triumphed throughout the country. Brune (March 16–19) put forth a wonderful scheme by which the Confederation with its "associates" and "subjects" was to be split into three republics—the Tellgau (*i.e.* the Forest districts), the Rhodanic (*i.e.* Vaud, the Valais, the Bernese Oberland and the Italian bailiwicks), and the Helvetic (*i.e.* the northern and eastern portions); but the directory disapproved of this (March 23), and on the 29th of March the "Helvetic republic, one and indivisible," was proclaimed. This was accepted by ten cantons only as well as (April 12) the constitution drafted by Ochs. By the new scheme the territories of the Everlasting League were split up into twenty-three (later nineteen, Raetia only coming in in 1799) administrative districts, called "cantons," a name now officially used in Switzerland for the first time, though it may be found employed by foreigners in the French treaty of 1452, in Commynes and Machiavelli, and in the treaties of Westphalia (1648). A central government was set up, with its seat at Lucerne, comprising a senate and a great council, together forming the legislature, and named by electors chosen by the people in the proportion of 1 to every 100 citizens, with an executive of five directors chosen by the legislature, and having four ministers as subordinates or "chief secretaries." A supreme court of justice was set up; a status of Swiss citizenship was recognized; and absolute freedom to settle in any canton was given, the political "communes" being now composed of all residents, and not merely of the burghers. For the first time an attempt was made to organize the Confederation as a single state, but the change was too sweeping to last, for it largely ignored the local patriotism which had done so much to create the Confederation, though more recently it had made it politically powerless. The three Forest districts rose in rebellion against the invaders and the new constitutions which destroyed their ancient prerogatives; but the valiant resistance of the Schwyzers, under Alois Reding, on the heights of Morgarten (April and May), and that of the Unterwaldners (August and September), were put down by French armies. The proceedings of the French, however, soon turned into disgust and hatred the joyful feelings with which they had been hailed as liberators. Geneva was annexed to France (April 1798); Gersau, after an independent existence of over 400 years, was made a mere district of Schwyz; immense fines were levied and the treasury at Bern pillaged; the land was treated as if it had been conquered. The new republic was compelled to make a very close offensive and defensive alliance with France, and its directors were practically nominated from Paris. In June–October 1799 Zürich, the Forest cantons and Raetia became the scene of the struggles of the Austrians (welcomed with joy) against the French and Russians. The manner, too, in which the reforms were carried out alienated many, and, soon after the directory gave way to the consulate in Paris (18 Brumaire or Nov. 10, 1799), the Helvetic directory (January 1800) was replaced by an executive committee.

The Helvetic Republic.

The scheme of the Helvetic republic had gone too far in the direction of centralization; but it was not easy to find the happy mean, and violent discussions went on between the "Unitary" (headed by Ochs and Laharpe) and "Federalist" parties. Many drafts were put forward and one actually submitted to but rejected by a popular vote (June 1802). In July 1802 the French troops were withdrawn from Switzerland by Bonaparte, ostensibly to comply with the treaty of Amiens, really to show the Swiss that their best hopes lay in appealing to him. The Helvetic government was gradually driven back by armed force, and the Federalists seemed getting the best of it, when (Oct. 4) Bonaparte offered himself as mediator, and summoned ten of the chief Swiss statesmen to Paris to discuss matters with him (the "Consulta"—December 1802). He had long taken a very special interest in Swiss matters, and in 1802 had given to the Helvetic republic the Frickthal (ceded to France in 1801 by Austria), the last Austrian possession within the borders of the Confederation. On the other hand, he had made (August 1802) the Valais into an independent republic. In the discussions he pointed out that Swiss needs required a federal constitution and a neutral position guaranteed by France. Finally (Feb. 19, 1803) he laid before the Consulta the Act of Mediation which he had elaborated and which they had perforce to accept—a document which formed a new departure in Swiss history, and the influence of which is visible in the present constitution.

The Act of Mediation.

Throughout, "Switzerland" is used for the first time as the official name of the Confederation. The thirteen members of the old Confederation before 1798 are set up again, and to them are added six new cantons—two (St Gall and Graubünden or Grisons) having been formerly "associates," and the four others being made up of the subject lands conquered at different times—Aargau (1415), Thurgau (1460), Ticino or Tessin (1440, 1500, 1512), and Vaud (1536). In the Diet, six cantons which had a population of more than 100,000 (viz. Bern, Zürich, Vaud, St Gall, Graubünden and Aargau) were given two votes, the others having but one apiece, and the deputies were to vote freely within limits, though not against their instructions. Meetings of the Diet were to be held alternately at Fribourg, Bern, Soleure, Basel, Zürich and Lucerne—the chief magistrate of each of these cantons being named for that year the "landamman of Switzerland." The "landsgemeinden," or popular assemblies, were restored in the democratic cantons, the cantonal governments in other cases being in the hands of a "great council" (legislative) and the "small council" (executive)—a property qualification being required both for voters and candidates. No canton was to form any political alliances abroad or at home. The "communes" were given larger political rights, the burghers who owned and used the common lands became more and more private associations. There was no Swiss burghership, as in 1798, but perfect liberty of settlement in any canton. There were to be no privileged classes or subject lands. A very close alliance with France (on the basis of that of 1516) was concluded (Sept. 27, 1803). The whole constitution and organization were far better suited for the Swiss than the more symmetrical system of the Helvetic republic; but, as it was guaranteed by Bonaparte, and his influence was predominant, the whole fabric was closely bound up with him, and fell with him. Excellent in itself, the constitution set forth in the Act of Mediation failed by reason of its setting.

For ten years Switzerland enjoyed peace and prosperity under the new constitution. Pestalozzi and Fellenberg worked out their educational theories; K. Escher of Zürich embanked the Linth, and his family was thence called "von der Linth"; the central government prepared many schemes for the common welfare. On the other hand, the mediator (who became emperor in 1804) lavishly expended his Swiss troops, the number of which could only be kept up by a regular blood tax, while the "Berlin decrees" raised the price of many articles. In 1806 the principality of Neuchâtel was given to Marshal Berthier; Tessin was occupied by French troops from 1810 to 1813, and in 1810 the Valais was made into the department of the Simplon, so as to secure that pass. At home, the liberty of moving from one canton to another (though given by the constitution) was, by the Diet in 1805, restricted by requiring ten years' residence, and then not granting political rights in the canton or a right of profiting by the communal property. As soon as Napoleon's power began to wane (1812–1813), the position of Switzerland became endangered. Despite the personal wishes of the tsar (a pupil of Laharpe's), the Austrians, supported by the reactionary party in Switzerland, and without any real resistance on the part of the Diet, as well as the Russians troops, crossed the frontier on the 21st of December 1813, and on the 29th of December the Diet was induced to declare the abolition of the 1803 constitution, guaranteed, like Swiss neutrality, by Napoleon. Bern headed the party which wished to restore the old state of things, but Zürich and the majority stood out for the nineteen cantons. The powers exercised great pressure to bring about a meeting of deputies from all the nineteen cantons at Zürich (April 6, 1814, "the long Diet"); party strife was very bitter, but on the 12th of September it decided that the Valais, Neuchâtel and Geneva should be raised from the rank of "associates" to that of full members of the Confederation (thus making up the familiar twenty-two). As compensation the congress of Vienna (March 20, 1815) gave Bern the town of Bienne (Biel), and all (save a small part which went to Basel) of the territories of the prince-bishop of Basel ("the Bernese Jura"); but the Valtellina was granted to Austria, and Mühlhausen was not freed from France.

The Pact of 1815.

On the 7th of August 1815 the new constitution was sworn to by all the cantons save Nidwalden, the consent of which was only obtained (Aug. 30) by armed force, a delay for which she paid by seeing Engelberg and the valley above (acquired by Nidwalden in 1798) given to Obwalden. By the new constitution the sovereign rights of each canton were fully recognized, and a return made to the lines of the old constitution, though there were to be no subject lands, and political rights were not to be the exclusive privilege of any class of citizens. Each canton had one vote in the Diet, where an absolute majority was to decide all matters save foreign affairs, when a majority of three-fourths was required. The management of current business, &c., shifted every two years between the governments of Zürich, Bern and Lucerne (the three "Vororte"). The monasteries were guaranteed in their rights and privileges; and no canton was to make any alliance contrary to the rights of the Confederation or of any other canton. Provision was made for a Federal army. Finally, the Congress, on the 20th of November 1815, placed Switzerland and parts of North Savoy (Chablais, Faucigny and part of the Genevois) under the guarantee of the Great Powers, who engaged to maintain their neutrality, thus freeing Switzerland from her 300 years' subservience to France, and compensating in some degree for the reactionary nature of the new Swiss constitution when compared with that of 1803.

Attempts at Reform.

5. The cities at once secured for themselves in the cantonal great councils an overwhelming representation over the neighbouring country districts, and the agreement of 1805 as to migration from one canton to another was renewed (1819) by twelve cantons. For some time there was little talk of reforms, but in 1819 the Helvetic Society definitely became a political society, and the foundation in 1824 of the Marksmen's Association enabled men from all cantons to meet together. A few cantons (notably Tessin) were beginning to make reforms, when the influence of the July revolution (1830) in Paris and the sweeping changes in Zürich led the Diet to declare (Dec. 27) that it would not interfere with any reforms of cantonal constitutions provided they were in agreement with the pact of 1815. Hence for the next few years great activity in this direction was displayed, and most of the cantons reformed themselves, save the most conservative (*e.g.* Uri, Glarus) and the advanced who needed no changes (*e.g.* Geneva, Graubünden). Provision was always made for revising these constitutions at fixed intervals, for the changes were not felt to be final, and seven cantons—Zürich, Bern, Lucerne, Soleure, St Gall, Aargau and Thurgau—joined together to guarantee their new free constitutions (Siebener Concordat of March 17, 1832). Soon after, the

question of revising the Federal pact was brought forward by a large majority of cantons in the Diet (July 17), whereon, by the league of Sarnen (Nov. 14), the three Forest cantons, with Neuchâtel, the city of Basel, and the Valais, agreed to maintain the pact of 1815 and to protest against the separation of Basel in two halves (for in the reform struggle Schwyz and Basel had been split up, though the split was permanent only in the latter case). A draft constitution providing for a Federal administration distinct from the cantons could not secure a majority in its favour; a reaction against reform set in, and the Diet was forced to sanction (1833) the division of Basel into the "city" and "country" divisions (each with half a vote in the Diet), though fortunately in Schwyz the quarrel was healed. Religious quarrels further stirred up strife in connexion with Aargau, which was a canton where religious parity prevailed, later in others. In Zürich the extreme pretensions of the Radicals and freethinkers (illustrated by offering a chair of theology in the university to D. F. Strauss of Tübingen because of his *Life of Jesus*, then recently published) brought about a great reaction in 1839, when Zürich was the "Vorort." In Aargau the parties were very evenly balanced, and, when in 1840, on occasion of the revision of the constitution, the Radicals had a popular majority the aggrieved clerics stirred up a revoit (1840), which was put down, but which gave their opponents, headed by Augustine Keller, an excuse for carrying a vote in the great council to suppress the eight monasteries in the canton (Jan. 1841). This was flatly opposed to the pact of 1815, which the Diet by a small majority decided must be upheld (April 1841), though after many discussions it determined (Aug. 31, 1843) to accept the compromise by which the men's convents only were to be suppressed, and declared that the matter was now settled. On this the seven Romanist cantons—Uri, Schwyz, Unterwalden, Lucerne, Zug, Fribourg and the Valais—formed (Sept. 13, 1843) a "Sonderbund" or separate league, which (February 1844) issued a manifesto demanding the reopening of the question and the restoration of *all* the monasteries. Like the Radicals in former years the Romanists went too far and too fast, for in October 1844 the clerical party in Lucerne (in the majority since 1841, and favouring the reaction in the Valais) officially invited in the Jesuits and gave them high posts, an act which created all the more sensation because Lucerne was the "Vorort." Twice (December 1844 and March 1845) parties of free lances tried to capture the city. In December 1845 the Sonderbund turned itself into an armed confederation, ready to appeal to war in defence of the rights of each canton. The Radicals carried Zürich in April 1845 and Bern in February 1846, but a majority could not be secured in the Diet till Geneva (Oct. 1846) and St Gall (May 1847) were won by the same party. On the 20th of July 1847, the Diet, by a small majority, declared that the Sonderbund was contrary to the Federal pact, which on the 16th of August it was resolved to revise, while on the 3rd of September it was decided to invite each canton to expel the Jesuits. Most of the Great Powers favoured the Sonderbund, but England took the contrary view, and the attempt of Metternich, supported by Louis Philippe, to bring about European intervention, on the plea of upholding the treaties of Vienna, was frustrated by the policy of masterly inactivity pursued by Lord Palmerston, who delayed giving an answer till the forces of the Sonderbund had been defeated, a friendly act that is still gratefully remembered in the country. On the 29th of October the deputies of the unyielding cantons left the Diet, which ordered on the 4th of November that its decree should be enforced by arms. The war was short (Nov. 10–29), mainly owing to the ability of the general, G. H. Dufour (1787–1875), and the loss of life trifling. One after another the rebellious cantons were forced to surrender, and, as the Paris revolution of February 1848, entailing the retirement of Guizot (followed three weeks later by that of Metternich), occupied all the attention of the Great Powers (who by the constitution of 1815 should have been consulted in the revision of the pact), the Swiss were enabled to settle their own affairs quietly. Schwyz and Zug abolished their "landsgemeinden," and the seven were condemned to pay the costs of the war (ultimately defrayed by subscription), which had been waged rather on religious than on strict particularist or states-rights grounds. The Diet meanwhile debated the draft constitution drawn up by Johann Conrad Kern (1808–1888) of Thurgau and Henri Druey (1799–1855) of Vaud, which in the summer of 1848 was accepted by fifteen and a half cantons, the minority consisting of the three Forest cantons, the Valais, Zug, Tessin and Appenzell (Inner Rhoden), and it was proclaimed on the 12th of September.

Constitution of 1848.

The new constitution inclined rather to the Act of Mediation than to the system which prevailed before 1798. A status of "Swiss citizenship" was set up, closely joined to cantonal citizenship; a man settling in a canton not being his birthplace got cantonal citizenship after a residence of at most two years, but was excluded from all local rights in the "commune" where he might reside. A Federal or central government was set up, to which the cantons gave up a certain part of their sovereign rights, retaining the rest. The Federal Legislature (or assembly) was made up of two houses—the Council of States (*Ständerat*), composed of two deputies from each canton, whether small or great (44 in all), and the National Council (*Nationalrat*), made up of deputies elected for three years, in the proportion of one for every 20,000 souls or fraction over 10,000, the electors being all Swiss citizens. The Federal council or executive (*Bundesrat*) consisted of seven members elected by the Federal Assembly sitting as a congress; they were jointly responsible for all business, though for sake of convenience there were various departments, and their chairman was called the president of the Confederation. The Federal judiciary (*Bundesgericht*) was made up of eleven members elected for three years by the Federal Assembly sitting in congress; its jurisdiction was chiefly confined to civil cases, in which the Confederation was a party (if a canton, the Federal council may refer the case to the Federal tribunal), but took in also great political crimes—all constitutional questions, however, being reserved for the Federal Assembly. A Federal university and a polytechnic school were to be founded. All military capitulations were forbidden in the future. Every canton must treat Swiss citizens who belong to one of the Christian confessions like their own citizens, for the right of free settlement is given to all such, though they acquired no rights in the "commune." All Christians were guaranteed the exercise of their religion, but the Jesuits and similar religious orders were not to be received in any canton. German, French and Italian were recognized as national languages.

The constitution as a whole marked a great step forward; though very many rights were still reserved to the cantons, yet there was a fully organized central government. Almost the first act of the Federal Assembly was to exercise the power given them of determining the home of the Federal authorities, and on the 28th of November 1848 Bern was chosen, though Zürich still ranks as the first canton in the Confederation. Soon after 1848 a beginning was made of organizing the different public services, which had now been brought within the jurisdiction of the central Federal authority. Thus in 1849 a uniform letter post service was established, in 1850 a single coinage replaced the intricate cantonal currencies, while all customs duties between cantons were abolished; in 1851 the telegraph service was organized, while all weights and measures were unified (in 1868 the metrical system was allowed, and in 1875 declared obligatory and universal), in 1854 roads and canals were taken in hand, while finally in 1855 the Federal Polytechnic School at Zürich was opened, though the Federal university authorized by the new constitution has not yet been set up. These were some of the non-political benefits of the creation of a Federal central executive. But in 1852 the Federal Assembly decided to leave the construction of railways to private enterprise and so had to buy them up in 1903 at a vastly enhanced price.

By this early settlement of disputes Switzerland was protected from the general revolutionary movement of 1848, and in later years her political history has been uneventful, though she has felt the weight of the great European crises in industrial and social matters.

The position of Neuchâtel, as a member of the Confederation (as regards its government only) and as a principality ruled by the king of Prussia, whose rights had been expressly recognized by the congress of Vienna, was uncertain. She had not sent troops in 1847, and, though in 1848 there was a republican revolution there, the prince did not recognize the changes. Finally, a royalist conspiracy in September 1856 to undo the work of 1848 caused great excitement and anger in Switzerland, and it was only by the mediation of Napoleon III. and the other powers that the prince renounced (1857) all his rights, save his title, which his successor (the German emperor) has also dropped. Since that time Neuchâtel has been an ordinary member of the Confederation. In 1859–1860 the cession of Savoy (part of it neutralized in 1815) to France aroused considerable indignation, and in 1862 the long-standing question of frontiers in the Vallée des Dappes was finally arranged with France. In 1871 many French refugees, especially Bourbaki's army, were most hospitably received and sheltered. The growth of the Old Catholics after the Vatican Council (1870) caused many disturbances in western Switzerland, especially in the Bernese Jura. The attack was led by Bishop Eugène Lachat (1819–1886) of Basel, whose see was suppressed by several cantons in 1873, but was set up again in 1884 though still not recognized by Bern. The appointment by the pope of the abbé Gaspard Mermillod (1824–1892) as "apostolic vicar" of Geneva, which was separated from the diocese of Fribourg, led to Monseigneur Mermillod's banishment from Switzerland (1873), but in 1883 he was raised to the vacant see of Lausanne and Geneva and allowed by the Federal authorities to return, but Geneva refused to recognize him, though he was created a cardinal in 1890. An event of great importance to Switzerland was the opening of the St Gotthard tunnel, which was begun in 1871 and opened in 1882; by it the Forest cantons seem likely to regain the importance which was theirs in the early days of the Confederation.

From 1848 onwards the cantons continually revised their constitutions, always in a democratic sense, though after the Sonderbund War Schwyz and Zug abolished their "landsgemeinden" (1848). The chief point was the introduction of the *referendum*, by which laws made by the cantonal legislature may (facultative referendum) or must (obligatory referendum) be submitted to the people for their approval, and this has obtained such general acceptance that Fribourg alone does not possess the referendum in either of its two forms. It was therefore only natural that attempts should be made to revise the federal constitution of 1848 in a democratic and centralizing sense, for it had been provided that the Federal Assembly, on its own initiative or on the written request of 50,000 Swiss electors, could submit the question of revision to a popular vote. In 1866 the restriction of certain rights (mentioned above) to Christians only was swept away; but the attempt at final revision in 1872 was defeated by a small majority, owing to the efforts of the anti-centralizing party. Finally, however, another draft was better liked, and on the 19th of April 1874 the new constitution was accepted by the people—$14\frac{1}{2}$ cantons against $7\frac{1}{2}$ (those of 1848 without Tessin, but with Fribourg and Lucerne) and 340,199 votes as against 198,013. This constitution is still in force, and is mainly a revised edition of that of 1848, the Federal power being still further strengthened. Among the more important novelties three points may be mentioned. A system of free elementary education was set up, under the superintendence of the Confederation, but managed by the cantons. A man settling in another canton was, after a residence of three months only, given all cantonal and communal rights, save a share in the common property (an arrangement which as far as possible kept up the old principle that the "commune" is the true unit out of which cantons and the Confederation are built), and the membership of the commune carries with it cantonal and federal rights. The "Referendum" was introduced in its

Revised Constitution of 1874.

"facultative" form; *i.e.* all federal laws must be submitted to popular vote on the demand of 30,000 Swiss citizens or of eight cantons. But the "Initiative" (*i.e.* the right of compelling the legislature to consider a certain subject or bill) was not introduced into the Federal Constitution till 1891 (when it was given to 50,000 Swiss citizens) and then only as to a partial (not a total) revision of that constitution. By the constitutions of 1848 and 1874 Switzerland has ceased to be a mere union of independent states jointed by a treaty, and has become a single state with a well-organized central government, to which have been given certain of the rights of the independent cantons, but increased centralization would destroy the whole character of the Confederation, in which the cantons are not administrative divisions but living political communities. Swiss history teaches us, all the way through, that Swiss liberty has been won by a close union of many small states, and we cannot doubt that it will be best preserved by the same means, and not by obliterating all local peculiarities, nowhere so striking and nowhere so historically important as in Switzerland.

M. Numa Droz (who was for seventeen years—1876 to 1892—a member of the Federal executive, and twice, in 1881 and in 1887, president of the Swiss Confederation) expressed the opinion shortly before his death in December 1899 (he was born in 1844) that while the dominant note of Swiss politics from 1848 to 1874 was the establishment of a Federal state, that of the period extending from 1874 to 1899 (and this is true of a later period) was the direct rule of the people, as distinguished from government by elected representatives. Whether this distinction be just or not, it is certain that this advance towards democracy in its true sense is due indirectly to the monopoly of political power in the Federal government enjoyed by the Radical party from 1848 onwards: many were willing to go with it some part of the way, but its success in maintaining its close monopoly has provoked a reaction against it on the part of those who desire to see the Confederation remain a Confederation, and not become a strongly centralized state, contrary to its past history and genius. Hence after 1874 we find that democratic measures are not advocated as we should expect by the Radicals, but by all the other political parties with a view of breaking down this Radical monopoly, for it is a strange fact that the people elect and retain Radical representatives, though they reject the measures laid before them for their approval by the said Radical representatives. For these reasons the struggle between Federalists and Centralists (the two permanent political parties in Switzerland), which up to 1874 resulted in favour of the Centralists, has been turning gradually in favour of the Federalists, and that because of the adoption of such democratic institutions as the Referendum and the Initiative.

The general lines on which Swiss politics have run since 1874 may be most conveniently summarized under three headings—the working of the political machinery, the principal political events, and then the chief economical and financial features of the period. But it must be always borne in mind that all the following remarks relate only to *Federal* politics, those of the several cantons being much more intricate, and of course turning more on purely local differences of opinion.

1. *Political Machinery.*—The Federal Constitution of 1848 set up a permanent Federal executive, legislature and tribunal, each and all quite distinct from and independent of any cantonal government. This system was a modified revival of the state of things that had prevailed from 1798 to 1803, and was an imitation of the political changes that had taken place in the cantonal constitutions after 1830. Both were victories of the Centralist or Radical party, and it was therefore but natural that this party should be called upon to undertake the Federal government under the new constitution, a supremacy that it has kept ever since. To the Centralists the *Council of States* (two members from each canton, however large or small) has always been a stumbling-block, and they have mockingly nicknamed it "the fifth wheel of the coach." In the other house of the Federal legislature, the *National Council* (one member per 20,000, or fraction of over 10,000 of the entire population), the

Radicals have always since its creation in 1848 had a majority. Hence, in the Congress formed by both houses sitting together, the Radicals have had it all their own way. This is particularly important as regards the election of the seven members of the Federal executive which is made by such a Congress. Now the Federal executive (*Federal Council*) is in no sense a cabinet, *i.e.* a committee of the party in the majority in the legislature for the time being. In the Swiss Federal Constitution the cabinet has no place at all. Each member of the Federal executive is elected by a separate ballot, and holds office for the fixed term of three years, during which he cannot be turned out of office, while as yet but a single instance has occurred of the rejection of a Federal councillor who offered himself for re-election. Further, none of the members of the Federal executive can hold a seat in either house of the Federal legislature, though they may appear and speak (but not vote) in either, while the Federal Council as such has not necessarily any common policy, and never expresses its views on the general situation (though it does as regards particular legislative and administrative measures) in anything resembling the "speech from the Throne" in England. Thus it seems clear that the Federal executive was intended by the Federal Constitution of 1848 (and in this respect that of 1874 made no change) to be a standing committee of the legislature as a whole, but *not* of a single party in the legislature, or a "cabinet," even though it had the majority. Yet this rule of a single political party is just what has taken place. Between 1848 and the end of 1908, 38 Federal councillors were elected (24 from German-speaking, 12 from French-speaking and 2 from Italian-speaking Switzerland, the canton of Vaud heading the list with 7). Now of these 38 three only were not Radicals, viz. M Paul Ceresole (1870–1875) of Vaud, who was a Protestant Liberal-Conservative, Herren Josef Zemp (1891–1908) and Josef Anton Schobinger (elected 1908), both of Lucerne and Romanist Conservatives, yet the Conservative minority is a large one, while the Romanists form about two-fifths of the population of Switzerland. But despite this predominance of a single party in the Federal Council, no true cabinet system has come into existence in Switzerland, as members of the council do not resign even when their personal policy is condemned by a popular vote, so that the resignation of Herr Welti (a member of the Federal Council from 1867 to 1891), in consequence of the rejection by the people of his railway policy, caused the greatest amazement and consternation in Switzerland.

The chief political parties in the Federal legislature are the Right, or Conservatives (whether Romanists or Protestants), the Centre (now often called "Liberals," but rather answering to the Whigs of English political language, the Left (or Radicals) and the Extreme Left (or the Socialists of varying shades). In the Council of States there is always a Federalist majority, since in this house the smaller cantons are on an equality with the greater ones, each indifferently having two members. But in the National Council (167 elected members) there has always (since 1848) been a considerable Radical majority over all other parties. The Socialists long worked under the wing of the Radicals, but now in every canton (save Geneva) the two parties have quarrelled, the Socialist vote having largely increased, especially in the town of Zürich. In the country the anti-Radical opposition is made up of the Conservatives, who are strongest in the Romanist, and especially the Forest, cantons, and of the "Federalists" of French-speaking Switzerland. There is no doubt that the people are really anti-Radical, though occasionally led away by the experiments made recently in the domain of State socialism: they elect, indeed, a Radical majority, but very frequently reject the bills laid before them by their elected representatives.

2. *Politics.*—The cantons had led the way before 1848, and they continued to do so after that date, gradually introducing reforms all of which tended to give the direct rule to the people. The Confederation was bound to follow this example, though it adopted a far more leisurely pace. Hence, in 1872 a new Federal Constitution was drafted, but was rejected on a popular vote by a small majority, as it was thought to go too far in a centralizing direction, and so encountered the combined opposition of the Conservatives and of the Federalists of French-speaking Switzerland. The last-named party was won over by means of concessions as to military matters and the proposed unification of cantonal laws, civil and criminal, and especially by strong provisions as to religious freedom, since the "Kulturkampf" was then raging in French-speaking Switzerland. Hence a revised draft was accepted in 1874 by a considerable popular majority, and this is the existing Federal Constitution. But it bears marks of its origin as a compromise, and no one party has ever been very eager to support it as a whole. At first all went smoothly, and various very useful laws carrying out in detail the new provisions of the constitution were drafted and accepted. But divisions of opinion arose when it was proposed to reform the military system at a very great expenditure, and also as to the question of the limitation of the right to issue bank-notes, while (as will be seen under 3 below) just at this time grave financial difficulties arose with regard to the Swiss railways, and in consequence of Prince Bismarck's anti-free trade policy, which threatened the prosperity of Switzerland as an exporting country. Further, the disturbed political state of the canton of Ticino (or Tessin) became more or less acute from 1873 onwards. There the Radicals and the Conservatives are nearly equally balanced. In 1872 the Conservatives obtained the majority in this canton, and tried to assure it by some certainly questionable means. The Radicals repeatedly appealed to the Federal government to obtain its armed intervention, but in vain. In 1876 the Conservatives at a rifle match at Stabio fired on the Radicals, but in 1880 the accused persons were acquitted. The long-desired detachment of Ticino from the jurisdiction of the foreign dioceses of Como and Milan was effected in 1888 by the erection of a see at Lugano, but this event caused the Radicals to fear an increase of clerical influence. Growing impatient, they finally took matters in their own hands, and in September 1890 brought about a bloody revolution. The partial conduct of the Radical Federal commissioner was much blamed, but after a state trial at Zürich in 1891 the revolutionists were acquitted, although they loudly boasted of their share in this use of force in political matters.

From 1885 onwards Switzerland had some troubles with foreign powers owing to her defence of the right of asylum for fugitive German Socialists, despite the threats of Prince Bismarck, who maintained a secret police in Switzerland, one member of which, Wohlgemuth, was expelled in 1889, to the prince's huge but useless indignation. From about 1890, as the above troubles within and without gradually subsided, the agitation in the country against the centralizing policy of the Radicals became more and more strongly marked. By the united exertions of all the opposition parties, and against the steady resistance of the Radicals, an amendment was introduced in 1891 into the Federal Constitution, by which 50,000 Swiss citizens can by the "Initiative" *compel* the Federal legislature and executive to take into consideration some point in the Federal Constitution which, in the opinion of the petitioners, requires reform, and to prepare a bill dealing with it which must be submitted to a popular vote. Great hopes and fears were entertained at the time as to the working of this new institution, but both have been falsified, for the Initiative has as yet only succeeded in inserting (in 1893) in the Federal Constitution a provision by which the Jewish method of killing animals is forbidden, and another (in 1908) prohibiting the manufacture or sale of absinthe in the country. On the other hand, it has failed (in 1894) to secure the adoption of a Socialist scheme by which the state was bound to provide work for every able-bodied man in the country, and (also in 1894) to carry a proposal to give to the cantons a bonus of two francs per head of the population out of the rapidly growing returns of the customs duties, similarly in 1900 an attempt to introduce the election of the Federal executive by a popular vote and proportional representation in the *Nationalrat* failed, as in 1903 did a proposal to make the elections to the *Nationalrat* depend on the Swiss population only, instead of the total population of the country.

The great rise in the productiveness of the customs duties (see 3 below) has tempted the Swiss people of late years to embark on a course of state socialism, which may be also described as a series of measures tending to give more and more power to the central Federal government at the expense of the cantons. So in 1890 the principle of compulsory universal insurance against sickness and accidents was accepted by a popular vote, in 1891 likewise that of a state or Federal bank, and in 1898 that of the unification of the cantonal laws, civil and criminal, into a set of Federal codes. In each case the Federal government and legislature were charged with the preparation of laws carrying out in detail these general principles. But in 1897 their proposals as to a Federal bank were rejected by the people, though another draft was accepted in 1905, so that the bank (with a monopoly of note issue, a provision accepted by a popular vote in 1891) was actually opened in 1907. At the beginning of 1900 the suspicion felt as to the insurance proposals elaborated by the Federal authorities was so keen that a popular demand for a popular vote was signed by 117,000 Swiss citizens, the legal minimum being only 30,000: they were rejected (May 20, 1900) on a popular vote by a nearly two to one majority. The preparation of the Federal civil and criminal codes has progressed quietly, drafts being framed by experts and then submitted for criticism to special commissions and public opinion, but finally the civil code was adopted by the Federal Assembly in December 1907. By a popular vote in 1887 the Federal authorities were given a monopoly of alcohol, but a proposal to deal similarly with tobacco has been very ill received (though such a monopoly would undoubtedly produce a large amount), and would pretty certainly be refused by the people if a popular vote were ever taken upon it. In 1895 the people declined to sanction a state monopoly of matches, even though the unhealthy nature of the works was strongly urged, and have also resolutely refused on several occasions to accept any projects for the centralizing of the various branches of military administration, &c., though in 1897 the forests high up on the mountains were placed under Federal supervision, while in 1902 large Federal grants in aid were made to the cantons towards the expenses of primary education, and in 1908 the supervision of the employment of the power derived from rivers and streams was given to the Confederation. Among other reforms which have recently been much discussed in Switzerland are the introduction of the *obligatory* referendum (which hitherto has applied only to amendments to the Federal Constitution) and the extension of the initiative (now limited to piecemeal revision of the Federal Constitution) to *all* Federal laws, &c. The first-named scheme is an attempt to restrain important centralizing measures from being presented as laws (and as such exempt from the compulsory referendum), and not as amendments to the Federal Constitution.

Besides the insurance project mentioned above, two great political questions have engaged the attention of the Swiss.

a. State Purchase of the Railways.—In 1891 the purchase of the Central railway was rejected by a popular vote, but in 1898, by the aid of various baits thrown out, the people were induced to accept the principle of the purchase by the Confederation of the five great Swiss railway lines—three in 1901, viz. the Central, the North-Eastern, and the United Swiss lines; one (the Jura-Simplon) in 1903, and one (the St Gotthard line) in 1909, this delay being due to international conventions that still have some years to run. Further, very important economical consequences, *e.g.* as to strikes, may be expected to result from the transformation of all railway officials of whatever grade into state servants, who may naturally be expected to vote (as in other cases) for their employers, and so greatly increase the strength of the Centralist political party.

b. The " Double Initiative."—This phrase denotes two purely political reforms that have been coupled together, though in reality they are by no means inseparable. One is the introduction of proportional representation (within the several cantons) into the elections for the National Council of the Federal parliament, the object being thus to secure for several large minorities a number of M.P.'s more in accordance with the size of those minorities in the country than is now possible under the régime of pure majorities: naturally these minorities would then receive a proper share of political power in the senate house, instead of merely exerting great political influence in the country, while if they were thus strengthened in the legislature they would soon be able to claim the right of naming several members of the Federal executive, thus making both legislature and executive a mirror of the actual political situation of the country, instead of the preserve of one political party. The other reform is the election of the members of the Federal executive by popular vote, the whole body of voters voting, not by cantons, but as a single electoral constituency. This would put an end to the " lobbying " that goes on previously to the election of a member of the executive by the two houses of the Federal parliament sitting jointly in Congress; but, on the other hand, it might stereotype the present system of electing members of the executive by the majority system, and so reduce large minorities to political impotence. The " double initiative " scheme was launched in the beginning of 1899, and by the beginning of the following July secured more than the requisite number of signatures (50,000), the first-named item having been supported by nearly 65,000 citizens, and the second item by 56,000. Hence the Federal parliament was *bound* to take these two reforms into formal consideration, but in June 1900 it rejected both, and this decision was confirmed by a popular vote taken in the following November.

3. *Economics and Finance.*—Soon after the adoption of the Federal Constitution of 1874 the economical and financial state of the Confederation became very unsatisfactory. The great financial crisis in Vienna in 1873 was a severe blow to Swiss commerce, which had taken a very great start after the Franco-German War of 1870–71. In the later 'seventies, too, the financial position of some of the great Swiss railway lines was very unfavourable: the bankruptcy of the National line ruined for the time (till a Federal loan at a very low rate of interest was forced upon them) the four Swiss towns which were its guarantors; the North-Eastern line had to beg for a "moratorium" (a *legal* delay of the period at which it had to pay its debts) from the Federal government; the Bern-Lucerne line was actually put up to auction, and was bought by the canton of Bern. Further, the expenses of constructing the St Gotthard railway vastly exceeded all estimates, and in 1876 over 100,000,000 francs more were required. Hence the subventions already granted had to be increased. Germany (which gave originally 20,000,000 francs) and Italy (original contribution 45,000,000 francs) each promised 10,000,000 francs more; the St Gotthard company itself gave 12,000,000, and the two Swiss railway lines interested (Central and North-Eastern) added 1,500,000 to the 20,000,000 they had already agreed to give jointly with the cantons interested in the completion of this great undertaking. But these latter refused to add anything to their previous contributions, so that finally the Federal government proposed that it should itself pay the 6,500,000 francs most urgently required. This proposal aroused great anger in east and west Switzerland, but the matter was ultimately settled by the Confederation paying 4,500,000 francs and the interested cantons 2,000,000, the latter gift being made dependent on a grant of 4,500,000 francs by the Federal government for new tunnels through the Alps in east and west Switzerland, and of 2,000,000 more for the Monte Cenere tunnel between Bellinzona and Lugano. This solution of a most thorny question was approved by a popular vote in 1879, and the St Gotthard line was successfully completed in 1882. Gradually, too, the other Swiss railway lines, attained a state of financial equilibrium, owing to the more careful management of new directors and managers. The completion of the Simplon tunnel (1906), the commencement (1906) of that beneath the Lötschen Pass (*q.v.*), and the rival claims of projected tunnels under the Splügen Pass (*q.v.*), besides the struggle for or against a tunnel under the Faucille (supported by Geneva almost alone), show that railway politics play a very prominent part in Swiss national life. They are, too, complicated by many local rivalries, which in this country are of greater importance than

elsewhere because of the considerable share of power still legally belonging to the cantons. Another kindred question (owing to the rapid development of electric traction in Switzerland) is the equitable proposal (accepted in 1908) that the utilization of the immense force supplied by the many rivers and torrents in Switzerland should become a Federal monopoly, so as to secure to the Confederation the control over such important sources of revenue as otherwise might easily be unscrupulously exploited by private companies and firms.

Switzerland, by reason of natural conditions, is properly a free trade country, for it exports far more than it imports, in order to supply the demand for objects that it cannot itself produce. But Prince Bismarck's protectionist policy in 1879 was imitated by France, Austria and Italy, so that Switzerland was gradually shut in by a high wall of tariffs. Hence in 1891 the Swiss people approved, in sheer self-defence, a great increase of the customs duties, and in 1903 sanctioned a further very considerable advance in these duties, so that it is now a thoroughly Protectionist country, despite its obvious natural disadvantages. The huge increase in revenue naturally led to increased expenditure, which took the form of lavish subventions to all sorts of cantonal objects, magnificent Federal buildings, most useful improvements in the post and telegraph services, and extensive and lamentable construction of military fortifications in Uri and the Valais against some unknown foe. In 1894 it was proposed to distribute part of this new wealth in giving a bonus to the cantons at the rate of 2 francs per head of the population, but this extravagant proposal (nicknamed the "Beutezug") was rejected, owing to the cool common sense of the Swiss people, by a majority of over two to one. These prosperous circumstances, however, contributed mainly to the adoption or suggestion of various measures of state socialism, *e.g.* compulsory sick insurance, Federal subvention to primary schools, purchase of the five great Swiss railway lines, giving a right to every able-bodied man to have work at the expense of the state, subventions to many objects, &c. (W. A. B. C.)

Literature

There is no such thing as a Swiss national vernacular literature properly speaking, this being explained by the diversity between the states of which it is composed, which has not favoured any common intellectual life. But there are four branches which make up a literature of Switzerland, distinguished according to the language in which the works in each are composed. As the Confederation, from its foundation in 1291 till 1798, was exclusively composed (with a partial exception in the case of Fribourg) of German-speaking districts, the real Swiss vernacular literature (if any one branch is to be dignified by that name) is in German, though in the 18th century French became the fashionable language in Bern and elsewhere, while the influence of the French-speaking "allies" and subject lands was more marked than before. Hence the German branch is by far the more important and more national, while the French branch is not really Swiss till after 1815, when these regions took full rank as cantons. Thus Geneva and Lausanne in the 18th century, with their respective brilliant societies, were only "Swiss" in so far as Geneva was an "ally" and Vaud a "subject land." The Italian and Romonsch-Ladin branches are of not sufficient importance to deserve more than a passing notice.

a. German Branch.—It is noticeable that while the original League of 1291 (like the earlier charters of liberties to the first members of the Confederation) is drawn up in Latin, all later alliances among the cantons, as well as documents concerning the whole Confederation (the Parsons' Ordinance of 1370, the Sempach Ordinance of 1393, and the Compact of Stans 1481) and all the Recesses of the Diets are compiled in German. Though such political documents are not "literature," yet they show that these early pre-Reformation alliances rested on the popular consent, and so were expressed in vernacular German rather than in clerkly Latin. But this vigorous popular life found other channels in which to develop its energy. First in order of date are the Minnesingers, the number of whom in the districts that ultimately formed part of the medieval Swiss Confederation are said to have exceeded thirty. Zürich then (as now) was the chief literary centre of the Confederation. The two Manesses (father and son) collected many of their songs in a MS. that has happily come down to us and is preserved in Paris. The most prominent personage of this circle of the muses was Master John Hadlaub, who flourished in the second half of the 13th and the first quarter of the 14th centuries. Next we have a long series of war songs, celebrating the marvellous victories of the early Swiss. One of the earliest and most famous of these was composed by Hans Halbsuter of Lucerne to commemorate the glorious fight of Sempach (1386), not far from his native town. There are other similar songs for the victory of Näfels (1388) and those of Grandson and Morat (both 1476) in the Burgundian War, while in the 14th century the Dominican friar Ulrich Boner of Bern versified many old fables. Still more important are the historical chronicles relating to different parts of Switzerland. Thus in the 14th century we have Christian Kuchimeister's continuation of the annals of the famous monastery of St Gall, in the early 15th century the rhymed chronicle of the war between the Appenzellers and the abbot of St Gall, and rather later in the same century the chronicles of Conrad Justinger of Bern and Hans Fründ (d. 1469) of Lucerne, besides the fantastical chronicle of Strättligen and a scarcely less fanciful poem on the supposed Scandinavian descent of the men of Schwyz and of Ober Hasle, both by Eulogius Kiburger (d. 1506) of Bern. In the 15th century, too, we have the *White Book* of Sarnen and the first Tell song (see TELL), which gave rise to the well-known legend, as well as the rather later play named the *Urnerspiel* dealing with the same subject. The Burgundian War witnessed a great outburst of historical ardour in the shape of chronicles written by Diebold Schilling (d. 1486) of Bern, by Melchior Russ (d. 1499), Diebold Schilling (d. between 1516 and 1523) and Petermann Etterlin (d. 1509), all three of Lucerne as well as by Gerold Edlibach (d. 1530) of Zürich, and by Johnanes Lenz (d. 1541) of Brugg. In the vernacular, too, are the earliest descriptions of the Confederation, those by Albert von Bonstetten of Einsiedeln (1479) and by Conrad Türst of Zürich (1496), to whom also we owe the first map of the country (1495–1497).

The Swiss Humanists wrote naturally in Latin, as did also, what was more surprising, the Swiss Reformers, at any rate for the most part, though the Zürich Bible of 1531 forms a striking exception. But Nicholas Manuel (1484–1530), a many-sided Bernese, composed satirical poems in German against the pope, while Valerius Anshelm (d. 1540), also of Bern, wrote one of the best Swiss chronicles extant. Giles Tschudi (*q.v.*) of Glarus, despite great literary activity, published but a single German work in his lifetime—the *Uralt warhafftig Alpisch Rhaetia sampt dem Tract der anderen Alpgebirgen* (1538)—besides his map of Switzerland (same date). Sebastian Münster (*q.v.*), who was a Swiss by adoption, published (1544) his *Cosmographia* in German, the work being translated into Latin in 1550. But the many-sided Conrad Gesner (*q.v.*), a born Swiss, wrote all his works in Latin, German translations appearing only at a later date. Thus the first important original product in German was the very remarkable and elaborate history and description of Switzerland, issued in 1548 at Zürich by Johannes Stumpf (*q.v.*) of that town. But Josias Simler (*q.v.*), who was in a way his continuator, wrote all his works, theological and geographical, in Latin. Matthew Merian (*q.v.*) engraved many plates, which were issued in a series of volumes (1642–1688) under the general title of *Topographia*, the earliest volume describing Switzerland, while all had a text in German by an Austrian, Martin Zeiller. Very characteristic of the age are the autobiography of the Valais scholar Thomas Platter (1499–1582) and the diary of his still more distinguished son Felix (1536–1614), both written in German, though not published till long after. But gradually Swiss historical writers gave up the use of Latin for their native tongue, so Michael Stettler (1580–1642) of Bern, Franz Haffner (1609–1671) of Soleure, and quite a number of Grisons authors (though the earliest in date, Ulrich Campell of Süs, *c.* 1509–*c.* 1582, still clung to Latin), such as Bartholomew Anhorn (1566–1640) and his son of the same name (1616–1670) and Johannes Guler (1562–1637). Yet Fortunatus Sprecher (1585–1647) preferred to write his *Pallas raetica* in Latin, as did Fortunatus Juvalta (1567–1654) in the case of his autobiography. But we have some compensation in the delightful autobiography of Hans Ardüser of Davos (1557–post 1614) and the amusing dialogue between the Niesen and the Stockhorn by Hans Rudolf Rebmann (1566–1605), both composed in naïve German. J. B. Plantin (1625–1697) wrote his description of Switzerland in Latin, *Helvetia nova et antiqua* (1656), but J. J. Wagner's (1641–1695) guide to Switzerland is in German, despite its titles *Index memorabilium Helvetiae* (1684) and *Mercurius helveticus* (1688), though he issued his scientific description of his native land in Latin, *Historia naturalis Helvetiae curiosa* (1680).

In the 18th century the intellectual movement in Switzerland greatly developed, though it was naturally strongly influenced by local characteristics. Basel, Bern and especially Zürich were the chief literary centres. Basel was particularly distinguished for its mathematicians, such as Leonhard Euler (1707–1783, *q.v.*) and three members of the Bernoulli family (*q.v.*) refugees from Antwerp, the brothers Jakob (1654–1705) and Johannes (1667–1748), and the latter's son Daniel (1700–1782). But its chief literary glory was Isaac Iselin (1728–1783), one of the founders of the Helvetic Society

(1760) and of the Economical Society (1777), and author of a treatise on the philosophy of history entitled *Geschichte der Menschheit* (1764), and of another on ideal politics, *Philosophische und patriotische Träume eines Menschenfreundes* (1755), while many of his economical tracts appeared (1776–1782) under the general title of *Ephemeriden der Menschheit.* At Bern Albrecht von Haller (*q.v.*), though especially distinguished as a scientific writer, yet by his poem *Die Alpen* (1732) and his travels in his native country did much to excite and stimulate the love of mountain scenery. Another Bernese, Charles Victor de Bonstetten (*q.v.*), is a type of the gallicized Liberal Bernese patrician, while Beat Ludwig von Muralt (1665–1749) analysed the racial characteristics of other nations for the instruction of his fellow-countrymen, his *Lettres sur les anglais et les français* (1725) being his principal work. Samuel Wyttenbach (1748–1830) devoted himself to making known the beauties of his country to its natives, travelling much and writing much about his travels. Gottlieb Sigmund Gruner (*q.v.*) wrote the *Eisgebirge des Schweizerlandes* (1760), a work describing the ice-clad mountains of Switzerland, though it is rather a useful compilation than an original contribution to knowledge, but a decided advance on his fellow Bernese Johann Georg Altmann's (1697–1758) *Versuch einer historischen und physischen Beschreibung der helvetischen Eisgebirge* (1751). In another department of knowledge a son of Albrecht von Haller, Gottlieb Emmanuel von Haller (1735–1786), compiled a most useful bibliography of writings relating to Swiss history, the *Bibliothek der Schweizergeschichte* (6 vols., 1784–1787), that is still indispensable to the historical student.

But in the 18th century Zürich was undoubtedly the intellectual and literary capital of German-speaking Switzerland, and gained the title of "Athens on the Limmat." One of its earliest and most famous celebrities was J. J. Scheuchzer (*q.v.*), who travelled much in Switzerland, and wrote much (his travels are described in Latin) as to its natural curiosities, being himself an F.R.S., and closely associated with Newton and the other English scientific men of the day. But in the purely literary domain the names of J. J. Bodmer (*q.v.*) and of his friend Johann Jakob Breitinger (1701–1776), are the most prominent. By their united exertions the antiquated traditions of German literature were broken down to a large extent, while great praise was bestowed on English poets, Shakespeare, Milton and others. Their views were violently opposed by Gottsched, the leader of the Saxon school, and the controversy that arose forms part of the history of German literature. In 1721–1723 they published jointly the *Discourse der Maler*, a periodical which spread their views, while more elaborate and systematic expositions of their critical doctrine as to poetry are Bodmer's *Kritische Abhandlung von dem Wunderbaren in der Poesie* (1740), and Breitinger's *Critische Dichtkunst* (also in 1740). Their untiring efforts helped to prepare the way for the later outburst of German literature begun by Klopstock, Wieland and Lessing. Another famous Zürich writer was Solomon Gesner (*q.v.*), the pastoral poet, and yet another was J. K. Lavater (*q.v.*), now best remembered as a supporter of the view that the face presents a perfect indication of character and that physiognomy may therefore be treated as a science. Other well-known Zürich names are those of J. H. Pestalozzi (1746–1827, *q.v.*), the educationalist, of Johann Caspar Hirzel (1725–1803), another of the founders of the Helvetic Society, and author of *Die Wirthschaft eines philosophischen Bauers* (1761), and of Johann Georg Sulzer (1720–1779), whose chief work is one on the laws of art or aesthetics, entitled *Allgemeine Theorie der schönen Künste* (1771–1774).

Outside the three towns named above there were several writers of German-speaking Switzerland who must be mentioned. One of the best known even now is Johann Georg Zimmermann (1728–1795 *q.v.*), whose *Betrachtungen über die Einsamkeit* (1756–1784–1785) profoundly impressed his contemporaries. He, like the fabulist A. E. Fröhlich (*q.v.*), was born at Brugg. Johannes von Müller (*q.v.*) of Schaffhausen, was the first who attempted to write (1780) a detailed history of Switzerland, which, though inspired rather by his love of freedom than by any deep research, was very characteristic of his times. J. G. Ebel (*q.v.*) was a Swiss by adoption only, but deserves mention as the author of the first detailed guide-book to the country (1793), which held its ground till the days of "Murray" and "Baedeker." A later writer, Heinrich Zschokke (1771–1848), also a Swiss by adoption only, produced (1822) a history of Switzerland written for the people, which had a great vogue.

In the later literary history of German-speaking Switzerland three names stand out above all others—Albrecht Bitzius (*q.v.*), known as Jeremias Gotthelf from the first of his numerous tales of peasant life in the Emmenthal, Gottfried Keller (*q.v.*), perhaps the most genuinely Swiss poet and novelist of the century, and Conrad Ferdinand Meyer (*q.v.*), also a poet and novelist, but of more cosmopolitan leanings and tastes. Jakob Burckhardt (*q.v.*) was a famous writer on Italian art, while Jakob Frey (1824–1875) continued the work of Bitzius by his tales of Swiss peasant life. Ulrich Hegner (1759–1840) of Winterthur wrote novels full of local colour, as is also the case with David Hess (1770–1843) in his description of a cure at Baden in Aargau and various tales. Johann Martin Usteri (1763–1828) of Zürich was one of the earliest to write poems in his native dialect. Later we have a number of Zürich poets or versifiers, some of whose writings have become very well known. Such were Heinrich Leuthold (1827–1879), August Corrodi (1826–1885) and Leonhard Widmer (1808–1868), the author of *Trittst im Morgenrot daher* (1842), which, set to music by the Cistercian monk Alberic Zwyssig (1808–1854), is now known as the "Swiss Psalm," of *Es lebt in jeder Schweizerbrust* (1842), and *Wo Berge sich erheben* (1844). To the Bernese poet, Johann Rudolf Wyss (1781–1830), whose father, J. D. Wyss (1743–1818), was the author of the *Swiss Family Robinson*, we owe the Swiss national anthem, *Rufst du mein Vaterland?* and the song, *Herz, myn Herz, warum so trurig?*—while Johann Georg Krauer (1792–1845), of Lucerne, wrote the Rütlilied, *Von ferne sei herzlich gegrüsset*, and Gottfried Keller himself was responsible for *O mein Heimatland.* Gottlieb Jakob Kuhn (1775–1845) wrote many poems in the Bernese dialect as to the Alps and their inhabitants. Less national in sentiment and more metaphysical are the lyrics of "Oranmor," the pen-name of the Bernese Ferdinand Schmid (1823–1888).

Among the chief contemporary Swiss writers in the department of belles-lettres, novelists, poets, &c., may be mentioned Ernst Zahn, Meinrad Lienert, Arnold Ott, Carl Spitteler, Fritz Marti, Walther Siegfried, Adolf Frey, Hermann Hesse, J. C. Herr, J. V. Widmann, and Gottfried Strasser.

Isabella Kaiser, by her poems and stories, upholds the honour of the fair sex, while the fame won by Johanna Spyri (d. 1891) for her children's stories is still fresh. Of historical writers in different departments of their subject in the course of the 19th century some of the principal were (in alphabetical order): Ildefons von Arx (1755–1833), the historian of St Gall, of which he had been a monk, E. Blösch (1838–1900), the historian of the Protestant churches in German-speaking Switzerland, J. J. Blumer (1819–1875), and J. C. Bluntschli (1808–1881), who both devoted their energies to Swiss constitutional matters, J. J. Hottinger (1783–1860), the continuator of J. von Müller's Swiss history, J. E. Kopp (1793–1866), who rewrote early Swiss history on the basis of authentic documents, R. Maag (1866–1899), who began the publication of the invaluable Habsburg terrier of the early 14th century, but had to leave the completion of the work to other competent hands, P. C. von Planta (1815–1902) and J. A. Pupikofer (1797–1882), the historians respectively of the Grisons and of the Thurgau, A. P. von Segesser (1817–1888), the historian and statesman of Lucerne, A. F. Stettler (1796–1849), A. von Tillier (1792–1854), E. von Wattenwyl (1815–1890), and J. L. Wurstemberger (1783–1862) who all four wrote on Bernese history, G. von Wyss (1816–1893), to whom we owe, among many excellent works, an admirable account of all Swiss historians and their works, his step-brother F. von Wyss (1818–1907), a great authority on the legal and constitutional history of Switzerland, and J. C. Zellweger (1768–1855), the historian of Appenzell. Among contemporary historical writers of German-speaking Switzerland we may mention (in alphabetical order), A. Büchi, J. L. Brandstetter, W. Burckhardt, K. Dändliker, J. Dierauer, R. Durrer, H. Escher, A. Heusler, R. Hoppeler, T. von Liebenau, W. Merz, G. Meyer von Knonau, W. F. von Mülinen, W. Oechsli, J. R. Rahn, L. R. von Salis, P. Schweizer, J. Schollenberger, J. Strickler, R. Thommen, and H. Wartmann.

b. French Branch.—The knight Othon of Grandson is the earliest figure in the literature of the *Suisse romande.* He was killed in a judicial duel in 1397, the last scion of his ancient house, and left some amatory poems behind him, while one is extant only in a translation by Chaucer, who makes flattering mention of him. In the 15th and 16th centuries many miracle plays in the local Romance dialect were known. The *Chronique des chanoines de Neuchâtel* was formerly supposed to date from the 15th century, but is now considered by many to be a forgery. More individual and characteristic are the romance about Charlemagne, entitled *Fierabras le Géant* (1478), by Jean Bagnyon, and the poem named *Congié pris du siècle séculier* (1480), by Jacques de Bugnin. But the first really prominent personage in this department of literature is François Bonivard (*q.v.*; d. 1570) who wrote the *Chroniques de Genève* that extend down to 1530 and were continued to 1562 by Michel Roset (d. 1613). The first Protestant French translation of the Bible was issued at Neuchâtel in 1535, its principal authors being Pierre Robert (nicknamed Olivétan) and Pierre de Vingle. As a sort of pendant to the Protestant Bonivard, we have the nun Jeanne de Jussie who in her *Levain du Calvinisme* (*c.* 1545) recounts the establishment of Calvinism at Geneva, while the noble Pierre de Pierrefleur in his *Mémoires* does the same in a lighter and less lachrymose style for Orbe, his native district. Naturally the Reformers of the Suisse Romande used French much in their theological and polemical works. Of more general interest are the writings of two Frenchmen who were driven by religious persecutions to end their lives at Geneva—the memoirs and poems of Théodore Agrippa d'Aubigné (1552–1630), and the historical writings and poems of Simon Goulart (1543–1628). The great deliverance of Geneva from the duke of Savoy, known as the Escalade (1602), was described in prose by David Piaget (1580–1644) in his *Histoire de l'escalade* and celebrated in verse by Samuel Chappuzeau (1625–1701) in his *Genève délivrée*, though the narratives of Goulart and that (published officially by the government) attributed to Jean Sarasin (1574–1632), the author of the *Citadin de Genève* (1606), are more laconic and more striking. J. B. Plantin (1625–1697), of Vaud, wrote his topography of Switzerland, *Helvetia antiqua et nova* (1656), in Latin, but his *Abrégé de l'histoire générale de la Suisse* (1666) in French, while Georges de Montmollin (1628–1703) of Neuchâtel wrote, besides various works as to local history, *Mémoires* of his times which have a certain historical value.

But the 17th century in the Suisse Romande pales before the glories of the 18th century, which forms its golden age, and was in a large degree due to the influence of French refugees who, with their families, flocked thither after the Revocation of the Edict of Nantes (1685) and settled down there for the rest of their lives. Such was Louis Bourguet (1678–1743), who, besides his geological works, founded two periodicals which in different ways did much to stimulate the intellectual life of the Suisse Romande; these were the *Bibliothèque italique* (1729–1734), which aimed at making more widely known the results of Italian research, and the *Mercure suisse* which, first issued in 1732, lasted till 1784, under different names (from 1738 onwards the literary section bore the name of *Journal helvétique*), and secured contributions from most of the leading writers of the Suisse Romande of the day, such as Firmin Abauzit (1679–1767), Abraham Ruchat (1678–1750), and others. Ruchat is now best remembered as the author (under the pen-name of Gottlieb Kypseler) of an excellent guide-book to Switzerland, the *Délices de la Suisse*, which first appeared in 1714 and passed through many editions, the latest being issued in 1778; but his *Histoire de la Réformation de la Suisse* (1727–1728) was much esteemed in his day. Another Vaudois historian and antiquary was Charles Guillaume Loys de Bochat (1695–1754) whose *Mémoires critiques sur divers points de l'ancienne histoire de la Suisse* (1747–1749) still form a treasure-house for archaeologists. Yet a third Lausanne man was J. P. de Crousaz (1663–1750; *q.v.*), who introduced there the philosophy of Descartes, and was, by his books, the master of Gibbon in logic. A French refugee at Lausanne, Jean Barbeyrac (1674–1744), published in 1712 the *Droit de la nature et des gens*, a translation of Puffendorf's treatise, with a striking preface of his own. A precursor of Montesquieu and of Rousseau was Jean Jacques Burlamaqui (1694–1750) in his *Principes du droit naturel et politique* (1747 and 1751, issued together in 1763), while the celebrated international lawyer, Eméric de Vattel (1714–1767), was a native of Neuchâtel by birth and descent, and, though he spent most of his life at foreign courts, died at Neuchâtel, not so very long after the publication of his famous *Droit des gens* (1758).

The year 1754 is a great date in the literary history of the Suisse Romande, for in that year Rousseau came back for good to Geneva, and Voltaire established himself at Ferney, while in 1753 Gibbon had begun his first residence (which lasted till 1758) in Lausanne. The earlier writers mentioned above had then nearly all disappeared, and a more brilliant set took their place. But Rousseau (*q.v.*), though a Genevese, belongs rather to European than to Swiss literature, as do later Jacques Necker (*q.v.*) and his daughter, Madame de Staël (*q.v.*), Benjamin Constant (*q.v.*) and Sismondi (*q.v.*). Madame de Charrière (1740–1805) was Dutch by birth, but married to a native of Neuchâtel. Among her earlier works were two novels, *Le Mari sentimental* (1783), and the *Lettres de Mistress Henley* (1784), both of which had a great vogue in their day and paint, from her own experience, the sad results of an unsuitable marriage. More celebrated by reason of the liveliness and acuteness with which the manners of a little provincial town are described are her *Lettres de Lausanne* (1871), and her *Lettres neuchâteloises* (1784), particularly the second part of a story of the former, entitled *Caliste*, and published in 1788, for, according to Sainte-Beuve, it was a sort of foreshadowing of the more famous *Corinne* (1807) of Madame de Staël. P. H. Mallet (*q.v.*), a Genevese, who held a chair at Copenhagen, devoted himself to making known to the educated world the history and antiquities of Scandinavia. But more characteristic of Geneva were the efforts of a group of men to spread the cause of natural science by personal investigations in the higher Alps, then but little known. Possibly their interest in such matters had been stimulated by the scientific and psychological speculations of Charles Bonnet (*q.v.*). The chief of this school was H. B. de Saussure (*q.v.*) one of the founders of geology and meteorology, while his Alpine ascents (undertaken in the cause of science) opened a new world even to non-scientific travellers. The brothers De Luc (*q.v.*) devoted themselves mainly to questions of physics in the Alps, while Senebier (*q.v.*), the biographer of Saussure, was more known as a physiologist than as a physicist, though he wrote on many branches of natural science, which in those days was not yet highly specialized. On the other hand Marc Théodore Bourrit (*q.v.*), the contemporary of these three men, was rather a curious and inquisitive traveller than a scientific investigator, and charms us even now by his genial simplicity as contrasted with the austerity and gravity of the three writers we have mentioned. Philippe Cyriaque Bridel (1757–1845), best known as the "doyen Bridel," was the earliest of the Vaudois poets by virtue of his *Poésies helvétiennes* (1782). But he is better known as the painter of the scenery and people among whom he worked as pastor at Basel, at Château d'Oex, and at Montreux successively. His *Course de Bâle à Bienne par les vallées du Jura* appeared in 1802, while descriptions of his travels, as well as of the manners of the natives, local history, and in short everything that could stimulate national sentiment, were issued in a series of periodicals from 1783 to 1831 under the successive titles of *Étrennes helvétiennes* and of *Conservateur suisse*. His patriotic aim met with great success, while his impressions of his mountain wanderings are fresh and unspoilt by any straining after effect. He was the first writer of the Suisse Romande to undertake such wanderings, so that, with obvious differences, he may be regarded not merely as the forerunner, but as the inspirer and model of later Vaudois travellers and climbers in the Alps, such as Rodolphe Töpffer (*q.v.*), of E. Rambert (*q.v.*), and of the last-named's most brilliant pupil, Émile Javelle (1844–1883), whose articles were collected in 1886 by the pious care of his friends under the title of *Souvenirs d'un alpiniste*. As a poet Juste Olivier (*q.v.*) surpassed Bridel. Nor can we wonder that with the advance of knowledge Bridel's history is found to be more picturesque than scientific. Two Vaudois, Charles Monnard (1790–1865) and Louis Vulliemin (1797–1879) carried out their great scheme of translating (1837–1840) J. von Müller's Swiss history with its continuation by Hottinger, and then completed it (1841–1851) down to 1815. This gigantic task did not, however, hinder the two friends from making many solid contributions to Swiss historical learning. Later in date were Alexandre Daguet (1816–1894) who wrote an excellent history of Switzerland, while Jean Joseph Hisely (1800–1866), Albert Rilliet (1809–1883), and Pierre Vaucher (1833–1898), all devoted much labour to studying the many problems offered by the early authentic history (from 1291 onwards) of the Swiss Confederation. A different type of history is the work of an honest but partisan writer, the Genevese Jules Henri Merle d'Aubigné (1794–1872), entitled *Histoire de la réformation au temps de Calvin* (1835–1878). The Vaudois noble Frédéric Gingins-la-Sarra (1790–1863) represents yet another type of historian, devoting himself mainly to the medieval history of Vaud, but occasionally going beyond the numberless authentic documents brought to light by him, and trying to make them prove more than they can fairly be expected to tell us. Jean Antoine Petit-Senn (1792–1870) was a thorough Genevese and a biting satirist, a pensive poet, the "Genevese La Bruyère," as he liked to be called, but was not fully appreciated till after his death, when his widely scattered writings were brought together. Alexandre Vinet (*q.v.*), the theologian, and H. F. Amiel (*q.v.*), the philosopher, in a fashion balance each other, and need only be mentioned here. Jean Jacques Porchat (1800–1864) was one of the most prominent among the minor poets of the region, very French owing to his long residence in Paris, and best remembered probably by his fables, first published in 1837 under the title of *Glanures d'Esope* (reissued in 1854 as *Fables et paraboles*), though in his day his stories for the young were much appreciated. Urbain Olivier (1810–1888), a younger brother of the poet, wrote many tales of rural life in Vaud, while the Genevese novelist Victor Cherbuliez (1829–1899, *q.v.*) was perhaps the most brilliant of a brilliant family. Fribourg has produced the local novelist Pierre Sciobéret (1830–1876) and the Bohemian poet Étienne Eggis (1830–1867), and Neuchâtel Auguste Bachelin (1830–1890) whose best novel was *Jean Louis*, a tale of which the scene is laid in the old-fashioned little village of St Blaise. Another Neuchâtel writer, Alice de Chambrier, the poetess, died young, as did the Genevese poet Louis Duchosal, both showing in their short lives more promise than performance. Madame de Gasparin's (1813–1894) best tale is *Horizons prochains* (1857), a very vivid story of rural life in the Vaudois Jura, remarkable for the virile imagination of its descriptions.

Edouard Rod (*q.v.*) the novelist, and Marc Monnier (*q.v.*), critic, poet, dramatist and novelist, are the most prominent figures in the recent literature of the Suisse Romande. Amongst lesser stars we may mention in the department of belles-lettres (novelists, poets or critics) Charles Du Bois-Melly, "T. Combe" (the pen name of Mlle Adèle Huguenin), Samuel Cornut, Louis Favre, Philippe Godet, Oscar Huguenin, Philippe Monnier, Noëlle Roger, Virgile Rossel, Paul Seippel and Gaspard Vallette. The chief literary organ of the Suisse Romande is the *Bibliothèque universelle*, which in 1816 took that title in lieu of *Bibliothèque britannique* (founded in 1796), and in 1861 added that of *Revue suisse*, which it then absorbed. Amongst historians the first place is due to one of the most learned men whom Switzerland has ever produced, and whose services to the history of the Valais were very great, and abbé Jean Gremaud (1823–1897) of Fribourg. The principal contemporary historians are Victor van Berchem, Francis De Crue, Camille Favre, Henri Fazy, B. de Mandrot, Berthold van Muyden and Édouard Rott.

c. Italian Branch.—Italian Switzerland is best known by its artists, while its literature is naturally subject to strong Italian influences, and not to any of a strictly Swiss nature. Stefano Franscini (1796–1857) did much for his native land, especially in educational matters, while his chief published work (1835) was one that gave a general account of the canton. But this is not so thorough and good as a later book by Luigi Lavizzari (1814–1875), entitled *Escursioni nel cantone Ticino* (1863), which is very complete from all points of view. Angelo Baroffio (d. 1893) and Emilio

Motta represent the historical sciences, the latter contributing much to the *Bollettino della Svizzera Italiana* (from 1879 onwards), which, though mainly historical, devotes much space to literary and historical matters relating to the canton. The art of novel writing does not flourish in Ticino. But it has produced a great number of poets such as Pietro Peri (1794–1869), who translated the Swiss national anthem into Italian, J. B. Buzzi (1825–1898), Giovanni Airoldi (died before 1900) and Carlo Cioccari (1829–1891)—the two former were lyric poets, and the third a dramatist. Two younger singers are F. Chiesa and M. A. Nessi.

d. Romonsch and Ladin Branch.—In the Grisons alone still lingers a quaint Romance dialect, which is a laggard sister of French and Italian, and has therefore not much to show in the way of literary activity. Indeed it would probably have perished altogether by this time had not certain energetic men and societies more or less successfully tried to bring about a sort of artificial revival. It is distinguished into two main dialects, that of the Bündner Oberland or the valley of the Vorder Rhine being called Romonsch, while that spoken in the Engadine and the neighbouring valleys is known as Ladin. Both took their origin from the spoken tongue or lingua rustica Romana in the days of the later empire. The earliest known monument of this interesting survival was discovered in 1907, and consists of a few lines, in an early form of the Romonsch dialect, of interlinear translation (with the original Latin text) of a sermon attributed to St Augustine. This monument is said to date from the early 12th century. The first poem in Ladin was one on the Musso War, written in 1527 by Johann von Travers (1483–1563), though it was not published till 1865. The first book printed in it (at Poschiavo in 1552) was the translation of a German catechism, and the next a translation of the New Testament, also at Poschiavo, but in 1560. Most of the works in both these dialects are translations of books of a religious or educational nature. The principal writers in the Romonsch dialect (the less literary of the two) of recent times are Theodor von Castelberg (1748–1830), a poet and translator of poetry, and P. A. de Latour (about 1814) also a poet, while the best of all poets in this dialect was Anton Huonder, whose lyrics are considered remarkable. Alexander Balletta (1842–1887) wrote prose romances and sketches, while J. C. Muoth (1844–1906), himself a most typical and characteristic figure, wrote much in prose and verse as regards his native region. In Ladin one of the chief figures was the poet Conradin von Flugi (1787–1874), who published volumes of poems in 1845 and 1861, but the poems, novels and translations of J. F. Caderas (1830–1891) are placed above them. Other Ladin poets are Florin Valentin, O. P. Juvalta and S. Caratsch (d. 1892), while P. Lansel represents a younger generation. Zaccaria Pallioppi (1820–1873) also wrote poems, but the excellent Ladin dictionary that he compiled was not published till 1895 by the care of his son. (W. A. B. C.)

BIBLIOGRAPHY.—*a. General.*—The indispensable work for any one desiring to know what books have been written on any subject relating to Switzerland is the officially published *Bibliographie der schweizerischen Landeskunde*, a series of detached parts, each complete in itself, and issued separately (Bern, from 1892 onwards). In particular may be mentioned: A. Wäber's *Landes- und Reisebeschreibungen* (1899; with a supplement, 1909), that deals with works of travel in Switzerland (see, too, the new edition, London, 1899, of J. Ball's *Hints and Notes for Travellers in the Alps*, pp. 140–152), and J. H. Graf, *Kartenwesen* (1896), which enumerates all the maps of Switzerland and its various districts. Among the best of the older descriptions may be mentioned those of A. von Bonstetten (1479), Conrad Türst (1495), Sebastian Münster (1544), J. Stumpf (1548), J. Simler (1574), M. Merian (1642), J. J. Scheuchzer (1723), G. S. Gruner (1760), P. F. D. de Zurlauben (1777) and W. Coxe (1779). More modern, but still useful in many ways, are Max Wirth, *Allgemeine Beschreibung und Statistik der Schweiz* (3 vols., Zürich, 1871–1875), and H. A. Berlepsch, *Schweizerkunde* (2nd ed., Brunswick, 1875). The most complete and recent monograph on the country from all points of view is the work (700 pp.) entitled *La Suisse* (also in German), with atlas of 48 maps, reprinted from the *Dictionnaire géographique de la Suisse* (Neuchâtel, 1909). For a pretty complete detailed account of its chief towns, villages and mountains, by far the best work is the *Dictionnaire géographique de la Suisse* (Neuchâtel, 1902, and following years; it is also issued in German). A complete account of the country in the 19th century is given in the work entitled *La Suisse au xix^{me} siècle* (3 vols., Lausanne, 1899–1900; also issued in German). For statistics see the official census of 1900 (Bern, 3 vols., 1904–1907), as well as the annual official publication *Statistisches Jahrbuch der Schweiz* (from 1891, see specially the vol. for 1897, *Atlas graphique et statistique de la Suisse*, with many diagrams), and another (appearing six times a year at Bern, since 1865) the *Zeitschrift für schweizerische Statistik*. For educational matters the annual official *Jahrbuch für Unterrichtswesen in der Schweiz* (Zürich, from 1894) is very useful. For mountaineers there is the Climbers' Guides Series (London, from 1890, now comprising 11 vols. relating to Switzerland), and the two works published by the Swiss Alpine Club, *Clubführer durch die Glarner Alpen* (1902), and *Clubführer durch die Urner Alpen* (2 vols., 1905). Murray's *Handbook for Travellers in Switzerland* was thoroughly revised (19th edition) in 1904, while it is not necessary to do more than mention the guide-books of Bäedeker and Joanne, of which new editions often appear (that by Iwan von Tschudi is no longer kept up to date).

The best *maps* of Switzerland are those published by the Federal Topographical Bureau at Bern. One, called from the director of the survey (G. H. Dufour, 1787–1875) the *Dufour Map* (scale 1 : 100,000), was published in twenty-five sheets between 1845 and 1863 (see the detailed history of this map in the work entitled *Die schweizerische Landesvermessung, 1832–1864*, Bern, 1896). It has however, been practically superseded by the issue (revised and corrected) of the original survey (scale 1 : 25,000 for the plains and 1 : 50,000 for the mountain districts) in 598 sheets, of which the publication began in 1870—this magnificent map, one of the finest ever executed, is named the *Siegfried Atlas*, from the successor of Dufour at the head of the survey, Hermann Siegfried (1819–1879). The history of Swiss travel has been told by G. Peyer, *Geschichte des Reisens in der Schweiz* (Basel, 1885), and W. A. B. Coolidge, *Swiss Travel and Swiss Guide-Books* (London, 1889). That of the exploration of the Swiss Alps is contained in Gottlieb Studer's *Über Eis und Schnee* (Bern, 3 vols., new ed., 1896–1899), while Bernard Studer's *Geschichte der physischen Geographie der Schweiz bis 1815* (Bern, 1863) describes the gradual examination of the country from the scientific point of view. The last-named work contains many short lives of eminent Swiss. These are narrated more in detail in R. Wolf's *Biographieen zur Kulturgeschichte der Schweiz* (4 vols., Zürich, 1858–1862); E. Secretan's *Galerie suisse* (3 vols., Lausanne, 1873–1880); and *Sammlung berner Biographieen* (Bern, as yet 5 vols., 1884–1906). (See also ALPS and GLACIERS.)

As to *languages* in Switzerland the best general work is J. Zimmerli's *Die deutsch-französische Sprachgrenze in der Schweiz* (3 vols., Basel and Geneva, 1891–1899); while for the Swiss-German dialects there is the splendid *Schweizerisches Idiotikon* (of which the publication began at Frauenfeld in 1881); and the *Glossaire des patois de la Suisse romande*. For one branch of the curious Ladin dialect, see Z. and E. Pallioppi's *Dizionari dels idioms romauntschs d'Engiadina*, &c. (Samaden, 1895); while for select extracts of all branches of the Romonsch or Ladin literature consult C. Decurtins, *Rätoromanische Chrestomathie* (8 vols., Erlangen, 1894–1907), of which the vols. i., ii., iii. and iv. refer to the Romonsch dialect of the Bündner Oberland, and the rest to the Ladin dialect of the Engadine. F. J. Stalder's *Versuch eines schweizerischen Idiotikon* (2 vols.- Aarau, 1806–1812) is still useful, as is his later work *Die Landessprachen der Schweiz* (Aarau, 1819).

The *Archiv für Volkskunde* published by the *Société suisse des traditions populaires* (Zürich, from 1897), contains much that is interesting in the way of folk-lore, while for Swiss legends in general consult E. Kohlrusch, *Schweizerisches Sagenbuch* (Leipzig, 1854); A. Lütolf, *Sagen, Bräuche, Legenden aus den Fünf Orten* (Lucerne, 1862); M. Tscheinen and P. J. Ruppen, *Walliser-Sagen* (Sion, 1872); A. Cérésole, *Légendes des alpes vaudoises* (Lausanne, 1885); J. Kuoni, *Sagen des Kantons St Gallen* (St Gall, 1903); T. Vernaleken, *Alpensagen* (Vienna, 1858); D. Gempeler's *Sagen und Sagengeschichten aus dem Simmenthal* (Thun, 1883–1893); and *Walliser-Sagen* (2 vols., Brieg, 1907). Another feature of the life of the people in Switzerland is treated in H. Herzog's *Schweizerische Volksfeste, Sitten, und Gebräuche* (Aarau, 1884).

For *educational* matters the two following books (with the *Jahrbuch für Unterrichtswesen in der Schweiz*, already mentioned) will be found specially useful: F. Escali, *L'Instruction primaire en Suisse* (Paris, 1883) and the annual volume (Geneva, from 1904) entitled *L'Education en Suisse*. For the Swiss universities see the special histories mentioned in the articles on the several cantons, while for the Swiss Polytechnic School at Zürich, consult W. Oechsli's *Geschichte der Gründung des eidg. Polytechnicums* (Frauenfeld. 1905).

As to the *mountain pastures*, see ALP, where a list of books is given.

Swiss *carriage roads*, especially across the Alpine passes, are described in S. Bavier, *Die Strassen der Schweiz* (Zürich, 1878), and the official book, *Die schweizerischen Alpenpässe* (2nd ed., 1893). For the history of the several Swiss Alpine passes consult in particular P. H. Scheffel, *Verkehrsgeschichte der Alpen* (Berlin, 1908–1909); R. Reinhard, *Pässe und Strassen in den schweizer Alpen* (Lucerne, 1903), which gives full references; and E. Oehlmann's articles "Die Alpenpässe im Mittelalter," published in vols. iii. and iv. (Zurich, 1878–1879) of the *Jahrbuch für schweizerische Geschichte*). The Simplon has a special history, F. Barbey, *La Route du Simplon* (Geneva, 1906), as has also the St Gotthard; E. Motta, *Dei Personaggi celebri che varcarono il Gottardo nei tempi antichi e moderni* (Bellinzona, 1884; later continued in the *Bollettino della Svizzera Italiana*). As to Swiss *railways* in general, see R. Herold, *Der schweizerische Bund und die Eisenbahnen bis zur Jahrhundertwende* (Munich, 1902); P. Weissenbach, *Die Eisenbahnverstaatlichung in der Schweiz* (Berlin, 1905); and C. P. Wiedemann, *Die geschichtliche Entwicklung der schweizer. Eisenbahngesetzgebung* (Zürich, 1905). The St Gotthard railway and its history are treated of at length by M. Wanner in his two works—*Geschichte der Begründung des Gotthardunternehmens* (Lucerne, 1880); and

Geschichte des Baues der Gotthardbahn (Lucerne, 1885). For a general estimate of the commercial importance of the Simplon railway, see A. Möhring, *Die Simplonbahn—eine verkehrswirthschaftliche Studie* (Bern, 1907). For a technical description of the works for the Simplon tunnel see an article (also issued separately) by K. Pressel in vol. xlvii. of the *Schweizerische Bauzeitung* (Zürich), while similar details, as well as more general notices, relating to the Splügen tunnel are given in G. Bener and R. Herold, *Studien zur Ostalpenbahnfrage* (Zürich, 1907); and A. Mettler, *Der Splügen als ostschweizerische Alpenbahn* (Zürich, 1907). As to the Jungfrau railway, see A. H. Guyer-Zeller, *Das Projekt der Jungfraubahn* (Zürich, 1896, with atlas of plates); and S. Herzog, *Die Jungfraubahn* (Zürich, 1904). A special part of the *Bibliographie der schweizer. Landeskunde* is devoted to Swiss railways.

Economical: Trade and Commerce.—As to the general economical state of Switzerland, the older *Volkswirthschafts-Lexikon der Schweiz*, by A. Furrer (Bern, 4 vols., 1885–1892), may still be consulted with advantage, while naturally more up to date is N. Reichesberg's *Handwörterbuch der Schweiz. Volkswirthschaft, Socialpolitik und Verwaltung* (Bern, since 1903). A very useful and well-arranged work is A. Le Cointe's *Inventaire des institutions économiques et sociales de la Suisse à la fin du xix^{me} siècle* (Geneva, 1900). W. H. Dawson's *Social Switzerland* (London, 1897), deals with matters rather from the social than from the strictly economical standpoint, but contains a variety of interesting information, while H. D. Lloyd's *The Swiss Democracy* (London, 1908), is rather more political. A very handy, trustworthy and admirable work of moderate size on Switzerland generally from an economical point of view is T. Geering and R. Hotz's *Économie politique de la Suisse* (Zürich, 1903, trans. of a German work issued in 1902)—the German only has the detailed bibliography. P. Clerget's *La Suisse au xx^{ème} siècle* (Paris, 1908), is very useful. Other works relating to Swiss industries and commerce are T. Geering, *Die Handelspolitik der Schweiz am Ausgang des xix. Jahrhunderts* (Berlin, 1902); E. Hofmann, *Die Schweiz als Industriestaat* (Zürich, 1902); and H. Wartmann, *Industrie und Handel der Schweiz im xix. Jahrhundert* (Bern, 1902). The following are historical monographs as to some of the principal Swiss industries: A. Bürkli-Meyer, *Die Geschichte der zürcherischen Seidenindustrie* (Zürich, 1894); H. Lehmann, *Die aargauische Strohindustrie* (Aarau, 1896); and A. Steinmann, *Die ostschweizerische Stickerei-Industrie* (Zürich, 1905); while the following deal rather with local centres of industry: H. Wartmann, *Industrie und Handel des Kantons St Gallen auf 1866* (St Gall, 1870, besides many reports as to local industry, 1708 to 1890); T. Geering, *Handel und Industrie der Stadt Basel* (Basel, 1886); A. Bachelin, *L'Horlogerie neuchâteloise* (Neuchâtel, 1888); and A. Pfleghart, *Die schweizerische Uhrenindustrie* (Leipzig, 1908). A full technical and well-illustrated description of some of the chief industrial establishments in Switzerland is given in *Die industrielle und kommerzielle Schweiz beim Eintritt ins xx. Jahrhundert* (Zürich, since 1900); while B. de Cérenville's *Le Système continental et la Suisse, 1803–1813* (Lausanne, 1906) treats of an interesting period in Swiss commercial history. Swiss mercantile law is expounded in A. Curti's *Schweizerisches Handelsrecht* (Zürich, 1903). For purely financial matters the *Finanz Jahrbuch* (Bern, from 1899), contains much information of the latest date; while H. Ernst's *Eine schweizerische Bundesbank* (Winterthur, 1904) sketches the foundation of the Swiss National Bank that was successfully launched in 1907. G. Schanz's *Die Steuern der Schweiz* (5 vols., Stuttgart, 1890) is a remarkably complete and instructive work; while the later book by J. Steiger, *Grundzüge des Finanzhaushaltes der Kantone und Gemeinden* (2 vols., Bern, 1903), is specially devoted to taxes levied by the cantons and the communes, and is of the greatest utility in studying a very complicated subject. E. Naef's *Tabakmonopol und Biersteuer* (Zürich, 1903), treats of two special sources of revenue in the Swiss financial system. The history of the Swiss coinage is admirably narrated, with many fine illustrations, by L. Coraggioni, in his *Münzgeschichte der Schweiz* (Geneva, 1896), and is the chief authority on Swiss numismatics in general.

As to the *fine arts*, the best general work on medieval Swiss architecture is J. R. Rahn's *Geschichte der bildenden Künste in der Schweiz* (Zürich, 1876). The same author has also collected various of his art essays in his *Kunst- und Wanderstudien in der Schweiz* (Vienna, 1883), while he has described (alone or with the help of others) the chief art monuments in the various Swiss cantons—these notices appeared in the *Anzeiger für schweiz. Alterthumskunde* (Zürich, from 1868), and for the cantons of Soleure, Ticino, Thurgau and Unterwalden, form appendices which are really art monographs. An older and more special work on the same subject is J. D. Blavignac's *Histoire de l'architecture sacrée du iv^{me} au x^{me} siècle dans les anciens évêchés de Genève, Lausanne, et Sion* (Geneva, 1853). There are two general books on the special subject of Swiss castles—Mme de Montmolier's *Les Châteaux suisses* (1816–1823, new ed., later); and F. Küpfer's *Burgen und Schlösser der Schweiz* (n.d.). Many have now special monographs; so *Habsburg* (1896) and *Lenzburg* (1904), both by W. Merz, whose later work *Die mittelälterlichen Burganlagen und Wehrbauten des Kantons Aargau* (2 vols., Aarau, 1906) is a very complete treatise on the most castellated region of the country. For the Bernese castles we have E. L. C. Eden and A. von Fischer's *Die Schlösser d. Kant. Bern* (Bern, about 1898). All the great churches of Switzerland have also been made the subject of monographs—so the Münster in Bern, by B. Haendcke and V. Muller (Bern, 1894); Lausanne, by E. Dupraz (Lausanne, 1906), &c. As to the wooden architecture so characteristic of Switzerland, consult E. G. Gladbach's *Die Holz-Architektur der Schweiz* (2nd ed., Leipzig, 1885—the same author has also issued several series of plates illustrating this subject). Domestic Swiss architecture in general is represented by J. Hunziker's *Das Schweizerhaus* (Aarau), which includes 4 vols. dealing respectively with the Valais (1900), Ticino (1902), the Grisons and Glarus (1905), and the Jura with most of the Suisse Romande (1907). A. Robida's *Les Vieilles villes de Suisse* (Paris, 1879) is a pleasantly written book. The biographies of Swiss artists are conveniently summarized in the *Schweizerisches Künstler-Lexikon* (Frauenfeld, from 1902 onwards), the order followed being alphabetical, while full references to special works, are given in each case. For Swiss glass painting, see H. Meyer's *Die schweizerische Sitte der Fenster- und Wappenschenkung vom xv. bis xvii. Jahrhundert* (Frauenfeld, 1884); and B. Haendcke's *Die schweiz. Malerei im xvi. Jahrhundert unter Berücksichtigung der Glasmalerei, des Formschnittes, und des Kupferstiches* (Aarau, 1893); while Swiss fresco painting is treated of in Konrad Escher's *Untersuchungen zur Geschichte der Wand- und Deckenmalerei in der Schweiz vom ix. bis zum Anfang des xvi. Jahrhunderts* (Strassburg, 1906); while the town shields are depicted in P. Küpfer's *Armorial des villes suisses* (Basel, 1885); and their seals in E. Schulthess's *Die Städte- und Landes-Siegel der Schweiz* (Zürich, 1853). Early Swiss heraldry is historically described in P. Ganz's *Geschichte d. herald. Kunst in der Schweiz im xii. und xiii. Jahrhundert* (Frauenfeld, 1899). The Swiss Renaissance is dealt with by G. Schneeli, *Renaissance in der Schweiz* (Munich, 1896); while J. H. Heer in his *Die schweiz. Malerei des xix. Jahrhunderts* (Leipzig, 1905), has printed his lectures relating to most of the best-known modern Swiss painters. Many splendid series of reproductions in various departments of Swiss art have appeared, two of the most striking being the three series of *Handzeichnungen schweizerischer Meister des xv.–xviii. Jahrhunderts* (Basel, from 1904); and the *Kunstdenkmäler der Schweiz* (2nd series, Geneva, from 1901), to which we may add R. Anheisser's *Altschweizerische Baukunst* (Bern, 1906–1907); R. Hinderer, *Alte schweizer Bauweise* (Frankfort, 1907); and the four series (Bern, 1883–1887) of E. von Rodt's *Kunstgeschichtliche Denkmäler der Schweiz.* The most artistic and accurate reproductions of Swiss costumes are the thirty-six coloured plates, drawn after originals, published by Fr. Julie Heierli (Zürich, 1897, sqq.), under the title of *Die schweizer Trachten vom xvii.–xix. Jahrhundert.*

b. History.—The great collection (officially published in 32 vols., 1858–1905) entitled *Amtliche Sammlung der ältern eidgenössischen Abschiede* contains all the recesses of the Diet, &c., from 1245 to 1848, and is absolutely indispensable. A series of selected extracts from chroniclers, documents, &c., is given in W. Oechsli's *Quellenbuch zur Schweizergeschichte* (2 vols. 2nd ed. of vol. i. 1901, and 1st ed. of vol. ii., Zürich, 1893). The texts (with short introductions) of all the Federal Constitutions from 1798 onwards are conveniently collected in S. Kaiser and J. Strickler's *Geschichte und Texte der Bundesverfassungen der schweiz. Eidgenossenschaft von 1798 bis zur Gegenwart* (Bern, 1901). The texts of the early alliances (1291–1513) are reprinted in J. von Ah's *Die Bundesbriefe der alten Eidgenossen* (Einsiedeln, 1891), while a commentary on all the Federal Constitutions from 1291 (with reprints of certain texts) is furnished by C. Hilty in his *Die Bundesverfassungen der schweiz. Eidgenossenschaft* (Bern, 1891; also in French). For more recent documents and laws see the *Amtliche Sammlung der Bundesgesetze* (from 1849 onwards), which are conveniently arranged and classified by P. Wolf in his *Die schweizerische Bundesgesetzgebung* (2nd ed., 3 vols., Basel, 1905–1908). G. von Wyss's *Geschichte der Historiographie in der Schweiz* (Zürich, 1895) is an admirable guide to the works and lives of all Swiss historians up to about 1850, while all articles (published in Swiss periodicals from 1812 to 1900) relating to the subject are most carefully indexed and classified in J. L. Brandstetter and H. Barth's *Repertorium über die in Zeit- und Sammelschriften enthaltenen Aufsätze und Mitteilungen schweizergeschichtlichen Inhaltes* (2 vols., Basel, 1892 and 1906).

The latest revised texts of the Federal Constitution and (often) of the cantonal constitutions can be procured separately, but the last official collection of all in one volume dates from 1891 (*Recueil des constitutions fédérales et cantonales*), since which time many changes have been made. These can generally be discovered, and much valuable present-day knowledge of Swiss matters gained, in C. Hilty's *Politisches Jahrbuch der schweizer. Eidgenossenschaft* (published at Bern annually since 1886).

The best general recent histories are J. Dierauer, *Geschichte der schweizerischen Eidgenossenschaft* (3 vols., up to 1648, Zürich, 1887–1907 to be continued), which gives in detail the original authorities and the statements of modern writers for every point; W. D. McCrackan, *The Rise of the Swiss Republic* (2nd ed., New York, 1901), and B. van Muyden, *Histoire de la nation suisse* (3 vols., Lausanne, 1896–1899). Some of the older histories (such as those of Daguet and Dändliker) may still be consulted with advantage, while W. Oechsli's

Lehrbuch für den Geschichtsunterricht in der Sekundärschule (Zürich, 1885), is very accurate and handy. Far more popular in style than any yet mentioned are J. Sutz's *Schweizer-Geschichte für das Volk erzählt* (La Chaux de Fonds, 1899), and A. Gobat, *Histoire de la Suisse racontée au peuple* (Neuchâtel, 1900). A very attractive summary (including social and economical history) is given in H. Vulliéty's *La Suisse à travers les âges* (Basel and Geneva, 1901).

J. Heierli's *Urgeschichte der Schweiz* (Zürich, 1901) has superseded all earlier works (such as Heer) on prehistoric Switzerland. The authentic early history of the Confederation (see also TELL, TSCHUDI, and WINKELRIED) is admirably told in W. Oechsli's *Die Anfänge der schweizerischen Eidgenossenschaft* (Zürich, 1891, also in French), as well as in the older work by A. Rilliet, *Les Origines de la confédération suisse* (2nd ed., Geneva and Basel, 1869). For the earlier medieval history (1273–1334) J. E. Kopp's *Geschichte der eidgenössischen Bünde* (5 vols., Leipzig, Lucerne and Basel, 1845–1882) is a perfect storehouse of information, while the medieval political Swiss system in relation to the empire has been very clearly described by W. Oechsli in his article (published in vol. v., 1890, of Hilty's *Politisches Jahrbuch*) "Die Beziehungen der schweiz. Eidgenossenschaft zum Reiche bis zum Schwabenkrieg, 1499," while the same writer's article (published in vol. xiii., 1888, of the *Jahrbuch für schweizerische Geschichte*) "Orte und Zugewandte," gives an admirable account of the relations of many small districts and towns to the Swiss Confederation, as "allies," from the earliest times to 1798. The two following works trace certain phenomena throughout Swiss history —P. Schweizer, *Geschichte der schweizerischen Neutralität* (Frauenfeld, 1895), and J. Schollenberger, *Geschichte der schweizer. Politik* (2 vols., Frauenfeld, 1906 and 1908). As to the more recent history of Switzerland (since 1798) see, besides various articles in Hilty's *Jahrbuch*, C. Hilty, *Öffentliche Vorlesungen über die Helvetik* (Bern, 1878); W. Oechsli, *Geschichte der Schweiz im xix. Jahrhundert* (vol. i., Leipzig, 1903, extends from 1798 to 1813); F. Burckhardt, *Die schweizerische Emigration, 1798–1901* (Basel, 1908); B. van Muyden, *La Suisse sous le pacte de 1815* (2 vols., 1815–1838, Lausanne, 1890–1891); G. H. Dufour, *Der Sonderbunds-Krieg und die Ereignisse von 1856 in Neuenburg* (Basel, 1876; also in French, Paris, 1876); G. Grote, *Seven Letters concerning the Politics of Switzerland* (1847, enlarged ed., London, 1876); T. Curti, *Die schweizerischen Volksrechte, 1848–1900* (Bern, 1900); J. Schollenberger, *Die Schweiz seit 1848* (Berlin, 1908); and the blue-book (London, 1848) entitled *Correspondence Relative to the Affairs of Switzerland*, with the following volumes of memoirs by Swiss statesmen: A. P. Segesser, *Fünf und vierzig Jahre im luzernischen Staatsdienst, 1841–1887* (Bern, 1887); J. C. Kern, *Souvenirs politiques, 1838–1883* (Bern, 1887); and Numa Droz, *Études et portraits politiques* (Geneva, 1895), as well as lives of others. For the history of Switzerland in the 19th century see T. Curti, *Geschichte der Schweiz im xix. Jahrhundert* (Neuchâtel, 1902), and the work entitled *La Suisse au xix^me siècle* (3 vols., Lausanne, 1899–1900; also issued in German).

The following works are very useful for various departments of Swiss history: *Genealogisches Handbuch zur schweizer Geschichte* (in course of publication since 1900 at Zürich); P. Ganz, *Geschichte der heraldischen Kunst in der Schweiz im xii. and xiii. Jahrhundert* (Frauenfeld, 1899); E. Schulthess, *Die Städte- und Landes-Siegel der Schweiz* (Zürich, 1853); P. Küpfer's *Armorial des villes suisses* (120 shields, Basel, 1885); A. Gautier, *Les Armoiries et les couleurs de la confédération et des cantons suisses* (2nd ed., Geneva and Basel, 1879); and L. Tobler's *Schweizerische Volkslieder* (2 vols., Frauenfeld, 1882–1884; many historical ballads, texts with introductions). The best historical atlas is the *Historisch-geographischer Atlas der Schweiz* by J. C. Vögelin, G. Meyer von Knonau and G. von Wyss (new ed., Zürich, 1870), while L. Poirier-Delay and F. Müllhaupt's *Historischer Atlas der Schweiz* (Bern, 1898), and J. S. Gerster's small maps (Zürich, 1886) are also useful. There is a set of small Swiss historical maps in one sheet (No. 25) in Droysen's *Allgemeiner historischer Atlas* (Bielefeld, 1886), and a single general one (No. 44) in R. L. Poole's *Historical Atlas of Modern Europe* (Oxford, 1902).

For the pre-1798 constitution of Switzerland see J. Simler, *De Helvetiae republicâ* (Zürich 1576; also in German and French), and Abraham Stanyan's *An Account of Switzerland* (London, 1714).

The best and most recent works on the existing Swiss constitution of 1874 and its history are the large volume by W. Burckhardt, *Kommentar der schweiz. Bundesverfassung von 1874* (Bern, 1905), and the smaller one by J. Schollenberger, *Bundesverfassung der Schweiz. Eidgenossenschaft. Kommentar mit Einleitung* (Berlin, 1905), while the same author's *Das Bundesstaatsrecht der schweiz. Geschichte und System* (Berlin, 1902) and his *Grundriss der Staats- und Verwaltungsrechts der schweiz. Kantone* (2 vols., Zürich, 1898–1899) are clear, and, especially the last-named, very useful as to cantonal matters. In English there is nothing better than J. M. Vincent's *Government in Switzerland* (New York and London, 1900), for the work by F. O. Adams and C. D. Cunningham is not very satisfactory, though better in its French edition (Basel and Geneva, 1890) than in its original English shape (London, 1889). The decisions of the Swiss Federal Tribunal as to Swiss constitutional law are collected (up to the end of 1902) in L. R. von Salis's *Schweizerisches Bundesrecht* (2nd ed., 5 vols., Bern, 1903–1904), while H. Ryffel's *Die schweizer. Landsgemeinden* (Zürich, 1904) and T. Curti's *Die schweizer. Volksrechte* (Bern, 1900) touch on special sides of the subject. See, too, COMMUNE (Swiss) and REFERENDUM AND INITIATIVE. Many of the older works are still worth consulting, such as those by Snell (1839–1844), Stettler (1847), Ullmer (1862–1866), Pfaff (1870), Bluntschli (2nd ed., 1875), Meyer (1875–1878), Dubs (1878), Orelli (1885), and Blumer (latest ed., vol. i., 1891; vols. ii. and iii., 1880–1887). There are also useful articles in Furrer's and Reichesberg's dictionaries. J. J. Blumer's *Staats- und Rechtsgeschichte der schweiz. Demokratieen* (2 vols., St Gall, 1850–1858) deals collectively with the old democratic cantons—Uri, Schwyz, Unterwalden, Glarus, Zug and Appenzell—and is still very useful for local history; the special works as to the constitutional history of other cantons are mentioned in the articles relating to them. A general theoretical work on federal constitutions in general is L. le Fur's *État Fédéral et Confédération d'états* (Paris, 1896), vol. i. of a new German edition of which (prepared by the author with the help of P. Posener) appeared at Breslau in 1902; this is more up to date than E. A. Freeman's *Federal Government* (new ed. of vol. i., London, 1893), or than J. B. Westerkamp's *Staatenbund und Bundesstaat* (Leipzig, 1900).

There is no really satisfactory general ecclesiastical history of Switzerland before the Reformation, though monographs abound, and much material has been collected in the *Zeitschrift für Schweizerische Kirchengeschichte* (Stans, from 1907). E. E. Gelpke's *Kirchengeschichte der Schweiz* (2 vols., Bern, 1856–1861) is now out of date, and only includes the early portion of the period (it is written from a Protestant standpoint), while vol. ii. of B. Fleischlin's *Studien und Beiträge zur schweizer. Kirchengeschichte* (Lucerne, 1902–1903) includes the period 800 to 1520, but is written from a strong Romanist point of view. As to the early history consult E. Egli's *Die christlichen Inschriften der Schweiz von iv–ix. Jahrhundert* (Zürich, 1895), and his *Kirchengeschichte der Schweiz bis auf Karl den Grossen* (Zürich, 1893); S. Guyer, *Die christlichen Denkmäler des ersten Jahrtausends in der Schweiz* (Leipzig, 1907); A. Lütolf, *Die Glaubensboten der Schweiz vor St Gallus* (Lucerne, 1871); and E. F. Gelpke, *Die christliche Sagengeschichte der Schweiz* (Bern, 1862). As to the medieval saints in Switzerland see E. A. Stückelberg, *Geschichte der Reliquien in der Schweiz* (2 vols., Zürich and Basel, 1902 and 1908), and his *Die schweiz. Heiligen des Mittelalters* (Zürich, 1903), and J. Genoud's *Les Saints de la Suisse française* (new ed., 2 vols., Fribourg, 1897). For the documentary history of some of the medieval Swiss dioceses see *Regesta episcoporum constantiensium*, edited by P. Ladewig and T. Müller (2 vols., from 596 to 1383, as yet published, Innsbruck, 1895 and 1905); M. Besson, *Recherches sur les origines des évêchés de Genève, Lausanne, et Sion* (Fribourg, 1906), and L. Stouff, *Le Pouvoir temporal des évêques de Bâle* (2 vols., Paris, 1891). E. E. von Mülinen's *Helvetia sacra* (2 vols., Bern, 1858 and 1861) gives the succession of the various bishops, abbots, provosts, &c., but requires bringing up to date. For the medieval Swiss monasteries we have *Die Regesten der Archive in der schweiz. Eidgenossenschaft* (edited by T. von Mohr; 2 vols., Coire, 1851–1854), though it refers only to a few monasteries, for which it is indispensable, while Arnold Nüscheler's *Die Gotteshäuser der Schweiz* (3 pts., Zürich, 1864–1873, continued by the author and others in the *Geschichtsfreund* and *Argovia*, complete index issued as an appendix to the *Anzeiger für schweizerische Geschichte*, 1900) is most valuable and useful. Some of the great monasteries have histories of their own, such as Einsiedeln (*q.v.*), Engelberg (*q.v.*), and Muri, the last by Pater M. Kiem, *Geschichte der Benedictiner-Abtei Muri* (2 vols., Stans, 1888 and 1891). Two monographs may be mentioned: R. G. Bindschedler, *Kirchliches Asylrecht und Freistätten in der Schweiz* (Stuttgart, 1906), and Augusta Steinberg, *Studien zur Geschichte der Juden in der Schweiz während des Mittelalters* (Zürich, 1903). For the Reformation and later times consult (on the Protestant side), besides biographies, &c., of Calvin and Zwingli (*qq. v.*), E. Bloesch, *Geschichte der schweizerisch-reformierten Kirchen* (2 vols., Bern, 1898–1899); and W. Hadorn, *Geschichte des Pietismus in der schweiz. reform. Kirchen* (Constance, 1901), and the same author's *Kirchengeschichte der reformierten Schweiz* (since 1906). F. Meyer's work, *Die evangelische Gemeinde in Locarno* (2 vols., Zürich, 1836), treats of an important event of that period. The Romanist standpoint is presented in vols. iii. and iv. (1904 sqq.) of Fleischlin's work mentioned above, and also in J. G. Mayer's *Das Conzil von Trient und die Gegenreformation in der Schweiz* (2 vols., Stans, 1901 and 1903).

For more modern days the best book, especially from the constitutional side, is C. Gareis and P. Zorn, *Staat und Kirche in der Schweiz* (2 vols., Zürich, 1877–1878), which tells the story down to the date of publication. Special subjects are treated of in M. Kothing, *Die Bisthumsverhandlungen der schweizerisch-konstanzischen Diözesanstände von 1803–1862* (Schwyz, 1863); F. Troxler, *Der Kulturkampf von 1863–1888* (Bienne, 1889); Ch. Woeste, *Histoire du Culturkampf en Suisse, 1871–1886* (Brussels, 1887, Romanist work); and P. Gschwind, *Geschichte der Entstehung der christkatholischen Kirche der Schweiz* (vol. i. appeared at Basel in 1904). The work by A. Büchi entitled *Die katholische Kirche in der Schweiz* (Munich, 1902) gives a full and authorized account of the present state of the Roman Catholic Church in Switzerland.

c. Literature.—For the Swiss medieval Minnesingers see Karl Bartsch, *Die schweizer Minnesänger* (Frauenfeld, 1887, texts, with introductions); and for popular ballads, historical or not, L. Tobler, *Schweizerische Volkslieder* (2 vols., Frauenfeld, 1882–1884, texts, with notes and introductions). In general consult J. Bächtold, *Geschichte der deutschen Literatur in der Schweiz* (Frauenfeld, 1892); E. H. Gaullieur, *Études sur l'histoire littéraire de la Suisse française, particulièrement dans la seconde moitié du xviii^me siècle* (Paris, 1856); P. Godet, *Histoire littéraire de la Suisse romande* (2nd ed., Neuchâtel and Paris, 1895); H. E. Jenny, *Die Alpendichtung der deutschen Schweiz* (Bern, 1905); J. C. Mörikofer, *Die schweizerische Literatur des xviii. Jahrhunderts* (Leipzig, 1861); F. Rausch, *Geschichte der Literatur des rhäto-romanischen Volkes* (Frankfort-on-the-Main, 1870); Virgile Rossel, *Histoire littéraire de la Suisse romande* (2 vols., Geneva and Paris, 1889–1891); R. Weber, *Die poetische Nationalliteratur der deutschen Schweiz* (3 vols., Glarus, 1866–1867). For the more recent Swiss writers see the literary sections of the work entitled *La Suisse au xix^me siècle*, vol. ii. ch. 4 (Lausanne, 1889–1900), and the biographers of the several writers noted under the separate articles. (W. A. B. C.)

SWOLD (or Swöld), **BATTLE OF,** the most famous of the sea-fights of the ancient Norsemen. It took place on the 9th of September 1000. The place cannot now be identified, as the formation of the Baltic coast has been much modified in the course of subsequent centuries, partly by the gradual silting up of the sea, and partly by the storms of the 14th century. Swold was an island probably on the North German coast, near Rügen. The battle was fought between Olaf Trygvesson, king of Norway, and a coalition of his enemies—Eric Hakonson, his cousin and rival; Olaf, the king of Sweden; and Sweyn Forkbeard, king of Denmark. The poets, and the poetically minded authors of the sagas, who are the only authorities, have told the story with many circumstances of romance. But when the picturesque details, which also have no doubt at least a foundation of truth, are taken at their true value, the account of the battle still presents a very trustworthy picture of the sea-fighting of the Norsemen. Olaf had been during the summer in the eastern Baltic. The allies lay in wait for him at the island of Swold on his way home. The Norse king had with him seventy-one vessels, but part of them belonged to an associate, Sigwald, a chief of the Jomsburg vikings, who was an agent of his enemies, and who deserted him. Olaf's own ships went past the anchorage of Eric Hakonson and his allies in a long column without order, as no attack was expected. The king was in the rear of the whole of his best vessels. The allies allowed the bulk of the Norse ships to pass, and then stood out to attack Olaf. He might have run past them by the use of sail and oar to escape, but with the true spirit of a Norse warrior he refused to flee, and turned to give battle with the eleven ships immediately about him. The disposition adopted was one which is found recurring in many sea-fights of the middle ages where a fleet had to fight on the defensive. Olaf lashed his ships side to side, his own—the "Long Serpent," the finest war-vessel as yet built in the north—being in the middle of the line, where her bows projected beyond the others. The advantage of this arrangement was that it left all hands free to fight, a barrier could be formed with the oars and yards, and the enemy's chance of making use of his superior numbers to attack on both sides would be, as far as possible, limited—a great point when all fighting was with the sword, or with such feeble missile weapons as bows and javelins. The Norse long ships were high in the bulwark—or, as the Greeks would have said, "cataphract." Olaf, in fact, turned his eleven ships into a floating fort. The Norse writers, who are the only authorities, gave all the credit to their own countrymen, and according to them all the intelligence of Olaf's enemies, and most of their valour, were to be found in Eric Hakonson. They say that the Danes and Swedes rushed at the front of Olaf's line without success. Eric Hakonson attacked the flank. His vessel, the "Iron Ram," was "bearded," that is to say, strengthened across the bows by bands of iron, and he forced her between the last and last but one of Olaf's line. In this way the Norse ships were carried one by one, till the "Long Serpent" alone was left. At last she too was overpowered. Olaf leapt into the sea holding his shield edgeways, so that he sank at once and the weight of his hauberk dragged him down. A legend of later days has it that at the last moment a sudden blaze of light surrounded the king, and when it cleared away he had disappeared. King Olaf is one of the same company as Charlemagne, King Arthur and Sebastian of Portugal—the legendary heroic figures in whose death the people would not believe, and whose return was looked for.

See the *Heims-Kringla*, in the Saga Library, trans. by W. Morris and E. Magmússon (1893) and the *Saga of King Olaf Tryggwason*, trans. by J. Sephton (1895). (D. H.)

SWORD (O. Eng. *sweord*; ultimately from an Indo-European root meaning to wound), a general term for a hand weapon of metal, characterized by a longish blade, and thus distinct from all missile weapons on the one hand, and on the other hand from staff weapons—the pike, bill, halberd and the like—in which the metal head or blade occupies only a fraction of the effective length. The handle of a sword provides a grip for the hand that wields it, or sometimes for two hands; it may add protection, and in most patterns does so to a greater or less extent. Still it is altogether subordinate to the blade. For want of a metal-headed lance or axe, which indeed were of later invention, a sharpened pole or a thin-edged paddle will serve the turn. But a sword-handle without a blade is naught; and no true sword-blade can be made save of metal capable of taking an edge or point.

1. *Historical.*—There are so-called swords of wood and even stone to be found in collections of savage weapons. But these are really flattened clubs; and the present writer agrees with the late General Pitt-Rivers in not believing that such modifications of the club have had any appreciable influence on the form or use of true swords. On this last point, however, the opinions of competent archaeologists have been much divided. We will only remark that the occurrence in objects of human handiwork of a form, or even a series of forms, intermediate between two types is not conclusive evidence that those forms are historical links between the different types, or that there is any historical connexion at all. In the absence of dates fixed by external evidence this kind of comparison will seldom take us beyond plausible conjecture. A traveller who had never seen velocipedes might naturally suppose, on a first inspection, that the tricycle was a modification of the old four-wheeled velocipede, and the bicycle a still later invention; but we know that in fact the order of development was quite different.

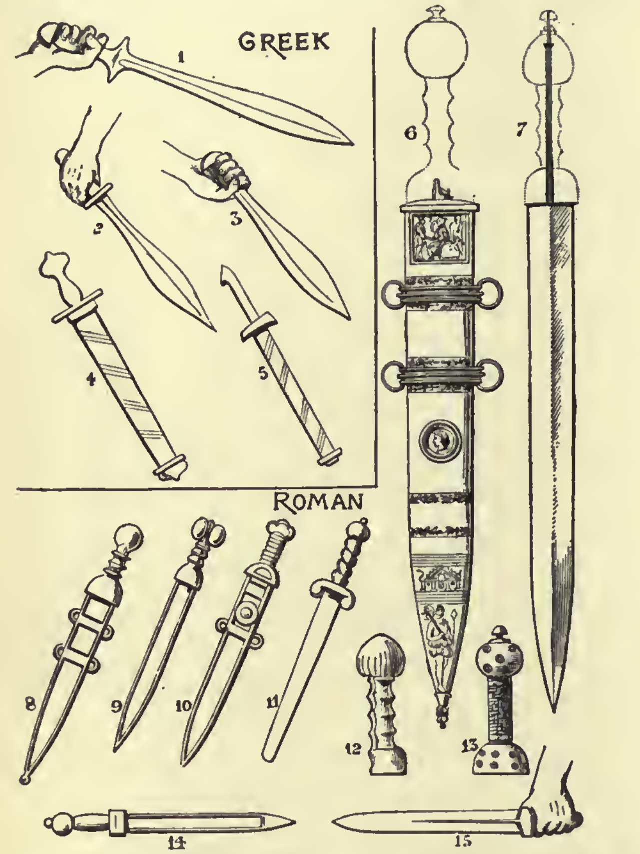
Origins and Early Forms.

It is more difficult as a matter of verbal definition to distinguish the sword from smaller hand weapons. Thus an ordinary sword is four or five times as long as an ordinary dagger: but there are long daggers and short swords; neither will the form of blade or handle afford any certain test. The real difference lies in the intended use of the weapon; we associate the sword with open combat, the dagger with a secret attack or the sudden defence opposed to it. One might say that a weapon too large to be concealed about the person cannot be called a dagger. Again, there are large knives, such as those used by the Afridis and Afghans, which can be distinguished from swords only by the greater breadth of the blade as compared with its length. Again, there are special types of arms, of which the yataghan is a good example, which in their usual forms do not look much like swords, but in others that occur must be classed as varieties of the sword, unless we keep them separate by a more or less artificial theory, referring the type as a whole to a different origin.

Of the actual origin of swords we have no direct evidence. Neither does the English word nor, so far as we are aware, any of the equivalent words in other languages, Aryan or otherwise, throw any light on the matter. Daggers shaped from reindeer antlers occur among the earliest relics of man, and there are flint daggers of the Neolithic period, which may be supposed to have been the model for the first hand weapons made of copper. Bronze took the place of copper about 2000 B.C., and the transition from bronze to iron is assigned to the period from 1000 to 700 B.C.[1] Whatever may be the further discoveries of archaeologists, we know that swords are found from the earliest

[1] As to the overlapping of the bronze and iron ages in the Homeric poems, see Burrows, *The Discoveries in Crete* (1907), p. 214. As to Britain, O. Montelius in *Archaeologia*, 61, pp. 155–6; Cowper, *Art of Attack*, 124 sqq. (Ulverston, 1906).

times of which we have any record among all people who have acquired any skill in metal-work. There are two very ancient types, which we may call the straight-edged and the leaf-shaped. Assyrian monuments represent a straight and narrow sword, better fitted for thrusting than cutting. Bronze swords of this form have been found in many parts of Europe, at Mycenae, side by side with leaf-shaped specimens, and more lately in Crete.[1] We have also from Mycenae some very curious and elaborately wrought blades, so broad and short that they must be called ornamental daggers rather than swords. The leaf-shaped blade is common everywhere among the remains of men in the "Bronze Period" of civilization, and this was the shape used by the Greeks in historical times, and is the shape familiar to us in Greek works of art. It is impossible, however, to say whether the Homeric heroes were conceived by the poet as wearing the leaf-shaped sword, as we see it, for example, on the Mausoleum sculptures, or a narrow straight-edged blade of the Minoan and Mycenaean pattern. In any case, the sword holds a quite inferior position with Greek warriors of all times.



(1–5, from Gerhard's *Griechische Vasenbilder*; 6–15, from Lindenschmit, *Tracht und Bewaffnung des römischen Heeres während der Kaiserzeit*, Brunswick, 1882.)

FIG. 1.

1–5, Greek Swords of the classical type; 6–15 Roman Swords.

6, So-called "sword of Tiberius" from Mainz (Brit. Mus.).
7, Bonn (private collection), length 765 mm.
8, Legionary (monument at Wiesbaden).
9, Cavalry (monument at Mainz).
10, Cavalry (monument at Worms).
12, 13, Sword handles (Kiel and Mainz).
11, 14, 15, From Trajan's column.

The relation of the Minoan long sword to the Greek leaf-shaped blade is obscure. It is conceivable that the leaf-shape was modified from a longer straight blade for the sake of handiness and cutting power, but not less so that the leaf-shape was independently produced by imitation in metal of flint daggers. Independence appears, on the whole, slightly more probable; the existence of specimens which might belong to an intermediate type is only an ambiguous fact without a more exact chronology than we have as yet, as it may be due to experiment or imitation after both types were in use. Strange as it is to a modern swordsman, representations in Minoan art seem to show that not only the bronze daggers but the long swords were used with an overhand stabbing action like a modern Asiatic dagger.[2] The handles are too short for any but a rigid grip without finger-play. Before about 1500 B.C. the rapier type was the prevailing one; but there is no evidence of historical connexion between the Assyrian and the Minoan rapiers. It is thought that the leaf-shaped blade came to the Mediterranean countries from the north. So far as we know from works of art, it was mostly used with a downright cutting blow, regardless of the consequent exposure of the swordsman's body; this, however, matters little when defence is left to a shield or armour, or both. Attic vases also show warriors giving point, though less often. The use of the sword as a weapon of combined offence and defence—swordsmanship as we now understand it—is quite modern. If the sword was developed from a spearhead or dagger, it would naturally have been (and it seems in fact to have been) a thrusting weapon before it was a cutting one. But when we come to historical times we find that uncivilized people use only the edge, and that the effective use of the point is a mark of advanced skill and superior civilization. The Romans paid special attention to it, and Tacitus tells us how Agricola's legionaries made short work of the clumsy and pointless arms of the Britons when battle was fairly joined.[3] The tradition was preserved at least as late as the time of Vegetius, who, as a technical writer, gives details of the Roman soldier's sword exercise. Asiatics to this day treat the sword merely as a cutting weapon, and most Asiatic swords cannot be handled in any other way.

Historical Types.

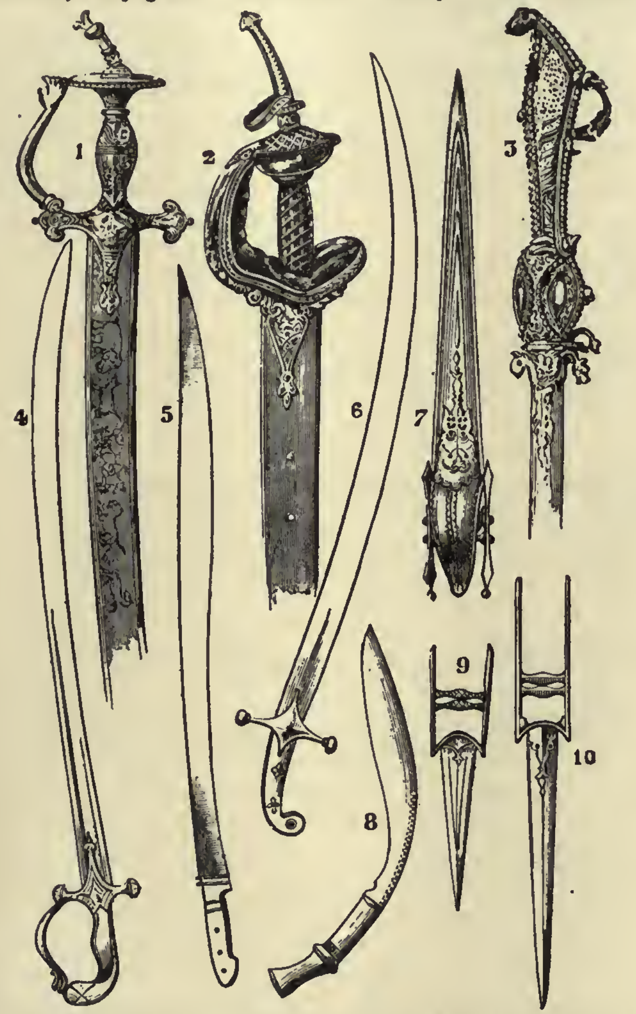
The normal types of swords which we meet with in historical times, and from which all forms now in use among civilized nations are derived, may be broadly classified as straight-edged or curved. In the straight-edged type, in itself a very ancient one, either thrusting or cutting qualities may predominate, and the blade may be double-edged or single-edged. The double-edged form was prevalent in Europe down to the 17th century. The single-edged blade, or back-sword as it was called in England, is well exemplified among the Scottish weapons commonly but improperly known as claymores (the real claymore, *i.e.* great sword, *claidheamh mór*, is an earlier medieval form), and is now all but exclusively employed for military weapons. But these, with few exceptions, have been more or less influenced by the curved Oriental sabre. Among early double-edged swords the Roman pattern (*gladius*, the thrusting sword, contrasted with the barbarian *ensis*) stands out as a workmanlike and formidable weapon for close fight. In the middle ages the Roman tradition disappeared, and a new start was made from the clumsy barbarian arm which the Romans had despised. Gradually the broad and all but pointless blade was lightened and tapered, and the thrust, although its real power was unknown, was more or less practised from the 12th century onwards. St Louis anticipated Napoleon in calling on his men to use the point; and the heroes of dismounted combats in the *Morte d'Arthur* are described as "foining" at one another. In the first half of the 16th century a well-proportioned and well-mounted cut-and-thrust sword was in general use, and great artistic ingenuity was expended, for those who could afford it, on the mounting and adornment. The growth and variations of the different parts of the hilt, curiously resembling those of a living species, would alone be matter enough for an archaeological study. One peculiar form, that of the Scottish basket-hilt, derived from the Venetian pattern known as *schiavone*, has persisted without material change.

[1] The Cretan finds are fully described by Arthur J. Evans, "The Prehistoric Tombs of Knossos," (*Archaeologia* (1905), 59, pt. 2; also separately published (1906). There are long (91–95 cm., 34·1 in.–37·1 in.) and short (50–61 cm., 20–24·2 in.), swords, daggers and bronze knives. A fine original specimen and several facsimiles (Mycenaean as well as Minoan) may be seen in the Ashmolean Museum at Oxford. Bronze daggers preceded both swords and spear-heads (Greenwell and Brewis, in *Archaeologia*, 61, pp. 443, 453).

[2] As the spear still was in historical times (Furtwängler-Reichhold, *Gr. Vasenmalerei*, iii. 122).

[3] *Agric.* 36: "Britannorum gladii sine mucrone complexum armorum et in aperto pugnam non tolerabant." The short Roman infantry sword, however, dates only from the Second Punic War.

Quite different from the European models is the crescent-shaped Asiatic sabre, commonly called scimitar. We are not acquainted with any distinct evidence as to the origin of this in time or place. Dr R. Forrer thinks the whole family of curved swords was developed from bronze knives. The Frankish *scramasax* would then represent an intermediate type. However that may be, the fame of the Damascus manufacture of sword-blades is of great antiquity, as is also that of Khorāsān, still the centre of the best Eastern work of this kind. Whoever first made these blades had conceived a very definite idea—that of gaining a maximum of cutting power regardless of loss in other qualities—and executed it in a manner not to be improved upon. The action of the curved edge in delivering a blow is to present an oblique and therefore highly acute-angled section of the blade to the object struck, so that in effect the cut is given with a finer edge than could safely be put on the blade in its direct transverse section. In a well-made sabre the setting of the blade with regard to the handle ("leading forward") is likewise ordered with a view to this result. And the cutting power of a weapon so shaped and mounted is undoubtedly very great. But the use of the point is abandoned,



(Reproduced by permission from Egerton's *Illustrated Handbook of Indian Arms*, published by the India Office, 1880, new ed. *s.t. Indian and Oriental Armour*, 1896.)

FIG. 2.—Oriental Swords.

1, 2, Decorated Persian arms.
3, Gauntlet sword.
4, Common type of talwar (North-West Provinces).
5, Yataghan type.
6, Persian talwar.
8, Kukri (Nepal).
7, 9, 10, Mahratta, showing transition to gauntlet sword.

and the capacities of defensive use (to which Orientals pay little or no attention) much diminished. These drawbacks have caused the scimitar type, after being in fashion for European light cavalry during the period of Napoleon's wars and somewhat longer, to be discarded in our own time. But, as long as Easterns adhere to their rigid grasp of a small handle and sweeping cut delivered from the shoulder, the Persian scimitar or Indian talwar will remain the natural weapon of the eastern horseman. Indian and Persian swords are often richly adorned; but their appropriate beauty is in the texture of the steel itself, the "damascening" or "watering" which distinguishes a superior from a common specimen.

There are special Asiatic varieties of curved blades of which the origin is more or less uncertain. Among these the most remarkable is perhaps the yataghan, a weapon pretty much coextensive with the Mahommedan world, though it is reported to be not common in Persia. It was imported from Africa, through a French imitation, as the model of the sword-bayonets which were common for about a generation in European armies; probably the French authorities caught at it to satisfy the sentiment, which lingered in continental armies long after it had disappeared in England, that even the infantry soldier after the invention of the bayonet must have some kind of sword. A compact and formidable hand weapon was thus turned into a clumsy and top-heavy pike. If we try to make a bayonet that will cut cabbages, we may or may not get a useful chopper, but we shall certainly get a very bad bayonet. The modern short sword-bayonet is a reversion to the original dagger type, and not open to this objection. The double curve of the yataghan is substantially identical with that of the Gurkha knife (*kukri*), though the latter is so much broader as to be more like a woodman's than a soldier's instrument. It is doubtful, however, whether there is any historical connexion. Similar needs are often capable of giving rise to similar inventions without imitation or communication. There are yet other varieties, belonging to widely spread families of weapons, which have acquired a strong individuality. Such are the swords of Japan, which are the highly perfected working out of a general Indo-Chinese type; they are powerful weapons and often beautifully made, but a European swordsman would find them ill-balanced, and the Japanese style of sword-play, being two-handed, has little to teach us.

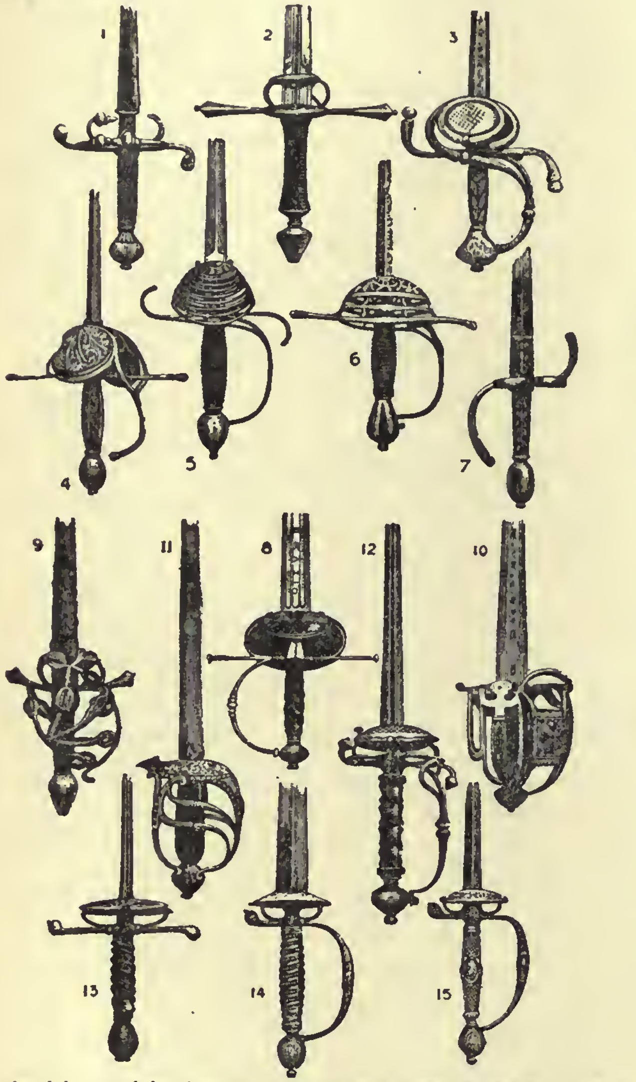
Other sorts of weapons, again, are so peculiar in form or historical derivation, or both, as to refuse to be referred to any of the normal divisions. The long straight gauntlet-hilted sword (*paṭā*, fig. 3) found both among the Mahrattas in the south of India and among the Sikhs and Rajputs in the north, is an elongated form of the broad-bladed dagger with a cross-bar handle (*kaṭār*, figs. 9, 10), as is shown by a transitional form, much resembling in shape and size of blade the medieval English anlace, and furnished with a guard for the back of the hand. This last-mentioned pattern seems, however, to be limited to a comparatively small region. When once the combination of a long blade with the gauntlet hilt was arrived at, any straight blade might be so mounted; and many appear on examination to be of European workmanship—German, Spanish or Italian. There are various other Oriental arms, notably in the Malay group, as to which it is not easy to say whether they are properly swords or not. The Malay "parang latok" is a kind of elongated chopper sharpened by being bevelled off to an edge on one side, and thus capable of cutting only in one direction. The anlace incidentally mentioned above seems to be merely an overgrown dagger; the name occurs only in English and Welsh; in which language first, or whence the name or thing came, is unknown.

Later European Developments.

In the course of the 16th century the straight two-edged sword of all work was lengthened, narrowed, and more finely pointed, till it became the Italian and Spanish rapier, a weapon still furnished with cutting edges, but used chiefly for thrusting. We cannot say how far this transition was influenced by the *estoc* or *Panzerstecher*,[1] a late medieval thrusting weapon carried by horsemen rather as an auxiliary lance than as a sword. The Roman preference of the point was rediscovered under new conditions, and fencing became an art. Its progress was from pedantic complication to lucidity and simplicity, and the fashion of the weapon was

[1] Probably this was the kind of sword called *Broch* in 14th-century English (*Eyre of Kent*, Selden Soc., 1910, p. 100).

simplified also. Early in the 18th century, the use of the edge having been finally abandoned in rapier-play, the two-edged blade was supplanted by the bayonet-shaped French duelling sword, on which no improvement has since been made except in giving it a still simpler guard. The name of rapier was often but wrongly given to this by English writers. About the same time, or a little earlier, the primacy of the art passed from Italy to France. There is still a distinct Italian school, but the rest of the world learns from French masters. It is unnecessary here to consider the history of fencing (*q.v.*); Mr Egerton Castle's book on the subject will be found a trustworthy guide, and almost indispensable for those who wish really to understand the passages relating to sword-play in our Elizabethan literature, of which the fencing scene in *Hamlet* is the most famous and obvious example.



(Reproduced by permission from Mr Egerton Castle's *Schools and Masters of Fence.*)

FIG. 3.—Typical European Swords, 16th–18th centuries.

1, Early 16th century.
2, German, *c.* 1550.
3, Italian rapier, third quarter 16th century.
4, Spanish rapier, late 16th century.
5, Italian, same period.
6, English, same period.
7, English musketeer's sword, early 17th century.
8, Spanish broadsword, early 17th century.
9, Venetian, *c.* 1550.
10, Italian, late 16th century.
11, English, time of Commonwealth.
12, French rapier, *c.* 1650.
13, German flamberg, early 17th century.
14, 15, Small-swords, 1700–1750.

Meanwhile a stouter and broader pattern, with sundry minor varieties, continued in use for military purposes, and gradually the single-edged form or broadsword prevailed. The well-known name of Ferrara, peculiarly associated with Scottish blades, appears to have originally belonged to a Venetian maker, or family of makers, towards the end of the 16th century. The Spanish blades made at Toledo had by that time acquired a renown which still continues. Somewhat later Oriental examples, imported probably by way of Hungary, induced the curvature found in most recent military sabres, which, however, is now kept within such bounds as not to interfere with the effective use of the point. An eccentric specialized variety—we may call it a "sport"—of the sabre is the narrow and flexible "Schläger" with which German students fight their duels (for the most part not arising out of any quarrel, but set trials of skill), under highly conventional rules almost identical with those of the old English "backswording" practised within living memory, in which, however, the swords were represented by sticks. These "Schläger" duels cause much effusion of blood, but not often serious danger to life or limb.

There are plenty of modern books on sabre-play, but comparatively little attention has been given to its scientific treatment. It is said that the Italian school is better than the French, and the modern German and Austrian the best of all. Some of the English cavalry regiments have good traditions, enriched by the application of a knowledge of fencing derived from eminent French masters.

Manufacture of Swords by Hand-work.

The following description, written for the 9th edition of this work from personal inspection, applies to the process used by the best private makers till near the end of the 19th century, and is purposely left unchanged. The present method of making army swords is separately described below. Mechanical invention has not been able to supersede or equal hand-work in the production of good sword-blades. The swordsmith's craft is still, no less than it was in the middle ages, essentially a handicraft, and it requires a high order of skill. His rough material is a bar of cast and hammered steel tapering from the centre to the ends; when this is cut in two each half is made into a sword. The "tang" which fits into the handle is not part of the blade, but a piece of wrought iron welded on to its base. From this first stage to the finishing of the point it is all hammer and anvil work. Special tools are used to form grooves in the blade according to the regulation or other pattern desired, but the shape and weight of the blade are fixed wholly by the skilled hand and eye of the smith. [Machine forging in the early stages is now common, and there is no difficulty in making the blade and tang of the same metal.] Measuring tools are at hand, but are little used. Great care is necessary to avoid overheating the metal, which would produce a brittle crystalline grain, and to keep the surface free from oxide, which would be injurious if hammered in. In tempering the blade the workman judges of the proper heat by the colour. Water is preferred to oil by the best makers, notwithstanding that tempering in oil is much easier. With oil there is not the same risk of the blade coming out distorted and having to be forged straight again (a risk, however, which the expert swordsmith can generally avoid); but the steel is only surface-hardened, and the blade therefore remains liable to bend. [This is disputed.] Machinery comes into play only for grinding and polishing, and to some extent in the manufacture of hilts and appurtenances. The finished blade is proved by being caused to strike a violent blow on a solid block with the two sides flat, with the edge, and lastly with the back; after this the blade is bent flatwise in both directions by hand, and finally the point is driven through a steel plate about an eighth of an inch thick. In spite of all the care that can be used both in choice of material and in workmanship, about 40% of the blades thus tried [now only about 10%] fail to stand the proof, and are rejected. The process we have briefly described is that of making a really good sword; of course, plenty of cheaper and commoner weapons are in the market, but they are hardly fit to trust a man's life to. It is an interesting fact that the peculiar skill of the swordsmith is in England so far hereditary that it can be traced back in the same families for several generations.

The best Eastern blades are justly celebrated, but they are not better than the best European ones; in fact, European swords are often met with in Asiatic hands, remounted in Eastern fashion.

The "damascening" or "watering" of choice Persian and Indian arms is not a secret of workmanship, but is due to the peculiar manner of making the Indian steel itself, in which a crystallizing process is set up; when metal of this texture is forged out, the result is a more or less regular wavy pattern running through it. There were early medieval damascened (in German called *wurmbunte*) blades. No difference is made by this in the practical qualities of the blade. (F. Po.)

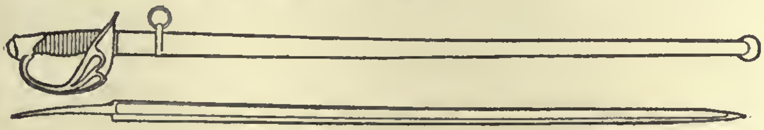


FIG. 4.

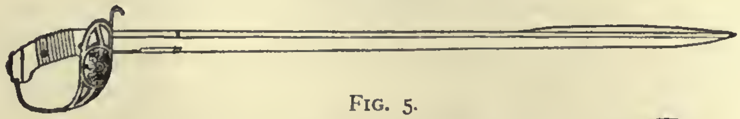


FIG. 5.

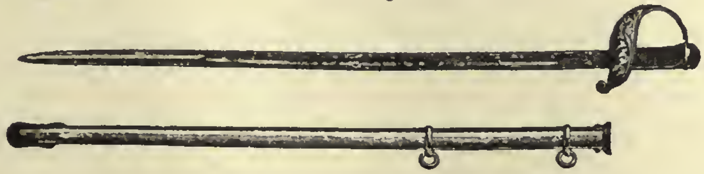


FIG. 6.

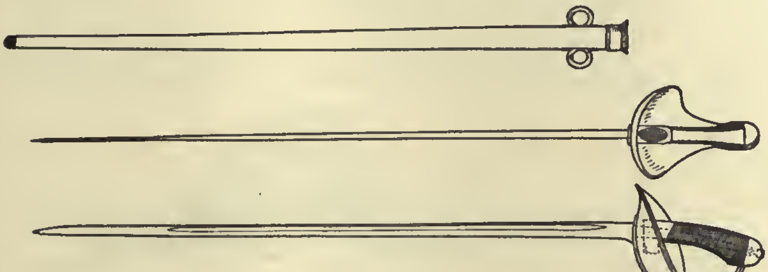


FIG. 7.

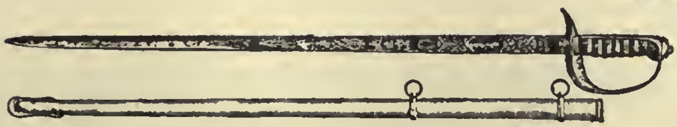


FIG. 8.

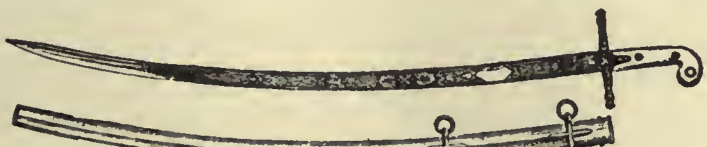


FIG. 9.

(FIGS. 6, 8, 9, Messrs Wilkins & Co. FIG. 7, H.M. War Office.)

Fig.		Length of Blade from hilt to point.	Weight without Scabbard.	Material of Scabbard.
		Inches.	lb. oz.	
4	French cavalry sword (men), pattern 1898	35	2 6	
5	German cavalry sword (men), pattern 1889	$32\frac{1}{2}$	2 $8\frac{1}{2}$	
6	British cavalry sword (officers)	35	2 0	Steel with wood lining.
7	British cavalry sword (men), pattern 1908 (two sizes) .	$35\frac{1}{8}$ & $34\frac{7}{8}$	2 $13\frac{1}{2}$ & 2 $15\frac{1}{2}$	
8	British infantry sword (officers)	$32\frac{1}{2}$	2 3	
9	British general officer's sword .	$32\frac{1}{2}$	1 12	

2. *Modern Military Swords.*—The present military swords are descended from the straight "back-sword" and the Eastern scimitar or talwar. The difference between the curved "sabre" and straight "sword" has been preserved abroad, not only in fact but in name (*e.g.* in German, *Degen* stands for the straight, and *Säbel* for the curved, sword), though in English the single word "sword" covers both varieties. The shape of the sword has varied considerably at different times; this is due to the fact that it is practically impossible to decide by trial whether a straight or a curved sword is the better under all circumstances. The trooper can use his sword in three different ways—to cut, to guard and to point; and his success depends upon the training of his horse, his skill in horsemanship, and, above all, upon the dexterity and methods of his adversary. Thus the effect the cavalryman can produce in combat depends upon much besides his arm or arms, and those other conditions cannot be reproduced accurately enough to make trustworthy tests. The result is that changes have often been made in cavalry armament under the erroneous impression that the arm used has been the main cause of success. The Ottoman cavalry up to the end of the 18th century was regarded as one of the best in Europe, and so much was it dreaded that the Austrians and Russians in their wars with Turkey at that time often carried "chevaux-de-frise" to protect their infantry against these redoubtable horsemen. The curved European cavalry sabre so long in use may undoubtedly be traced to this cause, the superiority of the Turks being put down to their curved scimitars, though there can be no doubt that horsemanship and dash were really the dominating factors.

The shape of the sword to be chosen depends obviously on the purpose for which it is mainly intended. If for cutting a curved blade, and for thrusting a straight and pointed one, will be adopted. The question naturally arises as to which is the better plan to adopt, and it is improbable that a definite answer can ever be given to it. The French, for instance, in 1822 adopted a curved blade for a short time for all their cavalry, and in 1882 again for a short time a straight blade, and in 1898 again a straight blade. In this much-debated matter the facts appear to be as follows: A determined thrust, especially when delivered by a horseman at full speed, is difficult to parry: if it gets home, it will probably kill the recipient outright or disable him for the rest of the campaign. That this is the case is borne out by the very large proportion of killed as compared with wounded in the British cavalry when engaged with that of the French in the Peninsular War, the French making much use of the point, and their heavy cavalry being armed with a long straight sword. On the other hand, to deliver a bold thrust, while disregarding the uplifted sword of the adversary, and leaving one's own body and head open to an impending blow, demands complete confidence that the thrust will get home before the blow can descend, or that the adversary's cut will probably be weakened by a momentary uncertainty as to whether it would not be better to convert the intended cut into a parry. Such confidence, it is argued with much truth, can only be the fruit of long training, especially as it is the natural tendency of all men to cut when excited; therefore, as the trooper in modern armies will often be a reservist who has not been able to keep up his swordsmanship, or a young soldier liable to lose his head and forget the lessons of peace in the excitement of the *mêlée*, it is considered by many most unwise to adopt a sword with which a powerful cut cannot be delivered as well as an effective thrust. The swords recently adopted by most nations have represented a compromise. They have blades which are nearly straight, but of sufficient weight towards their points to enable an efficient cut to be delivered with them. France, however, in 1898 decided on a long straight sword designed wholly for thrusting (see fig. 1), practically identical with that which was in use about a century ago. The following year Great Britain introduced a slightly curved weapon, but in 1908 a new sword was adopted which has a long straight blade and is intended to be used chiefly for thrusting.

As regards the swords worn by officers and men of corps other than cavalry, no remarks are necessary. As long as they are worn they should be efficient; but with the officer the sword is largely a badge of rank. From 1901 to 1908 the sword was worn only for ceremonial purposes by British infantry officers, but in the latter year it was again ordered to be worn on active service and at manœuvres. Mounted men in general wear cavalry swords, and swords are also worn by warrant officers and by certain staff-sergeants of dismounted arms and branches.

A good sword should be elastic, so as to stand bending or a heavy blow without breaking or permanent deformation, and yet stiff enough to deliver a powerful thrust without yielding too readily from the straight; it must also be as light as is possible consistently with strength, and well balanced. All four desiderata are met in the main by the use of a suitable steel, properly treated and disposed, but balance is also dependent on the weight and form of the hilt. As regards the effect of disposition, grooving or "fullering" the flats of the blade reduces weight without impairing strength, and is now very largely adopted.

The operations of manufacture, as carried out at the Royal Small Arms Factory at Enfield, may be described briefly as follows, the weapon being the pattern 1899 cavalry sword, which was slightly curved:—

The steel blank, about $17'' \times 1\frac{1}{4}'' \times \frac{1}{2}''$, is heated and drawn out to about double its length under a mechanical hammer; it is then reheated and rolled out between rolls suitably shaped, and the fullers formed; the tang (to which the hilt and grips are ultimately attached) is then formed by stamping under a machine hammer, and the blade is cut to length and roughly pointed. The blade, though approximately in its finished form, is now straight; the fins are ground off, the tang annealed, the blade set for grinding, and afterwards rough-ground. It is heated and set to curve in a press, then reheated and hardened by being plunged into a bath of oil kept cool by a water jet. On removal from the bath the blade is dead hard and so brittle that it can be broken by a slight blow, and consequently has to be let down by tempering. This is accomplished by heating in a bath of molten lead until the steel assumes a particular colour, at which stage, while hot, the blade is adjusted for straightness and curve, this being a delicate operation, as it must be performed while the blade retains its temper and heat before finally cooling. It is now ground to size, and the tang, which, though not hardened purposely, is harder than is desired for machining, is softened by cooling, and machined to the required form. The blade is then ground, reheated to spring temper and set, then tested as follows: When tempered and set before polishing it is fixed in a machine and caused to strike an oak block with a blow of 120 lb with both its edge and back, and with similar blows, but with a force of 60 lb, with both flats. These tests detect flaws, and over or under tempering, by the breakage or distortion of the blade, the blows by the flat being particularly searching tests. If the blade passes the above tests, it is then placed vertically in a machine and shortened 5 in. by bending towards each flat, and must recover perfect straightness; it is then shortened 1 in., and must recover itself when supporting a weight of 35 lb bearing on its tang. This tests the elasticity of the blade. After polishing it is again tested for stiffness as above, and must recover perfect straightness, but only under 32 lb, and for elasticity by a further shortening of 5 in., but towards one flat only.

The introduction of the system described above has greatly simplified and cheapened the process of manufacture, while the greater excellence of the product and the severe and certain tests applied to it by mechanical means have increased the standard of efficiency of the swords in the hands of the troops. It is certainly true that, of old, excellent blades were occasionally turned out by hand, but they were exceedingly costly, and the average merit of sword-blades when turned out in numbers by hand was poor. It must not, however, be supposed that the regular methods described have eliminated the necessity for personal skill. The steel can still be spoilt by over- or under-heating, whether for rolling or hardening; tempering and setting require much experience and skill, and blades can be easily injured both in form and temper by unskilful grinding. Sword-making, therefore, though not the somewhat uncertain art it once was, still requires skilled craftsmen for its successful accomplishment. (H. W. B.; F. Po.)

AUTHORITIES.—The following list of works is intended to guide the reader, if desired, to fuller acquaintance with the literature and authorities of the subject:—

Archaeology and General History.—R. Forrer, "Der Werdegang von Dolch und Schwert," introduction to *Die Schwerter und Schwertknäufe der Sammlung Carl von Schwerzenbach* (Leipzig, 1905), the best monograph; Dr Julius Naue, *Die vorrömischen Schwerter aus Kupfer, Bronze und Eisen* (Munich, 1903), with atlas of illustrations, a standard work for the prehistoric periods (neither of these authors has been able to use the Cretan materials); R. F. Burton, *The Book of the Sword* (only 1 vol. published; London, 1884); Colonel Lane Fox (afterwards Major-General Pitt-Rivers), *Catalogue of Anthropological Collection, South Kensington Museum* (London, 1874); "Primitive Warfare," in *Journal* of the Royal United Service Institution (1867, 1868, 1869). For special regions and periods, see Lord Egerton of Tatton, *Indian and Oriental Armour* (London, 1896); Lindenschmit, *Tracht und Bewaffnung des römischen Heeres während der Kaiserzeit* (Brunswick, 1882); Drummond and Anderson, *Ancient Scottish Weapons* (Edinburgh and London, 1881). The general treatises and handbooks on arms and armour, such as Grose, Meyrick, Hewitt, Lacombe and Demmin, may be consulted with advantage, but with caution in details. The same may be said of published catalogues of museums and private collections. W. Boeheim, *Handbuch der Waffenkunde* (Leipzig, 1900); R. C. Clephan, *The Defensive Armour and the Weapons and Engines of War of Medieval Times and of the Renaissance* (London, 1900); Ashdown, *British and Foreign Arms and Armour* (London, 1909); and G. F. Laking, *The Armour of Windsor Castle* (European section; London, 1904), are trustworthy guides. "The Forms and History of the Sword," in *Proceedings* of the Royal Institution (1883), by the present writer, reprinted in *Oxford Lectures*, &c. (London, 1890), gives further references and citations on various points.

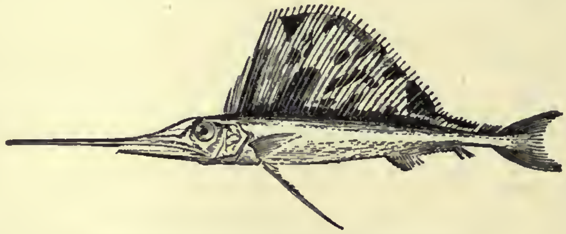
Swordsmanship.—Egerton Castle, *Schools and Masters of Fence from the Middle Ages to the Eighteenth Century* (including a critical bibliography; London, 1892); Carl A. Thimm, *Bibliography of Fencing and Duelling* (London, 1896). For the beginnings of the art in Italy, *Flos duellatorum* (a MS. of 1410 edited by Francesco Novati, with critical introduction and notes, Bergamo, 1902). Vigeant, *Bibliographie de l'escrime ancienne et moderne* (Paris, 1882); Gomard (assumed name of Possellier), *Théorie de l'escrime* (historical introduction; Paris, 1845). Grisier, *Les Armes et le duel* (preface by A. Dumas; Paris, 1847).

Technology.—Wilkinson, *Engines of War* (London, 1841); Latham, "The Shape of Sword-Blades," *Journal* of the Royal U.S. Institution (1862); Marey, *Mémoire sur les armes blanches* (Strassburg, 1841; trans. by Lieut.-Colonel Maxwell, London, 1860).

For the technique of Japanese swords, see A. Dobrée, "Japanese Sword Blades," *Archaeol. Journal*, lxii. 1, 218 (London, 1905); as to export of European blades to India, Lord Dillon, "Arms and Armour Abroad," ibid. 67, 69–72. (F. Po.)

SWORDFISH, the name given to a small family of spiny-rayed fishes (Xiphiidae), the principal characteristic of which consists in the prolongation of the upper jaw into a long pointed sword-like weapon. The "sword" is formed by the coalescence of the intermaxillary and maxillary bones, which possess an extremely hard texture; it has the shape of a much elongated cone, more or less flattened throughout its whole length; the end is sharply pointed. It is smooth above and on the upper part of the sides, and rough below owing to the presence of innumerable rudimentary teeth, which have no function.

The general form of the body is well proportioned, somewhat elongate, and such as is always found in fishes with great power



Swordfish (*Histiophorus pulchellus*).

of swimming, as, for instance, in the mackerel and tunny, and the tail terminates in a powerful bilobed caudal fin. A long fin occupies nearly the whole length of the back, whilst the anal fin is generally interrupted in the middle and consequently appears to be double. The skin is very firm, partly naked, partly with small lanceolate scales deeply embedded in the skin. The teeth of the lower jaw are, like those of the upper, merely rudimentary structures, which render the surface of the bone rough without possessing any special function.

Swordfishes have been divided into three generic groups:—

a. Histiophorus, with a high dorsal fin which can be spread out like a sail, and with ventral fins which are reduced to a pair of long styliform appendages.

b. Tetrapturus, with a dorsal fin of which the anterior rays only are elongate, the remainder of the fin being low or partly obsolete, and with styliform ventral fins as in the preceding genus.

c. Xiphias, with the dorsal fin shaped as in *Tetrapturus*, but without ventral fins.

Swordfishes are truly pelagic fishes, which either singly or in pairs or in smaller or larger companies roam over the oceans of the tropical and subtropical zones of both hemispheres. Some species wander regularly or stray far into the temperate seas. Some of the tropical forms are the largest of Acanthopterygian fishes, and not exceeded in size by any other Teleostean; such species attain to a length of from 12 to 15 ft., and swords have been preserved more than 3 ft. long and with a diameter of at least 3 in. at the base. The *Histiophori*, which inhabit chiefly the Indo-Pacific Ocean, but occur also in the Atlantic, seem to possess in their high dorsal fin an additional aid for locomotion. During the rapid movements of the fish this fin is folded downwards on the back, as it would impede the velocity of progress by the resistance it offers to the water; but, when the fish is swimming in a leisurely way, it is frequently seen with the fin erected, and projecting out of the water, and when quietly floating on the surface it can sail by the aid of the fin before the wind, like a boat.

The food of the swordfishes is the same as that of tunnies, and consists of smaller fish, and probably also in great measure of pelagic cuttle-fishes. It has been ascertained by actual observation that swordfishes procure their food by dashing into a school of fishes, piercing and killing a number of them with their swords; and this kind of weapon would seem to be also particularly serviceable in killing large cuttle-fish, like the saw of sawfishes, which is used for the same purpose. But the swords of the large species of *Histiophorus* and *Tetrapturus* are, besides, most formidable weapons of aggression. These fishes never hesitate to attack whales and other large cetaceans, and, by repeatedly stabbing them, generally retire from the combat victorious. That they combine in these attacks with the thresher-shark is an often-repeated story which is discredited by some naturalists on the ground that the dentition of the thresher-shark is much too weak to make an impression on the skin of any cetacean. The cause which excites swordfishes to such attacks is unknown; but they follow the instinct so blindly that they not rarely assail boats and ships in a similar manner, evidently mistaking them for cetaceans. They easily pierce the light canoes of the natives of the Pacific islands and the heavier boats of the professional swordfish fishermen, often dangerously wounding the persons sitting in them. Attacks by swordfishes on ocean-going ships are so common as to be included among sea-risks: they are known to have driven their weapon through copper-sheathing, oak-plank and timber to a depth of nearly 10 in., part of the sword projecting into the inside of the ship; and the force required to produce such an effect has been described by Sir R. Owen in a court of law as equal to "the accumulated force of fifteen double-handed hammers," and the velocity as "equal to that of a swivel-shot" and "as dangerous in its effects as a heavy artillery projectile." Among the specimens of planking pierced by swordfishes which are preserved in the British Museum there is one less than a foot square which encloses the broken ends of three swords, as if the fishes had had the object of concentrating their attack on the same vulnerable point of their supposed enemy. The part of the sword which penetrates a ship's side is almost always broken off and remains in the wood, as the fish is unable to execute sufficiently powerful backward movements to free itself by extracting the sword.

In the Mediterranean and on the Atlantic coasts of the United States the capture of swordfishes forms a regular branch of the fishing industry. The object of the fishery in the Mediterranean is the common European swordfish (*Xiphias gladius*), the average weight of which is about 1 cwt., and which is abundant off the Sicilian coasts and on the opposite coast of Calabria. Two methods are employed—that by harpoons, chiefly used for larger fish, and that by peculiarly constructed nets called *palamitare*. This fishery is very productive: a company of fishermen frequently capture from twenty to fifty fish in a single day, and the average annual catch in Sicily and Calabria is reported to be 140,000 kilogrammes (138 tons). The products of the fishery are consumed principally in a fresh state, but a portion is preserved in salt or oil. The flesh of the swordfish is much preferred to that of the tunny, and always commands a high price. This species is occasionally captured on the British coast.

On the coast of the United States a different species, *Histiophorus gladius*, occurs; it is a larger fish than the Mediterranean swordfish, attaining to a length of from 7 to 12 ft. and an average weight of 300 or 400 lb. It is captured only by the use of the harpoon. From forty to fifty vessels, schooners of some 50 tons, are annually engaged in this fishery, with an aggregate catch amounting annually to about 3400 swordfishes, of a value of $45,000. The flesh of this species is inferior in flavour to that of the Mediterranean species, and is principally consumed after having been preserved in salt or brine.

Useful and detailed information on the swordfish fishery can be obtained from A. T. Tozzetti, "La Pesca nei mari d'Italia e la pesca all' estero esercitata da Italiani," in *Catalogo esposizione internazionale di pesca in Berlino* (1880); also from *La Pesca del pesce-spada nello Stretto di Messina* (Messina, 1880), and from G. Brown Goode, "Materials for a History of the Sword-fish," in *Report of the Commissioner of Fish and Fisheries*, pt. viii. (Washington, 1883). (A. C. G.)

SWYNFORD, CATHERINE (*c.* 1350–1403), wife of John of Gaunt, duke of Lancaster, was a daughter of Sir Payne Roelt, a knight who came to England from Hainault in the train of Edward III.'s queen, Philippa. About 1367 she married Sir Hugh Swynford (1340–1372), a Lincolnshire man, by whom she had a son, Thomas (*c.* 1368–1433), who was a friend and companion of Henry IV. both before and after he came to the English throne. Soon after her husband's death in 1372 Catherine became the mistress of John of Gaunt, and in 1396, nearly two years after the duke had become a widower for the second time, she was married to him at Lincoln. She died at Lincoln on the 10th of May 1403. By John of Gaunt Catherine had four children, all of whom were born before their marriage. They were declared legitimate in 1397 and took the name of Beaufort from one of their father's castles in Anjou (see BEAUFORT).

SYAGRIUS (d. 487), the last of the independent Roman administrators of Gaul, was the son of Aegidius, who had seized Gaul while Ricimer was master of Italy. From 464 to 486 he governed that part of Gaul which lies between the Maas, the Scheldt and the Seine, and was termed "king of the Romans" by the German invaders, Franks, Burgundians and Visigoths, who already occupied the rest of Gaul. Defeated in 486 by Clovis, king of the Salian Franks, at the battle of Soissons, Syagrius fled, leaving his land at the mercy of the Franks. He sought refuge with Alaric II., king of the Visigoths, at Toulouse, but Alaric imprisoned him instead of granting him refuge, and delivered him up to Clovis. He was executed in 487, secretly and by the sword, according to Gregory of Tours.

SYBARIS, a city of Magna Graecia, on the Gulf of Tarentum, between the rivers Crathis (Crati) and Sybaris (Coscile), which now meet 3 m. from the sea, but in ancient times had independent mouths, was the oldest Greek colony in this region. It was an Achaean colony founded by Isus of Helice (about 720 B.C.), but had among its settlers many Troezenians, who were ultimately expelled. Placed in a very fertile, though now most unhealthy, region, and following a liberal policy in the admission of citizens from all quarters, the city became great and opulent, with a vast subject territory and divers daughter colonies even on the Tyrrhenian Sea (Posidonia, Laus, Scidrus). For magnificence and luxury the Sybarites were proverbial throughout Greece, and in the 6th century probably no Hellenic city could compare with its wealth and splendour. At length contests between the democrats and oligarchs, in which many of the latter were expelled and took refuge at Crotona, led to a war with that city, and the Crotoniats with very inferior forces were completely victorious. They razed Sybaris to the ground and turned the waters of Crathis to flow over its ruins (510 B.C.). Explorations undertaken by the Italian government in 1879 and 1887 failed to lead to a precise knowledge of the site. The only discoveries made were (1) that of an extensive necropolis, some 8 m. to the west of the confluence of the two rivers, of the end of the first Iron age, known as that of Torre Mordillo, the contents of which are now preserved at Potenza; (2) that of a necropolis of about 400 B.C.—the period of the greatest prosperity of Thurii (*q.v.*)—consisting of tombs covered by tumuli (called locally *timponi*), in some of which were found fine gold plates with mystic inscriptions in Greek characters; one of these tumuli was over 90 ft. in diameter at the base with a single burial in a sarcophagus in the centre.

See F. Lenormant, *La Grande-Grèce*, i. 325 seq. (Paris, 1881); F. S. Cavallari, in *Notizie degli Scavi* (1879, *passim*; 1880, 68, 152); A. Pasqui, ibid. (1888), 239, 462, 575, 648; P. Orsi, in *Atti del congresso di scienze storiche*, v. 195 sqq. (Rome, 1904) (T. As.)

SYBEL, HEINRICH VON (1817–1895), German historian, sprang from a Protestant family which had long been established at Soest, in Westphalia. He was born on the 2nd of December 1817 at Düsseldorf, where his father held important posts in the public service both under the French and the Prussians; in 1831 he had been raised to the hereditary nobility. His home was one of the centres of the vigorous literary and artistic life for which at that time Düsseldorf was renowned. Sybel was educated at the gymnasium of his native town, and then at the university of Berlin, where he came under the influence of Savigny and of Ranke, whose most distinguished pupil he was to become. After taking his degree, he settled down in 1841 as *Privatdozent* in history at the university of Bonn. He had already made himself known by critical studies on the history of the middle ages, of which the most important was his *Geschichte des ersten Kreuzzuges* (Düsseldorf, 1841; new ed., Leipzig, 1881), a work which, besides its merit as a valuable piece of historical investigation, according to the critical methods which he had learnt from Ranke, was also of some significance as a protest against the vaguely enthusiastic attitude towards the middle ages encouraged by the Romantic school. Lady Duff-Gordon published in 1861 an English translation of part of this book, to which are added lectures on the crusades delivered in Munich in 1858, under the title *History and Literature of the Crusades*. This was followed by a study on the growth of German kingship (*Die Entstehung des deutschen Königtums*, Frankfort, 1844, and again 1881), after which he was appointed professor.

In the same year (1844) Sybel came forward prominently as an opponent of the Ultramontane party. The exhibition of the Holy Coat at Trier had attracted enormous numbers of pilgrims, and so, indignant at what appeared to him an imposture, he assisted to publish an investigation into the authenticity of the celebrated relic. From this time he began to take an active part in contemporary politics and in controversy as a strong though moderate Liberal. In 1846 he was appointed professor at Marburg, and though this small university offered little scope for his activities as a teacher, a seat in the Hessian Landtag gave him his first experience of political affairs. In 1848 he was present at Frankfort, but he did not succeed in winning a seat for the National Assembly. His opposition to the extreme democratic and revolutionary party made him unpopular with the mob, who broke his windows, as his liberalism made him suspected at court. He sat in the Erfurt parliament of 1850, and was attached to the Gotha party, which hoped for the regeneration of Germany through the ascendancy of Prussia. During the years that followed all political activity was impossible, but he was fully occupied with his great work *Geschichte der Revolutionszeit 1879-1800*, for which he had made prolonged studies in the archives of Paris and other countries. The later editions of the earlier volumes are much enlarged and altered, and a new edition was published at Stuttgart in 1882. The first three volumes have been translated into English by W. C. Perry (1867–1869). In this work he for the first time showed the connexion between the internal and external history of France; he was also the first, by a systematic study of the records, to check and correct the traditional account of many episodes in the internal history. His demonstration that letters attributed to Marie Antoinette were not genuine roused much interest in France. For the history of German thought it was of the greatest importance that a Liberal from the Rhine, by a systematic history of the Revolution, attempted to overthrow the influence which the revolutionary legend, as expounded by French writers, had acquired over the German mind; and the book was an essential part of the influences which led to the formation of a National Liberal school of thought. Sybel had been much influenced by Burke, on whom he had published two essays. The work was in fact the first attempt to substitute for the popular representations of Thiers and Lamartine the critical investigation which has been carried on with such brilliance by Taine and Sorel.

In 1856, on the recommendation of Ranke, Sybel accepted the post of professor at Munich, where King Maximilian II. of Bavaria, a wise and generous patron of learning, hoped to establish a school of history. He found here a fruitful field for his activity. Besides continuing his work on the Revolution and on the middle ages, he was occupied with the *Historical Seminar* which he instituted; with the *Historische Zeitschrift* which he founded, the original and model of the numerous technical historical publications which now exist; and as secretary of the new historical commission. Political differences soon interfered with his work; as an adherent of Prussia and a Protestant, especially as a militant champion against the Ultramontanes, he was from the first an object of suspicion to the Clerical party. In the political excitement which followed the war of 1859 he found that he could not hope for the unreserved support of the king, and therefore in 1861 he accepted a professorship at Bonn, which he held till 1875. He was at once elected a member of the Prussian Lower House, and during the next three years was one of the most active members of that assembly: in several important debates he led the attack on the government, and opposed the policy of Bismarck, not only on financial but also on the Polish and Danish affairs. In 1864 he did not stand for re-election, owing to an affection of the eyes, but in 1866 he was one of the first to point out the way to a reconciliation between Bismarck and his former opponents. He had a seat in the Constituent Assembly of 1867, and while he joined the National Liberals he distinguished himself by his opposition to the introduction of universal suffrage, the effects of which he, as did many other Liberals, much distrusted. In 1874 he again accepted a seat in the Prussian parliament, in order to support the government in their conflict with the Clericals, and after 1878 with the Socialists. In two pamphlets, by an analysis of the teaching of the Socialists and a survey of Clerical policy during the 19th century, he explained and justified his opinions. In 1880 he retired, like so many other Liberals, disheartened by the change in political life, which he attributed to universal suffrage.

In 1875 he had been appointed by Bismarck to the post of director of the Prussian archives. Under his superintendence was begun the great series of publications, besides that of the correspondence of Frederick the Great, in the editing of which he himself took part. His last years were occupied on his great work, *Die Begründung des deutschen Reiches durch Wilhelm I.* (Munich, 1889–1894), a work of great importance, for he was allowed to use the Prussian state papers, and was therefore enabled to write a history of the greatest events of his own time with full access to the most secret sources of information. As a history of Prussian policy from 1860 to 1866 it is therefore of incomparable value. After the fall of Bismarck the permission to use the secret papers was withdrawn, and therefore vols. vi. and vii., which deal with the years 1866 to 1870, are of less importance. This work has been translated into English as *The Founding of the German Empire*, by M. L. Perrin and G. Bradford (New York, 1890–1891). Sybel did not live to write the account of the war with France, dying at Marburg on the 1st of August 1895. His other writings include *Die deutsche Nation und das Kaiserreich* (1862) and a large number of historical articles.

Sybel left two sons, one of whom became an officer in the Prussian army; the other, Ludwig von Sybel (b. 1846), professor of archaeology in the university of Marburg, is the author of several works dealing with Greek archaeology.

Some of Sybel's numerous historical and political essays have been collected in *Kleine historische Schriften* (3 vols., 1863, 1869, 1881; new ed., 1897); *Vorträge und Aufsätze* (Berlin, 1874); and *Vorträge und Abhandlungen*, published after his death with a biographical introduction by C. Varrentrapp (Munich, 1897).

SYCOPHANT (Gr. *συκοφάντης*), in ancient Greece the counterpart of the Roman delator (*q.v.*), a public informer. According to ancient authorities, the word (derived by them from *σῦκον*, "fig," and *φαίνειν*, "to show") meant one who informed against another for exporting figs (which was forbidden by law) or for stealing the fruit of the sacred fig-trees, whether in time of famine or on any other occasion. Another old explanation was that fines and taxes were at one time paid in figs, wine and oil, and those who collected such payments in kind were called sycophants because they "presented," publicly handed them over to the state. Böckh suggested that the word signified one who laid an information in reference to an object of trifling value, such as a fig (cf. "I don't care a fig about it"), but there seems no authority for such a use of σῦκον in Greek. According to C. Sittl (*Die Gebärden der Griechen und Römer*, Leipzig, 1890), the word refers to an obscene gesture of phallic significance (see also A. B. Cook in *Classical Review*, August 1907), called "showing the fig" (*faire la figue, far la fica* or *le fiche*), originally prophylactic in character. Such gesture, directed towards an inoffensive person, became an insult, and the word sycophant might imply one who insulted another by bringing a frivolous or malicious accusation against him. According to S. Reinach (*Revue des études grecques*, xix., 1906), who draws special attention to the similar formation "hierophant," the sycophant was an official connected with the cult of the Phytalidae, whose eponymus Phytalus was rewarded with a fig-tree by the wandering Demeter in return for his hospitality. The final act of the cult, the "exaltation" of the fig, with which Reinach compares the "exaltation" of the ear of corn by the hierophant at the Eleusinian mysteries, was performed by the sycophant. Again, like the hierophant, the sycophant publicly pronounced the formula of exclusion of certain unworthy persons from the celebration of the mysteries of the fig. As the cult of the Phytalidae sank into insignificance beside the greater mysteries, the term sycophant survived in popular language in the sense of an informer or denouncer, whose charges deserved but little consideration. L. Shadwell suggests that the real meaning is "fig-discoverer," not "fig-informer," referring to the blackmailer who discovers the "figs" (that is, the money) of the rich man and forces him to hand it over by the threat of bringing a criminal accusation against him. It must be remembered that any Athenian citizen was at liberty to accuse another of a public offence, and the danger of such a privilege being abused is sufficiently obvious. The people naturally looked upon all persons of wealth and position with suspicion, and were ready to believe any charge brought against them. Such prosecutions also put money into the pockets of the judges, and, if successful, into the public treasury. In many cases the accused persons, in order to avoid the indignity of a public trial, bought off their accusers, who found in this a fruitful source of revenue. Certain legal remedies, intended to prevent the abuses of the system, undoubtedly existed. Persons found guilty of bringing false charges, of blackmail, or of suborning false witnesses, were liable to criminal prosecution by the state and a fine on conviction. Penalties were also inflicted if an accuser failed to carry the prosecution through or to obtain a fifth part of the votes. But these remedies were rather simple deterrents, and instances of informers being actually brought to trial are rare. Sycophants were an inseparable accompaniment of the democracy, and the profession, at least from a political point of view, was not regarded as in any way dishonourable. The idea of encouraging the citizens to assist in the detection of crime or treason against the state was commendable; it was not the use, but the abuse of the privilege that was so injurious. Allusions to the sycophants are frequent in Aristophanes and the Attic orators. The word is now generally used in the sense of a cringing flatterer of the great.

See Meier and Schömann, *Der attische Process* (ed. J. H. Lipsius, 1883–1887); article by C. R. Kennedy and H. Holden, in Smith's *Dictionary of Antiquities* (3rd ed., 1891).

SYDENHAM, CHARLES EDWARD POULETT-THOMSON, 1ST BARON (1799–1841), British statesman, was born on the 13th of September 1799, being the son of John Buncombe-Poulett-Thomson, a London merchant. After some years spent in his father's business in Russia and in London he was returned to the House of Commons for Dover in 1826. In 1830 he joined Lord Grey's ministry as vice-president of the board of trade and treasurer of the navy. A free-trader and an expert in financial matters he was elected M.P. for Manchester in 1832, a seat which he occupied for many years. He was continuously occupied with negotiations affecting international commerce until 1839, when he accepted the governor-generalship of Canada, where it fell to his lot to establish the union of Upper and Lower Canada. His services in establishing the Canadian constitution were recognized in 1840 by a K.C.B. and a peerage. He took the title of Baron Sydenham of Sydenham in Kent and Toronto in Canada. He died unmarried on the 4th of September 1841, when his peerage became extinct.

His *Memoirs* were published by his brother, G. J. Poulett Scrope, in 1843.

SYDENHAM, THOMAS (1624–1689), English physician, was born on the 10th of September 1624 at Wynford Eagle in Dorset, where his father was a gentleman of property and good pedigree. At the age of eighteen he was entered at Magdalen Hall, Oxford; after a short period his college studies appear to have been interrupted, and he served for a time as an officer in the army of the parliament. He completed his Oxford course in 1648, graduating as bachelor of medicine, and about the same time he was elected a fellow of All Souls College. It was not until nearly thirty years later (1676) that he graduated as M.D., not at Oxford, but at Pembroke Hall, Cambridge, where his eldest son was then an undergraduate. After 1648 he seems to have spent some time studying medicine at Oxford, but he was soon again engaged in military service, and in 1654 he received the sum of £600, as a result of a petition he addressed to Cromwell, setting forth that various arrears were due to two of his brothers who had been killed and that he himself had faithfully served the parliament with the loss of much blood. In 1655 he resigned his fellowship at All Souls and married, and probably a few years later went to study medicine at Montpellier. In 1663 he passed the examinations of the College of Physicians for their licence to practice in Westminster and 6 m. round; but it is probable that he had been settled in London for some time before that. This minimum qualification to practise was the single bond between Sydenham and the College of Physicians throughout the whole of his career. He seems to have been distrusted by some members of the faculty because he was an innovator and something of a plain-dealer. In his letter to John Mapletoft he refers to a class of detractors "qui vitio statim vertunt si quis novi aliquid, ab illis non prius dictum vel etiam inauditum, in medium proferat"; and in a letter to Robert Boyle, written the year before his death (and the only authentic specimen of his English composition that remains), he says, "I have the happiness of curing my patients, at least of having it said concerning me that few miscarry under me; but [I] cannot brag of my correspondency with some other of my faculty . . . . Though yet, in taken fire at my attempts to reduce practice to a greater easiness, plainness, and in the meantime letting the mountebank at Charing Cross pass unrailed at, they contradict themselves, and would make the world believe I may prove more considerable than they would have me." Sydenham attracted to him in warm friendship some of the most discriminating men of his time, such as John Locke and Robert Boyle. His first book, *Methodus curandi febres*, was published in 1666; a second edition, with an additional chapter on the plague, in 1668; and a third edition, much enlarged and bearing the better-known title of *Observationes medicae*, in 1676. His next publication was in 1680 in the form of two *Epistolae responsoriae*, the one, "On Epidemics," addressed to Robert Brady, regius professor of physic at Cambridge, and the other "On the Lues venerea," to Henry Paman, public orator at Cambridge and Gresham professor in London. In 1682 he issued another *Dissertatio epistolaris*, on the treatment of confluent small-pox and on hysteria, addressed to Dr William Cole of Worcester. The *Tractatus de podagra et hydrope* came out in 1683, and the *Schedula monitoria de novae febris ingressu* in 1686. His last completed work, *Processus integri*, is an outline sketch of pathology and practice; twenty copies of it were printed in 1692, and, being a compendium, it has been more often republished both in England and in other countries than any other of his writings separately. A fragment on pulmonary consumption was found among his papers. His collected writings occupy about 600 pages 8vo, in the Latin, though whether that or English was the language in which they were originally written is disputed.

Hardly anything is known of Sydenham's personal history in London. He died in London on the 29th of December 1689, and was buried in the church of St James's, Piccadilly, where a mural slab was put up by the College of Physicians in 1810.

Although Sydenham was a highly successful practitioner and saw, besides foreign reprints, more than one new edition of his various tractates called for in his lifetime, his fame as the father of English medicine, or the English Hippocrates, was decidedly posthumous. For a long time he was held in vague esteem for the success of his cooling (or rather expectant) treatment of small-pox, for his laudanum (the first form of a tincture of opium), and for his advocacy of the use of Peruvian bark in quartan agues. There were, however, those among his contemporaries who understood something of Sydenham's importance in larger matters than details of treatment and pharmacy, chief among them being the talented Richard Morton. But the attitude of the academical medicine of the day is doubtless indicated in Martin Lister's use of the term "sectaries" for Sydenham and his admirers, at a time (1694) when the leader had been dead five years. If there were any doubt that the opposition to him was quite other than political, it would be set at rest by the testimony of Dr Andrew Brown,[1] who went from Scotland to inquire into Sydenham's practice and has incidentally revealed what was commonly thought of it at the time, in his *Vindicatory Schedule concerning the New Cure of Fevers*. In the series of Harveian orations at the College of Physicians, Sydenham is first mentioned in the oration of Dr John Arbuthnot (1727), who styles him "aemulus Hippocratis." H. Boerhaave, the Leyden professor, was wont to speak of him in his class (which had always some pupils from England and Scotland) as "Angliae lumen, artis Phoebum, veram Hippocratici viri speciem." A. von Haller also marked one of the epochs in his scheme of medical progress with the name of Sydenham. He is indeed famous because he inaugurated a new method and a better ethics of practice, the worth and diffusive influence of which did not become obvious (except to those who were on the same line with himself, such as Morton) until a good many years afterwards. It remains to consider briefly what his innovations were.

First and foremost he did the best he could for his patients, and made as little as possible of the mysteries and traditional dogmas of the craft. All the stories told of him are characteristic. Called to a gentleman who had been subjected to the lowering treatment, and finding him in a pitiful state of hysterical upset, he "conceived that this was occasioned partly by his long illness, partly by the previous evacuations, and partly by emptiness. I therefore ordered him a roast chicken and a pint of canary." A gentleman of fortune who was a victim to hypochondria was at length told by Sydenham that he could do no more for him, but that there was living at Inverness a certain Dr Robertson who had great skill in cases like his; the patient journeyed to Inverness full of hope, and, finding no doctor of the name there, came back to London full of rage, but cured withal of his complaint. Of a piece with this is his famous advice to Sir Richard Blackmore. When Blackmore first engaged in the study of physic he inquired of Dr Sydenham what authors he should read, and was directed by that physician to *Don Quixote*, "which," said he, "is a very good book; I read it still." There were cases, he tells us, in his practice where "I have consulted my patient's safety and my own reputation most effectually by doing nothing at all." It was in the treatment of small-pox that his startling innovations in that direction made most stir. It would be a mistake, however, to suppose that Sydenham wrote no long prescriptions, after the fashion of the time, or was entirely free from theoretical bias. Doctrines of disease he had, as every practitioner must have; but he was too much alive to the multiplicity of new facts and to the infinite variety of individual constitutions to aim at symmetry in his theoretical views or at consistency between his practice and his doctrines; and his treatment was what he found to answer best, whether it were *secundum artem* or not. His fundamental idea was to take diseases as they presented themselves in nature and to draw up a complete picture ("Krankheitsbild" of the Germans) of the objective characters of each. Most forms of ill-health, he insisted, had a definite type, comparable to the types of animal and vegetable species. The conformity of type in the symptoms and course of a malady was due to the uniformity of the cause. The causes that he dwelt upon were the "evident and conjunct causes," or, in other words, the morbid phenomena; the remote causes he thought it vain to seek after. Acute diseases, such as fevers and inflammations, he regarded as a wholesome conservative effort or reaction of the organism to meet the blow of some injurious influence operating from without; in this he followed the Hippocratic teaching closely as well as the Hippocratic practice of watching and aiding the natural crises. Chronic diseases, on the other hand, were a depraved state of the humours, mostly due to errors of diet and general manner of life, for which we ourselves were directly accountable. Hence his famous dictum: "*acutos* dico, qui ut plurimum Deum habent authorem, sicut chronici ipsos nos." Sydenham's nosological method is essentially the modern one, except that it wanted the morbid anatomy part, which was first introduced into the "natural history of disease" by Morgagni nearly a century later. In both departments of nosology, the acute and the chronic, Sydenham contributed largely to the natural history by his own accurate observation and philosophical comparison of case with case and type with type. The *Observationes medicae* and the first *Epistola responsoria* contain evidence of a close study of the various fevers, fluxes and other acute maladies of London over a series of years, their differences from year to year and from season to season, together with references to the prevailing weather—the whole body of observations being used to illustrate the doctrine of the "epidemic constitution" of the year or season, which he considered to depend often upon inscrutable telluric causes. The type of the acute disease varied, he found, according to the year and season, and the right treatment could not be adopted until the type was known. There had been nothing quite like this in medical literature since the Hippocratic treatise, Περὶ ἀέρων, ὑδάτων, τόπων; and there are probably some germs of truth in it still undeveloped, although the modern science of epidemiology has introduced a whole new set of considerations. Among other things Sydenham is credited with the first diagnosis of scarlatina and with the modern definition of chorea (in *Sched. monit.*). After small-pox, the diseases to which he refers most are hysteria and gout, his description of the latter (from the symptoms in his own person) being one of the classical pieces of medical writing. While Sydenham's "natural history" method has doubtless been the chief ground of his great posthumous fame, there can be no question that another reason for the admiration of posterity was that which is indicated by R. G. Latham, when he says, "I believe that the moral element of a liberal and candid spirit went hand in hand with the intellectual qualifications of observation, analysis and comparison."

Among the lives of Sydenham are one (anonymous) by Samuel Johnson in John Swan's translation of his works (London, 1742), another by C. G. Kühn in his edition of his works (Leipzig, 1827), and a third by Dr R. G. Latham in his translation of his works published in London by the Sydenham Society in 1848. See also Frédéric Picard, *Sydenham, sa vie, ses œuvres* (Paris, 1889), and J. F. Payne, *T. Sydenham* (London, 1900). Dr John Brown's "Locke and Sydenham," in *Horae subsecivae* (Edinburgh, 1858), is of the nature of eulogy. Many collected editions of his works have been published, as well as translations into English, German, French and Italian. Dr W. A. Greenhill's Latin text (London, 1844, Syd. Soc.) is a model of editing and indexing. The most interesting summary of doctrine and practice by the author himself is the introduction to the 3rd edition of *Observationes medicae* (1676).

SYDENHAM, a large residential district in the south of London, England, partly within the metropolitan borough of Lewisham (*q.v.*). The Crystal Palace (*q.v.*) is in this district.

SYDNEY, the capital of New South Wales, Australia, in Cumberland county, on the east coast of the continent, situated on the south shore of Port Jackson (*q.v.*), in 33° 15′ 44″ S., 151° 12′ 23″ E. Few capitals in the world can rival Sydney in natural advantages and beauty of site. It stands on undulating and easily drained ground, upon a bed of sandstone rock, on a peninsula jutting into one of the deepest, safest and most beautiful harbours in the world; and in addition it lies in the centre of a great carboniferous area. The metropolitan area of Sydney consists of a peninsula, about 13 m. in length, lying between the Parramatta and George's rivers. The sea frontage of this area stretches for 12 m. from the South Head of Port Jackson to the North Head of Botany Bay; it consists of bold cliffs alternating with beautiful beaches, of which some are connected with the city by tramway, and form favourite places of resort. The city proper occupies two indented tongues of land, having a water frontage on Port Jackson, and extending from Rushcutter's Bay on the east to Blackwattle Bay on the west, a distance of 8 m., nearly two miles of which is occupied by the Domain and the botanical gardens. The business quarter is a limited area lying between Darling Harbour and the Domain. The streets are irregular in width, some of them narrow and close together, while those leading down to Darling Harbour have a steep incline. Sydney has in consequence more than usually the appearance of an old-world town.

The main street of the city, George Street, is 2 m. long, running from north to south; it contains the town-hall, the post office and the Anglican cathedral. The post office is a handsome sandstone building in Renaissance style; it is colonnaded on two sides with polished granite columns and surmounted by a clock tower, containing a peal of bells. The town-hall, a large

[1] See Dr John Brown's *Horae subsecivae*, art. "Dr Andrew Brown and Sydenham."

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florid building of Classic order, stands on an eminence, and its clock tower forms a landmark; it contains the spacious Centennial Hall (commemorating the first Australian colonization here in 1787), and has one of the finest organs in the world. Opposite are the Queen Victoria Markets, a striking Byzantine erection, capped by numerous turrets and domes. Adjoining the town hall is the Anglican cathedral of St Andrew, in the Perpendicular style; it has two towers at the west end and a low central tower above the intersection of the nave and transepts, with a very handsome chapter house. Second in importance to George Street is Pitt Street, which runs parallel to it from the Circular Quay to the railway station; Macquarie Street runs alongside the Domain and contains a number of public buildings, including the treasury, the office of public works, the houses of parliament and the mint. In Bridge Street, behind the office of public works, are the exchange and the crown lands office. All these government offices are in classical style. The Roman Catholic Cathedral of St Mary lies on the north-east side of Hyde Park; it is a splendid Gothic structure, the finest in Australia. This cathedral has been twice destroyed by fire, and the existing building, from the designs of Mr W. W. Wardell, was consecrated in 1905. Government House, the residence of the governor-general, an excellent Tudor building erected in 1837, and several times enlarged, is delightfully situated in the Domain, overlooking Farm Cove. The residence of the state governor is at Rose Bay, east of the city. At the top of King Street there is a statue of Queen Victoria and close by a statue of Prince Albert, at the entrance to Hyde Park, in which the most elevated spot is occupied by a statue of Captain Cook. The university stands in its own grounds on the site of Grose Farm, the scene of one of the earliest attempts at government farming. Like most of the buildings at Sydney, the university is built of the excellent sandstone from the quarries of Pyrmont; it is 15th-century Gothic in style and stands at the top of a gentle slope, surrounded by gardens. Around it lie three Gothic colleges in the 14th-century style, affiliated to the university and known as St Paul's, St John's and St Andrew's. They are residential colleges belonging respectively to the Anglicans, Roman Catholics and Presbyterians. The university provides instruction and grants degrees in arts, law, medicine, science and engineering; instruction in theology, however, is given, not by the university, but by the different affiliated colleges.

To compensate for the narrowness of its streets and its lack of fine promenades Sydney possesses a number of grand parks, surpassed in few other capitals. Hyde Park is a plateau almost in the centre of the city, which in the early days of Sydney was used as a race-course. Adjoining are two smaller parks, Cook Park and Philip Park, while north of these stretches the Domain and the botanical gardens. The Domain embraces 138 acres, extending along one side of Woolloomooloo Bay and surrounding Farm Cove, in which the warships belonging to the Australian station are usually anchored; in this charming expanse of park land are the governor's residence and the National Art Gallery, which houses a splendid collection of pictures by modern artists, statuary, pottery and other objects of art. The botanical gardens on the southern shores of Farm Cove are the finest in the Commonwealth and are distinguished for their immense collection of exotics. On the south-east of the city lie Moore Park, 600 acres in extent, containing two fine cricket grounds and the show grounds of the agricultural society, and Centennial Park, formerly a water reserve of 768 acres. Adjoining Moore Park is the metropolitan race-course of Randwick. There are numerous other and smaller parks, of which the chief are Wentworth Park laid out on the site of Blackwattle Swamp, Prince Alfred Park, Belmore Park and Victoria Park adjoining the university grounds.

Sydney harbour is divided into a number of inlets by projecting headlands. The head of Woolloomooloo Bay, Sydney Cove, the shallow bay between Dawes and Millers Point, and Darling Harbour, are lined with wharves. The Circular Quay at the head of Sydney Cove is 1300 ft. long, and here all the great ocean liners from Europe, China and Japan are berthed, while to the great wharf in Woolloomooloo Bay, 3000 ft. in length, the American liners and the majority of the small coasting vessels come to discharge their cargoes. The whole of the eastern side of Darling Harbour is occupied by a succession of wharves and piers, there being in all 4000 ft. of wharfage. Connected with the main railway system of the colony is the Darling Harbour Wharf 1260 ft. long and equipped with electric light, stationary and travelling hydraulic cranes, machinery for meat freezing, and large sheds for storing corn and wool. In addition to these there are wharves at Pyrmont and Blackwattle Bay, respectively 3500 ft. and 1400 ft. long. These harbours on the eastern side of Sydney are mainly frequented by cargo boats trading in coal, corn, frozen meat, wool, hides and various ores. The total length of quays and wharves belonging to the port amounts to some 23 m. The dock accommodation is extensive. On Cockatoo Island, a few miles west of the city, the government have two large dry docks, the Fitzroy dock, 450 ft. long, and the Sutherland dock, 630 ft. Mort's dock, another large dry dock, is at Mort's Bay, Balmain, while there are five floating docks with a combined lifting power of 3895 tons, and the three patent slips in Mort's Bay can raise between them 3040 tons. Prior to 1899 the jurisdiction of the port was in the hands of a marine board, three members of which were elected by the shipping interest, and the remaining four nominated by the government, but in that year the board was replaced by a single official, known as the superintendent of the department of navigation and responsible to the colonial secretary.

Sydney has a great number of learned, educational and charitable institutions; it possesses a Royal Society, a Linnean Society and a Geographical Society, a women's college affiliated to the university, an astronomical observatory, a technical college, a school of art with library attached, a bacteriological institute at Rose Bay, a museum and a free public library. Standing in the centre of a great coal-bearing basin, Sydney is naturally the seat of numerous manufactures, to the prosperity of which the abundance and cheapness of coal has been highly conducive. In addition to the industries connected with the shipping, large numbers of hands are employed in the government railway works, where the locomotives and rolling stock used by the state railways are manufactured. There are several large tobacco factories, flour mills, boot factories, sugar refineries, tanneries, tallow works, meat-preserving, glue and kerosene-oil factories and soap works. Clothing, carriages, pottery, glass, paper and furniture are made, and there are numerous minor industries.

Sydney is governed municipally by a city council. The gas and electric lighting is in the hands of private firms. The administration of the park, the city improvements and the water and sewerage departments have been handed over to boards and trusts. The control of the traffic is in the hands of the police, who, with the wharves and the tramways, are directed by the state government. The whole district between Sydney and Parramatta on each side of the railway is practically one continuous town, the more fashionable suburbs lying on the east of the city while the business extension is to the westward and the southern quarters are largely devoted to manufacturing. The suburbs comprise the following distinct municipalities, Alexandria, with a population in 1901 of 9341; Annandale, 8349; Ashfield, 14,329; Balmain, 30,076; Bexley, 3079; Botany, 3383; North Botany, 3772; Burwood, 7521; Camperdown, 7931; Canterbury, 4226; Concord, 2818; Darlington, 3784; Drummoyne, 4244; Enfield, 2497; Erskineville, 6059; Glebe, 19,220; Hunter's Hill, 4232; Hurstville, 4019; Kogarah, 3892; Lane Cove, 1918; Leichhardt, 17,454; Manly, 5035; Marrickville, 18,775; Eastwood, 713; Mosman, 5691; Newtown, 22,598; North Sydney, 22,040; Paddington, 21,984; Petersham, 15,307; Randwick, 9753; Redfern, 24,219; Rockdale, 7857; Ryde, 3222; St Peter's, 5906; Vaucluse, 1152; Waterloo, 9609; Waverley, 12,342; Willoughby, 6004; Woollahra, 12,351. These suburbs are connected with the city, some by railway, some by steam, cable and electric tramways, and others by ferry across Port Jackson. The tramway system is owned by the government.

There are numerous places of resort for the citizens. Many of the bays in the harbour are largely visited on Sundays and holidays. The most popular resorts are Manly Beach, Chowder Bay and Watson's Bay, in the harbour; Cabarita, on the Parramatta river; Middle Harbour; and Coogee Bay and Bondi, on the ocean beach; Botany, Lady Robinson's Beach, Sandringham and Sans Souci on Botany Bay. Besides these there are two splendid national reserves, an hour's journey by rail from Sydney, viz. National Park, comprising an area of 36,810 acres, surrounding the picturesque bay of Port Hacking; and Kurringai Chase, with an area of 35,300 acres.

The two principal cemeteries are at Waverley and Rookwood. The former is most picturesquely situated on the cliff overlooking the Pacific Ocean.

The climate of Sydney is mild and equable; in summer sea breezes blow from the north-east, which, while they temper the heat, make the air exceedingly humid; in winter the winds blow from the west and the climate is dry and bracing. The mean average temperature is 63° Fahr., and the rainfall 49·66 in.

The population has increased with marvellous rapidity. In 1861 it was (city and suburbs inclusive) 95,000; in 1881, 237,300; in 1891, 399,270; and in 1901, 487,900. The proportion of city dwellers to suburban is as follows: in 1901—city, 112,137; suburbs, 369,693; total, 487,900. The incorporated area of the metropolitan district is about 142 sq. m., or 91,220 acres, so that the average density of population was 5·35 persons per acre, some of the more immediate suburbs being more densely populated than the city itself.

SYDNEY, the chief town of Cape Breton county, Nova Scotia, on a good harbour, the eastern terminus of the Intercolonial railway. Pop. (1891), 2427, (1901), 9900. Formerly a quiet country town, it became between 1891 and 1901 the chief shipping port of the Dominion Coal Company, and the site of the large works of the Dominion Iron and Steel Company. On the opposite side of the harbour are the flourishing towns of North Sydney and of Sydney Mines. It is the starting point for the line of steamers to the Bras d'Or lakes, and a favourite summer resort.

SYENITE, a name first used by Pliny to designate rocks of the same type as the hornblendic granite of Syene (Assouan) in Upper Egypt, so extensively used in ancient times for architectural work and monuments. Transferred by Werner to a rock of much the same appearance, though not identical in mineralogical character with the Egyptian granite, from the Plauen 'scher Grund near Dresden, it is now used as the group name of a class of holo-crystalline plutonic rocks composed essentially of an alkali felspar and a ferromagnesian mineral. The structure and appearance are very much the same as that of a hornblendic granite; from which it is difficult to distinguish these rocks in hand specimens. The important difference, however, is the absence or scarcity of quartz in the syenites. Their essential components are orthoclase, often with some albite, and augite, hornblende or biotite. The orthoclase is white or pink, and forms nearly one half of the rock. It may be veined with albite (microperthite) and small crystals of plagioclase (mostly andesine and oligoclase) often are present, usually having better crystalline forms than the potash felspar. The prevalent hornblende is green, but brown hornblende and dark blue hornblende, of strong pleochroism, occur in some syenites which are rich in alkalis. The augite is usually pale green and may be in perthitic intergrowth with the hornblende. The mica is always of brown colour, as muscovite is not known to occur in these rocks. In the alkali syenites dark green soda augites may be present; other syenites contain a violet augite which has the lamella structure of diallage.

The accessory minerals include sphene (very frequent), apatite, zircon, magnetite and pyrites; quartz as above stated is rarely absent but should never be abundant, otherwise the rock becomes a granite. Nepheline and sodalite occur only in those rocks which show transitions to the nepheline-syenites.

The structure of syenites is almost exactly the same as that of the granites; varieties with porphyritic felspar are known but none of these rocks are evenly granular. The apatite, zircon and magnetite crystallize first, and occur as small well-shaped crystals enclosed in the other minerals. Sphene also is of early formation; then follow augite, biotite and hornblende, the pyroxene usually taking precedence, but regular intergrowths due to simultaneous crystallization of these three minerals are common. The plagioclase felspar succeeds the ferromagnesian minerals, and the alkali felspar is last to crystallize with the exception of the small amount of quartz and of micropegmatite, if these are present. Exceptions to this rule occur, as for example when part of the soda-lime felspar has separated out of the magma before the ferric minerals have ceased to grow, and is consequently enclosed in them in ophitic fashion. Some syenites have a fluxion or even "augen" structure, due to movements during consolidation; orbicular structure may also occur but is very rare.

Although syenites are by no means common rocks and are not of equal importance with granites and diorites from a geological standpoint, they exhibit many varieties which are of interest. Transitional forms between syenite and granite are common as these rocks very frequently occur in the same mass and can hardly be separated from one another in the field. These syenites, comparatively rich in quartz, have been called syenite-granites. Many of the rocks known to the older geologists and shown on the early maps as "syenite" are of this type; others are hornblendic granites in which quartz is not abundant or conspicuous. Another variety of quartz-syenite, very rich in pink alkali felspar (microperthite), is known as nordmarkite; it occurs in Norway, Sweden and Scotland, and contains usually only a small amount of brown biotite and green augite.

The more normal syenites (with only small percentages of quartz) may be divided into augite-, hornblende- and biotite-syenites, according to their prevalent ferric mineral, but usually the rock contains two or even three of the dark-coloured bisilicates. Augite-syenites occur in Saxony and in Norway. In the latter country the most abundant type is laurvikite. These rocks may be red or grey in colour and very largely consist of a perthitic or cryptoperthitic alkali felspar having a beautiful shimmering dull metallic reflection or play of colours. They are coarse-grained rocks, and their great freshness and iridescent appearance when polished make them favourite ornamental stones for facades and pillars. The large felspars have often an elongated elliptical form and are arranged in sub-parallel fashion apparently by fluxion movements. Quartz is usually absent and plagioclase is still more uncommon, but the occasional presence of nepheline and sodalite indicates that these rocks are connected with the nepheline-syenites of the laurvikite type. The ferromagnesian minerals show a great variety and include diopside, aegirine-augite, biotite, brown hornblende, hypersthene and olivine. Zircon is often abundant (zircon-syenite). Rocks very similar to the laurvikites of Norway are known in the Sawtooth Mountains of Texas. These augite-syenites which have plagioclase and orthoclase felspar in nearly equal quantity are called nonzonites. Hornblende-syenites are regarded as being the typical members of the group, hence the best-known syenite, the original rock which Werner described, is of this kind; they are not very common, but occur in Germany, Piedmont and other places, usually with hornblende-granites and diorites. Biotite-syenites also are not frequent, being usually accompanied by granites of which they represent modifications poor in quartz. Most of the rocks formerly known as mica-syenites are now grouped with the lamprophyres as minettes. The following analyses show the chemical composition of a few of the principal types of syenite. They are characterized by a moderate amount of silica, relatively high alkalis (with potash usually preponderating) and alumina, while lime and magnesia are more variable but never in great amount.

(J. S. F.)

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MgO.	CaO.	Na_2O.	K_2O.
I. Hornblende-syenite (Plauen 'scher Grund, Dresden)	59·83	16·85	—	7·01	2·61	4·43	2·44	6·57
II. Laurvikite (Laurvik, Norway)	58·88	20·30	3·63	2·58	0·79	3·03	5·73	4·50
III. Nordmarkite (Christiania)	59·88	17·87	2·67	1·50	1·04	2·01	7·96	5·69

SYLBURG, FRIEDRICH (1536–1596), German classical scholar, son of a farmer, was born at Wetter near Marburg. He studied at Marburg, Jena, Geneva, and, lastly, Paris, where his teacher was Henry Estienne (Stephanus), to whose great Greek *Thesaurus* Sylburg afterwards made important contributions. Returning to Germany, he held educational posts at Neuhaus near Worms and at Lich near Giessen, where he edited a useful edition of the *Institutiones in graecam linguam* (1580) of Nicolaus Clenardus (Cleynaerts, 1495–1542). In 1583 he resigned his post at Lich and moved to Frankfort-on-the-Main to act as corrector and editor of Greek texts for the enterprising publisher Johann Wechel. To his Frankfort period belong the editions of Pausanias, Herodotus, Dionysius of Halicarnassus (one of his best pieces of work and highly praised by Niebuhr), Aristotle, the Greek and Latin sources for the history of the Roman emperors and the Περὶ συντάξεως of Apollonius Dyscolus. In 1591 he removed to Heidelberg, where he became librarian to the elector palatine. The Wechel series was continued by Hieronymus Commelinus of Heidelberg, for whom Sylburg edited Clement of Alexander, Justin Martyr, the *Etymologicum magnum*, the *Scriptores de re rustica*, the Greek gnomic poets, Xenophon, Nonnus and other works. All Sylburg's editions show great critical power and indefatigable industry. He died on the 17th of February 1596, a victim of over-work.

See F. Koldewey, in *Allgemeine deutsche Biographie*; K. W. Justi, in Strieder's *Hessische Gelehrten-Geschichte*, xviii. (Marburg, 1819); C. Bursian, *Geschichte der classischen Philologie in Deutschland* (1883); J. E. Sandys, *Hist. of Class. Schol.*, ii. (1908), p. 270.

SYLHET, a town and district of British India, in the Surma valley division of Eastern Bengal and Assam. The town is on the right bank of the river Surma, on rising ground, embowered in groves. Pop. (1901), 13,893. There are manufactures of mats, carved ivory and shells, and furniture. There is an unaided college, founded in 1892, which is mainly supported by a native gentleman. There are two dispensaries and an English church. The great earthquake of the 12th of June 1897 destroyed every substantial building, but caused very little loss of life. Sylhet is the largest town in Assam, but is steadily decaying, being 30 m. from a railway and inaccessible to steamers during the dry season.

The District of Sylhet has an area of 5388 sq. m. It consists of the lower valley of the Surma or Barak river, and for the most part is a uniform level broken only by scattered clusters of sandy hillocks called *tilās*, and intersected by a network of rivers and drainage channels. It is a broad and densely-cultivated plain, except in the extreme north, where the enormous rainfall converts many square miles of land into one huge lake during the rains, and in the south, where eight low ranges of hills, spurs of the Tippera mountains, run out into the plain, the highest range being about 1500 ft. above sea-level. There is also a small detached group in the centre of the district called the Ita hills. The district is watered by the branches of the Surma (*q.v.*) which are navigable by large boats, and support a busy traffic. The climate is extremely damp and the rainfall is heavy, reaching an annual average of over 150 in.; the rainy season generally lasts from April to October.

In 1901 the population was 2,241,848, showing an increase of 4% in the decade. More than half are Mahommedans. Tea cultivation is a flourishing industry in the southern hills. The Assam-Bengal railway crosses the district, but trade is still largely river-borne. Great damage was done by the earthquake of June 1897, which was followed by an outbreak of malarial fever.

Sylhet passed into the hands of the British in 1765, with the rest of Bengal, of which it formed an integral part until 1874, being included in the Dacca division. In that year it was annexed, together with the adjoining district of Cachar, to the chief-commissionership of Assam which was amalgamated with eastern Bengal in 1905.

See *Sylhet District Gazetteer* (Calcutta, 1905).

SYLLABUS (from Gr. συλλαμβάνειν, to take together, cf. "syllable"), literally something taken together, a collection (Late Lat. *syllabus*), hence a compendium, table or abstract giving the heads, outline or scheme of a course of lectures, teaching, &c. The word in the sense of a list or catalogue is used of a collection of eighty condemned propositions, addressed by order of Pius IX. to all the Catholic episcopate, under the date of the 8th of December 1864. The official title is: "A collection (*syllabus*) containing the principal errors of our times as noted in the Allocutions, Encyclicals and other Apostolic Letters of our Holy Father Pope Pius IX." This collection has a rather curious history. As early as 1849, the council of Spoleto asked the pope for a collective condemnation of all errors concerning the Church, her authority and property. In 1851 the *Civiltà cattolica* proposed that this should be drawn up in connexion with the definition of the Immaculate Conception of Mary. In 1852, Cardinal Fornari wrote by order of the pope to a certain number of bishops and laymen asking for their assistance in the study of the errors most prevalent in modern society. The answers are unknown; but after the definition of the Immaculate Conception (December 8, 1854), the commission of theologians charged with the preparatory investigations was entrusted with the further mission of studying modern errors. For six years it gave no outward signs of activity; but in 1860 Mgr Gerbet, bishop of Perpignan, published his *Instruction pastorale sur diverses erreurs du temps présent*; in it he enumerated 85 erroneous propositions, grouped under eleven heads. Pius IX. was much impressed by this work; he had it printed, and communicated it to the commission, to which he added a few new members, desiring them to take it as a fresh basis for their researches. In 1861 the commission had various meetings, at which the principal propositions were chosen and formulated in Latin, and the theological censure which they incurred applied to them. The result was a collection first of 70, and later of 61 propositions, of which only 27 have the note *haeretica*; Mgr Gerbet's divisions, and frequently his text, are adhered to. This Syllabus, which was excellently drawn up, was not promulgated, owing to an indiscretion. On the occasion of the festivals of the canonization of the Japanese martyrs, Pius IX. had gathered around him three hundred bishops from all parts of the world; he had the projected Syllabus communicated to each of them, under the seal of secrecy for the purpose of asking their opinion on it; each bishop was also, still under the seal of secrecy, empowered to consult a theologian selected by himself. But in October 1862, the Turin *Mediatore* published the catalogue in full, and Mgr Bourget, bishop of Montreal, thinking that it had been published in Rome, officially promulgated it for his diocese in December 1863. Pius IX. then modified his plans: a new commission was appointed to extract from the Allocutions, Encyclicals and papal Letters the chief errors dealt with in them. This work lasted about a year; the result of it was the Syllabus, in eighty propositions, arranged under the distinct heads; the propositions are not accompanied by any theological censure, but simply by a reference to the Allocution, Encyclical or Letter from which each had been more or less textually extracted. This was addressed to the episcopate together with a letter from Cardinal Antonelli, and dated the 8th of December 1864, the same date as the Encyclical *Quanta cura*, from which, however, it remains quite distinct. Its publication aroused the most violent polemics; what was then called the Ultramontane party was loud in its praise; while the liberals treated it as a declaration of war made by the Church on modern society and civilization. Napoleon III.'s government forbade its publication, and suspended the newspaper *l'Univers* for having published it. Controversies were equally numerous as to the theological value of the Syllabus. Most Catholics saw in it as many infallible definitions as condemned propositions; others observed that the pope had neither personally signed nor promulgated the collection, but had intentionally separated it from the Encyclical by sending it merely under cover of a letter from his secretary of state; they said that it was hastily, and sometimes unfortunately drawn up (cf. prop. 61); they saw in it an act of the pontifical authority, but without any of the marks required in the case of dogmatic definitions; they concluded, therefore, that each proposition was to be appreciated separately, and in consequence that each was open to theological comment. That such is the true view is proved by the fact that Rome never censured the theologians who, like Newman, took up this position.

The errors enumerated in the Syllabus are grouped under the ten following heads: (1) Pantheism, naturalism and absolute rationalism; (2) Moderate rationalism; (3) Indifferentism, latitudinarianism; (4) Socialism, communism, secret societies, Bible societies, clerico-liberal societies; (5) Errors regarding the Church and her rights; (6) Errors regarding civil society both in itself and in its relations with the Church; (7) Errors regarding Christian and natural morality; (8) Errors regarding Christian marriage; (9) Errors concerning the temporal power of the pope; (10) Errors relative to modern Liberalism. It was paragraphs 5, 6 and 10 which especially gave rise to discussion. In reality, however, the Syllabus did not contain a new doctrine: the Church was defending her traditional doctrine against the progressive invasion of what were called modern ideas of liberty, *i.e.* the independence of religious authority shown by secular societies, liberty of conscience, equality of all religious confessions before the state, &c. She upheld her theoretical position as in the time of Philip the Fair or of the Reformation, and the Syllabus goes no further in this respect than the Encyclical *Quanta cura* of the same date, or that of Gregory XVI., *Mirari vos*, of the 15th of August 1832. But the unusual form of the document should be considered: instead of an exposition of doctrine it enumerates the errors in the form of bare propositions, without any qualification, and with no variation in the degree of condemnation; the result being that many people on both sides were misled.

The name Syllabus has sometimes also been given to the collection of 65 "modernist" propositions condemned by the decree *Lamentabili* of the Holy Office, dated the 3rd of July 1907; but this name is in no wise official.

Bibliography.—The documents from which the propositions of the Syllabus were borrowed have been collected together in the *Recueil des allocutions consistoriales, &c. citées dans l'encyclique et le syllabus* (Paris, 1865). For the history of the Syllabus: P. Hourat, *Le Syllabus, étude documentaire* (Paris, 1904); and P. Rinaldi, *Il Valore del sillabo* (Rome, 1888). For its theological value: Newman, *A Letter Addressed to his Grace the Duke of Norfolk* (London, 1875); P. Viollet, *L'Infallibilité du pape et le syllabus* (Paris, 1904); L. Choupin, *Valeur des décisions doctrinales et disciplinaires du Saint Siège* (Paris, 1907). See also Mgr. Dupanloup, *La Convention du 15 septembre et l'encyclique du 8 décembre* (Paris, 1865); and for the opposite view, see Trarieux, *Le Syllabus et la déclaration des droits de l'homme* (Paris, 1902). (A. Bo.*)

SYLLOGISM (Gr. συλλογισμός, from σύν, and λόγος, an argument resulting from combination, *i.e.* of premises), in logic, an argument consisting of premises and a conclusion. Aristotle's definition is (*Anal. Pr.* α i. 24 b 18; cf. Top. α i. 100 a 25): συλλογισμὸς ἐστι λόγος ἐν ᾧ τεθέντων τίνων ἕτερόν τι τῶν κειμένων ἐξ ἀνάγκης συμβαίνει τῷ ταῦτα εἶναι, "a syllogism is an argument in which, certain things being posited (the premises), something other than the premises necessarily results from their being true." This definition, though it contains the really important facts, is too wide in two respects. (1) Aristotle himself and subsequent logicians restrict the term to arguments in which there are but two premises. (2) In point of fact, all logicians further confine the syllogism to arguments in which the terms are related as subject and predicate (or attribute in the widest sense). A fortiori arguments, for example, wherein relations of quantity are brought together, though syllogistic in type, are generally excluded. Owing largely to the simplicity and symmetry of the syllogism it has been a commonplace of logic to make the syllogistic form the type of all thought. Modern logicians (cf. especially F. H. Bradley in his *Logic*) have, however, shown that in practice its importance is greatly exaggerated.

A. *The Deductive Syllogism.*—This argument is the simplest form of "mediate" inference, *i.e.* an argument in which two terms are brought into a necessary relation by the aid of a "middle" term which serves as a bridge. It requires, therefore, two propositions known as premises [1] (also spelled premisses, as being more in accordance with the Lat. *praemissae* [*propositiones sententiae*], things put or posited in advance) which contain one common term and one other term each. In the conclusion the middle term disappears and the other two are brought together. The premises are assumed: whether true or false, the conclusion follows necessarily. If the premises are true, the conclusion must be true: if they are false the great probability is that the conclusion is false. The predicate of the conclusion is called the *major* term, the subject the *minor* term; the term which is common to the premises and disappears in the conclusion is the *middle* term. Hence the premise which contains the major term is called the major premise: that which contains the minor, the minor premise. The form of the syllogism is therefore:—

A is B	Major premise
C is A	Minor "
∴ C is B	Conclusion

Syllogisms differ in (*a*) "figure" and (*b*) "mood." (*a*) Difference of figure depends on the order of the terms in the premises. The above is the scheme of figure I. If the middle term is the predicate in both premises, the syllogism is in figure II.: if the subject in both, figure III. These are the only figures recognized by Aristotle, though he points out that the premises in figure I. may justify a conclusion in which the predicate is not, as normally, the major term, but the minor. This possibility, according to Averroes, led to the adoption by the physician Galen of the so-called fourth figure, in which the middle term is predicate of the major and subject of the minor. This, however, destroys the appropriateness of the phrases major and minor term which are specially chosen because in fact the major term does imply the more comprehensive notion. The conclusion is an artificial proposition which would be stated naturally in the converse.

b. The distinction of moods is according to the quantity or quality of the propositions of the syllogism (universal, particular, affirmative, negative, in all the possible combinations). So far as mere form goes, each mood may occur in every figure, though in many cases the conclusion apparently yielded from the premises is invalid. A simple calculation shows that formally there are 64 possible moods. Investigation shows that of these nineteen [2] only are valid, and rules have been formulated which give the reasons for the invalidity of the remaining 45.

The rules which govern syllogistic arguments thus described are:—

i. A syllogism must contain three and three terms only. (*a*) Four terms would mean the absence of any connecting link. (*b*) If the middle term is ambiguous there are really four not three terms. The violation of (*a*) is the fallacy "Quaternio terminorum"; of (*b*) "ambiguous middle."

ii. The middle term must be distributed in one premise at least, *i.e.* it must be taken universally, as including all the particulars over which it extends (see Extension). Violation of this is the fallacy of "undistributed middle."

iii. No inference can be made from two negative premises.

iv. If either premise is negative, the conclusion is negative.

v. The conclusion cannot be negative, if both premises are affirmative.

vi. No term may be distributed in this conclusion which was not distributed in the premise in which it occurs. Violation of this rule is called an "illicit process of the major (or the minor) term."

vii. From two particular premises nothing can be inferred.[3]

viii. If either premise is particular, the conclusion must be particular.[3]

[1] Aristotle προτάσεις, originally translated *propositiones*; *praemissae* dates from 12th century Latin translations of Arabic versions of Aristotle. The term "premises" (a house, &c.), is derived loosely from the legal phase denoting that which has already been mentioned in a document, and is etymologically the same.

[2] The following mnemonic hexameter verses are generally given (first apparently in Aldrich's *Artis logicae rudimenta*) to aid in remembering these moods. The vowels in the words, A, E, I, O, show the quantity and quality of the premises:—

Barbara Celarent Darii Ferioque prioris;
Cesare Camestres Festino Baroco secundi;
Tertia Darapti Disamis Datisi Felapton
Bocardo Ferison habet: quarta insuper addit
Bramantip Camenes Dimaris Fesapo Fresison.

[3] These latter are corollaries of previous rules.

The general criticism of the syllogism as a means of discovering truth is that it is a *petitio principii*, or begging of the question. This accusation is based to some extent on the Aristotelian "Dictum de omni et nullo" (*Anal. Pri.* α i. 24, b 26–30), generally stated as "That which is affirmed or denied of any whole may be affirmed or denied of anything contained within (or 'any part of') that whole." To take a concrete instance of a valid mood: all men are mortal, all Frenchmen are men, therefore all Frenchmen are mortal (the mood Barbara). It is argued that either there is here no real discovery (*i.e.* new truth) or the major premise is improperly used (begs the question) inasmuch as unless we knew that all Frenchmen are mortal we could not state that all *men* are mortal. The problem raised is a real one, and has been discussed by all logicians, from the time of Mill especially. In brief, the solution depends upon the view we take of the major premise, "all men are mortal." If that judgment is taken as a mere enumeration of particulars, *i.e.* in extension, as meaning that all men have been investigated and found to be mortal, clearly it could not be used to make the new discovery that a particular group of men are mortal; the syllogism so understood is a *petitio principii*. If, however, we take the true view of the major premise, namely, that it is not a mere summary of observed particulars but the enunciation of a necessary connexion between two concepts or universals, then the conclusion assumes a different character. The "whole" (*omne*) of the dictum, the major term, ceases to be taken in extension, and becomes intensive or connotative, and the inference consists in subsuming the minor under (bringing it into connexion with) the major. This is the true view of the scientific or inductive universal (as opposed to that of nominalism or pure empiricism). It remains true that in fact the conclusion is contained in the premises—this is essential to the validity of the syllogism—but the inference is a real one because it brings out and shows the necessity of a conclusion which was not before in our minds.

Hypothetical and Disjunctive Syllogisms.—The term syllogism has been extended to cover certain forms of ratiocination which are not based on categorical propositions. The propriety of this extended use is open to question and is denied by some logicians.

a. Hypothetical "Syllogisms" are those in which one premise is a hypothetical proposition, the other a categorical. Two forms are possible (i.) *modus ponens* (which establishes the consequent set down in the major premise): if A is B, it is C (or C is D); A is B; therefore A is C (or C is D), and (ii.) *modus tollens* (which disproves the antecedent): if A is B, it is C (or C is D); A is not C (or C is not D); therefore it is not B (or A is not B). In (i.) a valid conclusion follows from the affirmation of the antecedent: in (ii.) from denying the consequent, but in neither case conversely. The distinction is of greater importance than would appear when one realizes how obvious the facts really are, and in practice it happens frequently that speakers claim with success to disprove a proposition by disproving the fact alleged in support of it, or to establish a hypothesis by showing that facts agree with its consequences.

b. Disjunctive "Syllogisms" are those in which one premise is a disjunctive proposition, the other a categorical proposition which states or denies one of the two alternatives set forth. Again two forms occur: (i.) *modus ponendo tollens* which by the affirmation of one alternative denies the other (A is either B or C; A is B; therefore it is not C: *or* either A is B, or C is D; A is B; therefore C is not D: *or* either A or B is C; A is C; therefore B is not C); (ii.) *modus tollendo ponens* which by the denial of the one, establishes the validity of the other alternative (A is either B or C; A is not B; therefore it is C: *or* either A or B is C; A is not C; therefore B is C: *or* either A is B, or C is D; A is not B; therefore C is D). The validity of such arguments depends upon the sense in which we understand the disjunctive proposition: we must assume that the alternatives are mutually exclusive.[1]

Sorites.—Finally it is necessary to mention a complex syllogistic argument known as the *Sorites* (Gr. σωρός, heap). It has been defined as a syllogism in Fig. 1 (see above) having many middle terms; it is really a series of syllogisms (a polysyllogism), each one proving a premise of another, the intermediate conclusions being suppressed. Its form is A is B, B is C, C is D . . . . Y is Z, therefore A is Z. Each syllogism of the series is called a "prosyllogism"[2] in relation to the one that succeeds, and an "episyllogism" in relation to its predecessors. Resolution of the sorites into its constituent elements gives the rules (α) that no premise except the first may be particular and (β) that no premise except the last may be negative.

B. *The Inductive Syllogism*, like the deductive, is first systematized by Aristotle, who described it as ὁ ἐξ ἐπαγωγῆς συλλογισμός. Unlike the deductive it consists in establishing a conclusion from particular premises, *i.e.* of referring the major term to the middle by means of the minor. The form is "A B C D, &c., are P; A B C D are all M; thus all M are P." This so-called syllogism has been much criticized by modern logicians on various grounds (see LOGIC).

Discussions of the syllogism will be found in all textbooks on Logic, and the more elaborate syllogistic forms are discussed in the article LOGIC.

[1] For a dilemma which includes both hypothetical and disjunctive reasoning see DILEMMA.

[2] Where one premise of a prosyllogism is omitted (see ENTHYMEME), this argument is sometimes called an "epicheirema."

SYLPH, an imaginary spirit of the air; according to Paracelsus, the first modern writer who uses the word, an air-elemental, coming between material and immaterial beings. In current usage, the term is applied to a feminine spirit or fairy, and is often used in a figurative sense of a graceful, slender girl or young woman. The form of the word points to a Greek origin, and Aristotle's σίλφη, a kind of beetle (*Hist. anim.* 8. 17. 8), has usually been taken as the source. Similarly, the earth-elementals or earth-spirits were in Paracelsus's nomenclature, "gnomes" (Gr. γνώμη, intelligence, γιγνώσκειν, to know) as being the spirits that gave the secrets of the earth to mortals. Littré, however, takes the word to be Old Celtic, and meaning "genius," and states that it occurs in such forms as *sulfi*, *sylfi*, &c., in inscriptions, or latinized as *sulevae* or *suleviae*.

SYLT (probably from the O. Fris. *Silendi*, *i.e.* sealand), the largest German island in the North Sea, being about 38 sq. m. in area and nearly 23 m. long. It is, however, very narrow, being generally about half a mile in width, except in the middle, where it sends out a peninsula to the east 7 m. across. It belongs to the Prussian province of Schleswig-Holstein, and lies from 7 to 12 m. from the Schleswig coast. The central peninsula contains some marshland and moorland pasture, on which a few thousand sheep graze; but the rest of the island consists merely of dunes or sandhills. These attain at places a height of from 100 to 150 ft., and are continually shifting to the westward. The inhabitants (3500) are of Frisian origin, and the official language is German, though in the extreme north of the island, known as List, Danish is spoken. Their occupations are fishing, oyster-dredging, seafaring and wild-duck catching. The chief places are Keitum, Tinnum, Morsum, Rantum and Westerland. Westerland, one of the most frequented sea-bathing places of Germany, lies on the west side of the island, separated from the sea, which is seldom perfectly calm, by a chain of sand dunes, across which board walks lead to the beach. The island is reached by a regular steamboat service from Hoyer on the mainland to Munkmarsch, which is connected by a steam tram with Westerland. Another line of steamers runs from Hamburg to Sylt via Heligoland. During the Danish War of 1864, after suffering severely at the hands of the Danes, the island was occupied by the Prussians on the 13th of July (see FRISIAN ISLANDS).

See P. Knuth, *Botanische Wanderungen auf der Insel Sylt* (Tondern, 1890); C. P. Hansen, *Das Nordseebad Westerland auf Sylt* (Garding, 1891); Meyn, *Geologische Beschreibung der Insel Sylt* (Berlin, 1876); and Kepp, *Wegweiser auf Sylt* (Tondern, 1885).

SYLVANITE, a mineral consisting of gold and silver telluride, $AuAgTe_4$, containing gold 24·2 and silver 13·3 %; an important ore of gold. Crystals are monoclinic and often very rich in faces; they are frequently twinned, giving rise to branching forms resembling written characters; on this account the mineral was early known as "graphic gold" or "graphic tellurium" (Ger. *Schrifterz*). It was also known as "white gold," the colour being tin-white with a brilliant metallic lustre. The hardness is 2 and the specific gravity 8·2. It occurs with native gold in veins traversing porphyry at Offenbánya and Nagyág, near Déva in Transylvania (from which country it takes its name); also at several places in Boulder county, Colorado, and at Kalgoorlie in Western Australia. Sylvanite may be readily distinguished from calaverite ($AuTe_2$) by its perfect cleavage in one direction (parallel to the plane of symmetry), but in this character it resembles the very rare orthorhombic mineral krennerite ($[Au, Ag]Te_2$). (L. J. S.)

SYLVESTER, JAMES JOSEPH (1814–1897), English mathematician, was born in London on the 3rd of September 1814. He went to school first at Highgate and then at Liverpool, and in 1831 entered St John's College, Cambridge. In his Tripos examination, which through illness he was prevented from taking till 1837, he was placed as second wrangler, but being a Jew and unwilling to sign the Thirty-nine Articles, he could not compete for one of the Smith's prizes and was ineligible for a fellowship, nor could he even take a degree: this last, however, he obtained at Trinity College, Dublin, where religious restrictions were no longer in force. After leaving Cambridge he was appointed to the chair of natural philosophy at University College, London, where his friend A. De Morgan was one of his colleagues, but he resigned in 1840 in order to become professor of mathematics in the university of Virginia. There, however, he remained only six months, for certain views on slavery, strongly held and injudiciously expressed, entailed unpleasant consequences, and necessitated his return to England, where he obtained in 1844 the post of actuary to the Legal and Equitable Life Assurance Company. In the course of the ensuing ten years he published a large amount of original work, much of it dealing with the theory of invariants, which marked him as one of the foremost mathematicians of the time. But he failed to obtain either of two posts—the professorships of mathematics at the Royal Military Academy and of geometry in Gresham College—for which he applied in 1854, though he was elected to the former in the following year on the death of his successful competitor. At Woolwich he remained until 1870, and although he was not a great success as an elementary teacher, that period of his life was very rich in mathematical work, which included remarkable advances in the theory of the partition of numbers and further contributions to that of invariants, together with an important research which yielded a proof, hitherto lacking, of Newton's rule for the discovery of imaginary roots for algebraical equations up to and including the fifth degree. In 1874 he produced several papers suggested by A. Peaucellier's discovery of the straight line link motion associated with his name, and he also invented the skew pentagraph. Three years later he was appointed professor of mathematics in the Johns Hopkins University, Baltimore, stipulating for an annual salary of $5000, to be paid in gold. At Baltimore he gave an enormous impetus to the study of the higher mathematics in America, and during the time he was there he contributed to the *American Journal of Mathematics*, of which he was the first editor, no less than thirty papers, some of great length, dealing mainly with modern algebra, the theory of numbers, theory of partitions and universal algebra. In 1883 he was chosen to succeed Henry Smith in the Savilian chair of geometry at Oxford, and there he produced his theory of reciprocants, largely by the aid of his "method of infinitesimal variation." In 1893 loss of health and failing eyesight obliged him to give up the active duties of his chair, and a deputy professor being appointed, he went to live in London, where he died on the 15th of March 1897. Sylvester's work suffered from a certain lack of steadiness and method in his character. For long periods he was mathematically unproductive, but then sudden inspiration would come upon him and his ideas and theories poured forth far more quickly than he could record them. All the same his output of work was as large as it was valuable. The scope of his researches was described by Arthur Cayley, his friend and fellow worker, in the following words: "They relate chiefly to finite analysis, and cover by their subjects a large part of it—algebra, determinants, elimination, the theory of equations, partitions, tactic, the theory of forms, matrices, reciprocants, the Hamiltonian numbers, &c.; analytical and pure geometry occupy a less prominent position; and mechanics, optics and astronomy are not absent." Sylvester was a good linguist, and a diligent composer of verse, both in English and Latin, but the opinion he cherished that his poems were on a level with his mathematical achievements has not met with general acceptance.

The first volume of his *Collected Mathematical Papers*, edited by H. F. Baker, appeared in 1904.

SYLVESTER, JOSHUA (1563–1618), English poet, the son of a Kentish clothier, was born in 1563. In his tenth year he was sent to school at Southampton, where he gained a knowledge of French. After about three years at school he appears to have been put to business, and in 1591 the title-page of his *Yvry* states that he was in the service of the Merchant Adventurers' Company. He was for a short time a land steward, and in 1606 Prince Henry gave him a small pension as a kind of court poet. In 1613 he obtained a position as secretary to the Merchant Adventurers. He was stationed at Middelburg, in the Low Countries, where he died on the 28th of September 1618. He translated into English heroic couplets the scriptural epic of Guillaume du Bartas. His *Essay of the Second Week* was published in 1598; and in 1604 *The Divine Weeks of the World's Birth*. The ornate style of the original offered no difficulty to Sylvester, who was himself a disciple of the Euphuists and added many adornments of his own invention. The *Sepmaines* of Du Bartas appealed most to his English and German co-religionists, and the translation was immensely popular. It has often been suggested that Milton owed something in the conception of *Paradise Lost* to Sylvester's translation. His popularity ceased with the Restoration, and Dryden called his verse "abominable fustian."

His works were reprinted by Dr A. B. Grosart (1880) in the "Chertsey Worthies Library." See also C. Dunster's *Considerations on Milton's early Reading* (1800).

SYLVITE, a mineral consisting of potassium chloride (KCl), first observed in 1823, as an encrustation on Vesuvian lava. Well-formed crystals were subsequently found in the salt deposits of Stassfurt in Prussia and Kalusz in Austrian Galicia. It crystallizes in the cubic system with the form of cubes and cubo-octahedra and possesses perfect cleavages parallel to the faces of the cube. Although the crystals are very similar in appearance to crystals of common salt, they are proved by etching experiments to possess a different degree of symmetry, namely plagihedral-cubic, there being no planes of symmetry but the full number of axes of symmetry. Crystals are colourless (sometimes bright blue) and transparent; the hardness is 2 and the specific gravity 1·98. Like salt, it is highly diathermanous. The name sylvite or sylvine is from the old pharmaceutical name, *sal digestivus sylvii*, for this salt. (L. J. S.)

SYMBOL (Gr. σύμβολον, a sign), the term given to a visible object representing to the mind the semblance of something which is not shown but realized by association with it. This is conveyed by the ideas usually associated with the symbol; thus the palm branch is the symbol of victory and the anchor of hope. Much of early Christian symbolism owes its origin to pagan sources, the interpretations of the symbols having a different meaning; thus "the Good Shepherd with the lamb" is thought by some to have been derived from the figure of Hermes (Mercury) carrying the goat to sacrifice, and "Orpheus charming the wild beasts," which, when painted in the catacombs, was probably intended as the representation of a type of Christ. One of the earliest symbols of the Saviour, the fish, was derived from an acrostic of the Greek word ἰχθύς, the component letters of which were the initials of the five words Ἰησοῦς Χριστός, Θεοῦ Υἱός, Σώτηρ, Jesus Christ, Son of God, Saviour. The ship, another early symbol, represented the Church in which the faithful are carried over the sea of life. Other symbols are those which were represented by animals, real or fabulous, and were derived from Scripture: thus the lamb typified Christ from St John's Gospel (i. 29 and 36), and the lion from the Book of Revelations, in which Christ is called the "Lion of the tribe of Judah." The peacock stood for immortality; the phoenix for the Resurrection; the dragon or the serpent for Satan; and the stag for the soul thirsting for baptism. The sacred monogram Chi Rho, ☧ supposed to have been the celestial sign seen by the emperor Constantine on the eve of the defeat of Maxentius, represents the two first letters of the Greek word

Χριστός which Constantine figured on his labarum, or standard, and is found on early Christian coins, bearing also the favourite decoration of the Byzantine sarcophagi. The four evangelical symbols are taken from the book of Ezekiel and from the Book of Revelations; thus the winged man is St Matthew, the winged lion St Mark, the winged ox St Luke and the eagle St John; and these four symbols became the favourite subject for representation in the Church. Besides these the other evangelists and the saints carry emblems by which they may be recognized; thus St Andrew by the cross, St Peter by the keys, St Paul by the sword, St Edward by a cup and dagger, St Mary Magdalene by a box or vase, St Lawrence by a gridiron, St Faith also by a gridiron, &c.

SYME, JAMES (1799–1870), Scottish surgeon, was born at Edinburgh on the 7th of November 1799. His father was a writer to the signet and a landowner in Fife and Kinross, who lost most of his fortune in attempting to develop the mineral resources of his property. James was sent to the high school at the age of nine, and remained until he was fifteen, when he entered the university. For two years he frequented the arts classes (including botany), and in 1817 began the medical curriculum, devoting himself with particular keenness to chemistry. His chemical experiments led him to the discovery that "a valuable substance is obtainable from coal tar which has the property of dissolving india-rubber," and could be used for waterproofing silk and other textile fabrics—an idea which was patented a few months afterwards by Charles Mackintosh, of Glasgow. In the session 1818–1819 Syme became assistant and demonstrator of the dissecting room of Robert Liston, who had started as an extra-mural teacher of anatomy in competition with his old master, Dr John Barclay; in those years he held also resident appointments in the infirmary and the fever hospital, and spent some time in Paris practising dissection and operative surgery. In 1823 Liston handed over to him the whole charge of his anatomy classes, retaining his interest in the school as a pecuniary venture; the arrangement did not work smoothly, and a feud with Liston arose, which did not terminate until twenty years later, when the latter was settled in London. In 1824–1825 he started the Brown Square school of medicine, but again disagreed with his partners in the venture. Announcing his intention to practise surgery only, Syme started a surgical hospital of his own, Minto House hospital, which he carried on from May 1829 to September 1833, with great success as a surgical charity and school of clinical instruction. It was here that he first put into practice his method of clinical teaching, which consisted in having the patients to be operated or prelected upon brought from the ward into a lecture-room or theatre where the students were seated conveniently for seeing and taking notes. His private practice had become very considerable, his position having been assured ever since his amputation at the hip joint in 1823, the first operation of the kind in Scotland. In 1833 he succeeded James Russell as professor of clinical surgery in the university. Syme's accession to the clinical chair was marked by two important changes in the conditions of it: the first was that the professor should have the care of surgical patients in the infirmary in right of his professorship, and the second, that attendance on his course should be obligatory on all candidates for the medical degree. When Liston removed to London in 1835 Syme became the leading consulting surgeon in Scotland. On Liston's death in 1847 Syme was offered his vacant chair of clinical surgery at University College, London, and accepted it. He began practice in London in February 1848; but early in May the same year difficulties with two of his colleagues at Gower Street and a desire to "escape from animosity and contention" led him to throw up his appointment. He returned to Edinburgh in July, and was reinstated in his old chair, to which the crown authority had meanwhile found a difficulty in appointing. The judgment of his friends was that "he was always right in the matter, but often wrong in the manner, of his quarrels." In 1849 he broached the subject of medical reform in a letter to the lord advocate; in 1854 and 1857 he addressed open letters on the same subject to Lord Palmerston; and in 1858 a Medical Act was passed which largely followed the lines laid down by himself. As a member of the general medical council called into existence by the act, he made considerable stir in 1868 by an uncompromising statement of doctrines on medical education, which were thought by many to be reactionary; they were, however, merely an attempt to recommend the methods that had been characteristic of Edinburgh teaching since William Cullen's time—namely, a constant reference of facts to principles, the subordination (but not the sacrifice) of technical details to generalities, and the preference of large professional classes and the "magnetism of numbers" to the tutorial system, which he identified with "cramming." In April 1869 he had a paralytic seizure, and at once resigned his chair; he never recovered his powers, and died near Edinburgh on the 26th of June 1870.

Syme's surgical writings were numerous, although the terseness of his style and directness of his method saved them from being bulky. In 1831 he published *A Treatise on the Excision of Diseased Joints* (the celebrated ankle-joint amputation is known by his name). His *Principles of Surgery* (often reprinted) came out a few months later; *Diseases of the Rectum* in 1838; *Stricture of the Urethra and Fistula in Perineo* in 1849; and *Excision of the Scapula* in 1864. In 1848 he collected into a volume, under the title of *Contributions to the Pathology and Practice of Surgery*, thirty-one original memoirs published in periodicals from time to time; and in 1861 he issued another volume of *Observations in Clinical Surgery*. Syme's character is not inaptly summed up in the dedication to him by his old pupil, Dr John Brown, of the series of essays *Locke and Sydenham*: "Verax, capax, perspicax, sagax, efficax, tenax."

See *Memorials of the Life of James Syme*, by R. Paterson, M.D., with portraits (Edinburgh, 1874).

SYMEON METAPHRASTES,[1] the most renowned of the Byzantine hagiographers. Scholars have been very much divided as to the period in which he lived, dates ranging from the 9th century to the 14th having been suggested; but it is now generally agreed that he flourished in the second half of the 10th century. Still greater divergences of opinion have existed as to the lives of saints coming from his pen, and here again the solution of the problem has been attained by studying the composition of the great Greek menologies. The menology of Metaphrastes is a collection of lives of saints for the twelve months of the year, easily recognizable among analogous collections, and consisting of about 150 distinct pieces, some of which are taken bodily from older collections, while others have been subjected to a new recension (μετάφρασις). Among other works attributed (though with some uncertainty) to Symeon are a *Chronicle*, a canonical collection, some letters and poems, and other writings of less importance. Symeon's great popularity is due more particularly to his collection of lives of saints. About his life we know only very few details. The Greeks honour him as a saint on the 28th of November, and an office has been composed in his honour.

See L. Allatius, *De Symeonum scriptis diatriba* (Paris, 1664); F. Hirsch, *Byzantinische Studien*, pp. 303–355 (Leipzig, 1876); A. Ehrhard, *Die Legendensammlung des Symeon Metaphrastes* (Rome, 1897); and in *Römische Quartalschrift* (1897), pp. 67–205 and 531–553; H. Delehaye, *La Vie de S. Paul le jeune et la chronologie de Métaphraste* (1893); *Analecta Bollandiana*, xvi. 312–327 and xvii. 448–452. (H. De.)

SYMMACHUS, pope from 498 to 514, had Anastasius II. for his predecessor and was himself followed by Hormisdas. He was a native of Sardinia, apparently a convert from paganism, and was in deacon's orders at the time of his election. The choice was not unanimous, another candidate, Laurentius, having the support of a strong Byzantine party; and both competitors were consecrated by their friends, the one in the Lateran Church and the other in that of St Mary, on the 22nd of November 498. A decision was not long afterwards obtained in favour of Symmachus from Theodoric, to whom the dispute had been referred; but peace was not established until 505 or 506, when the Gothic king ordered the Laurentian party to surrender the churches of which they had taken possession. An important incident in the protracted controversy was the

[1] The surname is based on the title, *Metaphrasis*, of some of his works.

decision of the "palmary synod." The remainder of the pontificate of Symmachus was uneventful; history speaks of various churches in Rome as having been built or beautified by him.

SYMMACHUS, the name of a celebrated Roman family of the 4th to 6th centuries of our era. It belonged to the gens Aurelia and can be traced back to Aurelius Julianus Symmachus, proconsul of Achaea (according to others, vicar or vice-prefect of Macedonia) in the year 319. Lucius Aurelius Avianius Symmachus, presumably his son, was prefect of Rome in the year 364, and had also other important posts. He was celebrated for his virtues and the senate awarded him in 377 a gilded statue.

QUINTUS AURELIUS SYMMACHUS (*c.* 345–410), son of the last-named, was one of the most brilliant representatives in public life and in the literature of 4th-century paganism in Rome. He was educated in Gaul, and, having discharged the functions of praetor and quaestor, rose to higher offices, and in 373 was proconsul of Africa (for his official career see *C.I.L.* vi. 1699). His public dignities, which included that of pontifex maximus, his great wealth and high character, added to his reputation for eloquence, marked him out as the champion of the pagan senate against the measures which the Christian emperors directed against the old state religion of Rome. In 382 he was banished from Rome by Gratian for his protest against the removal of the statue and altar of Victory from the senate-house (see Gibbon, *Decline and Fall*, ch. 28), and in 384, when he was prefect of the city, he addressed to Valentinian II. a letter praying for the restoration of these symbols. This is the most interesting of his literary remains, and called forth two replies from St Ambrose, as well as a poetical refutation from Prudentius. After this Symmachus was involved in the rebellion of Maximus, but obtained his pardon from Theodosius, and appears to have continued in public life up to his death. In 391 he was Consul ordinarius. His honesty, both in public and in private affairs, and his amiability made him very popular. The only reproach that could be made against this last valiant defender of paganism is a certain aristocratic conservativeness, and an exaggerated love of the past. As his letters do not extend beyond the year 402, he probably died soon after that date.

Of his writings we possess: (1) *Panegyrics*, written in his youth in a very artificial style, two on Valentinian I. and one on the youthful Gratian. (2) Nine books of Epistles, and two from the tenth book, published after his death by his son. The model followed by the writer is Pliny the Younger, and from a reference in the *Saturnalia* of Macrobius (bk. v., i. § 7), in which Symmachus is introduced as one of the interlocutors, it appears that his contemporaries deemed him second to none of the ancients in the "rich and florid" style. We find them vapid and tedious. (3) Fragments of *Complimentary Orations*, five from a palimpsest (also containing the *Panegyrics*), of which part is at Milan and part in the Vatican, discovered by Mai, who published the Milan fragments in 1815, the Roman in his *Scriptorum veterum nova collectio*, vol. i. (1825), and the whole in 1846. (4) The *Relationes*, which contain an interesting account of public life in Rome, composed for the emperor. In these official writings (reports as prefect of the city), Symmachus is not preoccupied by style and becomes sometimes eloquent; especially so in his remarkable report on the altar of Victory.

His son, QUINTUS FABIUS MEMMIUS SYMMACHUS, was proconsul of Africa (415) and prefect of the city (418). He was probably the father of the Symmachus who was consul in 446, and whose son was QUINTUS AURELIUS MEMMIUS SYMMACHUS (d. 525), patrician, one of the most cultivated noblemen of Rome of the beginning of the 6th century, editor (*e.g.* of Macrobius, *Somnium Scipionis*) and historian, and especially celebrated for his building activity. He was consul in 485. Theodoric charged him with the restoration of the theatre of Pompey. He was father-in-law of Boëtius (*q.v.*), and was involved in his fate, being disgraced and finally put to death by Theodoric in 525.

See E. Morin, *Études sur Symmaque* (1847); G. Boissier, *La Fin du paganisme* (1891), vol. ii.; T. R. Glover, *Life and Letters in the Fourth Century* (1901); S. Dill, *Roman Society in the last century of the Western Empire* (1898); T. Hodgkin, *Italy and her Invaders*, (1880–1899) vol. iii. (on the Boëtius "conspiracy"); M. Schanz, *Geschichte der römischen Litteratur* (1904), vol. iv. pt. 1; and Teuffel-Schwabe, *Hist. of Roman Literature* (Eng. trans., 1900), pp. 425, 477, 4. All editions of the works of Symmachus are now superseded by that of O. Seeck in *Monumenta Germaniae historica. Auctores antiquissimi* (1883), vi. 1, with introductions on his life, works and chronology, and a genealogical table of the family.

SYMONDS, JOHN ADDINGTON (1840–1893), English critic and poet, was born at Bristol, on the 5th of October 1840. He was the only son of John Addington Symonds, M.D. (1807–1871), the author of an essay on *Criminal Responsibility* (1869), *The Principles of Beauty* (1857) and *Sleep and Dreams* (2nd ed., 1857). His mother, Harriet Symonds, was the eldest daughter of James Sykes of Leatherhead. He was a delicate boy, and at Harrow, where he was entered in 1854, took no part in school games and showed no particular promise as a scholar. In 1858 he proceeded to Balliol as a commoner, but was elected to an exhibition in the following year. The Oxford training and association with the brilliant set of men then at Balliol called out the latent faculties in Symonds, and his university career was one of continual distinction. In 1860 he took a first in "Mods," and won the Newdigate with a poem on *The Escorial*; in 1862 he was placed in the first class in Literae Humaniores, and in the following year was winner of the Chancellor's English Essay. In 1862 he had been elected to an open fellowship at Magdalen. The strain of study unfortunately proved too great for him, and, immediately after his election to a fellowship, his health broke down, and he was obliged to seek rest in Switzerland. There he met Janet Catherine North, whom, after a romantic betrothal in the mountains, he married at Hastings on the 10th of November 1864. He then attempted to settle in London and study law, but his health again broke down and obliged him to travel. Returning to Clifton, he lectured there, both at the college and to ladies' schools, and the fruits of his work in this direction remain in his *Introduction to the Study of Dante* (1872) and his admirably vivid *Studies of the Greek Poets* (1873–1876). Meanwhile he was occupied upon the work to which his talents and sympathies were especially attracted, his *Renaissance in Italy*, which appeared in seven volumes at intervals between 1875 and 1886. The *Renaissance* had been the subject of Symonds' prize essay at Oxford, and the study which he had then given to the theme aroused in him a desire to produce something like a complete picture of the reawakening of art and literature in Europe. His work, however, was again interrupted by illness, and this time in a more serious form. In 1877 his life was in acute danger, and upon his removal to Davos Platz and subsequent recovery there it was felt that this was the only place where he was likely to be able to enjoy life. From that time onward he practically made his home at Davos, and a charming picture of his life there will be found in *Our Life in the Swiss Highlands* (1891). Symonds, indeed, became in no common sense a citizen of the town; he took part in its municipal business, made friends with the peasants, and shared their interests. There he wrote most of his books: biographies of Shelley (1878), Sir Philip Sidney (1886), Ben Jonson (1886), and Michelangelo (1893), several volumes of poetry and of essays, and a fine translation of the *Autobiography of Benvenuto Cellini* (1887). There, too, he completed his study of the *Renaissance*, the work by which he will be longest remembered. He was assiduously, feverishly active throughout the whole of his life, and the amount of work which he achieved was wonderful when the uncertainty of his health is remembered. He had a passion for Italy, and for many years resided during the autumn in the house of his friend, Horatio F. Brown, on the Zattare, in Venice. He died at Rome on the 19th of April 1893, and was buried close to Shelley.

He left his papers and his autobiography in the hands of Mr Brown, who published in 1895 an excellent and comprehensive biography. Two works from his pen, a volume of essays, *In the Key of Blue*, and a monograph on *Walt Whitman*, were published in the year of his death. His activity was unbroken to the last. In life Symonds was morbidly introspective, a Hamlet among modern men of letters, but with a capacity for action which Hamlet was denied. Robert Louis Stevenson described him, in the Opalstein of *Talks and Talkers*, as "the best of talkers, singing the praises of the earth and the arts, flowers and jewels, wine and music, in a moonlight, serenading manner, as to the light guitar." But under his excellent good-fellowship lurked a haunting melancholy. Full of ardour and ambition, sympathy and desire, he was perpetually tormented by the riddles of existence; through life he was always a seeker, ardent but unsatisfied. This side of his nature stands revealed in his gnomic poetry, and particularly in the sonnets of his *Animi Figura* (1882), where he has portrayed his own character with great subtlety. His poetry is perhaps rather that of the student than of the inspired singer, but it has moments of deep thought and emotion. It is, indeed, in passages and extracts that Symonds appears at his best. Rich in description, full of "purple patches," his work has not that harmony and unity that are essential to the conduct of philosophical argument. He saw the part more clearly than the whole; but his view, if partial, is always vivid and concentrated. His translations are among the finest in the language; here his subject was found for him, and he was able to lavish on it the wealth of colour and quick sympathy which were his characteristics. He was a lover of beauty, a poet and a philosopher; but in his life and his work alike he missed that absolute harmony of conviction and concentration under which alone the highest kind of literature is produced. (A. Wa.)

SYMONDS, WILLIAM SAMUEL (1818–1887), was born in Hereford in 1818. He was educated at Cheltenham and Christ's College, Cambridge, where he graduated B.A. in 1842. Having taken holy orders he was appointed curate of Offenham, near Evesham in 1843, and two years later he was presented to the living of Pendock in Worcestershire, where he remained until 1877. While at Offenham he became acquainted with H. E. Strickland and imbibed from him such an interest in natural history and geology, that his leisure was henceforth devoted to these subjects. He was one of the founders of the Woolhope Naturalists' Field Club (1851) and of the Malvern Naturalists' Field Club (1853), and was an active member of the Cotteswold Field Club and other local societies. In 1858 he edited an edition of Hugh Miller's *Cruise of the "Betsey."* He was the author of numerous essays on the geology of the Malvern country, notably of a paper "On the passage-beds from the Upper Silurian rocks into the Lower Old Red Sandstone at Ledbury" (*Quart. Journ. Geol. Soc.* 1860). His principal work was *Records of the Rocks* (1872). He was author of *Stones of the Valley* (1857), *Old Bones, or Notes for Young Naturalists* (1859, 2nd ed. 1864), and other popular works. He died at Cheltenham on the 15th of September 1887.

See *A Sketch of the Life of the Rev. W. S. Symonds*, by the Rev. J. D. La Touche.

SYMOND'S YAT, one of the most famous view points on the river Wye, England. At a point 9 m. above Monmouth and 12 m. below Ross by water, the Wye makes a sweep of nearly 5 m. round a peninsula whose neck is only some 600 yds. across. The peninsula is occupied by the limestone acclivity of Huntsham Hill. Caverns are seen in the limestone on both precipitous banks of the river. The Yat or Gate is situated on the west side of the neck, which reaches an elevation over 500 ft., and a road from the east drops to a ferry, which was of early importance as a highway between England and Wales. The boundary between Herefordshire and Gloucestershire crosses the neck; the Yat is in the county first named, but the railway station, on the east side (left bank) is in Gloucestershire. It is on the Ross-Monmouth line of the Great Western railway. There are here groups of cottages and several inns on both banks, while opposite the Yat itself is the hamlet of New Weir, and a little above it the village of Whitchurch. The river banks are densely wooded, except where they become sheer cliffs, as at the Coldwell rocks above the station. The surrounding country is hilly and rich, and the views from the Yat are superb, embracing the Forest of Dean to the south and east, and backed by the mountains of the Welsh border in the west.

SYMONS, ARTHUR (1865–), English poet and critic, was born in Wales on the 28th of February 1865, of Cornish parents. He was educated privately, spending much of his time in France and Italy. In 1884-1886 he edited four of Quaritch's *Shakespeare Quarto Facsimiles*, and in 1888–1889 seven plays of the "Henry Irving" Shakespeare. He became a member of the staff of the *Athenaeum* in 1891, and of the *Saturday Review* in 1894. His first volume of verse, *Days and Nights* (1889), consisted of dramatic monologues. His later verse is influenced by a close study of modern French writers, of Baudelaire and especially of Verlaine. He reflects French tendencies both in the subject-matter and style of his poems, in their eroticism and their vividness of description. His volumes of verse are: *Silhouettes* (1892), *London Nights* (1895), *Amoris victima* (1897), *Images of Good and Evil* (1899), *A Book of Twenty Songs* (1905). In 1902 he made a selection from his earlier verse, published as *Poems* (2 vols.). He translated from the Italian of Gabriele d'Annunzio *The Dead City* (1900) and *The Child of Pleasure* (1898), and from the French of Émile Verhaeren *The Dawn* (1898). To *The Poems of Ernest Dowson* (1905) he prefixed an essay on the deceased poet, who was a kind of English Verlaine and had many attractions for Mr Symons. Among his volumes of collected essays are: *Studies in Two Literatures* (1897), *The Symbolist School in Literature* (1899), *Cities* (1903), word-pictures of Rome, Venice, Naples, Seville, &c., *Plays, Acting and Music* (1903), *Studies in Prose and Verse* (1904), *Spiritual Adventures* (1905), *Studies in Seven Arts* (1906).

SYMONS, GEORGE JAMES (1838–1900), English meteorologist, was born in Pimlico, London, on the 6th of August 1838. In 1860 he obtained a post in the meteorological department of the Board of Trade under Admiral Robert Fitzroy, who was then deeply interested in the subject of storm-warnings, and in the same year he published the first annual volume of *British Rainfall*, which contained records from 168 stations in England and Wales, but none from Scotland or Ireland. Three years later he resigned his appointment at the Board of Trade, where his rainfall inquiries were not appreciated—at least not as a prior study of storm-warnings—and devoted his whole energies to the organization of a band of volunteer observers for the collection of particulars of rainfall throughout the British Isles. So successful was he in this object that by 1866 he was able to show results which gave a fair representation of the distribution of rainfall, and the number of recorders gradually increased until the last volume of *British Rainfall* which he lived to edit (that for 1899) contained figures from 3528 stations—2894 in England and Wales, 446 in Scotland, and 188 in Ireland. Apart from their scientific interest, these annual reports are of great practical importance, since they afford engineers and others engaged in water supply much-needed data for their calculations, the former absence of which had on some occasions given rise to grave mistakes. Symons himself devoted special study not only to rainfall, but also to the evaporation and percolation of water as affecting underground streams, and his extensive knowledge rendered him a valuable witness before parliamentary committees. In other branches of meteorology also he took a keen interest, and he was particularly indefatigable, though consistently unsuccessful, in the quest of a genuine thunderbolt. The history of the science too attracted his attention, and he possessed a fine library of meteorological works, which passed to the Meteorological Society at his death. Of that society he became a member when only eighteen, and he retained his connexion with it in various official capacities up to the end of his life. He served as its president in 1880, and in view of the celebration of its jubilee was re-elected to that office in 1900, but the illness that caused his death prevented him from acting. He died in London on the 10th of March 1900.

SYMPATHETIC SYSTEM, in physiology. By the "sympathetic system" is understood a set of nerves and ganglia more or less sharply marked off from the cerebro-spinal, both functionally and anatomically. (For anatomy see NERVOUS SYSTEM.) Formerly it was thought more independent from the rest of the general nervous system than recent discoveries have found it actually to be. It used to be supposed that the ganglia of the sympathetic system were analogous in function to the great central nervous masses forming the brain and spinal cord. These latter masses, as now becomes more and more evident, are the only structures in which occurs the work of transmuting afferent-nerve impulses into efferent-nerve impulses with all the accompanying changes in intensity, rhythm; &c., which make up reflex action. Such functions, it is now known, are not attributable to sympathetic ganglia. These last are structures in which one neurone makes communication with other neurones. To that extent, therefore, redistribution of nervous impulses does occur in them, impulses arriving by a few neurones being distributed so as to affect many. But the sympathetic ganglia are not the seat of reflex action. The sympathetic system is now known to consist entirely of conducting paths which, like the nerve-trunks of the cerebro-spinal system, merely conduct nerve impulses either toward the great nervous centres of the spinal cord and brain, or, on the other hand, away from those great centres. In the cerebro-spinal nerves the preponderance of the conduction is toward the centres, in the sympathetic system the preponderance of conduction is away from the centres.

More is known of the sympathetic system from its efferent aspect than its afferent, and we shall consider the former first. One great difference between the efferent paths of the sympathetic and those of the ordinary cerebro-spinal system is that the former carry nervous impulses not only to muscular tissue but to secreting glands, whereas the latter convey them to muscle only, indeed only to muscle of the striated kind. Another difference is that the efferent path which the sympathetic affords from the great central nervous centres to its muscles and glands consists always of *two* nerve-cells or neurones, whereas the efferent path afforded by the cerebro-spinal motor nerves consists of one neurone only. The two neurones forming the sympathetic path are so arranged that one of them whose cell-body lies in the spinal cord has a long axone-process passing out from the cord in the motor spinal root, and this extends to a group of nerve-cells, a sympathetic ganglion, quite distant from the spinal cord and somewhere on the way to the distant organ which is to be innervated. In this ganglion the first sympathetic neurone ends, forming functional connexion with ganglion cells there. These ganglion cells extend each of them an axone process which attains the organ (muscular cell or gland cell), which it is the office of the sympathetic path to reach and influence. The axone-process of the first nerve cell is a myelinated nerve-fibre extending from the spinal cord to the ganglion; it constitutes the pre-ganglionic fibre of the conduction chain. The axone-process of the second nerve-cell, that is the neurone whose cell-body lies in the ganglion, is usually non-myelinate and constitutes the post-ganglionic fibre of the chain.

This construction, characteristic as it is of the sympathetic efferent path, has been found also in certain other efferent paths outside the sympathetic proper. And as these other efferent paths convey impulses to the same kind of organs and tissues as do those of the sympathetic itself, it has been proposed to embrace them and the sympathetic under one name, the *autonomic* system. This term includes all the efferent paths of the entire body excepting only those leading to the voluntary muscles.

That the term " autonomic system " is not merely a convenience of nomenclature, but really represents a physiological entity, seems indicated by the action of nicotin. This drug acts selectively on the autonomic ganglia and not on the cerebro-spinal. In the former it paralyses the nexus between pre-ganglionic and post-ganglionic fibre. It is by taking advantage of this property that many of the recent researches which have done so much to elucidate the sympathetic have been executed.

The term " autonomic system " must not be taken to imply that this system is independent of the central nervous system. As mentioned above in regard to the sympathetic, that is not the case. The autonomic system is closely connected with the central nervous system through the ordinary channel of the nerve-roots, spinal and cranial. It may, in fact, be regarded as an appendage of the cranial and spinal roots, or rather of certain of them, for with a considerable proportion of their number it is not connected.

The sympathetic is that part of the autonomic system which is connected with the spinal roots from the second thoracic to the second lumbar inclusive (man). Its ganglia are divided by anatomists into the vertebral, those which lie as a double chain on the ventral face of the vertebral column, and those which lie scattered at various distances among the viscera, the pre-vertebral. Langley has shown that there is no essential difference between these except that the vertebral send some of their post-ganglionic fibres into the spinal nerves, whereas the latter send all their fibres to the viscera. The sympathetic sends its post-ganglionic fibres—

1. To the muscular coats of the whole of the alimentary canal from the mouth to the rectum; to the glands opening into the canal from the salivary glands in front back to the intestinal glands; to the blood vessels of the whole of the canal frcm mouth to anus inclusive.

2. To the generative organs, external and internal, and to the muscular coats of the urinary bladder.

3. To the skin; (*a*) to its blood vessels, (*b*) to its cutaneous glands, (*c*) to unstriated muscle in the skin, *e.g.* the erectors of the hairs.

4. To the iris muscles and blood vessels of the eyeball.

The sympathetic nervous system is sometimes called the visceral. It will be seen from the above that this term is not well suited in some respects, because the sympathetic supplies many structures which are not visceral. Another objection is that a great deal of important nerve-supply to the viscera is furnished by parts of the autonomic system other than sympathetic. That the sympathetic does, however, of itself constitute a more or less homogeneous entity is indicated by a curious fact. The substance adrenalin, which is the active constituent of extracts of the adrenal gland, has the property when introduced into the circulation of exciting all over the body just those actions which stimulation of the efferent fibres of the sympathetic causes, and no others. It is possible that when a nerve is stimulated some body at the nerve ending is set free, and this by combining with another chemical substance induces activity in the end organ (gland or muscle). It may be that when a sympathetic nerve is excited adrenalin is set free and combines with some substance which induces activity.

The rest of the autonomic system consists of two portions, a cranial and a sacral, so called from their proceeding from cranial and sacral nerve-roots respectively. The cranial portion is subdivided into a part belonging to the mid-brain and a part belonging to the hind-brain. The ciliary ganglion belonging to the eyeball is the ganglion of the former part, and its post-ganglionic fibres innervate the iris and the ciliary muscles. The hind-brain portion gives pre-ganglionic fibres to the facial (intermedius) glossopharyngeal and vagus nerves; its post-ganglionic distribution is to the blood vessels of the mucous membrane of the mouth and throat, to the musculature of the digestive tube from the oesophagus to the colon, to the heart, and to the musculature of the windpipe and lungs.

The sacral part of the autonomic system issues from the spinal cord with the three foremost sacral nerves. Its ganglia are scattered in the neighbourhood of the pelvic organs, which they innervate. The distribution of its post-ganglionic fibres is to the arteries of rectum, anus and external genitalia, to the musculature of colon, rectum, anus and the urinary bladder, and to that of the external genitalia.

The part played by the sympathetic and the rest of the autonomic system in the economy of the body is best considered by following broad divisions of organic functions.

Movements of the Digestive Tube.—It is those movements of alimentation not usually within range of our consciousness which the autonomic system regulates and controls. Nor is its control over them apparently essential or very complete. For instance, the pendular and peristaltic movements of the intestine still go forward when all nerves reaching the viscus have been severed. Extirpation of the abdominal sympathetic has not led to obvious disturbance of digestion or nutrition in the dog. It is noteworthy that the sympathetic inhibits contraction of the musculature of the stomach and intestine, while the other, the vagus, portion of the autonomic system excites it. The actions of these two components of the system are, therefore, mutually opposed on the viscera innervated by both.

Action on the Circulation.—The blood supply of most organs is under the control of vaso-constrictor nerves. All vaso-constrictor nerves are sympathetic. Organs to which vaso-constrictor nerves are supplied either poorly or not at all are the lungs, heart, liver, brain and probably the skeletal muscles. The blood vessels of certain parts of the body have, in addition to vaso-constrictor nerves, nerves which relax their muscular wall, vaso-dilatator nerves. The latter are never furnished by the sympathetic, they are in the mucous membranes and glands at the oral end of the body furnished by the cranial portion of the autonomic system. In regions at the aboral end of the body they are furnished by the sacral portion of the autonomic system. Elsewhere the vaso-dilatators when present are derived from the nerve-cells of the spinal ganglia (Bayliss).

The control of the calibre of the blood vessels by the autonomic system is of importance in several well-ascertained respects. By constricting the blood vessels of the viscera the system is able to favour an increase of blood supply to the brain. A noteworthy instance of such an action occurs when the erect attitude is assumed after a recumbent posture. Were it not for vaso-constriction in the abdominal organs the blood would then, under the action of gravity, sink into the more dependent parts of the body and the brain would be relatively emptied of its supply, and fainting and unconsciousness result. Again, it is essential to the normal functioning of the organs of warm-blooded animals that their temperature, except in the surface layer of the skin, should be kept constant. Part of the regulative mechanism for this lies in nervous control of the quantity of blood flowing through the surface sheet of the skin. That sheet is a cool zone through which a greater or smaller quantity of blood may, as required, be led and cooled. By the sympathetic vaso-constrictors the capacity of these vessels in the cool zone can be reduced, and thus the loss of heat from the body through that channel lessened. In cold weather the vaso-constrictors brace up these skin vessels and lessen the loss of heat from the body's surface. In hot weather the tonus of these nerves is relaxed and the skin vessels dilate; a greater proportion of the blood then circulates through the comparatively cool skin-zone.

The heart itself is but a specialized part of the blood-vascular tubing, and its musculature, like that of the arteries, receives motor nerves from the sympathetic. These nerves to the heart from the sympathetic are known as the accelerators, since they quicken and augment the beating of the cardiac muscle. The heart receives also nerves from the cranial part of the autonomic system, and the influence of these nerves is antagonistic to that of the sympathetic supply. The cranial autonomic nerves to the heart pass via the vagus nerves and lessen the beating of the heart both as to rate and force. These inhibitory nerves of the heart are analogous to the dilatator nerves to the blood vessels, which, as mentioned above, come not from the sympathetic, but from the cranial and sacral portions of the autonomic system.

Skin-glands.—In close connexion with the temperature regulating function of the sympathetic stands its influence on the sweat secreting glands of the skin. Secretory nerves to the sweat glands are furnished apparently exclusively by the sympathetic.

Pilomotor Nerves.—The skin in many places contains muscle of the unstriped kind. Contraction of this cutaneous muscular tissue causes knotting of the skin as in "goose-skin," and erection of the hairs as in the cat, or of the quills as in the hedgehog and porcupine. The efferent nerve-fibres to the unstriped muscles of the skin are always furnished by the sympathetic (pilomotor nerves, &c.). In this case the sympathetic contributes to emotional reactions and perhaps further to the regulation of temperature, as by ruffling the fur or feathers in animals exposed to the cold.

The Respiratory Tube.—The windpipe and the air passages of the lungs contain in their walls much unstriped muscular tissue, arranged so as to control the calibre of the lumen. The nerve-supply to this muscular tissue is furnished by the cranial autonomic system via the vagus nerves.

Eyeball.—An important office of the sympathetic is the controlling of the brightness of the visual image by controlling the size of the pupil. The sympathetic sends efferent fibres to the dilatator muscle of the pupil. In this case, as in others noted above, the cranial part of the autonomic system sends nerves of antagonistic effect to those of the sympathetic, first through the third cranial nerves from the efferent fibres to the constrictor muscle of the pupil. This same part of the cranial autonomic system supplies also motor fibres to the ciliary muscle, thus effecting the accommodation of the lens for focusing clearly objects within the range of what is termed near-vision.

Of the afferent fibres of the sympathetic little is known save that they are, relatively to the efferent, few in number, and that they, like the afferents of the cerebro-spinal system, are axones of nerve-cells seated in the spinal ganglia. (C. S. S.)

SYMPHONIA (Gr. *συμφωνία*), a much discussed word, applied at different times (1) to the bagpipe, (2) to the drum, (3) to the hurdy-gurdy, and finally (4) to a kind of clavichord. The sixth of the musical instruments enumerated in Dan. iii. 5, 10, 15, erroneously translated "dulcimer," in all probability refers to the bagpipe (*q.v.*). *Symphonia*, signifying drum, occurs in the writings of Isidor of Seville. "Tympanum est pellis vel corium ligno ex una parte extentum. Est enim pars media symphoniae in similitudinem cribri. Tympanum autem dictum quod medium est. Unde, et margaritum medium tympanum dicitur, et ipsum ut symphonia ad virgulam percutitur." The reference comparing the tympanum (kettledrum) to half a pearl is borrowed from Pliny (*Nat. hist. IX.* 35, 23). *Symphonia* or *Chifonie* was applied during the 13th and 14th centuries, in the Latin countries more especially, to the hurdy-gurdy. *Symphonia* is applied by Praetorius[1] to an instrument which he classed with the clavichord, spinet, regals and virginal, but without giving any clue to its distinctive characteristics. (K. S.)

SYMPHONIC POEM (*Symphonische Dichtung*, *Tondichtung*, *Poème symphonique*, &c.). This term covers the experiments in a new style of instrumental music which first showed a coherent method in the twelve *Symphonische Dichtungen* of Liszt. The term at present implies a large orchestral composition which, whatever its length and changes of tempo, is not broken up into separate movements, and which, moreover, illustrates a definite poetic train of thought that can be expressed in literature, whether it is actually so expressed or not. Thus the form of the symphonic poem is the form dictated by its written programme or unwritten poetic idea; and so it is not every piece of "programme music" that can be called a symphonic poem. Beethoven's sonata *Les Adieux*, and his *Pastoral Symphony*, are, for instance, works in which the poetic idea does not interfere with the normal development of sonata style required by the musical nature of Beethoven's material.

Great disturbances in musical art have always been accompanied by constant appeals to external literary ideas; and there is nothing peculiarly modern in the present tendency to attack and defend the rising style of large indivisible schemes of instrumental music by unprofitable metaphysical discussions as to the claims of "absolute music" against "music embodying poetic ideas." New art-forms are not born mature, and in their infancy their parent arts naturally invite other arts to stand godfather. If the rise of the sonata style was not accompanied by as much "programme music" as the new art of the present day (and as a matter of fact it was accompanied by a good deal), it at all events coincided with highly Wagnerian discussions

[1] See "Syntagm. mus." pt. ii., *De organographia*, pp. 72, 73, 178 (Wolfenbüttel, 1618).

of dramatic music on literary grounds. What is certain is, firstly, that no amount of theorizing can prevent a musician from developing his musical ideas; secondly, that musical ideas are just as likely to be inspired by literature and other arts as by any other kind of experience; and lastly, that, as musicians attain greater mastery in the handling of their ideas, their musical readiness soon outstrips their powers or inclination for literary analysis, at all events while they are working at the music. Hence the frequent ability of great composers to set inferior words to music which is not only great but evidently based upon those words. Hence the digust of great composers at even the cleverest unauthorized literary interpretations of their works. Hence, on the other hand, the absence of any general classical attitude of vigorous protest against the use of music to convey external ideas. Be this as it may, we believe the importance of the symphonic poem to lie not in its illustrative capacity, but in its evident tendency towards a new kind of instrumental art.

It is not mere convention and prejudice that has delayed the ripening of this art. Every classical art-form is made by the greatest artists to be a natural thing in every individual case, no matter how artificial the conditions of the form become in ordinary hands. In the highest classical art not even a thousand examples identical in form would really be examples of an art-form set up like a mould for the material to be shovelled into it. In each case, however much the artist may have been helped by custom, his material would have taken that shape by its own nature. A sufficient number of sufficiently similar cases of this kind may conveniently, though dangerously, be regarded as establishing an art-form; and most art-forms coincide to a striking degree with practical and local limitations, for in these a great artist can almost always find suggestions for the character of his material instead of mere hindrances to its development. Thus art-forms become the vehicle for perfectly natural works in the hands of great artists, even when in the abstract they are highly artificial and conventional. But there is probably no case of an important art-form (and still less of a whole style of art) remaining productive in so artificial a condition when the facts which made that condition natural are changed. The great works in such forms remain, and are thoroughly natural, for they express their environment so perfectly as to recall it. It makes singularly little difference to the value of a great work of art, in the long run, whether its vividness is in the light it throws on a remote and forgotten past, or on a living and actual present. When Alcinous welcomes Odysseus, on hearing that he is an honourable pirate and not one of those disreputable merchants, our pleasure at the realistic glimpse of Homeric social distinctions differs from the pleasure of the Homeric audience only in so far as our point of view is more romantic. But new art must, if it is to live, be produced, like the classics, on conditions which the artist himself understands; and it is improbable that these conditions (if they admit of healthy art at all) will be of a less common-sense character than those of older art.

In the absence of musical criteria for a future art, perhaps the analogy of drama may be useful here. The chorus of Greek tragedy can by no stretch of imagination be said to behave like a corresponding group of persons in real life. Yet the Greek chorus becomes natural enough when we realize the necessary material circumstances of Greek drama; indeed in the best examples it becomes the only natural (or even, in a certain religious aspect, realistic) treatment of a natural set of materials. In the same way we are taught that Shakespeare's dramatic technique becomes perfectly natural when we realize his equally natural type of stage, which was so constructed and situated in regard to the audience that scenery would obstruct the view just as it would in a circus. But with the modern conception of a stage as a kind of magnified peep-show, with the audience looking into a painted box, realistic scenery is inevitable; and with realistic scenery comes speech so realistic that the use of verse and other classical resources is attended with dangers hitherto unknown. At the same time the condition of the modern stage obviously approximates far more closely to such an idea of the art of imitating human life by human speech and action, as would most naturally occur to a common-sense mind at any period. And it is probable that the final condition of an art will always tend to approximate to such an idea. In the same way it cannot be doubted that the sonata form, with its subtle balance between independence of form and interdependence of contrast, is far too artificial to be such a final form of instrumental music as would commend itself in the abstract to ordinary common sense. And we may look forward to a time, perhaps by the middle of the century, when the new and single continuous forms now adumbrated by the symphonic poems shall be the greatest forms of instrumental music, and shall need no literary crutches to make them intelligible. The pioneers of these forms at the present day frequently and sometimes justifiably claim that their music is intelligible apart from its "programme," but this is far from being so constantly the case that the symphonic poem can as yet be regarded as a mature kind of art. But when the mature art it foreshadows shall appear, then critics will need to face the fact that its genuine achievements will outwardly resemble the immature efforts which led to them, while the spiritual resemblance to classical music will lie too deep for the recognition of any but those who have the courage to make the new art their own. The symphonies of Mozart are in texture and phraseology far more like those of Philipp Emanuel Bach than they are like the great works of John Sebastian Bach; and if we try the experiment of reading one of John Sebastian's motets after a long course of Palestrina, we may realize that a lover of the Palestrina style living during the monodic revolution would really have had no means of telling the difference between Bach's art and the squalid sensational impressionism of Gesualdo, the prince of Venosa. Yet the impassable gulf is in all cases that between the great art and the crude efforts that foreshadow it, while the universal spirit of mature art remains the same whether the age or style be called "classical," "romantic," or "secessionist."

See also PROGRAMME MUSIC and SONATA FORMS (*ad fin.*).

(D. F. T.)

SYMPHONY in music. 1. The term *συμφωνία* was used by the Greeks, firstly, to denote the general conception of concord, both between successive sounds and in the unison of simultaneous sounds; secondly, in the special sense of concordant pairs of successive sounds (*i.e.* the "perfect intervals" of modern music; the 4th, 5th and octave); and thirdly as dealing with *τὸ ἀντίφωνον*, the concord of the octave, thus meaning the art of singing in octaves, or *magadizing*, as opposed to *ὁμοφωνία*, or singing and playing in unison. In Roman times the word appears in the general sense which still survives in poetry, viz. as harmonious concourse of voices and instruments. It also appears to mean a concert. In St Luke xv. 25, it is distinguished from *χόροι*, and the passage is appropriately translated in the English Bible as "music and dancing." Polybius and others seem to use it as the name of a musical instrument.

2. In the 17th century the term is used, like "concerto," for certain vocal compositions accompanied by instruments, *e.g.* the *Kleine geistliche Concerte* and *Symphoniae sacrae* of Schütz. Most of Schütz's works of this class are for from one to three solo voices in various combinations with instruments. The *Geistliche Concerte* are generally accompanied by figured bass and are to German texts; and the voices may in many cases be choral. The *Symphoniae sacrae* are to Latin texts and are written for various combinations of instruments, while the voice parts are evidently for solo singers. The word symphony is sometimes used for the instrumental ritornello of songs and vocal movements in aria form. In this sense it already appears in No. 28 of the second book of Schütz's *Geistliche Concerte.*

3. The principal modern meaning of the word is a sonata for orchestra (see SONATA FORMS). The orchestral symphony originated in the operatic overture (*q.v.*), which in the middle of the 18th century began to assimilate the essentials of the sonata style. At first such sonata-style overtures consisted of

three movements, viz. a moderately quick binary movement, a short slow movement, and a lively finale. Thus Mozart, at the age of twelve, used his 7th symphony as the overture to *La Finta semplice*, and Haydn's maturest symphonies are still called overtures in some early editions. *La Finta giardiniera*, written by Mozart in his eighteenth year, marks the differentiation of the opera overture from the independent symphony, since it contains the usual first movement and slow movement, but the curtain rises with what sounds like the beginning of the finale.

The sonata style was not at first invariably associated with what we now call sonata form, nor indeed was that form at first the most favourable to the dramatic expression desirable for operatic music. Hence the overtures of Gluck are generally in forms based on the contrast of loosely knit passages of various textures; forms which he probably learned from San Martini, and which may be found in the concertos of Vivaldi, so many of which were freely transcribed by Sebastian Bach. These methods are no less evident in the symphonies of Philipp Emmanuel Bach, which thus occupy an analogous place, away from the normal line of the sonata style. The differentiation between symphony and overture was of immense importance in raising the dignity of the symphony; but the style was more essential than the form; and in Mozart's and Haydn's mature works we find the sonata form as firmly established in the overture as in the symphony, while nevertheless the styles and scope of the two forms are quite distinct. Mozart's most elaborate overture, that of *Die Zauberflöte*, could not possibly be the first movement of one of his later symphonies; nor could the finale of his "Jupiter" symphony (which has often been compared with that overture because of its use of *fugato*) conceivably be used as the prelude to an opera.

See also MUSIC; SONATA FORMS; INSTRUMENTATION; OVERTURE; SCHERZO; VARIATIONS. (D. F. T.)

SYMPHOSIUS, or SYMPOSIUS, the name given to the author of a collection of 100 riddles of uncertain date, but probably composed in the 4th or 5th century A.D. They have been attributed to Lactantius, and identified with his *Symposium*, but this view is not generally accepted. The style and versification of the riddles, each of which consists of three hexameter lines, are good. They were written to form part of the entertainment at the Saturnalia.

Text in E. Bährens, *Poetae latini minores*, vol. iv.; there is a good French metrical version by E. F. Corpet (1868); monograph by W. T. Paul (Berlin, 1854); see also Teuffel, *Hist. of Roman Literature*, 449 (Eng. trans., 1900).

SYMPOSIUM (Gr. *συμπόσιον*, a drinking party, from *συμπίνειν*, to drink together, *σύν*, with, and *πίνειν*, to drink, root *πο*, cf. Lat. *potare*, to drink, *poculum*, cup), the convivial drinking which took place after a great banquet, accompanied by intellectual or witty conversation, and by music or dancing performed by slaves or attendants. The term has been applied in modern usage, due to Plato's *Symposium*, to a collection of opinions of different writers on a given subject.

SYNAGOGUE (*συναγωγή*), literally "assemblage," is the term employed to denote either a congregation of Jews, *i.e.* a local circle accustomed to meet together for worship and religious instruction, or the building in which the congregation met. In the first sense the word is a translation of כנסת, *keneseth* (assemblage), in the second of בית הכנסת, *bēth hakkeneseth* (house of assemblage). Further the term is often used to denote the system of Judaism, as when the "Synagogue" is contrasted to the "Church." The germ of the synagogue, that is, of religious assemblages dissociated from the ancient ritual of the altar, may be found in the circle of the prophets and their disciples (see especially Isa. viii. 16 seq.); but the synagogue as an institution characteristic of Judaism arose after the work of Ezra, and is closely connected with the development of Judaism, to which his reformation gave definite shape. From the time of Ezra downwards it was the business of every Jew to know the law; the school (*bēth hammidrāsh*) trained scholars, but the synagogue, where the law was read every Sabbath (Acts xv. 21), was the means of popular instruction. Such synagogues existed in all parts of Judaea in the time of Ps. lxxiv. 8 (probably a psalm of the Persian period); in Acts xv. 21 it appears that they had existed for many generations "in every city." This held good not only for Palestine, but for the Dispersion; in post-Talmudic times the rule was that a synagogue must be built wherever there were ten Jews. In the Dispersion the synagogue filled a greater place in the communal life, for on Palestinian soil the Temple enjoyed a predominant position. In this sense the synagogue is a child of the Dispersion, but this does not imply that it was a product of the Hellenic diaspora. For the Aramaic papyri discovered at Assuan show that in the 5th century B.C. the Egyptian Jews had their place of worship in Syene long before Greek influences had begun to make themselves felt. The fact that the Books of the Maccabees never refer to synagogues is not evidence that synagogues were unknown in Judaea in the Maccabean period. These books refer mostly to a time of war, when assemblages in the cities were impossible; their interest, moreover, is concentrated in the Temple and the restoration of its services. During the second Temple there is no doubt but that public worship was organized in the provinces as well as in the Jewish settlements outside the Holy Land. And though the name "synagogue" varies with *προσευχή* ("place of prayer"), it appears that everywhere the assemblage was primarily one for instruction in the law; the synagogue, as Philo puts it, was a *διδασκαλεῖον*. Prayer, in the more restricted sense, invariably accompanied the instruction, and several parts of the extant liturgy go back to the 3rd century B.C. A formed institution of this sort required some organization: he general order of the service was directed by one or more "rulers of the synagogue" (*ἀρχισυνάγωγοι*, Luke xiii. 14; Acts xiii. 15), who called on fit persons to read, pray and preach; alms were collected by two or more "collectors" (*gabbāē ṣedāqā*); and a "minister" (*ḥazzān*, *ὑπηρέτης*, Luke iv. 20) had charge of the sacred books (preserved in an "ark") and of other ministerial functions, including the teaching of children to read. The discipline of the congregation was enforced by excommunication (*ḥērem*) or temporary exclusion (*niddūi*), and also by the minor punishment of scourging (Matt. x. 17), inflicted by the *ḥazzān*. The disciplinary power was in the hands of a senate of elders (*πρεσβύτεροι*, *γερουσία*), the chief members of which were *ἄρχοντες*. The principal service of the synagogue was held on Sabbath morning, and included, according to the Mishnah, the recitation of the *shema'* (Deut. vi. 4-9, xi. 13-21; Num. xv. 37-41), prayer, lessons from the law and prophets with Aramaic translation, a sermon (*derāshah*) based on the lesson (Acts xiii. 15), and finally a blessing pronounced by the priest or invoked by a layman. On Sabbath afternoon and on Monday and Thursday there was a service without a lesson from the prophets; there were also services for all feast-days. Synagogues were built by preference beside water, in order to avoid proximity to the idol temples, rather than, as some think, for the convenience of the ceremonial ablutions (cf. Acts xvi. 13). Remains of very ancient buildings of this class exist in several parts of Galilee; they generally lie north and south, and seem to have had three doors to the south, and sometimes to have been divided by columns into a nave and two aisles.

Modern synagogues are mostly built of oblong shape, with a gallery for women. Since the middle ages, Renaissance and Moorish types of decoration have been generally favoured, but there is nowadays a great variety of types. The ancient synagogue of Alexandria (destroyed by Trajan) was a basilica. A number of recent synagogues have been built in octagonal form. The main interior features of the synagogue are the "ark" (a cupboard containing the scrolls of the law, &c.) and the *almemar* (or reading-desk, from the Arabic *al-minbar*, pulpit). This is sometimes in the centre, sometimes at the eastern end of the building. The Talmud prescribed an elevated site for the synagogue, but this rule has been impossible of fulfilment in modern times. The synagogues are theoretically "orientated" —*i.e.* the ark (which worshippers face during the principal prayer) is on the eastern side. But this rule, too, is often ignored under the stress of architectural difficulties.

Jewish tradition has a great deal to say about a body called "the great synagogue," which is supposed to have been the supreme religious authority from the cessation of prophecy to the time of the high priest Simeon the Just, and is even said to have fixed the Old Testament canon (cf. v. 3 seq.). But Kuenen in his essay "Over de Mannen der Groote Synagoge" (*Verslagen* of the Amsterdam Academy, 1876) has powerfully argued that these traditions are fiction, and that the name *keneseth haggādōla* originally denoted, not a standing authority, but the great convocation of Neh. viii.–x. Some more recent scholars are, however, more willing to attach credence to the older tradition.

Compare, in general, Schürer, *Geschichte des jüdischen Volkes*, § 27, where the older literature is catalogued. For some unconventional views the reader may refer to M. Friedländer, *Synagoge und Kirche in ihren Anfängen* (Berlin, 1908). For the usages of the synagogue in more recent times, see Buxtorf, *Synagoga judaica* (Basel, 1641). On the history of synagogue services the works of Zunz are the chief authorities; there is also a good article on Liturgy in the *Jewish Encyclopedia*. Useful summaries in English are to be found in Dembitz, *Jewish Services in Synagogue and Home* (Philadelphia, 1898); and Oesterley and Box, *The Religion and Worship of the Synagogue* (London, 1907). The article "Synagogue" in the *Jewish Encyclopedia* is illustrated with numerous pictures of buildings and plans.

SYNAGOGUE, UNITED, an organization of London Jews, founded, with the sanction of an act of parliament, in 1870. It is confined, in its direct work, to the metropolis, but it exercises, indirectly, considerable influence over the Jews of the British Empire. It is governed by an elected council representing the constituent congregations. In religious and ritual matters it is under the jurisdiction of the chief rabbi, who is, to a certain extent, recognized throughout the empire. The president of the United Synagogue in 1910 was Lord Rothschild. Besides providing the worship of some twenty congregations, the United Synagogue directs and supports educational and charitable work. The title "chief rabbi" is not found in the pre-expulsion records, though, before the Jews were banished in 1290, there was an official named "presbyter omnium Judaeorum Angliae." The functions of this official cannot be proved to have been ecclesiastical. The title "chief rabbi" has become well known through the eminence of recent occupants of the position such as Solomon Hirschell (1762–1842). He was succeeded by Dr Nathan Marcus Adler (1803–1890), who was followed by his son, Hermann Adler, who raised the position to one of much dignity and importance. Dr Hermann Adler was born in Hanover in 1839, graduated at Leipzig, and received honorary degrees from Scotch and English universities, including Oxford. In 1909 he received the order of M.V.O. Dr Adler was elected chief rabbi in 1891. Besides several essays in the *Nineteenth Century*, Dr Adler has written extensively on topics of Anglo-Jewish History and published two volumes of sermons. (I. A.)

SYNANTHY (Gr. σύν, with, and ἄνθος, a flower), a botanical term for the adhesion of two or more flowers.

SYNAXARIUM (Gr. συναξάριον, from συνάγειν, to bring together), the name given in the Greek Church to a compilation corresponding very closely to the martyrology (*q.v.*) of the Roman Church. There are two kinds of synaxaria—simple synaxaria, which are merely lists of the saints arranged in the order of their anniversaries, *e.g.* the calendar of Morcelli; and historical synaxaria, which give biographical notices besides, *e.g.* the menology of Basil and the synaxarium of Sirmond. The notices given in the historical synaxaria are summaries of those in the great menologies, or collections of lives of saints, for the twelve months of the year. The oldest historical synaxaria apparently go back to the tenth century. The heterodox Eastern churches also have their synaxaria.

The publication of the Arabic text of the synaxarium of the Church of Alexandria was started simultaneously by J. Forget in the *Corp. script. orient.* and by R. Basset in the *Patrologia orient.*, and that of the Ethiopian synaxarium was begun by I. Guidi in the *Patrologia orient.* The Armenian synaxarium, called the synaxarium of Ter Israël was published at Constantinople in 1834.

See S. A. Morcelli, *Kalendarium ecclesiae Constantinopolitanae* (Rome, 1788); H. Delehaye, "Le Synaxaire de Sirmond," in *Analecta bollandiana*, xiv. 396–434, where the terminology is explained; idem, *Synaxarium ecclesiae Constantinopolitanae e codice Sirmondiano* (Brussels, 1902), forming the volume *Propylaeum ad acta sanctorum novembris*. (H. De.)

SYNCELLUS, a hybrid word (Gr. σύν, Lat. *cella*),[1] meaning literally "one who shares his cell with another." In ecclesiastical usage it refers to the very early custom of a priest or deacon living continually with a bishop, *propter testimonium ecclesiasticum*; thus Leo III. speaks of Augustine as having been the *syncellus* of Gregory the Great. The term came into use in the Eastern Church, where the *syncelli* were the chaplains of metropolitans and patriarchs. At Constantinople they formed a corporation, and the *protosyncellus* took precedence of metropolitans and ranked next to the patriarch, to whose office he generally succeeded.

SYNCOPE (Gr. συγκοπή, a cutting up or short, from κόπτειν, to cut), a term used in grammar for the elision of a letter or syllable in the middle of a word (*e.g.* "ne'er" for "never"); and in medicine for the condition of fainting or shock (*q.v.*); and so occasionally in a general sense for a suspension or cessation of function. "Syncopate" and "syncopation" are analogous derivatives; and in music a syncopation is the rhythmic method of tying (⌒) two beats of the same note into one tone in such a way as to displace the accent.

SYNCRETISM (Gr. συγκρητισμός, from σύν and κεράννυμι, mingle or blend, or, according to Plutarch, from σύν and κρητίζειν, to combine against a common enemy after the manner of the cities of Crete), the act or system of blending, combining or reconciling inharmonious elements. The term is used technically in politics, as by Plutarch, of those who agree to forget dissensions and to unite in the face of common danger, as the Cretans were said to have done; in philosophy, of the efforts of Cardinal Bessarion and others in the 16th century to reconcile the philosophies of Plato and Aristotle; and in theology, of a plan to harmonize the hostile factions of the Church in the 17th century, advocated by Georg Calixtus, a Lutheran professor of theology at Helmstadt. Its most frequent use, however, is in connexion with the religious development of antiquity, when it denotes the tendency, especially prominent from the 2nd to the 4th centuries of the Christian era, to simplify and unify the various pagan religions. During this period, as a result of the intimate knowledge of the world's religions made possible by the gathering of every known cult of importance into the religious system of the Roman Empire, belief in the identity of many deities which resembled each other, and indeed in the essential identity of all, received a special impulse. Not only were various forms of the same deity, such as, for example, Jupiter Capitolinus and Jupiter Latiaris, recognized as being really the same under different aspects, but even the gods of different nations were seen to be manifestations of a single great being. Roman Jupiter, Greek Zeus, Persian Mithras and Phrygian Attis were one. The Great Mother, Isis, Ceres, Demeter, Ops, Rhea, Tellus, were the same great mother deity under different masks (see GREAT MOTHER OF THE GODS). Venus and Cupid, Aphrodite and Adonis, the Great Mother and Attis, Astarte and Baal, Demeter and Dionysus, Isis and Serapis, were essentially the same pair. Syncretism even went so far as to blend the deities of paganism and Christianity. Christ was compared with Attis and Mithras, Isis with the Virgin Mary, &c. Isis, perhaps more than any other deity, came to be regarded as the great maternal goddess of the universe whose essence was worshipped under many different names. This fact, with the spirit of syncretism in general, is well illustrated by Apuleius (*Metamorph.* xi. 2 and 5). Lucius invokes Isis: "Queen of Heaven, whether thou art the genial Ceres, the prime parent of fruits, who, joyous at the discovery of thy daughter, didst banish the savage nutriment of the ancient acorn, and, pointing out a better food, dost now till the Eleusinian soil; or whether thou art celestial Venus, who, in the first origin of things, didst

[1] Apollinaris Sidonius uses the pure Latin term *concellus*.

associate the different sexes, through the creation of mutual love, and having propagated an eternal offspring in the human race, art now worshipped in the sea-girt shrine of Paphos; or whether thou art the sister of Phoebus, who, by relieving the pangs of women in travail by soothing remedies, hast brought into the world multitudes so innumerable, and art now venerated in the far-famed shrines of Ephesus; or whether thou art Proserpine, terrific with midnight howlings . . . by whatever name, by whatever ceremonies, and under whatever form it is lawful to invoke thee; do thou graciously, &c." The goddess replies: "Behold me . . . I, who am Nature, the parent of all things, the mistress of all the elements, the primordial offspring of time, the supreme among divinities, the queen of departed spirits, the first of the celestials, and the uniform manifestation of the gods and goddesses; who govern by my nod the luminous heights of heaven, the salubrious breezes of the ocean, and the anguished silent realms of the shades below; whose one sole divinity the whole orb of the earth venerates under a manifold form, with different rites, and under a variety of appellations. Hence the Phrygians, that primeval race, call me Pessinuntica, the Mother of the Gods; the Aborigines of Attica, Cecropian Minerva; the Cyprians, in their sea-girt isle, Paphian Venus; the arrow-bearing Cretans, Diana Dictynna; the three-tongued Sicilians, Stygian Proserpine; and the Eleusinians, the ancient goddess Ceres. Some call me Juno, others Bellona, others Hecate, others Rhamnusia. But those who are illumined by the earliest rays of that divinity, the Sun, when he rises, the Aethopians, the Arii, and the Egyptians, so skilled in ancient learning, worshipping me with ceremonies quite appropriate, call me by my true name, Queen Isis. Behold, then, &c." (Trans. Bohn's Lib.).

Naturally, the influence of Greek philosophy was very pronounced in the growth of syncretism. Plutarch and Maximus of Tyre affirmed that the gods of the different nations were only different aspects of the same deity, a supreme intelligence and providence which ruled the world. The Neoplatonists, however, were the first school to formulate the underlying philosophy of syncretism: "There is only one real God, the divine, and the subordinate deities are nothing else than abstractions personified, or celestial bodies with spirits; the traditional gods are only demons, that is, being intermediate between God and man . . . All, like every other created being, are emanations from the absolute God" (Jean Réville, *La Religion à Rome sous les Sévères*). Care must be taken, however, not to place too much emphasis upon syncretism as a conscious system. The movement which it represented was not new in the 2nd century A.D. The identification of Latin with Etruscan gods in the earliest days of Rome, and then of Greek with Italian, and finally of Oriental with the Graeco-Roman, were all alike syncretistic movements, though not all conscious and reasoned. The ideal of the common people, who were unreflecting, as well as of philosophers who reflected, was "to grasp the religious verity, one and constant, under the multiplex forms with which legend and tradition had enveloped it" (Réville). The advent of Greek philosophy only hastened the movement by conscious and systematic effort.

Syncretic, being a movement toward monotheism, was the converse of the tendency, so prominent in the early history of Rome, to increase the number of deities by worshipping the same god under special aspects according to special activities. In the hands of the Neoplatonists it was instrumental in retarding somewhat the fall of paganism for the time, but in the end contributed to the success of Christianity by familiarizing men with the belief in one supreme deity. The triumph of Christianity itself represented a result of syncretism, the Church being a blending of the beliefs and practices of both the new and old religions.

See Jean Réville, *op. cit.*, especially pages 104–127, 159–174, 284–295. For other examples of syncretism, cf. that of Buddhism Zoroastrianism in the state religion of the Indo-Scythian kingdom of Kanishka (see PERSIA: *Ancient History*, vii.; *The Parthian Empire*, § 2); see articles on almost all the religions of the East, *e.g.* MITHRAS; ZOROASTER. (G. SN.)

SYNDERESIS, a term in scholastic philosophy applied to the inborn moral consciousness which distinguishes between good and evil. The word is really *synteresis* (Gr. *συντήρησις*, from *συντηρεῖν*, to look after, take care of), but synderesis is the commoner form. Diogenes Laërtius in his account of the Stoics (vii.85, *τὴν δὲ πρώτην ὁρμήν φασι τὸ ζῷον ἴσχειν ἐπὶ τὸ τηρεῖν ἑαυτό*) uses the phrase *τηρεῖν ἑαυτό* to describe the instinct for self-preservation, the inward harmony of Chrysippus, the recognition of which is *συνείδησις*. The term *synderesis*, however, is not found till Jerome, who in dealing with Ezek. i. 4–15, says the fourth of the "living creatures" of the vision is what the Greeks call *συντήρησις*, *i.e. scintilla conscientiae* the "spark of conscience." Here apparently synderesis and conscience (*συνείδησις*) are equivalent. By the schoolmen, however, the terms were differentiated, conscience being the practical envisaging of good and evil actions; synderesis being, so to speak, the tendency toward good in thought and action. The exact relation between the two was, however, a matter of controversy, Aquinas and Duns Scotus holding that both are practical reason, while Bonaventura narrows synderesis to the volitional tendency to good actions.

SYNDIC (Late Lat. *syndicus*, Gr. *σύνδικος*, one who helps in a court of justice, an advocate, representative, *σύν*, with, and *δίκη*, justice), a term applied in certain countries to an officer of government with varying powers, and secondly to a representative or delegate of a university, institution or other corporation, entrusted with special functions or powers. The meaning which underlies both applications is that of representative or delegate. Du Cange (*Gloss. s.v. Syndicus*), after defining the word as *defensor*, *patronus*, *advocatus*, proceeds "*Syndici* maxime appellantur Actores universitatum, collegiorum, societatum et aliorum corporum, per quos, tanquam in republica quod communiter agi fierive oportet, agitur et fit," and gives several examples from the 13th century of the use of the term. The most familiar use of "syndic" in the first sense is that of the Italian *sindico*, who is the head of the administration of a commune, answering to a "mayor"; he is a government official but is elected by the communal council from their own members by secret ballot.

Nearly all the companies, gilds, and the university of Paris had representative bodies the members of which were termed *syndici*. Similarly in England, the senate of the university of Cambridge, which is the legislative body, delegates certain functions to special committees of its members, appointed from time to time by Grace, *i.e.* a proposal offered to the senate and confirmed by it; these committees are termed "syndicates" and are permanent or occasional, and the members are styled "the syndics" of the particular committee or of the institution which they administer; thus there are the syndics of the Fitzwilliam Museum, of the University Press, of the Observatory, of local examinations and lectures, of the Antiquarian Committee, &c.

SYNDICATE, a term originally meaning a body of syndics. In this sense it is still sometimes used, as at the university of Cambridge, for the body of members or committee responsible for the management of the University Press. In commerce, a syndicate is a body of persons who combine to carry through some financial transaction, or who undertake a common adventure. Syndicates are very often formed to acquire or take over some undertaking, hold it for a short time, and then resell it to a company. The profits are then distributed and the syndicate dissolves. Sometimes syndicates are formed under agreements which constitute them mere partnerships, the members being therefore individually responsible, but they are now more generally incorporated under the Companies Acts.

The more usual cases in which syndicates are commonly formed will be found in F. B. Palmer's *Company Precedents*, 10th ed., vol. i. pp. 129 seq.

SYNECHISM (from Gr. *συνεχής*, continuous, from *σύν*, *ἔχειν*, to hold together), a philosophical term proposed by C. S. Peirce (*Monist*, ii. 534) to express the general theory that the essential feature in philosophic speculation is continuity. It is specially directed to the question of hypothesis, and holds that a hypothesis is justifiable only on the ground that it provides an explanation.

All understanding of facts consists in generalizing concerning them. The fact that some things are ultimate may be recognized by the synechist without abandoning his standpoint, since synechism is a normative or regulative principle, not a theory of existence. The adjective "synechological" is used in the same general sense; "synechology" is a theory of continuity or universal causation; "synechia" is a term in ophthalmology for a morbid union of parts.

SYNEDRIUM (*συνέδριον*), a Greek word which means "assembly" and is especially used of judicial or representative assemblies, is the name by which (or by its Hebrew transcription, סנהדרין, *sanhedrīn, sanhedrīm*) that Jewish body is known which in its origin was the municipal council of Jerusalem, but acquired extended functions and no small authority and influence over the Jews at large (see xiii. 424 seq.). In the Mishnah it is called "the sanhedrin," "the great sanhedrin," "the sanhedrin of seventy-one [members]" and "the great court of justice" (*bēth dīn haggādōl*). The oldest testimony to the existence and constitution of the synedrium of Jerusalem is probably to be found in 2 Chron. xix. 8; for the priests, Levites and hereditary heads of houses there spoken of as sitting at Jerusalem as a court of appeal from the local judicatories does not correspond with anything mentioned in the old history, and it is the practice of the chronicler to refer the institutions of his own time to an origin in ancient Israel. And just such an aristocratic council is what seems to be meant by the gerousia or senate of "elders" repeatedly mentioned in the history of the Jews, both under the Greeks from the time of Antiochus the Great (Jos. *Ant.* xii. 3, 3) and under the Hasmonean high priests and princes. The high priest as the head of the state was doubtless also the head of the senate, which, according to Eastern usage, exercised both judicial and administrative or political functions (cf. 1 Macc. xii. 6, xiv. 20). The exact measure of its authority must have varied from time to time at first with the measure of autonomy left to the nation by its foreign lords and afterwards with the more or less autocratic power claimed by the native sovereigns.

The original aristocratic constitution of the senate began to be modified under the later Hasmoneans by the inevitable introduction of representatives of the rising party of the Pharisees, and this new element gained strength under Herod the Great, the bitter enemy of the priestly aristocracy. Finally under the Roman procurators the synedrium was left under the presidency of the chief priest as the highest native tribunal, though without the power of life and death (John xviii. 31). The aristocratic and Sadducean element now again preponderated, as appears from Josephus and from the New Testament, in which "chief priests" and "rulers" are synonymous expressions. But with these there sat also "scribes" or trained legal doctors of the Pharisees and other notables, who are simply called "elders" (Mark xv. 1). The Jewish tradition which regards the synedrium as entirely composed of rabbins sitting under the presidency and vice-presidency of a pair of chief doctors, the *nāsī* and *āb bēth dīn*, is inconsistent with the evidence of Josephus and the New Testament. It is generally held that it was after the fall of the state that a merely rabbinical *bēth dīn* sat at Jabneh and afterwards at Tiberias, and gave legal responses to those who chose to admit a judicature not recognized by the civil power. Dr A. Büchler has sought to reconcile the various accounts by the theory that there were two great tribunals in Jerusalem, one wielding religious, the other civil authority (*Das Synedrion in Jerusalem*, Vienna, 1902).

The council chamber (*βουλή*) where the synedrium usually sat was between the Xystus and the Temple, probably on the Temple-hill, the Mishnah states that the meetings were held within the inner court. The meeting in the palace of the high priest which condemned Jesus was exceptional. The proceedings also on this occasion were highly irregular, if measured by the rules of procedure which, according to Jewish tradition, were laid down to secure order and a fair trial for the accused.

Of the older literature of the subject it is enough to cite Selden, *De synedriis*. The most important critical discussion is that of Kuenen in the *Verslagen*, &c., of the Amsterdam Academy (1866), p. 131 seq. A good summary is given by Schürer, *Geschichte des jüdischen Volkes*, 4th ed., § 23. Cf. also G. A. Smith, *Jerusalem* (1907), vol. i. ch. 9.

SYNESIUS (*c.* 373–*c.* 414), bishop of Ptolemais in the Libyan Pentapolis after 410, was born of wealthy parents, who claimed descent from Spartan kings, at Cyrene between 370 and 375. While still a youth (393) he went with his brother Euoptius to Alexandria, where he became an enthusiastic Neoplatonist and disciple of Hypatia (*q.v.*). On returning to his native place about the year 397 he was chosen to head an embassy from the cities of the Pentapolis to the imperial court to ask for remission of taxation and other relief. His address to Arcadius (*De regno*) is full of advice as to the studies of a wise ruler in such perilous times. His three years' stay in Constantinople was wearisome and otherwise disagreeable; the leisure it forced upon him he devoted in part to literary composition. The *Aegyptus sive de providentia* is an allegory in which the good Osiris and the evil Typhon, who represent Aurelian and the Goth Gainas (ministers under Arcadius), strive for mastery; and the question of the divine permission of evil is handled. After the successful Aurelian had granted the petition of the embassy, Synesius returned to Cyrene in 400, and spent the next ten years partly in that city, when unavoidable business called him there, but chiefly on an estate in the interior of the province, where in his own words "books and the chase" made up his life. His marriage took place at Alexandria in 403; in the previous year he had visited Athens. In 409 or 410 Synesius, whose Christianity had until then been by no means very pronounced, was popularly chosen to be bishop of Ptolemais, and, after long hesitation on personal and doctrinal grounds, he ultimately accepted the office thus thrust upon him, being consecrated by Theophilus at Alexandria. One personal difficulty at least was obviated by his being allowed to retain his wife, to whom he was much attached; but as regarded orthodoxy he expressly stipulated for personal freedom to dissent on the questions of the soul's creation, a literal resurrection, and the final destruction of the world, while at the same time he agreed to make some concession to popular views in his public teaching (*τὰ μὲν οἴκοι φιλοσοφῶν, τὰ δ' ἔξω φιλομυθῶν*). His tenure of the bishopric was troubled not only by domestic bereavements but also by barbaric invasions of the country (in repelling which he proved himself a capable military organizer) and by conflicts with the prefect Andronicus, whom he excommunicated for interfering with the Church's right of asylum. The date of his death is unknown; it is usually given as *c.* 414. His many-sided activity, as shown especially in his letters, and his loosely mediating position between Neoplatonism and Christianity, make him a subject of fascinating interest. His scientific interests are attested by his letter to Hypatia in which occurs the earliest known reference to areometry, and by a work on alchemy in the form of a commentary on pseudo-Democritus. He was a man of the highest personal character.

His extant works are—(1) a speech before Arcadius, *De regno*; (2) *Dio, sive de suo ipsius instituto*, in which he signifies his purpose to devote himself to true philosophy; (3) *Encomium calvitii* (he was himself bald), a literary *jeu d'esprit*, suggested by Dio Chrysostom's *Praise of Hair*; (4) *De providentia*, in two books; (5) *De insomniis*; (6) 157 *Epistolae*; (7) 12 *Hymni*, of a contemplative, Neoplatonic character; and several homilies and occasional speeches. The *editio princeps* is that of Turnebus (Paris, 1553); it was followed by that of Morell, with Latin translation by Petavius (1612; greatly enlarged and improved, 1633; reprinted, inaccurately, by Migne, 1859). The *Epistolae*, which for the modern reader greatly exceed his other works in interest, have been edited by Demetriades (Vienna, 1792) and by Glukus (Venice, 1812), the *Calvitii encomium* by Krabinger (Stuttgart, 1834), the *De providentia* by Krabinger (Sulzbach, 1835), the *De regno* by Krabinger (Munich, 1825), and the *Hymns* by Flach (Tübingen, 1875).

See Clausen, *De Synesio philosopho* (Copenhagen, 1831); R. Volkmann, *Synesius von Cyrene* (Berlin, 1869); A. Gardner's monograph in "The Fathers for English Readers" (London, 1886); and a life by W. S. Crawford (London, 1901).

SYNOD (Gr. *σύνοδος*), a term denoting an assembly of ecclesiastical officials legally convoked to discuss and decide points of faith, discipline and morals. It is practically synonymous with the word council (*q.v.*); *concilium* is used in the same technical sense by Tertullian *c.* 200, and *σύνοδος* a century or so later in the Apostolic canons. In time, however, the word council came to be restricted to oecumenical gatherings, while synod was applied to meetings of the eastern or western branches of the Church (the first council of Constantinople was originally a mere council or synod of the East), or to councils of the Reformed churches, *e.g.* the Synod of Dort. Provincial synods were held in the 2nd century, and were not completely organized before the advent of oecumenical councils. The two terms are still used side by side; thus there are patriarchal, national and primatial councils, as well as provincial councils (under the metropolitan of a province) and diocesan synods, consisting of the clergy of a diocese and presided over by the bishop (or the vicar-general). The supreme governing body in the Russian branch of the Orthodox Eastern Church (*q.v.*) is known as the Holy Synod. In the Presbyterian churches (see PRESBYTERIANISM) a synod is an assembly containing representatives of several presbyteries and intermediate between these and the General Assembly; similarly in the Wesleyan and other Methodist churches the synod is the meeting of the district which links the circuits with the conference. The term is not in use in self-governing churches like the Congregationalists and Baptists, though these from time to time hold councils or assemblies (national and international), for conference and fellowship without any legislative power.

SYNODIC PERIOD, in astronomy, the apparent period of a planet or satellite when its revolution is referred to the line passing through the earth or the sun. In the case of the planets it is the period between successive conjunctions of the same kind, inferior or superior, with the sun. In the case of the satellites it is the period relative to the radius vector from the sun.

SYNTHESIS (Gr. *σύνθεσις*, from *συντιθέναι*, to put together), a term used both generally and technically, with the fundamental meaning of composition, opposed to analysis (*q.v.*), the breaking up of a whole into its component parts. In teaching, for example, when a new fact is brought into connexion with already acquired knowledge and the learner puts them together ("synthesizes"), the result is "synthetic" and the process is "synthesis." The reverse process is analysis, as in grammar when a child breaks up a sentence into subject, verb, object, &c. Thus all inductive reasoning is synthetic in character. The term "synthesis" is much used in philosophy. Thus Kant makes a distinction, fundamental to his theory of knowledge, between analytic and synthetic judgments, the latter being those judgments which are not derivable from the nature of the subject, but in which the predicate is obtained rather by experience or by the operation of the mind (the "synthetic judgment a priori"; see KANT). Perhaps the most famous use of the term is in Herbert Spencer's "Synthetic Philosophy," the name given to the several treatises which contain his philosophic system—the "unification of knowledge" from the data of the separate sciences.

SYNTIPAS, the Greek form of Sindibad or Sendabar, an Indian philosopher supposed to have lived about 100 B.C., and the reputed author of a collection of tales known generally in Europe as the story of the Seven Wise Masters. They enjoyed immense popularity, and appeared in many Oriental and Western languages. A Greek translation (probably from a Syriac version), the earliest specimen of Romaic prose (11th century), is extant under the title of *The most pleasing Story of Syntipas the Philosopher.* It is preceded by an introduction in iambic verse by a certain Michael Andreopulos, who states that it was executed by order of Michael, probably the duke of Melitene in Armenia. The translator is evidently a Christian, although he has generally preserved the Oriental colouring. The main outline is the same in the different versions, although they vary in detail and include different stories. A certain prince, who had taken a vow of silence for a time on the advice of his tutor, was tempted by his stepmother. Her advances having been rejected, she accused him to his father, who decided to put him to death. The device of the *Arabian Nights* is introduced by the wise men of the court, who in turn relate stories to dissuade the king from over-hasty punishment, each story being answered by the queen, who desires instant action to be taken. When the period of silence is over the prince speaks and establishes his innocence. In the Greek version the king is a king of Persia, named Cyrus, and Syntipas himself is the prince's tutor (text in A. Eberhard, *Fabulae Romanenses*, i., 1872, "Teubner Series").

For a discussion of the whole subject, see D. Comparetti, *Ricerche intorno al libro di Sindibad* (1869; Eng. trans. by H. C. Coote, *Folk-Lore Society*, 1882); W. A. Clouston, *The Book of Sindibad* (from the Persian and Arabic, 1884; from the Syriac, by H. Gollancz, 1897); J. C. Dunlop, *Hist. of Prose Fiction* (new ed., 1888), vol. ii.; C. Krumbacher, *Geschichte der byzantinischen Litt.* (2nd ed., 1897). Sixty-two Aesopic fables, also translated from Syriac into Greek, are attributed to this same Syntipas (ed. C. F. Matthäi, 1781).

SYRA, or SYROS (anc. *Σύρος*, perhaps Homeric *Συρίη*), a Greek island in the middle of the Cyclades, which in the 19th century became the commercial centre of the Archipelago, and is also the residence of the nomarch of the Cyclades and the seat of the central law courts. The length of the island is about 10 m., the breadth 5, and the area is estimated at 42½ sq. m. The population rose to about 33,700, of whom about 20,500 were in the chief town, Hermoupolis, but that of the town had in 1907 declined again to 18,132. Syra is also a province of the department of the Cyclades (pop. 1907, 31,939). The importance of the island in prehistoric times is attested by considerable remains of early Aegean antiquities. In ancient times it was remarkably fertile, as is to be gathered not only from the Homeric description (*Od.* xv. 403), which might be of doubtful application, but also from the remains of olive presses and peculiarities in the local nomenclature. The destruction of its forests has led to the loss of all its alluvial soil, and now it is for the most part a brown and barren rock, covered at best with scanty aromatic scrub, pastured by sheep and goats.

Hermopolis (better Hermoupolis), the chief town, is built round the harbour on the east side of the island. It is governed by an active municipality, whose revenue and expenditure have rapidly increased. Among the public buildings are a spacious town-hall in the central square, a club-house, an opera-house and a Greek theatre. Old Syra, on a conical hill behind the port town, is an interesting place, with its old Roman Catholic church of St George's still crowning the summit. This was built by the Capuchins, who in the middle ages chose Syra as the head-quarters of a mission in the East. Louis XIII., hearing of the dangers to which the Syra priests were exposed, took the island under his especial protection, and since that time the Roman Catholic bishops of Syra have been elected by the pope. About the beginning of the 19th century the inhabitants of Syra numbered only about 1000; whenever a Turkish vessel appeared they made off to the interior and hid themselves. On the outbreak of the war of Greek independence refugees from Chios, after being scattered throughout Tenos, Spezia, Hydra, &c., and rejected by the people of Ceos, took up their residence at Syra under the protection of the French flag. Altogether about 40,000 had sought this asylum before the freedom of Greece was achieved. The chief city was called Hermoupolis after the name of the ship which brought the earlier settlers. Most of the immigrants elected to stay, and, though they were long kept in alarm by pirates, they continued to prosper. In 1875 1568 sailing ships and 698 steamers (with a total of 740,731 tons) entered and 1588 sailing ships and 700 steamers (with a total of 756,807 tons) cleared this port; in 1883 3379 sailing and 1126 steam vessels (with a total of 1,056,201 tons) entered and 3276 sailing and 1120 steam vessels (with a total of 960,229 tons) cleared. Most of the sailing vessels were Greek and Turkish, and most of the steamers were Austrian, French and Turkish.

But since the energetic development of Peiraeus, Syra has ceased to be the chief commercial entrepôt and distributing centre of this part of the Levant, and consequently its trade has seriously declined. Whereas in 1890 the foreign commerce was valued at £1,313,730, in 1900 it only amounted to £408,350. Coal, textiles and iron and steel goods figure prominently amongst the imports, and emery, leather, lemons, sponges, flour, valonia and iron ore amongst the exports. Syra is the seat of several industries, ship-building, tanneries, flour and cotton mills, rope-walks, factories for confectionery ("Turkish delight"), hats, kerchiefs, furniture, pottery and distilleries. The harbour, which is protected by a breakwater 273 yds. long, has a depth of 25 ft., diminishing to 12 ft.

SYRACUSE (Gr. Συράκουσαι; Lat. *Syracusae*, Ital. *Siracusa*), a city of Sicily, the capital of a province of the same name, situated on the east coast of the island, 54 m. by rail S. by E. of Catania, and about 32 m. direct. Pop. (1881), 21,739; (1906), 23,250 (town), 35,000 (commune).

History.—Syracuse was the chief Greek city of ancient Sicily, and one of the earliest Greek settlements in the island. According to Strabo (vi. 4, p. 269) Chersicrates and Archias of Corinth, both Heraclidae, left their native city together with a band of colonists, the former stopping with half the force at Corcyra, where he expelled the Liburnians and occupied the island, while Archias proceeded to Syracuse.[1] Thucydides (vi. 3) gives the date as the year after the foundation of Naxos (*i.e.* 734 B.C.), and mentions that Archias expelled the Sicel inhabitants from the island. Their presence there was definitely proved by the discovery in 1905 of a rock-cut tomb of the beginning of the second Sicel period (see SICILY) on the west side of the island (Orsi in *Notizie degli Scavi*, 1905, 381), while similar tombs may be seen both on the north and south edges of the terrace of Epipolae, and on the peninsula of Plemmyrium. There is, on the other hand, no conclusive evidence for the previous existence of a Phoenician settlement on the island,[2] though it is certainly such a place as Thucydides (vi. 2) describes as occupied by them for purposes of trade with the Sicels. The name of the island, Ortygia (ὄρτυξ, a quail), has, again, been held to point to the possible existence of an Aetolian settlement on the island before Archias came. But it is more probable that the name was given to the island owing to the establishment there by the first settlers of a special cult of Artemis (the name Ortygia appears in Homer, *Odyssey*, v. 123, as an island sacred to Artemis, though the identification with Delos (*q.v.*) is not certain), though why Corinthians should have worshipped Artemis in preference to any other deity is not clear.

Till the beginning of the 5th century B.C. our notices of Syracusan history are quite fragmentary. Almost the only question is whether, as some stray notices (see Freeman, *History of Sicily*, ii. 431) might suggest, the primitive kingship was retained or renewed at Syracuse, as it certainly was in some other Greek colonies. A king Pollis is spoken of; but nothing is known of his actions. It is far more certain that Syracuse went through the usual revolutions of a Greek city. The descendants of the original settlers kept the land in their own hands, and they gradually brought the Sicel inhabitants to a state not unlike villenage. Presently other settlers, perhaps not always Greek, gathered round the original Syracusan people; they formed a distinct body, δῆμος or *plebs*, personally free, but with an inferior political franchise or none at all. The old citizens thus gradually grew into an exclusive or aristocratic body, called γαμόροι or landowners. We hear incidentally of disputes, seditions and changes, among others the expulsion of the Gamori early in the 5th century B.C. (Thuc. v. 5; Arist. *Pol.* v. 3, 5; 4, 1). In its external development Syracuse differed somewhat from other Sicilian cities. Although it lagged in early times behind both Gela and Acragas (Agrigentum), it very soon began to aim at a combination of land and sea power.[3] In 663 it founded the settlement of Acrae, in 643 Casmenae,[4] and in 598 Camarina, of which the first was unusually far inland. The three together secured for Syracuse a continuous dominion to the south-east

[1] Strabo goes on to say that Archias fell in with certain men who had come from the Sicilian Megara, and took them with him to share in his enterprise. But this version implies that Megara was founded before Syracuse, which is contrary to all other authorities. The whole question of the various tales relating to the foundation of Syracuse is discussed by E. A. Freeman, *History of Sicily*, i. 335 sqq., 572 sqq.

[2] The origin of the name Συράκουσαι is quite uncertain. It has been suggested that it may be Phoenician: and, again, the plural form has been thought to point perhaps to "the union of two originally distinct posts," one on the island, the other on the mainland on the hill where the ruins of the Olympieum stand, known as πολίχνη—the latter being the original Syracuse.

[3] Netum (Noto) and Helorum, both to the S.S.W. of Syracuse, must have been among its earliest settlements (Freeman ii. 17).

[4] The site of Casmenae is uncertain; it was to the south-west of Syracuse, and not improbably at Spaccaforno (Freeman ii. 25).

coast. They were not strictly colonies but outposts; Camarina indeed was destroyed after a revolt against the ruling city (Thuc. v. 1). Whether the inland Sicel town of Henna was ever a Syracusan settlement is doubtful. It is extremely probable that Acrae was not founded until after two obvious outposts had already been occupied—a post guarding the road to Acrae itself, and including the sacred enclosure of Apollo, which later, when it became a quarter of the city, acquired the name Temenites; and another post on the road to the north, in the upper part of the region known as Achradina. The latter was defended on the north and east by the sea, on the west by a long straight cutting of the rock serving as a scarp on which the wall stood (see below), and on the south by extensive quarries (Freeman ii. 43, 139, 144). About the middle of the 6th century B.C.[1] the island was connected with the mainland by a mole (Freeman ii. 140, 505). At the beginning of the 5th century B.C. Syracusan history becomes far more clear. Hippocrates, tyrant of Gela (498–491), threatened the independence of Syracuse as well as of other cities, and it was saved only by the joint intervention of Corinth and Corcyra and by the cession of the vacant territory of Camarina. In 485 the Gamori, who had been expelled by the Demos and the Sicel serfs, and had taken refuge at Casmenae, craved help of Gelo, the successor of Hippocrates, who took possession of Syracuse without opposition, and made it the seat of his power. He gave citizenship both to mercenaries and to settlers from Greece, and added to the population the inhabitants of other cities conquered by him, so that Syracuse became a city of mixed population, in which the new citizens had the advantage. He then extended the city by including within the fortifications the low ground (or at any rate the western portion of the low ground) between Upper Achradina and the island, and making the Agora there[2]; at the same time (probably) he was able to shift the position of the crossing to the island by making a new isthmus in the position of the present one, the old mole being broken through so as to afford an outlet from the Little Harbour on the east (Lupus, p. 91). The island thus became the inner city, the stronghold of the ruler, so that, despite its low level, it is often spoken of as the "acropolis." Gelo's general rule was mild, and he won fame as the champion of Hellas by his great victory over the Carthaginians at Himera. He is said to have been greeted as king; but he does not seem to have taken the title in any formal way.

Gelo's brother and successor, Hiero (478–467), kept up the power of the city; he won himself a name by his encouragement of poets, especially Aeschylus and Simonides, and philosophers; and his Pythian and Olympian victories made him the special subject of the songs of Pindar and Bacchylides; among the recently discovered works of the latter are three *Odes* (iii.–v.) written for him. He appeared also as a Hellenic champion in the defence of Cumae against the Etruscans, and he attempted after the victory to found a Syracusan colony on the island of Aenaria, now Ischia. But his internal government, unlike that of Gelo, was suspicious, greedy and cruel. After some family disputes the power passed to his brother Thrasybulus, who was driven out next year by a general rising. In this revolution Thrasybulus and his mercenaries held the fortified quarters of Ortygia and Achradina; the revolted people held the unwalled suburbs, already, it is plain, thickly inhabited. Thrasybulus yielded to the common action of Siceliots and Sicels. Syracuse thus became a democratic commonwealth. Renewed freedom was celebrated by a colossal statue of Zeus Eleutherius and by a yearly feast in his honour. But when the mercenaries and other new settlers were shut out from office[3] new struggles arose. The mercenaries again held Ortygia and Achradina. The people now walled in the suburb of Tyche to the west of Achradina (Freeman iii. 306, 312, 456). The mercenaries were at last got rid of in 461. Although we hear of attempts to seize the tyranny and of an institution called *petalism*, like the Athenian ostracism, designed to guard against such dangers, popular government was not seriously threatened for more than fifty years. The part of Syracuse in general Sicilian affairs has been traced in the article SICILY (*q.v.*); but one striking scene is wholly local, when the defeated Ducetius took refuge in the hostile city (451), and the common voice of the people bade "spare the suppliant." We hear of a naval expedition to the Etruscan coast and Corsica about 453 B.C. and of the great military and naval preparations of Syracuse in 439 (Diod. xii. 30). Yet all that we read of Syracusan military and naval action during the former part of the Athenian siege shows how Syracuse had lagged behind the cities of old Greece, constantly practised as they were in warfare both by land and sea.

The Athenian siege (415–13) is of the deepest importance for the topography of Syracuse, and it throws some light on the internal politics. At first complete incredulity prevailed as to the Athenian expedition (Thuc. vi. 32). Hermocrates, the best of counsellors for external affairs, is suspected, and seemingly with reason, of disloyalty to the democratic constitution. Yet he is, like Nicias and Phocion, the official man, head of a board of fifteen generals, which he persuades the people to cut down to three. Athenagoras, the demagogue or opposition speaker, has an excellent exposition of democratic principles put into his mouth by Thucydides (vi. 36–40). Through the whole siege[4] there was a treasonable party within the city, which—for what motives we are not told—kept up a correspondence with the besiegers. When the Athenian fleet under Nicias, Alcibiades and Lamachus was at Rhegium in Italy, after the discovery of the trick that had been played by the Segestans, the question for the commanders was whether they should seek to strengthen themselves by fresh alliances on the spot or strike the blow at once. Lamachus was for immediate action, and there can hardly be a doubt that Syracuse must have fallen before a sudden attack by so formidable an armament in the summer of 415. The Syracusans were neither united nor adequately prepared for effectual defence, and it is perfectly clear that they owed their final deliverance to extraordinary good fortune. Athens had the prize within her grasp, and she lost it wholly through the persistent dilatoriness and blundering of Nicias (*q.v.*). It was at his advice that the summer and autumn of 415 were frittered away, and the siege not begun till the spring of 414. By that time the Syracusans were both in better spirits and better prepared; their troops were better organized, and they had built a wall from north to south across Epipolae, taking in Tyche and Temenites, so as to screen them from attack on the side of Epipolae on the north-west. The effect of this was to bar the enemy's approach and push back his blockading lines, which had to be carried over an inconveniently large extent of ground. They did not, however, occupy Euryelus, at the western extremity of the high ground of Epipolae, and this omission allowed the Athenians to obtain possession of the whole plateau, and to begin the investment of the city. The Syracusans had been at first thoroughly cowed; but they were cowed no longer, and they even plucked up courage to sally out and fight the enemy on the high ground of Epipolae. They were beaten and driven back; but at the suggestion of Hermocrates they carried a counter-work up the slope of Epipolae, which, if completed, would cut in two the Athenian lines and frustrate the blockade. At this point Nicias showed considerable military skill. The Syracusans' work was destroyed by a prompt and well-executed attack; and a second counter-work carried across marshy ground some distance to the south of Epipolae and near to the Great Harbour was also demolished after a sharp action, in which Lamachus fell, an irretrievable loss. However, the blockade on the land side was now almost

[1] Holm and Cavallari (cf. Lupus, *Topographie von Syrakus*, 91) make the construction of the mole and of the wall across it contemporary with the fortification of Achradina in the middle of the 7th century B.C. They also consider that the original west boundary of Achradina ran down to the Little Harbour, so that the southern boundary of Achradina was the sea itself.

[2] Holm and Cavallari (see Lupus, p. 99) are inclined to attribute to him the addition of Tyche to the city.

[3] Diod. xi. 72; cf. Arist. *Pol.* v. 3, 10.

[4] The chief authorities for the siege are Thucydides (bks. vi. and vii.), Diodorus (bk. xiii.) and Plutarch, *Nicias*.

complete, and the Athenian fleet had at the same time entered the Great Harbour. The citizens began to think of surrender, and Nicias was so confident that he neglected to push his advantages. He left a gap to the north of the circular fort which formed the centre of the Athenian lines, the point where Epipolae slopes down to the sea, and he omitted to occupy Euryelus.

The second act of the drama may be said to open with the irretrievable blunder of Nicias in letting the Spartan Gylippus first land in Sicily, and then march at the head of a small army, partly levied on the spot, across the island, and enter Syracuse by way of Epipolae, past Euryelus. Gylippus was felt to be the representative of Sparta, and of the Peloponnesian Greeks generally, and his arrival inspired the Syracusans with the fullest confidence. Just before his arrival a few ships from Corinth had made their way into the harbour with the news that a great fleet was already on its way to the relief of the city. The tables were now completely turned, and we hear of nothing but defeat and disaster for the besiegers till their final overthrow. The military skill of Gylippus enabled the Syracusan militia to meet the Athenian troops on equal terms, to wrest from them their fortified position on Plemmyrium, which Nicias had occupied as a naval station shortly after Gylippus's arrival, and thus to drive them to keep their ships on the low beach between their double walls, to take Labdalum, an Athenian fort on the northern edge of Epipolae, and make a third counter-work right along Epipolae in a westerly direction, to the north of the circular fort. The Athenians were thus reduced to such a plight that, as Nicias said in his despatch towards the close of 414, they were themselves besieged rather than besieging. The naval preparations of the Syracusans, under the advice of Hermocrates, had led them, too, to confidence in their powers of giving battle to the Athenian fleet. In the first sea-fight, which took place simultaneously with the capture of Plemmyrium, they had been unsuccessful; but in the spring of 413 they actually won a victory over the Athenians in their own element.

On the very next day, however, a second Athenian fleet arrived under Demosthenes and Eurymedon, with seventy-three ships of war and a large force of heavy infantry and light troops. The despatch of this expedition seems to prove an almost blind confidence in Nicias, whose request to be superseded the Athenian people refused to grant. Demosthenes decided at once to make a grand attack on Epipolae, with a view to recovering the Athenian blockading lines and driving the Syracusans back within the city walls. The assault was made by night by way of Euryelus under the uncertain light of the moon, and this circumstance turned what was very nearly a successful surprise into a ruinous defeat. The affair seems to have been well planned up to a certain point, and well executed; but the Athenian van, flushed with a first success, their ranks broken and disordered by a pursuit of the enemy over rough ground, were repulsed with great loss by a body of heavy-armed Boeotians, and driven back in disorder. The confusion spread to the troops behind them, and the action ended in wild flight and slaughter. The army was now thoroughly out of heart, and Demosthenes was for at once breaking up the camp, embarking the troops, and sailing back to Athens. (It must be remembered that the Spartans were all this time in occupation of Deceleia; see PELOPONNESIAN WAR.) But Nicias could not bring himself to face the Athenian people at home, nor could he be prevailed on to retire promptly to some position on the coast, such as Catania or Thapsus. He dallied till the end of August, many weeks after the defeat, when the coming of Syracusan reinforcements decided him to depart; but on the 27th of that month was an eclipse of the moon, on the strength of which he insisted on a delay of almost another month. His fleet, too, lingered uselessly in the harbour, till after a defeat in which Eurymedon perished, though the simultaneous land attack was unsuccessful. The Syracusans now blocked the mouth of the Great Harbour, and the Athenian fleet, after a frantic effort to break out and a desperate conflict, was utterly defeated and half destroyed. The broken and demoralized army, its ranks thinned by fever and sickness, at last began its hopeless retreat, attempting to reach Catania by a circuitous route; but, harassed by the numerous Syracusan cavalry and darters, after a few days of dreadful suffering, it was forced to lay down its arms. The Syracusans sullied the glory of their triumph by putting Nicias and Demosthenes to death, and huddling their prisoners into their stone-quarries—a living death, dragged out, for the allies from Greece proper to the space of seventy days, for the Athenians themselves and the Greeks of Sicily and Italy for six months longer. Games called Assinarian, from the name of the river at which the final surrender occurred, were instituted to commemorate it.

Her great deliverance and victory naturally stirred up the energies of Syracuse at home and abroad. Syracusan and Selinuntine ships under Hermocrates now play a distinguished part in the warfare between Sparta and Athens on the coast of Asia. Under the influence of Diocles the constitution became a still more confirmed democracy, some at least of the magistracies being filled by lot, as at Athens (Diod. xiii. 31, 35; Arist. *Pol.* v. 3–6). Diocles appears also as the author of a code of laws of great strictness, which was held in such esteem that later lawgivers were deemed only its expounders. Under these influences Hermocrates was banished in 409; he submitted to the sentence, notwithstanding the wishes of his army. He went back to Sicily, warred with Carthage on his own account, and brought back the bones of the unburied Syracusans from Himera, but was still so dreaded that the people banished Diocles without restoring him. In 407 he was slain in an attempt to enter the city, and with him was wounded one who was presently to outstrip both rivals.

This was Dionysius (the "Elder"), son of another Hermocrates and an adherent of the aristocratic party, but soon afterwards a demagogue, though supported by some men of rank, among them the historian Philistus (Diod. xiii. 91, 92). By accusing the generals engaged at Acragas in the war against Carthage, by obtaining the restoration of exiles (no doubt others of the partisans of Hermocrates), by high-handed proceedings at Gela, he secured his own election first as one of the generals, then as sole general (or with a nominal colleague), with special powers. He next, by another trick, procured from a military assembly at Leontini a vote of a bodyguard; he hired mercenaries and in 406–405 came back to Syracuse as tyrant of the city (Diod. xiii. 91–96). Dionysius kept his power till his death thirty-eight years later (367). But it was well-nigh overthrown before he had fully grasped it. His defeat before Gela and his consequent decision that both Gela and Camarina should be evacuated, and left for the Carthaginians to plunder, were no doubt due to previous arrangement with the latter. His enemies in the army, chiefly the horsemen, reached Syracuse before him, plundered his house, and horribly maltreated his wife. He came and took his vengeance, slaying and driving out his enemies, who established themselves at Aetna (Diod. xiii. 113). In 397 Syracuse had to stand a siege from the Carthaginians under Himilco, who took up his quarters at the Olympieum, but his troops in the marshes below suffered from pestilence, and a masterly combined attack by land and sea by Dionysius ended in his utter defeat. Dionysius, however, allowed him to depart without further pressing his advantage. This revolution and the peace with the Carthaginians confirmed Dionysius in the possession of Syracuse, but of no great territory beyond, as Leontini was again a separate city. It left Syracuse the one great Hellenic city of Sicily, which, however enslaved at home, was at least independent of the barbarian. Dionysius was able, like Gelo, though with less success and less honour, to take up the rôle of the champion of Hellas.

During the long tyranny of Dionysius the city grew greatly in size, population and grandeur. In fact the free Greek cities and communities, in both Sicily and southern Italy, were sacrificed to Syracuse; there the greatness and glory of the Greek world in the West were concentrated. The mass of the population of Gela and Camarina in the disastrous year 405 had, at the prompting of Dionysius, taken refuge at Syracuse. Gela had in the previous year received the fugitive inhabitants of Acragas (Agrigentum), which had been sacked by the

Carthaginians. Syracuse thus absorbed three of the chief Greek cities of Sicily. It received large accessions from some of the Greek cities of southern Italy, from Hipponium on its west and Caulonia on its east coast, both of which Dionysius captured in 389 B.C. There had also been an influx of free citizens from Rhegium. At the time of the Athenian siege Syracuse consisted of two quarters—the island and the "outer city" of Thucydides, generally known as Achradina, and bounded by the sea on the north and east, with the adjoining suburbs of Apollo Temenites farther inland, at the foot of the southern slopes of Epipolae and Tyche west of the north-west corner of Achradina. Dionysius largely extended the fortifications. The island (Ortygia) had been provided with its own defences, converted, in fact, into a separate stronghold, with a fort to serve specially as a magazine of corn, and with a citadel or acropolis which stood apart and might be held as a last refuge. Dionysius, to make himself perfectly safe, drove out a number of the old inhabitants and turned the place into a barracks, he himself living in the citadel. For any unpopularity he may have thus incurred he seems to have made up by his great works for the defence of the city. Profiting by the experience gained during the Athenian siege, he included in his new lines the whole plateau of Epipolae, with a strong fortress at Euryelus, its apex on the west; the total length of the outer lines (excluding the fortifications of the island) has been calculated at about 12 m. The material (limestone) was quarried on the spot. Each quarter of the city had its own distinct defences, and Syracuse was now the most splendid and the best fortified of all Greek cities. Its naval power, too, was vastly increased; the docks were enlarged; and 200 new warships were built. Besides the triremes, or vessels with three banks of oars, we hear of quadriremes and quinqueremes with four and five banks of oars—larger and taller and more massive ships than had yet been used in Greek sea warfare. The fleet of Dionysius was the most powerful in the Mediterranean. It was doubtless fear and hatred of Carthage, from which city the Greeks of Sicily had suffered so much, that urged the Syracusans to acquiesce in the enormous expenditure which they must have incurred under the rule of Dionysius. Much, too, was done for the beauty of the city as well as for its strength and defence. Several new temples were built, and gymnasia erected outside the walls near the banks of the Anapus (Diod. xv. 13).

"Fastened by chains of adamant" was the boastful phrase in which Dionysius described his empire; but under his son, the younger Dionysius—an easy, good-natured, unpractical man—a reaction set in amongst the restless citizens of Syracuse, which, with its vast and mixed populations, must have been full of elements of turbulence and faction. But the burdensome expenditure of the late reign would be enough to account for a good deal of discontent. A remarkable man now comes to the front—Dion, the friend and disciple of Plato—and for a time the trusted political adviser of his nephew Dionysius. Dion's idea seems to have been to make Dionysius something like a constitutional sovereign, and with this view he brought him into contact with Plato. All went well for a time; but Dionysius had Philistus and others about him, who were opposed to any kind of liberal reform, and the result was the banishment of Dion from Syracuse as a dangerous innovator. Ten years afterwards, in 357, the exile entered Achradina a victor, welcomed by the citizens as a deliverer both of themselves and of the Greeks of Sicily generally. A siege and blockade, with confused fighting and alternate victory and defeat, and all the horrors of fire and slaughter, followed, till Dion made himself finally master of the mainland city. Ortygia, provisions failing, was also soon surrendered. Dion's rule lasted only three years, for he perished in 354 by the hand of a Syracusan assassin. It was, in fact, after all his professions, little better than a military despotism. The tyrant's stronghold in the island was left standing.

Of what took place in Syracuse during the next ten years we know but little. The younger Dionysius came back and from his island fortress again oppressed the citizens; the plight of the city, torn by faction and conflicts and plundered by foreign troops, was so utterly wretched that all Greek life seemed on the verge of extinction (Plato, *Epist.* viii.). Sicily, too, was again menaced by Carthage. Syracuse, in its extremity, asked help from the mother-city, Corinth; and now appears on the scene one of the noblest figures in Greek history, Timoleon (*q.v.*). To him Syracuse owed her deliverance from the younger Dionysius and from Hicetas, who held the rest of Syracuse, and to him both Syracuse and the Sicilian Greeks owed a decisive triumph over Carthage and the safe possession of Sicily west of the river Halycus, the largest portion of the island. From 343 to 337 he was supreme at Syracuse, with the hearty good will of the citizens. The younger Dionysius had been allowed to retire to Corinth; his island fortress was destroyed and replaced by a court of justice. Syracuse rose again out of her desolation—grass, it is said, grew in her streets—and, with an influx of a multitude of new colonists from Greece and from towns of Sicily and Italy, once more became a prosperous city. Timoleon, having accomplished his work, accepted the position of a private citizen, though, practically, to the end of his life he was the ruler of the Syracusan people. After his death (337) a splendid monument, with porticoes and gymnasia surrounding it, known as the Timoleonteum, was raised at the public cost to his honour.

In the interval of twenty years between the death of Timoleon and the rise of Agathocles (*q.v.*) to power another revolution at Syracuse transferred the government to an oligarchy of 600 leading citizens. All we know is the bare fact. It was shortly after this revolution, in 317, that Agathocles with a body of mercenaries from Campania and a host of exiles from the Greek cities, backed up by the Carthaginian Hamilcar, who was in friendly relations with the Syracusan oligarchy, became a tyrant or despot of the city, assuming subsequently, on the strength of his successes against Carthage, the title of king. Syracuse passed through another reign of terror; the new despot proclaimed himself the champion of popular government, and had the senate and the heads of the oligarchical party massacred wholesale. He seems to have had popular manners, for a unanimous vote of the people gave him absolute control over the fortunes of Syracuse. His wars in Sicily and Africa left him time to do something for the relief of the poorer citizens at the expense of the rich, as well as to erect new fortifications and public buildings; and under his strong government Syracuse seems to have been at least quiet and orderly. After his death in 289 comes another miserable and obscure period of revolution and despotism, in which Greek life was dying out; and but for the brief intervention of Pyrrhus in 278 Syracuse, and indeed all Sicily, would have fallen a prey to the Carthaginians.

A better time began under Hiero II., who had fought under Pyrrhus and who rose from the rank of general of the Syracusan army to be tyrant—king, as he came to be soon styled—about 270. During his reign of over fifty years, ending probably in 216, Syracuse enjoyed tranquillity, and seems to have grown greatly in wealth and population. Hiero's rule was kindly and enlightened, combining good order with a fair share of liberty and self-government. His financial legislation was careful and considerate; his laws[1] as to the customs and the corn tithes were accepted and maintained under the Roman government, and one of the many bad acts of the notorious Verres, according to Cicero, was to set them aside (Cic. *In Verr.* ii. 13, iii. 8). It was a time, too, for great public works—works for defence at the entrance of the Lesser Harbour between the island and Achradina, and temples and gymnasia. Hiero through his long reign was the stanch friend and ally of Rome in her struggles with Carthage; but his paternal despotism, under which Greek life and civilization at Syracuse had greatly flourished, was unfortunately succeeded by the rule of a man who wholly reversed his policy.

Hieronymus, the grandson of Hiero, thought fit to ally himself with Carthage; he did not live, however, to see the mischief he had done, for he fell in a conspiracy which he had wantonly provoked by his arrogance and cruelty. There was a fierce

[1] The laws of Hiero are often mentioned with approval in Cicero's speeches against Verres.

popular outbreak and more bloodshed; the conspirators were put to death and Hiero's family was murdered; whilst the Carthaginian faction, under the pretence of delivering the city from its tyrants, got the upper hand and drew the citizens into open defiance of Rome. M. Claudius Marcellus was then in command of the Roman army in Sicily, and he threatened the Syracusans with attack unless they would get rid of Epicydes and Hippocrates, the heads of the anti-Roman faction. Epicydes did his best to stir up the citizens of Leontini against Rome and the Roman party at Syracuse. Marcellus, therefore, struck his first blow at Leontini, which was quickly stormed; and the tale of the horrors of the sack was at once carried to Syracuse and roused the anger of its population, who could not but sympathize with their near neighbours, Greeks like themselves. The general feeling was now against any negotiations with the Roman general, and, putting themselves under Epicydes and Hippocrates, they closed their gates on him. Marcellus, after an unsuccessful attempt to negotiate, began the siege in regular form (214 B.C.) by both land and sea, establishing a camp on Polichne, where stood the old temple of Olympian Zeus; but he made his chief assault on the northern side and on the defences of Tyche, particularly at the Hexapylum, the entrance facing Megara and Leontini. His assault seawards was made mainly on Achradina,[1] but the city was defended by a numerous soldiery and by what seems to have been still more formidable, the ingenious contrivances of Archimedes, whose engines dealt havoc among the Roman ships, and frustrated the attack on the fortifications on the northern slopes of Epipolae (Liv. xxiv. 34). Marcellus had recourse to a blockade, but Carthaginian vessels from time to time contrived to throw in supplies. At length treachery began to work within. Information was given him in the spring of 212 (two years from the commencement of the siege) that the Syracusans were celebrating a great festival to Artemis; making use of this opportunity, he forced the Hexapylum entrance by night and established himself in Tyche and on the heights of Epipolae. The strong fortress of Euryelus held out for a time, but, being now isolated, it soon had to surrender. The "outer" and the "inner" city of Thucydides still held out, whilst a Carthaginian fleet was moored off Achradina and Carthaginian troops were encamped on the spot. But a pestilence broke out in the autumn of 212, which swept them clean away, and thinned the Roman ranks. The ships sailed away to Carthage; on their way back to Syracuse with supplies they could not get beyond Cape Pachynus owing to adverse winds, and they were confronted by a Roman fleet. All hope for the city being now at an end, the Syracusans threw themselves on the mercy of Marcellus; but Achradina and the island still held out for a brief space under the Syracusan mercenaries, till one of their officers, a Spaniard, betrayed the latter position to the enemy, and at the same time Achradina was carried and taken. Marcellus gave the city up to plunder (Liv. xxv. 31), and the art treasures in which it was so rich—many of the choicest of them, no doubt—were conveyed to Rome. Archimedes perished in the confusion of the sack while he was calmly pursuing his studies (Liv. xxv. 31).

Syracuse was now simply one of the provincial cities of Rome's empire, and its history is henceforward merged in that of Sicily. It retained much of its Greek character and many of its finest public buildings, even after the havoc wrought by Marcellus. Its importance and historic associations naturally marked it out as the residence of the Roman praetor or governor of Sicily. Cicero often speaks of it as a particularly splendid and beautiful city, as still in his own day the seat of art and culture (*Tusc.* v. 66; *De deor. nat.* iii. 81; *De rep.* i. 21), and in his speeches against Verres (iv. 52, 53) he gives an elaborate description of its four quarters (Achradina, Neapolis, Tyche, the island). It seems to have suffered in the civil wars at the hands of Sextus Pompeius, the son of the triumvir, who for a short time was master of Sicily; to repair the mischief, new settlers were sent by Augustus in 21 B.C., and established in the island and in the immediately adjoining part of Achradina (Strabo vi. 270). It was he who probably constructed the amphitheatre. Tacitus, in a passing mention of it (*Ann.* xiii. 49), says that permission was granted to the Syracusans under Nero to exceed the prescribed number of gladiators in their shows. Caligula restored its decayed walls and some of its famous temples (Suetonius, *Calig.* 21). In the 4th century it is named by the poet Ausonius in his *Ordo nobilium urbium*, chiefly, perhaps, on the strength of its historic memories. In 665 Heraclius Constans fixed his capital here, but owing to his oppressive government was assassinated in 668. Syracuse has been a place of comparatively little importance since the year 878, when it was destroyed by the Saracens under Ibrahim ibn Ahmad.

Archaeology.—The medieval and modern town of Syracuse (with the exception of a new quarter which has sprung up since the construction of the railway between the station and the island) is confined to the island. This contains the remains of two Doric temples. The older, belonging probably to the beginning of the 6th century B.C., appears, from an inscription on the uppermost step, to have been dedicated to Apollo. It was a peripteral hexastyle, and must have had at least nineteen columns at the sides; the portion excavated shows that its total width is 74¼ ft., the width of the cella 38½ ft., the lower diameter of the columns 6¼ ft. The other temple, into which the cathedral was built in A.D. 640, is to be dated after 440 B.C. It was a peripteral hexastyle of thirty-six columns, with a total length of 160½ ft. and a total breadth of 72 ft.; the columns have a lower diameter of 5¾ ft., and the inter-columniation is 13½ ft. It is generally regarded as the temple of Athena.

Near the west coast of the island is the famous fountain of Arethusa.[2] According to the legend, the nymph Arethusa was changed into the fountain by Artemis to deliver her from the pursuit of the river-god Alpheus (*q.v.*); and the spring, which was fresh until an earthquake broke the barrier and let in the salt water, was supposed to be actually connected with the river. There are interesting remains of medieval architecture in the closely built town with its narrow streets; the beautiful 14th-century windows of the Palazzo Montalto may be especially noticed, and also the 13th-century Castello Mainace at the southern extremity of the island. The town also contains the archaeological museum, which, under the direction of Professor Orsi, is now the best arranged in the island. The discoveries of recent years in the south-eastern portion of Sicily, including especially the objects found in Sicel and Greek cemeteries, may be studied here. The isthmus connecting the island with the mainland, which was defended by strong fortifications erected by Charles V. and Philip II. (now demolished), does not occupy the site of the mole erected in the 6th or 7th century B.C., which may be recognized as having run due north from the north point of the island to the mainland near the ferry of S. Lucia.[3] The Little Harbour was thus in origin merely a recess of the Great Harbour; and it was probably Gelo who was responsible for making it an independent port, by establishing the crossing to the island in its present position. On the landward side of the new isthmus was the Agora, in which remains of a colonnade of the Roman period have been found. To the west are the remains of an extensive building of the Roman period, probably a palaestra, with a small Odeum attached. To the W.N.W. is the so-called Piano del Fusco, an extensive necropolis, in which over six hundred tombs, mostly of the 7th and 6th centuries B.C., have been found.[4] This necropolis was included within the defensive wall of Dionysius, a portion of which, no less than 18½ ft. thick, was found in 1886 running diagonally across the new cemetery, and in 1903 an outwork in front of it was discovered (P. Orsi, in *Notizie degli scavi*, 1903, 517). East of this point it probably followed the edge

[1] This statement made by Polybius (viii. 5) is almost incredible. Livy's account of the siege, too, is full of topographical difficulties (Lupus, 214 sqq.).

[2] The name is a widespread Greek name for a spring.

[3] Lupus, *Topographie von Syrakus*, 26, 88, 91. Near the ferry are a row of long parallel cuttings in the rock, which must be remains of the ancient docks, each being intended to take a ship.

[4] It is remarkable that hardly any tombs of the 5th century B.C. have come to light.

of the low terrace above the marsh (the ancient Lysimeleia),[1] while in the other direction it ran N.N.W., making straight for the western edge of the gorge known as the Portella del Fusco, which was thus included within the fortifications, as it would otherwise have afforded a means of access to the enemy. Here the wall gained the top of the cliffs which mark the southern edge of the plateau of Epipolae, which from this point onwards it followed as far as Euryelus. The south wall of Epipolae, considerable remains of which exist, shows traces of different periods in its construction, and was probably often restored.[2] It is built of rectangular blocks of limestone generally quarried on the spot, about $5\frac{3}{4}$ ft. long, 2 ft. high and $2\frac{1}{2}$ ft. deep. The thickness of the wall averages 10 ft., but varies 3 or 4 ft. each way. The point where the terrace of Epipolae narrows down to a ridge about 60 yds. wide, which is its only link with the hills to the west, had thrice proved during the Athenian siege to be the key to Syracuse. It now bears the ruins of a mighty fortress, finer than that which defends the entrance to the acropolis of Selinus—the most imposing, indeed, that has come down to us from the Greek period—which there is no doubt is the work of Dionysius. The total length of the works is about 440 yds. In front of the castle proper are three ditches, the innermost of which can be reached from the interior of the castle by a complicated system of underground passages. The front of the castle is formed by five massive towers: behind it are two walled courtyards, to the north of the easternmost of which is the well-guarded main entrance to the plateau of Epipolae (narrower minor entrances are to be seen on both the north and the south sides) communicating by a long underground passage with the inner ditch in front of the castle proper. That this point is to be identified with Euryelus is now generally admitted (see Lupus, 125–127; Freeman, iii. 661). Earlier writers make this the site of Labdalum, and put Euryelus farther west; but Labdalum must be sought somewhat farther east, near the northern edge of the plateau, in a point not visible from the Athenian central fort (*κύκλος*) with a view over Megara —not therefore in the commanding position of Dionysius's fort, with an uninterrupted view on all sides. On the north side of Epipolae the cliffs are somewhat more abrupt; here the wall, of a similar construction to that on the south, is also traceable: but here it is apparently all of one period. It is, indeed, recorded by Diodorus that Dionysius built the north wall from Euryelus to the Hexapylon in twenty days for a length of $2\frac{3}{4}$ m., employing 60,000 peasants and 6000 yoke of oxen for the transport of the blocks. Several smaller entrances are to be seen in it, as in the south wall: among them one with a series of inclined planes cut in the rock, which leads to an ancient road running south-east to the neighbourhood of the theatre. The Hexapylon plays an important part in the Roman siege of Syracuse. It was the main entrance on the north, and no doubt is to be identified with the so-called Scala Greca, where the modern highroad leaves the plateau.[3] This highroad, which probably follows an ancient line, may be reasonably held to mark the west boundary of Tyche. Five hundred yards to the east of it an interesting postern was discovered in 1895 (Orsi, in *Notizie degli scavi*, 1893, 168), at the point where the wall leaves the edge of the plateau and begins to follow the sea-coast; and half a mile farther on we reach the deep gorge of S. Bonagia (more correctly Panagia), which here forms the boundary between Tyche and Achradina. The west boundary of Achradina is marked farther south by a perpendicular cutting in the rock, on the top of which a wall must have run (see above). To the east of the gorge the wall still follows the edge of low cliffs of the coast, and continues to do so all along the east side of Achradina as far as the Little Harbour. On this side traces of it are very scanty, as the sea-spray has eaten away the stone.

The most important buildings of which we have any remains are to be found in the lower part of Achradina and in Neapolis, a quarter of which we hear first in the time of Dionysius, and which at first was confined to the lower ground below Temenites, but in Roman times included it and the theatre also (Lupus, 168), though it did not extend beyond the theatre to the uppermost part of the plateau. In lower Achradina remains of Roman private houses have been found, and it is in this district that the early Christians[4] constructed their catacombs. Those which are entered from near the 12th-century church of S. Giovanni, situated near an ancient temple, are extensive and important, and include the ancient crypt of S. Marcianus, and the type is different from that of the Roman catacombs, the galleries being far larger (partly owing to the hardness of the limestone in which they are excavated), and having circular chambers at the points of junction. In Neapolis, on the other hand, public buildings predominate. The temple of Apollo Temenites has entirely disappeared, but the theatre, entirely hewn in the rock, is still to be seen. It is the largest in Sicily, being about 146 yds. in diameter, and having about sixty rows of seats; the eleven lower tiers were originally covered with marble. Each of the nine *cunei* bore a name: the inscriptions of five of them, still preserved on the rock, are in honour of Zeus, Heracles, King Hiero II., his wife Philistis, and his daughter-in-law Nereis. Of the stage nothing but cuttings in the rock for foundations are visible. The situation is well chosen, commanding a splendid view over the Great Harbour. Not far off to the south-east is the amphitheatre, probably erected by Augustus when he founded a colony at Syracuse; it is partly cut in the rock and partly built. It is inferior in size only to the Colosseum and the amphitheatres of Capua and Verona, measuring about 153 by 130 yds. over all: the arena is 76 by 43 yds. To the west of the amphitheatre is the foundation of the great altar erected by Hiero II. (Diod. xvi. 83), 217 yds. long by 24 wide, and about 6 yds. in height. To the north-west of the theatre a winding road ascends through the rock, with comparatively late tomb chambers on each side of it. In this district are seen hundreds of small niches cut in the rock, as a rule about 2 ft. square and a few inches deep, which served for containing inscriptions or reliefs, sometimes of a sepulchral character, but sometimes relating to the cult of a divinity. Many of them are also found in the quarries (Orsi, in *Notizie degli scavi*, 1904, 277). Both the districts just described also contain huge quarries, the famous Lautumiae (from Gr. λᾶας, stone, and τεμεῖν, to cut; hence λατομία, quarry) of Syracuse, over 100 ft. deep and of great extent (though through the collapse of the pillars supporting the undermined rock they have become still larger than they were in ancient times). They are now overgrown with luxuriant vegetation. The upper plateau (Achradina, Tyche, Epipolae itself) is now largely cultivated at the east end, less so at the west end. It is traversed by the subterranean aqueducts by which the city was supplied[5] (see AQUEDUCTS), and by a few ancient roads, but contains practically no remains of ancient buildings. Cuttings in the rock for the foundations of such are numerous round the south edge of Temenites and Achradina, and are to be seen at various points near the city wall. But otherwise the disappearance of the edifices of ancient Syracuse is most striking.

We have already seen that immediately outside Lower Neapolis on the south the marshes of Lysimeleia begin, which proved fatal to more than one besieging force. They are traversed by the Anapus, with its tributary the Cyane, the latter famous for the papyrus planted by the Arabs, which here alone in Europe grows wild in the stream. To the south of the Anapus is the hill of Polichne, on which stood the Olympieium, attributed on stylistic grounds to 581 B.C. Its monolithic

[1] The date of the fragment of city wall immediately to the north-east of the so-called palaestra is uncertain; it is therefore doubtful whether it can belong to this system of defences (Lupus, pp. 308, 331).

[2] As to the question whether it was finished at the time of the Carthaginian invasion of 397 B.C., see Freeman, iv. 55. In any case it must have been completed by 385 B.C.

[3] Here are numerous caves in the rock, used for the worship of Artemis.

[4] St Paul tarried at Syracuse three days on his way to Rome (Acts xxviii. 12).

[5] A large reservoir of the Greek period exists under the present railway station (*Notizie degli scavi*, 1904, 280).

columns, of which two are still standing, are about 21 ft. in height and 6 ft. in lower diameter: its length is estimated at 197 ft., its breadth at 66¾ ft. (Orsi, in *Monumenti dei Lincei*, 1903, xiii. 369). The hill was frequently occupied in attacks on Syracuse by the besieging force. It is not, however, defensible in the rear: hence Dionysius's success against the Carthaginians. The hill of Dascon is to be sought a trifle to the south-east, to the south of the mouth of the Anapus, on the edge of the Great Harbour, at the Punta Caderini. From this point southwards the shore of the Great Harbour, previously low and marshy, begins to rise, until the rocky promontory of Plemmyrium is reached, which closes it on the south. Here Sicel tombs have been found, in some of which it appears that the Athenian dead were hastily buried (Freeman iii. 365, n. 1), while a colossal tomb, attributable also to the time of the Athenian invasion, was found there in 1899.

See A. Holm and F. S. and C. Cavallari, *Topografia archeologica di Siracusa* (Palermo, 1883), or the more handy German translation by B. Lupus, *Topographie von Syrakus* (Strassburg, 1887); P. Orsi, in *Atti del congresso di scienze storiche*, v. 181 (Rome, 1904), and in *Notizie degli scavi, passim*; E. Mauceri, *Siracusa* (Palermo, 1904); J. Führer and V. Schultze, "Die altchristlichen Grabstätten Siziliens," *Jahrbuch des k. d. arch. Inst.*; Ergänzungsheft, vii. 17 sqq. (Berlin, 1907). In the hills to the west of Syracuse many Sicel villages must have existed; cemeteries of the second and third period have been found at Pantalica 15 m. to the north-west, with the ruins of the habitation of the chief of the tribe, and of the second at Cassibile, 10 m. S.S.W. (see Orsi in *Monumenti dei Lincei* (1899) ix. 33, 146). (E. A. F.; T. As.)

SYRACUSE, a city and the county-seat of Onondaga county, New York, U.S.A., situated at the southern end of Onondaga Lake, about 75 m. E. of Rochester and about 150 m. W. of Albany. Pop. (1880), 51,792; (1890), 88,143; (1900), 108,374, of whom 23,757 were foreign-born (including 7865 German, 5717 Irish, 2393 English Canadian and 2383 English) and 1034 were negroes; (1910, census), 137,249. Area (1906), 16·62 sq. m. Syracuse is served by the New York Central & Hudson River, the West Shore, and the Delaware, Lackawanna & Western railways, by the Erie Canal and the Oswego Canal, which joins the Erie within the city limits, and by several electric inter-urban lines. The city is built on high ground in an amphitheatre of hills surrounding the lake, which is a beautiful body of clear water, 5 m. long by 1½ m. broad at its widest point. Of the residential streets, James Street, in the north-eastern part of the city, is the most attractive. Salina Street is the principal business thoroughfare. The park system comprises more than fifty parks and squares, with a total area of 278 acres. The largest and most noteworthy are Burnet park (about 100 acres), on high land in the western part of the city, Lincoln park, occupying a heavily wooded ridge in the east, and Schiller, Kirk and Frazer parks. A boulevard runs along the shore of the lake. A fine water-supply controlled by the city is obtained from Skaneateles Lake, 18 m. distant, by a gravity system which cost $5,000,000; and the city has an intercepting sewer system.

Among the most noteworthy churches of Syracuse are the Roman Catholic cathedral of the Immaculate Conception—Syracuse became the see of a Roman Catholic bishop in 1887—and St Paul's Protestant Episcopal, the first Presbyterian, first Methodist Episcopal, Dutch Reformed and May Memorial (Unitarian) churches, the last erected in memory of Samuel Joseph May (1797–1871), a famous anti-slavery leader, pastor of the church in 1845–1868, and author of *Some Recollections of Our Anti-Slavery Conflict* (1873). Among the public buildings are the Federal Building, the Onondaga county courthouse, costing $1,500,000 and containing a law library of 15,000 vols., the city-hall, the Central high school, a fine building erected at a cost of $400,000, the North high school ($300,000), and the public library (Carnegie) with 60,000 volumes in 1908 and housing the Museum of Fine Arts (1897), also.

Among the hospitals and charitable institutions are the Syracuse hospital (1872) for infectious diseases, the Hospital of the Good Shepherd (1873), the Syracuse homoeopathic hospital (1895), the Syracuse hospital for women and children (1887), St Mary's infant and maternity hospital (1900) under the Sisters of Charity, St Joseph's hospital (1869) under Sisters of the Third Order of St Francis, the Syracuse home for aged women (1852), Onondaga county orphan asylum (private; 1841), and two other orphan asylums controlled by the Sisters of Charity, and the state institution for feeble-minded children (1896). The University block (an office building owned by Syracuse University), the Union Building, the Onondaga county savings bank and the Syracuse savings bank are among the most notable business structures; and the Onondaga, the Vanderbilt House and the Yates and St Cloud hotels are the principal hotels. In Jamesville, about 6 m. south, is the Onondaga penitentiary. Adjacent to the city is Oakwood cemetery, overlooking the lake; and north-west of the city are the state fair grounds, with extensive exhibition halls and barns, where the annual fairs of the New York State Agricultural Society are held. Six miles south of the city is the Onondaga Indian reservation, the present capital of the "Six Nations." The city has an annual carnival and a musical festival.

Syracuse University, whose campus (of 100 acres) in the south-east part of the city commands a fine view of the lake, is a co-educational institution largely under Methodist Episcopal control, but not sectarian, which in 1908–1909 had 239 instructors and 3205 students (1336 in the college of liberal arts; 189 in the summer school; 62 in the library school; 933 in the college of fine arts; 147 in the college of medicine; 179 in the college of law; 401 in the college of applied science; and 78 in the teachers' college). The university was opened in 1871, when the faculty and students of Genesee College (1850) removed from Lima (New York) to Syracuse—a court-ruling made it impossible for the corporation to remove; in 1872 the Geneva medical college (1835) removed to Syracuse and became a college of the university. The courses in library economy (college of liberal arts) are particularly well known. The university library (about 80,000 bound volumes and 40,000 pamphlets) includes (since 1887) the collection of the German historian, Leopold von Ranke. There are seventeen buildings, among which the Holden observatory, the John Crouse memorial college (of fine arts), the hall of languages, the Lyman Smith college of applied science, the Lyman hall of natural history, the Bowne hall of chemistry, and the Carnegie library, are the most notable. There are a large gymnasium and a stadium of re-enforced concrete for athletic contests, capable of seating 20,000 people and one of the largest athletic fields in the world. The plant of the university in 1909 was valued at $3,193,128, and in 1908–1909 its productive funds amounted to about $2,000,000 and its income from all sources was about $784,000.

Other educational institutions are the Syracuse Teachers' training school, Christian Brothers' academy (Roman Catholic), St John's Catholic academy, Travis preparatory school (non-sectarian), and at Manlius (pop. 1910, 1314), a suburb, St John's military academy (Protestant Episcopal, 1869). The Onondaga Historical Association was organized in 1862, and after 21 years of inactivity was reorganized in 1892; it occupies its own building; its committee on natural science developed (1896) into the Onondaga academy of science. Several educational journals are published at Syracuse. There are three daily newspapers, the *Post-Standard* (*Standard*, 1829; *Post*, 1894; consolidated, 1899, Republican), *Journal* (1839; daily since 1844, Republican, and *Evening Herald* (1877), Independent).

The government is that of all cities of the second class in New York state, with an elective mayor and other important officers and a single-chambered city council.

Power from Niagara Falls is used by factories in the city, and the manufactures are extensive and greatly diversified. In 1905 the aggregate capital of the city's manufacturing industries was $38,740,651, and the value of its factory products was $34,823,751, 31·2% more than in 1900. The principal products in 1905 were: men's and women's clothing ($3,527,494, of which $3,082,052 represented men's clothing), foundry and machine-shop products, of which agricultural implements and machinery constituted the greater part ($2,415,466), iron and steel products ($2,117,585), chemicals, malt liquors ($1,960,466), typewriters and typewriting supplies ($1,553,113), and boots and shoes ($1,253,982). Other important products were automobiles and sewing machines, hosiery and knit goods, candles, furniture, flour, crockery, and canned goods (especially mince-meat).

Syracuse was long the principal seat of the salt industry in America.

The Onondaga salt deposits were mentioned in the journal of the French Jesuit Lemoyne as early as 1653, and before the War of Independence the Indians marketed Onondaga salt at Albany and Quebec. In 1788 the state undertook, by treaty with the Onondaga Indians, to care for the salt springs and manage them for the benefit of both the whites and the Indians. In 1795, by another treaty, the state acquired for $1000, to be supplemented by an annual payment of $700 and 150 bushels of salt, the salt springs and land about them covering about 10 sq. m. In 1797 the state leased the lands, the lessees paying a royalty of 4 cents per bushel and being forbidden to charge more than 60 cents per bushel. The state sank wells and built and maintained tanks from which brine was delivered to lessees. During 1812–1834 a royalty of 12½ cents was charged to raise funds for building canals (a rebate being granted in the last three years covering the entire amount of the royalty for these years). During 1834–1846 the royalty was 6 cents, and between 1846 and 1898 it remained stationary at one cent. In 1898 the state ordered the sale of the salt lands, because the revenues were less than the expense of keeping up the works; but state ownership was maintained until 1908, when the last of the lands were sold and the office of superintendent of salt lands, created in 1797, was abolished. Until 1840 only boiled salt was manufactured; in that year the solar process was introduced. The annual production, which amounted to 100,000 bushels in 1804, reached its highest point in 1862 (9,053,874 bushels, of which 1,983,022 bushels were solar, and 7,070,852 boiled). The development of the Michigan salt deposits and (after 1880) of the deposits in Wyoming, Genesee and Livingston counties in New York caused a rapid decline in the Onondaga product. In 1876 both processes yielded together only 5,392,677 bushels, and in 1896 only 2,806,600 bushels. The salt deposits at Syracuse had, however, laid the basis for another industry, the manufacture of soda-ash, which has grown to important proportions. At the village of Solvay (pop. 1905, 5196), adjoining Syracuse on the lake shore, are the largest works for the production of soda-ash in the world, giving employment to more than 3000 hands.

The Syracuse region became known to Europeans through its salt deposits. Until several years after the close of the War of Independence, however, there was no settlement. Ephraim Webster, who built a trading-post near the mouth of Onondaga Creek in 1786, was the first white settler. About 1788–1789 small companies began to visit the place every summer to work the salt deposits. In 1796–1797 there was a permanent settlement known as Webster's Landing, and in 1797 a settlement was begun at Salina, a short distance to the north on the lake shore. Geddes, another "salt settlement," was founded in 1803. In 1800 "the landing" received the name "Bogardus's Corners," from the proprietor of a local inn. Between 1800 and 1805 a dozen families settled here, and in the latter year a grist mill, the first manufacturing establishment, was built on Onondaga Creek. A sawmill was built in the following year. In 1804 the state government, which had assumed control of the saltfields, sold to Abraham Walton of Albany, for $6550, some 250 acres, embracing the district now occupied by Syracuse's business centre, to secure money for the construction of a public road. During the succeeding years the name of the place was frequently changed. It was called Milan in 1809, South Salina in 1809–1814, Cossitt's Corners in 1814–1817, and Cossitt in 1817–1824. In 1824 a post office was established, and as there was another office of that same name in the state, the name was again changed, the present name being adopted. The village was incorporated in 1825, Salina being incorporated independently at the same time. In the meantime the settlement had been growing rapidly. In 1818 Joshua Forman bought an interest in the Walton tract, had the village platted, and became the "founder" of the city. The first newspaper, the *Onondaga Gazette*, was established in 1823; and in 1825 the completion of the Erie Canal opened a new era of prosperity. In 1827 Syracuse became the county-seat of Onondaga county. In 1847 Salina was united to Syracuse, and the city was chartered. Geddes was annexed in 1886. Syracuse has been the meeting-place of some historically important political conventions; that of 1847, in which occurred the split between the "Barnburner" and "Hunker" factions of the Democratic party, began the Free Soil movement in the state. The strong anti-slavery sentiment here manifested itself in 1851 in the famous "Jerry rescue," one of the most significant episodes following the enactment of the Fugitive Slave Law of 1850; Samuel J. May, pastor of the Unitarian church, and seventeen others, arrested for assisting in the rescue, were never brought to trial, although May and two others publicly admitted that they had taken part in the rescue, and announced that they would contest the constitutionality of the Fugitive Slave Law, if they were tried.

See Carroll E. Smith, *Pioneer Times in Onondaga County* (Syracuse, 1904).

SYR-DARYA (Gr. and Lat. *Jaxartes*; Arab. *Shash* or *Sihun*), a river of Asia, flowing into the Sea of Aral, and having a length of 1500 m. and a drainage area of about 320,000 sq. m. Its headstream is the Naryn, which rises in the heart of the Tian-shan complex south of Lake Issyk-kul, on the southern slope (12,000 ft.) of the Terskei Ala-tau. After its union with another mountain stream, the Barskaun, it flows W.S.W. at 11,000 to 10,000 ft. above the sea, in a barren longitudinal valley between the Terskei Ala-tau and the foothills of the Kokshal-tau. On entering a wild narrow gorge in the south-west continuation of the Terskei Ala-tau it receives the name of Naryn. Within this gorge it descends some 4000 ft.; Fort Narynsk, 20 m. below the confluence of the Great and the Little Naryn, is only 6800 ft. above the sea. Here the river enters a broad valley—formerly the bottom of an alpine lake—and flows past the ruins of Fort Kurtka, for 90 m. westward, as a stream some 50 yds. wide and from 3 to 11 ft. deep. Its waters are utilized by the Kirghiz for irrigating their cornfields, which contrast strangely with the barren aspect of the lofty treeless mountains. The At-bash, a large mountain stream, joins the Naryn at the head of this valley and the Alabuga or Arpa at its lower end, both from the left. Before reaching the low-lands the Naryn cuts its way through three ridges which separate the valley of Kurtka from that of Ferghana, and does so by a series of wild gorges and open valleys (170 m.), representing the bottoms of old lakes; the valleys of the Toguz-torau, 2000 ft. lower than Kurtka, and the Ketmen-tube are both cultivated by the Kirghiz. Taking a wide sweep towards the north, the river enters Ferghana—also the bottom of an immense lake—where, after receiving the Kara-darya (Black River) near Namangan, it assumes the name of Syr-darya.[1] The Kara-darya is a large stream rising on the northern spurs of the Alai Mountains. As it deflects the Naryn towards the west, the natives look upon it as the chief branch of the Syr-darya, but its volume is much smaller. At the confluence the Syr is 1440 ft. above sea-level.

The waters of the Syr-darya and its tributaries are in this part of its course largely drained away for irrigation. It is to the Syr that Ferghana is indebted for its high, if somewhat exaggerated, repute in Central Asia as a rich garden and granary; cities like Khokand, Marghilan and Namangan, and more than 800,000 inhabitants of the former khanate of Khokand, subsist by its waters. Notwithstanding this drain upon it, the Syr could be easily navigated, were it not for the Bigovat rapids at Irjar, at the lower end of the valley, where the river pierces the Mogol-tau.

On issuing from this gorge the Syr enters the Aral depression, and flows for 850 m. in a north-westerly and northerly direction before reaching the Sea of Aral. On this section it is navigated by steamers. Between the Irjar rapids and Baildyr-turgai (where it bends north) the river flows along the base of the subsidiary ranges which flank the Chotkal Mountains on the north-west, and receives from the longitudinal valleys of these alpine tracts a series of tributaries (the Angren, the Chirchik, the Keles), which in their lower courses fertilize the wide plains of loess on the right bank of the Syr.

Some 50 m. below Chinaz (770 ft. above sea-level) the Syr bends northwards, but resumes its north-westerly course 150 m. farther down, following with remarkable persistency the edge of the loess. Its low banks, overgrown with reeds and rendered uninhabitable in summer by clouds of mosquitoes, are inundated for 20 m. on both sides when the snows begin to melt. These inundations prevent the moving sands of the Kyzyl-kum desert from approaching the Syr; below Perovsk, however, the steppe does gain the upper hand. Down to Perovsk the river rolls its muddy yellow waters, at the rate of 3 to 5 m. an hour, in a channel 300 to 600 yds. wide and 3 to 5 fathoms deep; at Perovsk its vertical section is 8220 sq. ft., and 312,500 cub. ft. of water are discharged per second. The Arys and the Bugun are the only tributaries worthy of notice along this part of its course; the other streams which descend from the Kara-tau fail to reach the river. The Kirghiz rear numerous herds of cattle and

[1] *Syr* and *darya* both signify "river," in two different dialects.

sheep in the valley of the Arys, while lower down, as far as Julek, the Iginchis carry on agriculture. All this applies of course only to the right bank; on the left the moisture is absorbed by the hot winds which cross the Kyzyl-kum sands towards the river. The dryness of the atmosphere has a marked effect upon the Syr when it gets below Julek, the Kara-kum sands being then on its right. Ten miles below Perovsk the river traverses a marshy depression (the bottom of a lake not yet fully dried up), where it divides into two branches—the Jaman-darya and the Kara-uzyak. The latter spreads out into marshes and ponds, from which it again issues to join the former at Karamakchi, after a course of 80 m. The main arm, owing to its shallowness and sinuosity, is very difficult to navigate, and the difficulty is increased by the rapidity of the current and the want of fuel. Between Kazalinsk and the Sea of Aral (158 ft.) navigation becomes somewhat easier, except for the last 10 m., where the river divides into three shallow branches before entering the "Blue Sea." All three have at their mouths sandy bars with only 3 ft. of water.

Two former right-hand tributaries of the Syr—the Chu and the Sary-su—now disappear in the sands some 60 m. before reaching it. The Chu, which is 600 m. in length, rises in the Tian-shan south-west of Lake Issyk-kul, and as the Kashkar flows towards Lake Issyk-kul, but a few miles before reaching that lake turns suddenly to the north-west, enters under the name of Chu the narrow gorge of Buam, and, piercing the snow clad Kunghei Ala-tau, emerges on its northern slope, having descended from 5500 ft. to less than 2000 in a distance of not more than 50 m. In this part of its course it receives from the right the Kebin, whose high valley equals in size that of the upper Rhone. It then flows north-westwards through the valley of Pishpek, and, avoiding the Muyun-kum sands, describes a wide curve to the north before finally taking a western direction. Numberless streams flow towards it from the snow-clad Alexander Mountains, but they are for the most part lost in the sands before reaching it. The Talas, 170 m. long, formerly an affluent of the Chu, which rises in the highest parts of that range, pierces the Cha-archa Mountains, and, flowing past Aulie-ata on the south border of the Muyun-kum, enters the salt lake of Kara-kul 60 m. from the Chu. The Chu terminates in the Saumal-kul group of lakes, 60 m. from the Syr. Another elongated group of lakes—the Uzun-kul—near the above, receives the Sary-su, which has a length of nearly 570 m. and flows rapidly in a narrow channel along the western edge of the northern Famine Steppe (Bekpak-dala).

The delta of the Syr begins at Perovsk, whence it sends a branch to the south-west, the Jany-darya (New River), which formerly reached the south-eastern corner of the Sea of Aral, very near to the mouth of the Amu-darya. The Kirghiz affirm that a canal dug for irrigation by the Kara-kalpaks gave origin to this river. It had, however, but a temporary existence. A dam erected by the people of Khokand at Ak-mechet (Perovsk) caused its disappearance, and the Russians found nothing but a dry bed in 1820. When the dam was removed the Jany-darya again reappeared, but it failed to reach the Sea of Aral; in 1853 it terminated in Lake Kuchka-denghiz, after a course of 250 m.; all traces of its bed were then lost in the sand. Five centuries ago, in the time of Timur, the Mongol prince of Samarkand, the Jany-darya brought the waters of the Syr to the Daukara lakes, close by the present mouth of the Amu. The series of old river-beds in the Kyzyl-kum, which are still seen above Perovsk, indicates that the Syr had a constant tendency to seek a channel to the south-west, and that its present delta is but a vestige of what it was once. At a still more remote period this delta probably comprised all the space between the Kara-tau and the Nura-tau in Samarkand; and the series of elongated lakes at the base of the Nura-tau—the Tuz-kaneh and Bogdan-ata lakes—represent an old branch of the delta of the Syr which probably joined the Zarafshan before reaching the Amu. The cause of this immense change is simply the rapid desiccation of all the northern and central parts of Asia, due to the fact that we are now living in the later phase of the Lacustrine period, which has followed the Glacial period. The extension of the Caspian Sea as far as the Sary-kamysh lakes during the post-Pliocene period and the extension of the Sea of Aral at least 100 m. to the east of its present position are both proved by the existence of post-Pliocene marine deposits. (P. A. K.; J. T. Be.)

SYR-DARYA, or Syr-Dariinsk, a province of Russian Turkestan, lying on both sides of the Syr-darya river, from its embouchure in the Sea of Aral up to Khojent, where it issues from the mountain region of the Tian-shan. The province is bounded N. by the provinces of Turgai, Akmolinsk and Semipalatinsk; E. by Semiryechensk; S. by Ferghana, Zarafshan, Bokhara and Khiva; and W. by Khiva and the Sea of Aral. Its area (166,000 sq. m.), its population (over a million and a half) and the city of Tashkent make it the most important province of Russian Turkestan.

The south-eastern boundary runs along the Chotkal Mountains (14,000 ft.), which separate the river Chotkal from the river Naryn, and join the Alexander Mountains on the east. A series of short chains, such as the Talas-tau and Ala-tau, fringe the above on the north-west, and occupy the south-east of the province. The snow-clad summits of the Talas-tau reach 14,000 to 15,000 ft. in altitude, and immense glaciers occur about Manas Mountain. This range seems to run from west-south-west to east-north-east; the other flanking chains have a decidedly south-westerly direction, and are much lower, the outlying ranges having rather the character of broad plateaus above 2000 ft. in altitude, where the Kirghiz find excellent pasture-grounds. Some of them, such as the Kazyk-urt, rise isolated from the steppe. The Kara-tau is quite separate from the preceding and runs at right angles to them—that is, from north-west to south-east. It belongs therefore to another series of upheavals prevalent in western Asia, to which Richthofen has given the name of the "Kara-tau series." Its length is about 270 m., and its average altitude about 5000 ft., rising at some points to 6000 and 7000 ft. It separates the river Syr-darya from the river Chu, and its gentle south-western slope contains the sources of a multitude of streams which water the oasis around the town of Turkestan.

The mountainous tracts occupy, however, only a small part of Syr-darya, the rest is steppe. Three different areas must be distinguished—the Kyzyl-kum, the Muyun-kum or Ak-kum, and the Kara-kum. The Kyzyl-kum (red sands) sands stretch between the Amu and the Syr, and have a gradual ascent from 160 ft. at the Sea of Aral to 1500 and 2000 ft. in the south-east. They are partly shifting, partly stationary (see Kara-Kum). In the west the surface is overlaid with remains of Aral-Caspian deposits. As the Tian-shan is approached the steppe assumes another character: a thick sheet of loess girdles the foothills and forms the fertile soil to which Turkestan is indebted for its productive fields and gardens. The Kara-kum sands, situated north-east of the Sea of Aral, are manifestly a former bottom of the lake.

In the east the steppe yields some vegetation and is visited by the Kirghiz. The barkhans do not shift, being covered with *Calligonum*, *Tamarix*, *Holoxylon anemodendron*. The Muyun-kum or Ak-kum steppe, between the Kara-tau Mountains and the Chu River, is quite uninhabited, except in the loess region at the northern base of the mountains. (For the geological history of the western Tian-shan ranges see Tian-Shan.) Throughout the Cretaceous and earlier Tertiary periods the lowlands of Syr-darya were under the sea. The character of the region during the post-Pliocene period remains unsettled. A girdle of loess, varying in width from 30 to 50 m., encircles all the mountain tracts, increasing in extent in Bokhara and at the lower end of the valley of Ferghana. It seems certain that during the Lacustrine period the Caspian was connected by a narrow gulf with the Aral basin, which was then much larger, while another inland sea of great dimensions covered the present Balkash basin, and at an earlier period may have been connected with the Aral basin. Recent traces of these basins are found in the steppes.

The chief river of the province is the Syr-darya (*q.v.*). The frontier touches the eastern shore of the Sea of Aral, and numerous small lakes, mostly salt, are scattered over the sandy plains. A few lakes of alpine character occur in the valleys of the hilly tracts.

The climate of the province varies greatly in its different parts. It is most severe in the mountain region; and in the lowlands it is very hot and dry. As a whole, the western parts of the Tian-shan receive but little precipitation, and are therefore very poor in forests. In the lowlands the heat of the dry summer is almost insupportable, the thermometer rising to 111° F. in the shade; the winter is severe in the lower parts of the province, where the Syr remains frozen for three months. The average yearly temperature at Tashkent and Kazalinsk respectively is 58·3° and 46·4° (January, 29° and 12°; July, 77·5° and 78°).

The terraces of loess mentioned above are alone available for cultivation, and accordingly less than 1 % (0·8) of the total area of the province is under crops, the remainder being either quite barren (57 %) or pasture land (42 %). In the few cases where cultivation is possible, it is carried to great perfection owing to a highly developed system of irrigation—two crops being gathered every year. Wheat and barley come first, then peas, millet and lentils, which are grown in the autumn. Rye and oats are grown only about Kazalinsk. Cotton is cultivated. Gardening is greatly developed. Sericulture is an important source of income. Livestock breeding is largely pursued, not only by the nomads but by the settled population. Fishing is prosecuted to some extent on the lower Syr. Timber and firewood are exceedingly dear.

The population of the province was estimated in 1906 as 1,779,000. It is comparatively dense in certain parts. The Russians number barely 8500, if the military be left out of account. Kirghiz (50 %) and Sarts (9·8 %) are the main elements of the population, with Uzbegs (4·3 %), and a few Jews, Tajiks, Tatars, Persians and Hindus. The predominant occupations of the Sarts, Uzbegs, Tajiks and settled Kirghiz are agriculture and gardening, but the Kirghiz lead chiefly a nomadic pastoral life. Manufactures are represented by cotton mills, tanneries and distilleries; but a great variety of petty industries are practised in the towns and villages.

Syr-darya is divided into six districts, the chief towns of which are Tashkent, Aulie-ata, Kazalinsk, Perovsk, Chimkent and Amu-darya. (P. A. K.; J. T. Be.)

SYRIA, the name given generally to the land lying between the easternmost shore of the Levantine Gulf and a natural inland boundary formed in part by the Middle Euphrates and in part by the western edge of the *Hamād* or desert steppe. The northern limit is the Tauric system of mountains, and the southern limit the edge of the Sinaitic desert. This long strip extends, therefore, for about 400 m. between 38° and 31° N. lat. with a mean breadth of about 150 m. Since, however, the steppe edge on the east is somewhat indefinite, some early Moslem and other geographers have included all the Hamād in Syria, making of the latter a blunt-headed triangle with a base some 700 m. long resting on the north Arabian Nefud. But Strabo, Pliny and Ptolemy, as well as the better Moslem geographers, drew the eastern frontier obliquely from the Gulf of Akeba to Rakka (Raqqa) on Euphrates, and thus placed the Hamād in Arabia.

The name *Syria* is not found in the Hebrew original of the Scriptures; but it was used by the Septuagint to translate Aram. Homer knows only Ἄριμοι, but Herodotus speaks of "Syrians" as identical with Assyrians, the latter being, he thinks, a "barbarian" form, and he applies the name very widely to include, *e.g.* north Cappadocians ("White Syrians" of Pteria). Syria, however, is probably the Babylonian *Suri*, used of a north Euphratean district, and a word distinct from Assyria. Generally the ethnic term, Syrians, came to mean in antiquity the Semiti peoples domiciled outside the Mesopotamian and Arabian areas: but neither in pre-Greek nor in Greek times had the word Syria any very precise geographical significance, various lands, which we include under it, retaining their distinctive status, *e.g.* Commagene (Kummukh), Cyrrhestica, Phoenicia, Palestine, &c. It is only under the Graeco-Roman administration that we find a definite district known as Syria, and that was at first restricted to the Orontes basin. Later, all that we understand by Syria came to be so known officially to the Romans and Byzantines; but the only province called simply Syria, without qualification, remained in the Orontes valley. Under the present Ottoman distribution "Syria" is the province of Sham or Damascus, exclusive of the vilayets of Aleppo and Beirut and the sanjaks of Lebanon and Jerusalem, which all fall in what is called Syria is the wider geographical sense.

Taking Syria as the strip limited by the sea, the edge of the Hamād, the Taurus and the Sinaitic desert, we have a remarkably homogeneous geographical area with very obvious natural boundaries; but these, for various reasons, have proved very ineffective in history, especially on the south and east. Syria happens to lie on the line of least resistance for communication between the early subtropic seats of civilization in the Nile and Euphrates valleys and the civilizations of Europe. Its eastern boundary is in great part a steppe, which breeds population, but, unable to nourish increase, sends it over its boundaries in a constant stream of migration. Consequently south Palestine has been continuously "Arabized"; and indeed the whole of Syria has been characterized by racial and religious fusions, and by civilization of a singularly syncretic and derived kind, of which the ancient Phoenician is a sufficient example.

The surface configuration of almost all the strip is remarkably uniform. With the exception of the extreme north (Commagene), which is shut off by a barrier of hills and belongs to foreign hydrographic systems, the whole country is roughly a gable-shaped plateau, falling north and south from a medial ridge, which crosses Syria at about its central point. This gable is tilted eastwards, and its two long slopes are defined by bordering mountain chains which run across its medial ridge; the main Syrian streams are those which follow those slopes between the chains, thus running either north or south for most of their courses, and only finding their way to the western sea by making sharp elbows at the last. Syrian orography, therefore, is simple, being composed of nothing but these two parallel systems. That on the west, which rises behind the Mediterranean littoral, springs from Taurus in the well-afforested Mt Amanus (Giaour Dagh), and is continued by Jebel Bereket and J. Akhma, over the northern end of which runs a single easy pass (Beilan) to the north-east angle of the Levant coast (Alexandretta), while at the southern end is a gap through which the Orontes turns sharply to the sea. South of this, with J. Akra (the Bald Mountain, anc. *Casius*) begins a further section, rounded and grassy, called J. Ansariya, which presently springs up into a high chain of Jurassic limestone with basaltic intrusions, whose peaks rise to 10,000 ft. and whose passes do not fall under 6000 ft. Here it is called J. al-Gharbi or Libnan (see LEBANON). Thereafter it broadens out and becomes the high table-land of Galilee, Samaria and Judaea, and gradually sinks into the plateau of north Sinai.

The eastern system springs from the Tauric offshoot (Kurd Dagh, &c.), which shuts off the Commagenian basins, and as the triple chain of J. al Ala, it defines the Orontes valley on the east. Like its western parallel it springs up presently into a higher chain and is known as J. es-Sharki, or Anti-Libanus, which culminates in a knot on the south, to which is given the name J. es-Sheikh, or Hermon (8000 ft.). Thereafter it loses much of its distinctive character, but may be traced southwards in J. Ḥauran and the Moabite hills to Horeb and the Midianite Mountains of the Hebrews, which run into Arabia.

Hydrography.—Between these systems run the main rivers; and these naturally rise near the medial ridge, in the lacustrine district of el-Buka'a, or Coelesyria, and flow in opposite directions. That following the northern slope is the Nahr al-'Asi (see ORONTES) into which, when it has turned sharply towards the sea, flow some tributary streams from the Commagenian divide on the north. The main stream flowing south is the Jordan, which fails to reach the sea, being absorbed into the great rift of the Ghor: but a smaller stream, the North Litani (called Kasimiya in its lower course), whose source lies very near that of Jordan, repeats the course of the Orontes on a minor scale and gets through the western mountain system to the sea near Sur (Tyre). Outside the basins of these rivers and their bordering mountain systems there only remain to be considered the following: (1) The Mediterranean littoral strip (the ancient PHOENICIA), with a few torrent-like streams. (2) The shut-off district in the extreme north, ancient Commagene, which consists of two basins divided by a low ridge running from south to north. These basins belong, one to the Cilician river-system, and the other to the Euphratean. In the first lay the ancient Germanicia (mod. Marash); in the second the ancient Samosata (mod. Samsat), whose importance has now passed to Adiaman. The southern boundary of both basins is a low chain which leaves the Euphrates near the mouth of the Sajur tributary, and runs west towards Mt Amanus, to which it is linked by a sill whereon stood the ancient fortified palace of Samal (Sinjerli; see HITTITES). (3) A succession of oases lying east of the eastern mountain system on the edge of the steppe, and fed by short local streams. Of these the most important are, from north to south, (*a*) the Saltpan of Jebeil, fed by the North al-Dahab; (*b*) the oases of Kinnesrin and Aleppo, fed by the North Kuwaik; and (*c*) that of Sham or Damascus, fed by streams from Hermon, of which the Barada (Abana) and the Awaj (Pharpar) are the chief.

Since these streams had in no case originally easy access to the sea, we naturally find lakes on their course, and several of them terminate in tracts of more or less permanent inundation. Those which occur on the course of the principal rivers are described under ORONTES and JORDAN. The others, which terminate streams, are the Bahr el-Ateiba, which receives the waters of Damascus; the Mat, into which the Kuwaik flows below Kinnesrin; and the Ak Deniz, or Bahrat Antakia, the ancient Lake of Antioch, which collects the waters of the Kara Su and Afrin, the southward from the watershed which shuts off Commagene. The last-named lake has now been almost entirely dried up by the cutting of a channel, which conducts its feeders directly to the Orontes.

Geology.—Geologically, Syria belongs to two distinct regions of the earth's crust, the northern and smaller portion lying within the great belt of folding of southern Europe and central Asia, and the southern and larger portion belonging to the Indo-African area, which, though often faulted, is usually free from crumpling. According to M. Blanckenhorn the boundary between the two regions runs from the Bay of Jebele along the Afrin River to Aintab, and thence to the Euphrates above Birejik. In the southern region which is by far the better known, the oldest rocks are granites, crystalline schists and other rocks of Archean aspect. These are overlaid by conglomerates, tuffs, sandstones and arkoses, which perhaps do not all belong to the same period. In Palestine a limestone containing Carboniferous fossils is found in the midst of the sandstone series, and here the sandstone is immediately succeeded by limestones with Hippurites and other fossils belonging to the Upper Cretaceous. Farther north, however, Jurassic beds are met with, but of very limited extent. Cretaceous limestones cover the greater part of Palestine and rocks of the same period form Mt Lebanon, the Casius Mons, &c., farther north. Nummulitic limestone (Eocene) overlies the Cretaceous in Philistia, and north of Lebanon Eocene and Miocene deposits cover the greater part of the country. The Pliocene deposits are not very widely spread and are generally of fresh-water origin excepting near the coast, but marine Pliocene beds have been found at el Forklus in the Palmyra desert. Jebel Hauran, east of the Jordan, is capped by a great sheet of basalt; and many other basalt flows are found, especially in the country north of Lebanon. They are mostly true felspar basalts, but a few contain nepheline in addition to the felspar. In most cases the eruptions appear to be of Pliocene or later date, but in the extreme north some of the basalt seems to belong to the Miocene period. There is historic evidence of mud eruptions in some of the volcanic areas. The most striking feature in the structure of Syria is the existence of long *Graben*, or narrow depressions formed by faulting. The best known of these Graben is that of the Jordan, but the upper part of the Orontes lies in a similar depression, which is, indeed, very probably the continuation of the Jordan-Araba trough. The faulting which formed the depressions is certainly later than the deposition of the Cretaceous beds and probably belongs to the later portion of the Tertiary era. Little is known of the part of Syria which lies within the folded belt, and includes the Amanus and Kurd mountains. The rocks do not appear to differ very markedly from those farther south, but the Devonian is believed to be represented. The folds are approximately parallel to those of the Taurus, and geologically these mountains may be said to belong to that range.[1]

Climate.—Within historic times the climate, and with it the productivity of the country, cannot have greatly changed; at most the precipitation may have been greater, the area under wood having been more extensive. Except for Jerusalem, we have hardly any accurate meteorological observations; there the mean annual temperature is about 63° F.; in Beirut it is about 68°. The rainfall in Jerusalem is 36·22 in., in Beirut 21·66. The heat at Damascus and Aleppo is great, the cooling winds being kept off by the mountains. Frost and snow are occasionally experienced among the mountains and on the inland plateaus, but never along the coast. Even the steppe exhibits great contrasts of temperature; there the rainfall is slight and the air exceedingly exhilarating and healthy. The sky is continuously cloudless from the beginning of May till about the end of October; during the summer months the nights as a rule are dewy, except in the desert. Rain is brought by the west wind; the north-west wind, which blows often, moderates the heat. On the other hand, an ozoneless east wind (sirocco) is occasionally experienced—especially during the second half of May and before the beginning of the rainy season—which has a prejudicial influence on both animal and vegetable life. On the whole the climate of Syria—if the Jordan valley and the moister districts are excepted—is not unhealthy, though intermittent fevers are not uncommon in some places.

The general character of the country, resultant on these conditions, varies according to elevation and latitude. Owing to the high barrier which shuts off almost all Syria from the sea, and precipitates vapours mainly on the western slope, little of the land is highly productive without irrigation, except the narrow littoral strip which was the ancient Phoenicia, and the small deltas, such as that of Latakia (Laodicea). Palestine, being less shut in and enjoying a comparatively large general rainfall, would be still a land "flowing with milk and honey" had its forests not been destroyed, and the terracing, which used to hold up soil on the highlands, been maintained. As it is, it has very fertile patches of lowland, such as the plains of Esdraelon and Jaffa; and the high levels, largely composed of disintegrated igneous rock, west of Jordan, over which the sea-wind carries the rains, offer excellent corn-land. In the extreme south Palestine begins to be affected by the Arabian dryness. For the rest, Syria needs irrigation; and since neither of its larger rivers, Orontes or Jordan, flowing as these do in deep beds, is of much use for this purpose, all Mid-Syria, except the lacustrine oases, is a region mainly occupied by pastures, and yielding only thin cereal crops. Commagene, where not rocky, and the district lying along the southward drains from its divide (anc. *Cyrrhestica*), is in better case, enjoying perennial streams which can be utilized, and the fringe of the Tauric rainfall. The latter dies away over the plains east and south-east of Aleppo, making them afford good spring pasture, which has attracted the nomads from farther south: but below the latitude of Rakka-Homs thin steppe begins, and quickly degenerates into sheer desert broken only by a chain of poor oases, south of a low ridge running from Anti-Lebanon to Euphrates. Of these the principal are Karietein and Tadmor (Palmyra), through which passes the trade from Damascus to the east. In ancient times,

[1] See O. Fraas, *Aus dem Orient*, pt. ii. (Stuttgart, 1878); C. Diener, *Libanon* (Vienna, 1886); M. Blanckenhorn, *Beiträge zur Geologie Syriens* (Cassel, 1890, &c.), and *Grundzüge der Geologie und physikalischen Geographie von Nord-Syrien* (Berlin, 1891). See also the references under PALESTINE. A summary by M. Blanckenhorn will be found in *Monatsschr. f. wirtschaftl. Erschliessung Palästinas*, pp. 289–301 (Berlin, 1904).

up to the Arab invasion, the northern part of the eastern plateau, between Orontes and Euphrates, was made habitable and even fertile by storage of rainfall. It supported a large number of villages and small towns, whose remains are remarkably well preserved, and still serve to shelter a sparse pastoral population.

Flora.—Two distinct floral regions meet in Syria, that of the Mediterranean and that of the west Asian steppe-land. The first, to be seen on the coast and the western slopes of the highlands, is characterized by a number of evergreen shrubs with small leathery leaves, and by quickly-flowering spring plants. On the lowest levels the southern forms, the *Ficus sycomorus* and the date-palm, appear, and increase in the direction of Egypt (see LEBANON and PALESTINE). The steppe region, whose flora begins to appear east of the western ridge, is distinguished by the variety of its species, the dry and thorny character of its shrubs, and great poverty in trees. Between these regions the greatly depressed valley of Jordan shows a subtropic vegetation. Among cultivated trees, the olive is at home throughout Syria, except on the steppe; the mulberry is planted extensively in the lower Lebanon; and all sorts of fruit-trees flourish in irrigated gardens, especially on the Phoenician coast, in the Palestinian plain, in the oasis of Damascus, and in the Buka'a, The main cereal regions are the Hauran, and the plains of Antioch and Commagene; and the lower western slopes of the coast range are largely devoted to the culture of tobacco. On the northern inland downs liquorice grows wild and is collected by the peasants and sent down to Alexandretta.

Fauna.—The mammals of Syria are rather sharply to be distinguished into those which range only north of Mt Carmel, and those which pass that limit. The first class includes the isabelline bear, badger, pole-cat, ermine, roe and fallow deer, wild ass, Syrian squirrel, pouched marmoset, gerbill and leopard. The second class will be found under PALESTINE; and it includes a sub-class which is not found outside Palestine at all. In the latter are the coney, jerboa, several small rodents and the ibex. Only in the Jordan valley do intrusions from the Ethiopic region appear. Elsewhere the forms are Palaearctic with intrusions from the east; but the length of the Syrian strip and the variety of its surface relief admit of considerable difference in the species inhabiting different districts. The Lebanon and the hills of north Galilee offer the greatest number of mammals.

Population.—The actual population of Syria is over 3,000,000, spread over a superficial area of about 600,000 sq. m., *i.e.* about 5½ persons to the square mile. But this poor average is largely accounted for by the inclusion of the almost uninhabited northern steppe-land; and those parts of Syria, which are settled, show a much higher rate. Phoenicia and the Lebanon have the densest population, over 70 to the square mile, while Palestine, the north part of the western plateau east of Jordan, the oases of Damascus and Aleppo, the Orontes valley, and parts of Commagene, are well peopled. The bulk of the population, so far as race goes, is of the Semitic family, and at bottom Aramaean with a large admixture of immigrant Arabian blood, which is constantly being reinforced, and a comparatively small strain of Hebrew blood. The latter appears mainly in Palestine, and has of late been considerably strengthened by immigration of European Jews, who have almost doubled the population of Jerusalem, and settled upon several fertile spots throughout the Holy Land. But how far these, or the indigenous " Jews " are of Hebrew rather than of Aramaean origin is impossible to say. We only know that as long ago as the 1st century B.C. true Hebrew blood was becoming rare, and that a vast proportion of the Jews of Roman times were Hebraized Aramaeans, whose assimilation into the Jewish community did not date much further back than the Maccabaean age.

Among this Semitic folk is to be observed a great variety of immigrant stocks, settled in isolated patches, which have done much to contaminate the masses about them. In the extreme north (Commagene) the highlands are almost entirely held by Kurds who entered from beyond Euphrates in comparatively recent times. Kurds live upon the Commagenian plains here and there, as also in the northern trans-Euphratean plains. Among them in the Tauras and Amanus, and outnumbering them on the plains, are Armenian communities, the remains of the Rupenian invasion of the 10th century A.D. (see ZEITUN). These are found as far south as the plain of Antioch and the basin of the Sajur. To the north of Aleppo and Antioch live remnants of pre-Aramaean stocks, mixed with many half-settled and settled Turkomans (Yuruks, Avshars, &c.) who came in before the Mahommedan era, and here and there colonies of recently imported Circassians. The latter are also settled numerously to the west of Jordan. Mid-Syria shows a medley of populations of more or less mixed origin, in large part alien, for which see DRUSES; MARONITES and LEBANON. In the Phoenician coast towns are many Greeks (to be distinguished from Orthodox Syrians, called also Greeks on account of creed). In the steppe-land and in the southern trans-Jordanic districts are numbers of true Arabs, mostly belonging to the great Anazeh family, which has been coming northwards from Nejd in detachments since the 13th century. These are mainly nomadic, and include offshoots of the great tribes of Ruala, Walad Ali, B. Sokhr, Adwan and Bishr, the first two roaming mainly in the north, the last two in Moab and Ammon. Ottoman Turks, scattered gipsy communities, German settlers in north Palestine, and all sorts of Europeans make up a heterogeneous and incompatible population.

Religion.—The religious types also are strongly divergent. The bulk of the population is Mahommedan; the Bedouins have not much religion of any kind, but they profess Islam. Besides orthodox Moslems there are also Shi'ite sects, as well as a number of religious communities whose doctrine is the outcome of the process of fermentation that characterized the first centuries of Islam. To this last class belong the Ismailites (Assassins), *q.v.*, Metawali, Nosairis, Ansarieh, and especially the Druses (*q.v.*). In many cases it is obvious that the political antipathy of the natives to the Arabs has found expression in the formation of such sects. The Ansarieh, for instance, and no doubt the Druses also, were originally survivals of the Syrian population. The Jews are found mainly in the larger centres of population. The Christians are an important element, constituting probably as much as a fifth of the whole population; the majority of them belong to the Orthodox Greek Church, which has two patriarchs in Syria, at Antioch and Jerusalem. Catholics—United Greeks, United Syrians and Maronites—are numerous. The mission of the American Presbyterian Church, which has had its centre in Beirut for the last sixty years, has done much for Syria, especially in the spread of popular education; numerous publications issue from its press, and its medical school has been extremely beneficial. The Catholic mission has done very good work in what relates to schools, institutes and the diffusion of literature. The Christians constitute the educated portion of the Syrian people; but the spirit of rivalry has produced stimulative effects on the Mahommedans, who had greatly fallen away from that zeal for knowledge which characterized the earlier centuries of their faith.

Language.—The language throughout southern and middle Syria as high as Killis is Arabic, which has entirely ousted Aramaic and Hebrew from common use, and tends to prevail even over the speech of recent immigrants like the Circassians. The last survivals of Aramaic are to be sought in certain remote villages of Anti-Lebanon, and in the Syriac known to the clergy. From the upper Sajur northwards Turkish prevails, even among the Armenians; but many Kurdish communities retain their own tongue.

Government.—The political status of the country is controlled by the Ottoman Empire, of which Syria makes part, divided into the vilayets of Aleppo, Sham or Syria (Damascus), the Lebanon (*q.v.*) and Beirut, and the separate sanjaks or mutessarifliks of Zor and Jerusalem. Ottoman control is imperfect in Lebanon, the Houran, and over the Armenian mountain region of Zeitun and over the eastern steppe-lands, whose nomadic populations can withdraw themselves out of reach. But considerable success has been achieved in inducing the Syrian Arabs to settle and in supplying a counteracting influence to their unrest by the establishment of agricultural colonies, *e.g.* those of the Circassians in Bashan, Ammon and Moab.

Communications are still very imperfect, but have been greatly improved of late years. Railways run from Beirut to Homs, Hamah, Aleppo and Damascus (French), and to the latter also from Haifa (Turkish). From the termination of the Damascus-Mzerib railway a line (the " Mecca railway ") has been laid by Ottoman enterprise east of Jordan to the southern limit of Syria and beyond. From Jaffa a short line runs to Jerusalem, and a steam tramway connects Beirut with Tripoli. There are carriage roads radiating from Aleppo to the sea at Alexandretta, and to Aintab; and Antioch is also connected with Alexandretta; Beirut and Homs with Tripoli; Damascus with Beirut; and Nazareth with Haifa. But carriage roads in the Ottoman dominions are seldom completely made, and hardly ever kept in repair. The Lebanon district is well supplied with both roads and made mule-tracks.

Commerce.—From the Egyptian and Assyrio-Babylonian monuments we learn that in ancient times one of the principal exports of Syria was timber; this has now entirely ceased. But it continues to export wheat. Other articles of export are silk cocoons, wool, hides, sponges, eggs and fruits (oranges, almonds, raisins and the like); the amounts of cotton, tobacco and wine sent out of the country are small. The only good harbours are those of Beirut and Alexandretta (Iskanderun). The caravan trade with the East has almost entirely ceased, and the great trade routes from Damascus northwards to Aleppo and eastwards through the wilderness are quite abandoned. The traffic with Arabia has ceased to be important, being limited to the time of the going and returning of the great pilgrimage to Mecca, which continues to have its mustering-place at Damascus, but leaves mainly by rail. The native industries in silk, cotton and wool have been almost entirely destroyed by the import trade from Europe. The land is poor in minerals, including coal; water-power also is deficient, so that the introduction of European industries is attended with difficulties even apart from the insecurity of affairs, which forbids such experiments as the improvement of agriculture by means of European capital. As regards the cultivation of the soil Syria remains stable; but the soil is becoming relatively poorer, the value of the imports constantly gaining upon that of the exports. The latter are estimated at some 2½ millions sterling; the former at 4 millions.

History.—Rude stone monuments (circles and dolmens) and other prehistoric remains show that Syria must have been inhabited from a very early period. Within historic times a great number of different nationalities have fought and settled within its borders, the majority belonging to the Semitic stock. This last circumstance has rendered possible a considerable degree of fidelity in the tradition of the oldest local names. After the Aramaeans had absorbed what remained of the earlier population, they themselves were very powerfully influenced by Graeco-Roman civilization, but as a people they still retained their Aramaean speech. Of the political relations of Syria in the most ancient times we know but little. Each town with its surrounding district seems to have constituted a small separate state; the conduct of affairs naturally devolved upon the noble families. In the latter part of the 16th century B.C. all north Syria fell under the Cappadocian Hatti domination. The south part of Syria was known to Sargon of Akkad (*Agade*) as Ammon and was visited by his armies. This is known as the Canaanite period, succeeded about 1000 B.C. by the Aramaean. At a very early period—as early probably as the 16th century B.C.—Syria became the meeting-place of Egyptian and Babylonian elements, resulting in a type of western Asiatic culture peculiar to itself, which through the commerce of the Phoenicians was carried to the western lands of the Mediterranean basin. Industry especially attained a high state of development; rich garments were embroidered, and glass, pastes, faience, &c., were manufactured. The extant inventories of spoil carried off by the ancient conquerors include a variety of utensils and stuffs. The influence exercised at all times on Syrian art by the powerful neighbouring states is abundantly confirmed by all the recent finds which, in addition to our previous knowledge, show the action of the Aegean culture on Phoenicia and Palestine. The Syrians were more original in what related to religion; every place, every tribe, had its "lord" (Ba'al) and its "lady" (Ba'alat); the latter is generally called 'Ashtar or 'Ashtaret (*i.e.* Ishtar, Astarte). Besides the local Baal there were "the god of heaven" (El) and other deities; human sacrifices as a means of propitiating the divine wrath were not uncommon. But in the Syrian mythology foreign influences frequently betray themselves. Over against its want of originality must be set the fact, not merely that Syrian culture ultimately spread extensively towards the West, but that the Syrians (as is shown by the inscriptions of Teima, &c.) long before the Christian era exercised over the northern Arabs a perceptible influence which afterwards, about the beginning of the 1st century, became much stronger through the kingdom of the Nabataeans. The art of writing was derived by the Arabs from the Syrians.

Something about the ancient political and geographical relations of Syria can be gleaned from Egyptian sources, especially in connexion with the campaigns of Tethmosis (Thothmes) III. in western Asia and the administration of Amenophis (Amenhotep) IV. (the Tell el-Amarna Letters). The Egyptians designated their eastern neighbours collectively as 'Amu. Syria up to and beyond the Euphrates is called more precisely Ṣahi (or Zahi), and is regarded as consisting of the following parts: (1) Rutenu, practically the same as Palestine (occasionally Palestine with Coelesyria is called Upper Rutenu, as distinguished from Lower Rutenu extending to the Euphrates); (2) the land of the Kheta (sometimes reckoned as belonging to Rutenu with Kadesh on the Orontes as its capital in the Ramesside period; (3) Naharina, the land on both sides of the Euphrates (extending, strictly speaking, beyond the Syrian limits). The Canaanites in general are called Kharu. From these lands the Egyptian kings often derived rich booty, so that in those days Syria must have been civilized and prosperous. Moreover, we possess enumerations of towns in the geographical lists of the temple of Karnak and in a hieratic papyrus dating about 200 years after Tethmosis III. Some of these names can be readily identified, such as Aleppo, Kadesh, Sidon, and the like, as well as many in Palestine. The Tell el-Amarna Letters (15th century B.C.) show Syria held in part by Egyptian viceroys, who are much preoccupied with southward movements in the Buka'a and the rest of the interior beyond their control, due to pressure of Amorite peoples, and of the Mitanni and the Kheta, whose non-Semitic blood was mingled with that of the Aramaeans even in Palestine. On the latter in Syria, see HITTITES. It need only be said here that this people bulked most largely in the relations of Egypt with Syria from the 16th to the 14th centuries. During the reign of Rameses II. it was centred on the upper Orontes (Kadesh) and had comparatively free access to Palestine and the Egyptian border. Later on we find Kheta focused farther north, on the middle Euphrates (Carchemish), and more or less cut off from Egypt by the Hebrew state. They or their confederacy remained, however, the most powerful of the Syrian elements till the westward extension of Assyria about 1050 B.C., under Tiglath-Pileser I. Late in the 8th century Sargon III. took Carchemish and ended Hittite power.

With the fall of the Kheta the Aramaeans were the people who held the most important towns of Syria, gradually advancing until at last they occupied the whole country. Of the Aramaean stocks named in Gen. x. 23, xxii. 21 seq., very little is known, but it is certain that Aramaeans at an early period had their abode close on the northern border of Palestine (in Maachah). A great part was played in the history of Israel by the state of Aram Dammesek, *i.e.* the territory of the ancient city of Damascus; it was brought into subjection for a short time under David. The main object of the century-long dispute between the two kingdoms was the possession of the land to the east of the Jordan (Ḥauran, and especially Gilead). Another Aramaean state often mentioned in the Bible is that of Aram Zobah. That Zobah was situated within Syria is certain, though how far to the west or north of Damascus is not known; in any case it was not far from Ḥamath (Ḥamah). Ḥamath in the valley of the Orontes, at the mouth of the Buka'a valley, was from an early period one of the most important places in Syria; according to the Bible, its original inhabitants were Canaanites. The district belonging to it, including amongst other places Riblah (of importance on account of its situation), was not very extensive. In 733 B.C. Tiglath-Pileser II. compassed the overthrow of the kingdom of Damascus; he also took Arpad (Tel Arfad), an important place three hours to the north of Aleppo. Ḥamath was taken by Sargon in 720. Henceforward the petty states of Syria were at all times subject to one or other of the great world-empires, and were still in dispute between Babylonia and Egypt as late as Necho. Thereafter the Mesopotamian powers prevailed, even if in some cases a certain degree of independence was preserved, as *e.g.* by the Phoenician cities. These, however, in spite of more than one revolt, continued to supply fleets to the Persians down to the time of the Macedonia invasion (332 B.C.), and inland Syria remained comparatively peaceful first under its own local governors, and, after Darius, as a satrapy, till its subjugation by Alexander. Alien domination alone has been able to correct the tendency of this long strip of land to break up into hostile belts.

The foundation of numerous Greek cities shortly after Alexander's time was of great importance for Syria (see *e.g.* ANTIOCH). The Graeco-Syrian civilization extended far to the south down both sides of Jordan, and, but for the Maccabaean revival, would have absorbed the Jews. The Seleucidae had severe struggles with the Ptolemies for the possession of the southern part of Syria.

After having been reckoned for a short time (from 83 to 69 B.C.) among the dominions of Tigranes, king of Armenia, the country was conquered for the Romans by Pompey (64–63 B.C.). It is impossible here to follow in detail the numerous changes in the distribution of the territory and the gradual disappearance of particular dynasties which maintained a footing for some time longer in Chalcis, Abila, Emesa and Palestine; but it is of special interest to note that the kingdom of the Arab Nabataeans was able to keep its hold for a considerable period on the north as far as Damascus. In the year 40 B.C. Syria had to endure a sudden but brief invasion by the Parthians. The country soon became one of the most important provinces of the Roman Empire; its proconsulship was from the first regarded as the most desirable, and this eminence became still more marked afterwards. Antioch, adorned with many sumptuous buildings, as the chief town of the provinces of Asia, became in point of size the third city of the empire and an eastern Rome. The high degree of civilization then prevailing in the country is proved by its architectural remains dating from the early Christian centuries; the investigations of De Vogüé, Butler and others, have shown that from the 1st to the 7th century there prevailed in north Syria and the Ḥauran a special style of architecture —partly, no doubt, following Graeco-Roman models, but also showing a great deal of originality in details.

The administrative divisions of Syria during the Roman period varied greatly at different times. Hadrian made three provinces of it, Syria, Syria Phoenice and Syria Palestina. At the beginning of the 5th century we find the following: (1) Syria Euphratensis, which had for its capital Hierapolis (*q.v.*). (2) Syria I., or Coelesyria, having Antioch as its capital. The name Coelesyria (ἡ κοιλὴ Συρία), no doubt, was applied originally to the valley ("hollow") between Lebanon and Anti-Lebanon, but was afterwards extended to the district stretching eastwards from the latter range. (3) Syria II., or Syria Salutaris, with Apamea as capital. (4) Phoenice Maritima; capital, Tyre. (5) Phoenice ad Libanum; capital, Emesa (Homs). To this division Damascus and Palmyra belonged; occasionally they were reckoned to Coelesyria, the middle strip of coast being designated Syrophoenicia. (6, 7, 8) Palestina I., II. and III. (9) Arabia (capital, Bostra), which embraced all the region from the Ḥauran to the Arnon, and skirted the Jordan valley, stretching southwards to Petrae. Through the kingdom of the Nabataeans Roman influence penetrated from Syria far into northern Arabia.

In 616 Syria was subjugated for a brief period by the Persian Choroes II.; from 622 till 628 it was again Byzantine; 636 and the immediately following years saw its conquest by the Mahommedans (see CALIPHATE). Moawiya, the first Omayyad caliph, chose Damascus for his residence; but in 750 the capital of the empire was removed by the Abbasids to Bagdad. Under the early caliphs the Arabs divided Syria into the following military districts (*gonds*). (1) Filistin (Palestine), consisting of Judaea, Samaria and a portion of the territory east of Jordan; its capital was Ramleh, Jerusalem ranking next. (2) Urdun (Jordan), of which the capital was Tabaria (Tiberias); roughly speaking, it consisted of the rest of Palestine as far as Tyre. (3) Damascus, a district which included Baalbek, Tripoli and Beirut, and also the Ḥauran. (4) Ḥoms, including Ḥamath. (5) Kinnesrin, corresponding to northern Syria; the capital at first was Kinnesrin (Qinnasrin) to the south of Ḥaleb (Aleppo), by which it was afterwards superseded. (6) The sixth district was the military frontier (*'awāsim*) bordering upon the Byzantine dominions in Asia Minor. During the struggles of the Mahommedan dynasties for the possession of Syria the country still enjoyed a considerable degree of prosperity.

In the crusading period the kingdom of Jerusalem, whose rulers were never able to establish a foothold to the east of the Jordan, extended northwards to Beirut; next to it lay the countship of Tripoli on the coast; and beyond that in north Syria was the principality of Antioch. Syria suffered severely from the Mongol invasions (1260), and it never recovered its former prosperity. In 1516 the Ottomans took it from the Egyptian Mamelukes. For its subsequent history, see TURKEY: *History*. Its medieval importance as an intermediary of trade between Europe and the East was greatly impaired by the opening of the Red Sea route, and finally abolished by the Suez Canal; and Syria is at present important mainly for the sentimental reason that it contains the holiest places of Judaism and Christianity, and for the strategic reason that it lies on the flank of the greatest trade-route of the eastern hemisphere.

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SYRIAC LANGUAGE. Syriac is the eastern dialect of the Aramaic language which, during the early centuries of the Christian era, prevailed in Mesopotamia and the adjoining regions. Its main centres were at Edessa and Nisibis, but it was the literary language of practically all the Christian writers in the region east of Antioch, as well as of the Christian subjects of the Persian empire.

All the Semitic languages[1] are built up from triliteral roots: that is, the great majority of the words are derived from a simple verbal form, of which the essential elements are three consonants. This form is seen in the 3rd pers. sing. perf. of the verb, *e.g.* Aram. *q'ṭal* or *ḳ'ṭal* (" he killed "), which corresponds to Heb. *qāṭal* and Arab. *qatala*. The vowels play no part in differentiating the roots, for the vowels are practically the same in the corresponding forms of every root. The form *q'ṭal* illustrates one main peculiarity of Aramaic, as opposed to the other Semitic languages, viz. its paucity of vowels: for where Hebrew has two full vowels—a long and a short— in *qāṭal*, and Arabic has three short vowels in *qatala*, Aramaic has only one short vowel, the sound ' between *q* and *ṭ* being merely a half vowel which is not indicated in Syriac writing. Another chief characteristic of Aramaic appears in nouns, viz. the entire absence of a prefixed definite article. Aramaic gives to the noun instead an ending *ā*,

[1] On the place of Aramaic among the Semitic languages, and of Syriac among the various dialects, see SEMITIC LANGUAGES.

making the so-called "emphatic" state. In the older Aramaic dialects this is used exactly as the noun with prefixed article is used in other languages; but in Syriac the emphatic state has lost this special function of making the noun definite, and has become simply the normal state of the noun. The main grammatical distinction between Syriac and all the west Aramaic dialects is that in Syriac the 3rd person of the imperfect (singular and plural) of the verb begins with *n*, but in west Aramaic, as in the other Semitic languages, it begins with *y*.

When, in the 5th century A.D., owing to theological differences the Syriac-using Christians became divided into Nestorians or East Syrians and Jacobites (Monophysites) or West Syrians, certain differences of pronunciation, chiefly in the vowels, began to develop themselves. The East Syrians in most cases kept the more primitive pronunciation: *e.g.* the old Semitic *ā* with them remained *ā*, but with the Jacobites passed into *ō*. One very tangible difference appears in the fact that the name *Jesus* was by the East Syrians written and pronounced *Īshō'*, by the West Syrians *Yeshū*.

The Syriac alphabet, which derived its letters from forms ultimately akin to those of the Old Hebrew and Phoenician alphabets, has the same twenty-two letters as the Hebrew. And as in Hebrew, the six letters *b g d k p t* are aspirated when immediately preceded by any vowel sound. On the other hand, the guttural letters affect the vowels much less than in Hebrew: their chief effect is when final to change the preceding vowel, if other than *a* or *ā*, into *a*, but even this is not always the case.[1] The vowels, which are ten in number (ā a ē e ī i ō o ū u), were, as usual in the Semitic languages, indicated only partially by the use of consonants as vowel-letters[2] and by means of certain diacritical points, so long as Syriac remained a living language. But about the time when it began to be supplanted by Arabic, two systems of vowel-signs were invented, one for the West Syrians, who borrowed the forms of Greek vowels, and the other more elaborate for the East Syrians, who used combinations of dots. Neither system completely differentiates long and short vowels; the Nestorian scheme is the more satisfactory, though more cumbrous.

Where the same root exists in Arabic, Syriac and Hebrew, its fundamental consonants are usually the same in all three languages. But letters belonging to the same group occasionally interchange. As regards the dentals and sibilants there are one or two rules which govern the interchange, in the manner of a Grimm's Law. (1) Where Arabic has an ordinary dental, Syriac and Hebrew have the same; but where Arabic has an aspirated dental (*e.g. th*), Syriac has an ordinary dental *t*, but Hebrew has a sibilant (*sh*). (2) Hebrew has one more sibilant than Arabic or Syriac: thus, as corresponding to *s* (*sāmekh*), *s* (*sīn*) *sh* in Hebrew, Arabic has only *s* (*sīn*) *sh*, while Syriac has a different pair *s* (*sāmekh*) *sh*. Hebrew *sāmekh* is represented by Ar. *sīn* and Syr. *sāmekh*; but Heb. *sīn* (Syr. *sāmekh*) is represented by Ar. *sh*, while Heb. and Syr. *sh* is represented by Ar. *sīn*. As regards this crossing of *s* and *sh*, Arabic has with it the other south Semitic language, Ethiopic: the evidence as to the other north Semitic language, Assyrian, is conflicting.

In vowel-sounds Syriac is clearly more primitive than Hebrew (as pointed by the Massoretes), less so than Arabic. Thus Ar. and Syr. *a* is often thinned in Hebrew into *i* (*ē* when accented), as in the first syllable of Ar. *qattala* = Syr. *qaṭṭēl* = Heb. *qiṭṭēl*. But the second syllable of the same word shows Syriac siding with Hebrew against Arabic. Again the primitive *ā* of Arabic is in the older (Nestorian) pronunciation of Syriac maintained, while in Jacobite Syriac and in Hebrew it passes into *ō*: thus Ar. *qātil* Nestorian *qāṭēl* = Jacobite and Hebrew *qōṭēl*. Again Syriac maintains the diphthongs *ai* and *au*, which in Hebrew have usually passed into *ē* and *ō*.

The *accent* plays much less part in lengthening and altering the vowels in Syriac than in Hebrew, but there are well-marked cases of lengthening from this cause.

A few words may now be said about the three main parts of speech—pronouns, nouns and verbs.

1. *Pronouns.*—As in the other Semitic languages, these stand almost entirely outside the system of triliteral roots, being mainly derived from certain demonstrative letters or particles. Each of the personal pronouns (except the 3rd plur.) exists in a longer and a shorter form: the one is used as a nominative and is a separate word, the other is attached to verbs and (in a slightly different form) to nouns to express the accusative or genitive. These pronominal suffixes are of much the same form as in Hebrew, but produce less change in the vowels of the words to which they are attached. Demonstrative adjectives and adverbs are formed by prefixing the syllable *hā* (= *ecce*, "behold") to other pronominal elements, and interrogatives similarly by prefixing the interrogative syllable *ay*; but there are other interrogative pronouns. The relative consists only of the letter *d* (indeclinable) prefixed to words.

2. *Nouns and Adjectives.*—The Syriac noun has three states—the *absolute* (used chiefly in adjectival or participial predicates, but also with numerals and negatives, in adverbial phrases, &c.), the *construct* (which, as in Hebrew, must be immediately followed by a genitive), and the *emphatic* (see above). There are only two genders and two numbers: the neuter gender is entirely wanting, and the dual number is not recognized in Syriac grammar, though there are plain traces of it in the language. The fem. sing. ending is absolute *ā*, construct *ath*, emphatic *tā* or *'tha*: thus the fem. sing. abs. is always identical in form with the masc. sing. emph. The plural endings are—masc. abs. *īn*, const. *ai*, emph. *ē*; fem. abs. *ān*, const. *āth*, emph. *āthā*. Syriac is not, like Arabic and Hebrew, confined to the use of the construct for the ordinary expression of the genitive or possessive relation: for it has a preposition (*d*) which expresses "of," "belonging to." The noun preceding this preposition may be in the emphatic state or may (as is usually the case when the noun is definite) have a pleonastic suffix. Thus "the son of the king" is more commonly expressed by *b'rā dh'malkā* or *b'rēh d'malkā* than by *bar malkā*, whereas the latter type would alone be permissible in Hebrew. And a genitive with prefixed *d* does not require the governing noun to precede it immediately, as must be the case when the construct is used. This is one of the many respects where Syriac has gained greater flexibility in syntax than Hebrew.

3. *Verbs.*—The Syriac verb is remarkable for having entirely lost the original passive forms, such as in Arabic can be formed in every conjugation and in Hebrew are represented by the Pual and Hophal. For these Syriac has substituted middle or reflexive forms with prefixed *eth* and a change in the last vowel. The simple active *q'ṭal* makes its passive *ethq'ṭel*; the intensive *qaṭṭēl* makes *ethqaṭṭal*; and the causative *aqṭēl* makes *ettaqṭal*. The inflexion of the verbs is, on the whole, more regular than in Hebrew: thus, to take one instance, the 3rd plur. fem. impf. *neqṭ'lān* corresponds better to 3rd plur. masc. *neqṭ'lūn* than does the equivalent Hebrew form *tiqṭōlnā* to *yiqṭ'lū*. But the most important peculiarity of Syriac verbs is again in the sphere of syntax, and shows the same progress towards flexibility which we found in the nouns. Whereas the Hebrew verb is devoid of real *tenses*, and only expresses an action as completed or as in process without indicating time past, present or future, Syriac has by the help of an auxiliary verb constructed a set of tenses. Thus we have—

Pres. *qāṭel*, "he kills," "he is killing" (sometimes "he is about to kill").
Impf. *qāṭel wā*, "he was killing."
Fut. *neqṭōl*, "he will kill."
Pf. or Aor. *q'ṭal* "he has killed," "he killed."
Plup. or Aor. *q'ṭal wā*, "he had killed," "he killed."

The same progress towards flexibility in syntax is seen in the copious supply of conjunctions possessed by Syriac. No doubt the tendency towards a more flowing construction of sentences was helped by the influence of Greek, which has also supplied a large stock of words to the Syriac vocabulary. (N. M.)

SYRIAC LITERATURE.[3] By *Syriac* is denoted the dialect of Aramaic which, during the early centuries of the Christian era, prevailed in Mesopotamia and the adjoining regions. The literary use of Syriac by Christians had its first centre in Edessa (Syr. Ūrhāi, modern Urfa), where, in all probability, the chief Syriac versions of the Bible were made. The use of the same dialect appears in the earliest Christian literature connected

[1] It may indeed be remarked that Syriac, which is generally more primitive in its sounds than Hebrew, shows a more advanced stage of weakening as regards the gutturals: thus in a good many forms it has substituted *ālef* for initial *hē*, and often shows a dislike for the presence of two gutturals in the same word, weakening one of them to *ālef*. A much more advanced stage of weakening is seen in some of the other dialects.

[2] With regard to this, Syriac has one great difference from Hebrew, viz. that final *ā* is indicated not by *hē*, but by *ālef*.

[3] The sketch of the history of Syriac literature here presented is based on Wright's great article in the 9th edition of the *Ency. Brit.*, which was afterwards published separately under the title of *A Short History of Syriac Literature* (London, 1894).

with such Mesopotamian cities as Nisībis, Amid, Mardīn, Taghrīth and Seleucia-Ctesiphon, as well as west of the Euphrates at such centres as Mabbogh (Hierapolis) and Aleppo, northwards at Malatiah and Maiperkaṭ and in the districts of Lake Van and Lake Urmia, and to the east and south-east of the Tigris in many places which from the 5th century onwards were centres of Nestorian Christianity within the Sasanian Empire. In Palestine and western Syria, the home of pre-Christian Aramaic dialects, the vernacular Semitic speech had under Roman dominion been replaced by Greek for official and literary purposes. Apparently this state of things lasted till after the Mahommedan conquest, for Barhebraeus[1] tells us that it was the caliph Walīd I. (A.D. 705–715) who, out of hatred to Christianity, replaced Greek by Arabic as the language of official documents at Damascus. Probably (as Duval suggests) the use of Syriac in these regions went hand in hand with the spread of the monophysite doctrine, for the liturgies and formulas of the Jacobite Church were composed in Syriac. Similarly the spread of Nestorian doctrines throughout the western and south-western regions of the Persian Empire was accompanied by the ecclesiastical use of a form of Syriac which differed very slightly indeed from that employed farther west by the Jacobites.

So far we have spoken only of the *Christian* use of Syriac. Of the *pagan* Syriac literature which issued mainly from Ḥarrān, a city about one day's journey south of Edessa, not a single example appears to have survived. From Christian writers we learn that Ḥarrān continued to be a seat of pagan worship and culture down to and even later than the Mahommedan era. A native of the city, Thābit ibn Ḳurra, in a passage from a Syriac work of his (now lost) quoted by Barhebraeus,[2] speaks of the paganism of Ḥarrān as distinguished by its steadfast resistance to Christian propaganda. "When many were subdued to error through persecution, *our* fathers through God were steadfast and stood out manfully, and this blessed city has never been defiled by the error of Nazareth." He goes on to attribute the world's science and civilization to pagan inventors; but it is not clear whether in this he is alluding specially to the culture of his own city. Anyhow, it is much to be regretted that no Syriac writing from Ḥarrān has survived.[3]

Syriac literature continued in life from the 3rd to the 14th century A.D., but after the Arab conquest it became an increasingly artificial product, for Arabic gradually killed the vernacular use of Syriac.

In the literature as it survives many different branches of writing are represented—homilies in prose and verse, hymns, exposition and commentary, liturgy, apocryphal legends, historical romance, hagiography and martyrology, monastic history and biography, general history, dogmatics, philosophy and science, ecclesiastical law, &c. But the whole is dominated by the theological and ecclesiastical interest. All chief writers were bishops, inferior clergy or monks, and their readers belonged to the same classes. When we put aside one or two exceptionally fine pieces, like the hymn of the soul in the apocryphal Acts of Thomas, the highest degree of excellence in style is perhaps attained in staightforward historical narrative—such as the account of the Perso-Roman War at the beginning of the 6th century by the author who passes under the name of Joshua the Stylite, or by romancers like him who wrote the romance of Julian; by biographers like some of those who have written lives of saints, martyrs and eminent divines; and by some early writers of homilies such as Philoxenus (in prose) and Isaac of Antioch (in verse). Nearly all the best writers are characterized by a certain naïve and earnest piety which is attractive, and not infrequently display a force of moral indignation which arrests attention. These latter qualities are even more apparent in poetry than in prose. There are indeed but few specimens of Syriac verse which exhibit high poetic quality; except for a fairly copious and occasionally skilful use of simile and metaphor, there is little of soaring imagination in Syriac poets. On the other hand there is much effective rhetoric, and much skilful play of language.[4]

As was to be expected, the better qualities of style were more often shown during the early centuries when the language was still a living speech. After it had been supplanted by Arabic in the ordinary intercourse of life its literary use was more and more affected by Arabic words and constructions, and its freedom as a vehicle of thought was much impaired. Nevertheless, so late as the 13th century it was still an effective instrument in the hands of the most many-sided of Syriac authors, the eminent Barhebraeus.

For the general history of culture the work of Syriac writers as *translators* is, perhaps, as important as any of their original contributions to literature. Beginning with the earliest versions of the Bible, which seem to date from the 2nd century A.D., the series comprises a great mass of translations from Greek originals—theological, philosophical, legendary, historical and scientific. In a fair number of cases the Syriac version has preserved to us the substance of a lost original text. Often, moreover, the Syriac translation became in turn the parent of a later Arabic version. This was notably the case with some of the Aristotelian writings, so that in this field, as in some others, the Syriac writers handed on the torch of Greek thought to the Arabs, by whom it was in turn transmitted to medieval Europe. The early Syriac translations are in many cases so literal as to do violence to the idiom of their own language; but this makes them all the more valuable when we have to depend on them for reconstructing the original texts. The later translators use greater freedom.[5] It was not from Greek only that translations were made into Syriac. Of translations from Pahlavī we have such examples as the version of pseudo-Callisthenes' *History of Alexander*, made in the 7th century from a Pahlavī version of the Greek original—that of *Kalilah and Dimnah* executed in the 6th century by the periodeutēs Bōdh—and that of *Sindbad*, which dates from the 8th century; and in the late period of Syriac literature, books were translated from Arabic into Syriac as well as vice versa.

All our historical sources support the view taken above that Edessa, the capital of the kingdom which the Greeks and Romans called Osrhoene, was the earliest seat of Christianity in Mesopotamia and the cradle of Syriac literature. But as to the date and circumstances of its evangelization we have little reliable information. The well-known legend of the correspondence of Abgar Ukkāmā, king of Edessa, with Christ and the mission of Addai to Edessa immediately after the Ascension was accepted as true by the historian Eusebius (†340) on the faith of a Syriac document preserved in the official archives of the city. An amplified form of the same story is furnished by the *Doctrine of Addai*, an original Syriac work which survives complete in a St Petersburg MS. of the 6th century, and is also represented by fragments in other MSS. of the 5th and 6th centuries. This work was probably written at Edessa about the end of the 4th century. It adds many new features to the shorter form of the story as given by Eusebius, among which is the noteworthy promise of Christ about the impregnability of the city—"Thy city shall be blessed and no enemy shall ever henceforth obtain dominion over it." This is probably a later addition made to the legend at a time when such facts as the capture of Edessa by Lusius Quietus in 116 and its second capture and the destruction of its kingdom by the Romans in 216 had faded from memory.[6]

[1] *Chron. syr.*, ed. Bruns, p. 120, ed. Bedjan, p. 115; cited by Duval, *Litt. syr.*[3], p. 5.

[2] *Chron. syr.*, ed. Bruns, p. 176, ed. Bedjan, p. 168. Thābit was the author of about 16 Syriac works, of which the majority survived in the 13th century, but all are now lost. Of his 150 Arabic treatises a few at least survive; see Brockelmann, *Geschichte der arabischen Litteratur*, i. 217 seq.

[3] On this subject, see especially Chwolsen's *Ssabier und Ssabismus*.

[4] On the mechanism of Syriac verse, see Duval's admirable section on *la poésie syriaque* (*Litt. syr.*[3], p. 10 sqq.).

[5] Cf. Duval, *op. cit.* p. 303 seq.

[6] Cf. Tixeront, *Origines de l'Église d'Édesse*, p. 93, and Duval, *op. cit.* p. 99. The above view is more probable than that taken by F. C. Burkitt (*Early Eastern Christianity*, p. 14), that Eusebius knew of Christ's promise as part of the letter to Abgar, and purposely suppressed it as inconsistent with historical facts.

But whether in its longer or its shorter form, the whole narrative must be pronounced unhistorical. In all probability the first king of Osrhoene to adopt Christianity was Abgar IX., son of Ma'nū, who reigned from A.D. 179 to 214 or 216, and the legend has confounded him with an earlier Abgar, also son of Ma'nū, who reigned first from B.C. 4 to A.D. 7 and again from A.D. 13 to 50.[1] A contemporary of Abgar IX. at Edessa was the famous Bardaiṣān, himself a convert from heathenism, who was of noble birth and a *habitué* of the Edessene court. It was no doubt partly under his influence—also possibly in part through impressions received by Abgar during his visit to Rome about A.D. 202—that the king's conversion took place. But Christianity must have reached Edessa some thirty to fifty years earlier. Our oldest native historical document in Syriac—the account of a severe flood which visited Edessa in Nov. A.D. 201[2]—mentions "the temple of the church of the Christians" as overthrown by the flood. The form of this notice shows, as von Gutschmid and others have remarked, that Christianity was not yet the religion of the state; but it must for some time have had a home in Edessa. The same thing is seen from the fact that the heresy of the Marcionites was already showing itself in this district, for (in Tixeront's words) "heresies, in the first centuries at least, only spread in already constituted Christian communities." And by a skilful piecing together of the date furnished by the oldest Syriac versions of the Bible—such as the derivation of the Old Testament version from the Jews, and the almost exclusive use of Tatian's Diatessaron as the gospel of the Syriac Church down to the beginning of the 5th century—F. C. Burkitt has shown it to be probable that the preaching of Christianity at Edessa reaches back to the middle of the 2nd century or even to about the year 135.[3]

The Syriac versions of the Bible are treated elsewhere (see BIBLE) and may here be dismissed with a brief summary of facts and opinions. The received Syriac Bible or Vulgate (called the Pĕshiṭṭā or "simple" version from the 9th century onwards[4]) contains all the canonical books of the Old Testament.[5] In the New Testament, 2 Peter, 2 and 3 John, Jude and the Apocalypse were originally left out, but Syriac versions were made at a later time. The Peshitta version of the Old Testament must have been originally made mainly by Jews, of whom we know there were colonies in Mesopotamia in the 2nd century. The translation was executed entirely from the Hebrew, but underwent later revision which brought it more into conformity with the LXX—this to a greater degree in some books than in others. The Peshitta New Testament—according to the convincing theory which at present holds the field[6]—is not the oldest form of the Syriac version, at least as regards the Gospels. From the beginning of the 3rd to the beginning of the 5th century Tatian's Harmony or Diatessaron—whether originally compiled in Syriac, or compiled in Greek and translated into Syriac—was the current form of gospel in the Syriac Church. The text of the Gospels underlying it "represents the Greek text as read in Rome about A.D. 170." Slightly later was made the Old Syriac version of the separate Gospels, which survives in two MSS.—the Curetonian and the Sinaitic—in two differing forms: but this never obtained much currency. Its text "represents, where it differs from the Diatessaron, the Greek text as read in Antioch about A.D. 200." Then at the beginning of the 5th century, by the efforts of the masterful Rabbūlā, who was bishop of Edessa from 411-412 to 435, a new version or recension of the Gospels was made and incorporated in the Peshitta or Vulgate, the use of the Diatessaron being henceforth proscribed. Rabbūlā's text of the Gospels "represents the Greek text as read in Antioch about A.D. 400." The history of the Peshitta rendering of the Acts and Epistles is less clear; apparently the earliest Syrian writers used a text somewhat different from that which afterwards became the standard.[7]

Of the large number of Apocryphal books existing in Syriac[8] the majority have been translated from Greek, one or two (such as *Bar Sīrā* or *Ecclesiasticus*) from Hebrew, while some (like the *Doctrine of Addai* above referred to) are original Syriac documents. Special mention may be made here of the tale of Aḥīḳār—the wise and virtuous secretary of Sennacherib, king of Assyria—and of his wicked nephew Nādhān. This is the Syriac version of a narrative which has had an extraordinary vogue in the world's literature. It is now known to have existed in Aramaic as far back as the 5th century B.C., appearing on Jewish papyri which were lately discovered by the German mission to Elephantine.[9] It appears to be traceable in its Greek dress in writings of the philosopher Democritus and the dramatist Menander; it was certainly known to the author of Tobit and perhaps to the author of Daniel; some would trace its influence in the New Testament, in the parable of the wicked servant and elsewhere; it was known to Mahomet and is referred to in the Koran; it has been included among the tales in the *Arabian Nights*; and it survives in a good many versions ancient and modern. The old Syriac version, which is to be found in a number of MSS., was probably made from an early Aramaic version, if not from the original itself (which must surely have been Semitic). The Syriac has in turn become the parent of the Arabic, Armenian and Ethiopic—possibly also of the Greek and Slavonic versions.[10]

Another deeply interesting Syriac Apocryphon is the *Acts of Judas Thomas* (*i.e.* Judas the Twin), which is included in the collection of *Apocryphal Acts of the Apostles*. The *Acts of Thomas* is now generally recognized to be an original Syriac work (or "novel," as Burkitt calls it), although a Greek version also exists. It seems to have arisen in Gnostic circles, and its tendency is wholly in favour of asceticism and celibacy. Among its peculiarities is the fact that Judas Thomas is regarded as the twin brother of Christ. The author has incorporated in it the finest poem to be found in all Syriac literature, the famous Hymn of the Soul. This depicts the journey of the soul from heaven to earth, its life in the body, and its final return to the heavenly home, under the figure of a Parthian prince who is sent from the court of his parents to the land of Egypt to fetch the serpent-guarded pearl; after a time of sloth and forgetfulness he fulfils his quest, and returns triumphant and again puts on the heavenly robe. According to Burkitt, the hymn must have been composed before the fall of the Arsacids and the commencement of the Sasanian Empire in 224. It is plainly Gnostic and may perhaps have been composed by Bardaiṣān or his son Harmonius.[11]

Among recent editions of Apocrypha in Syriac may be mentioned those of the *Apocalypse of Baruch*, the *Epistle of Baruch*,

[1] See especially Lipsius, *Die edessenische Abgar-Sage* (1880), and the brilliant analysis of the legend by A. von Gutschmid in *Mém. de l'acad. impér. des sciences de St Pétersbourg*, tome xxxv. No. 1. The above dates for the kings' reigns are taken from von Gutschmid.

[2] Incorporated in the *Chronicle of Edessa* (Hallier's edition, p. 145 sqq.).

[3] *Early Eastern Christianity*, Lecture II.

[4] See the explanation in Burkitt, *op. cit.* p. 41 seq.

[5] The MSS. which contain the Syriac *Massorah* or tradition of the reading of the text pass over Chronicles, Ezra and Nehemiah, and in the case of the Nestorians also Esther. But all these books are quoted by Aphraates.

[6] That of F. C. Burkitt. See especially his *S. Ephraim's Quotations from the Gospel* (Cambridge, 1901); *Evangelion da-mepharreshe* (Cambridge, 1904), and the above cited Lecture.

[7] For the later Monophysite versions, none of which attained much popularity, see Wright's *Syr. Lit.* pp. 13–17, and for the single Nestorian attempt at revision, ibid. p. 19.

[8] See the lists in Wright, *op. cit.* pp. 5 seq. 25–27, and Duval, *Litt. Syr.*[3] ch. viii.

[9] See F. Nau, *Histoire et sagesse d'Ahikar l'Assyrien* (Paris, 1909), p. 288 sqq.

[10] See especially *The Story of Ahikar from the Syriac, Arabic, Armenian, Ethiopic, Greek and Slavonic Versions*, by F. C. Conybeare, J. R. Harris and A. S. Lewis (Cambridge, 1898); and Nau, *op. cit.* The latter has a very full bibliography.

[11] Of the *Apocryphal Acts of the Apostles* there is the well-known edition and translation by Wright (London, 1871); the *Acts of Judas* were re-edited by Bedjan in the 3rd volume of *Acta martyrum et sanctorum* (Paris, 1892); of the *Hymn of the Soul* there is a fresh edition and translation by A. A. Bevan (Cambridge, 1897). See also Lecture VI. in Burkitt's *Early Eastern Christianity*.

and the *Testament of Adam* by M. Kmosko (Graffin's *Patrologia Syriaca*, vol. ii.).

Lives of saints and martyrs form a large group among Syriac books. Among such documents connected with the early history of Edessa we have, besides the *Doctrine of Addai*, certain martyrdoms, those of Sharbēl and Barsamyā assigned to the reign of Trajan, and those of Guryā and Shāmōnā and of the Deacon Habbībh under Diocletian and Licinius. All these documents, like *Addai*, belong probably to the 2nd half of the 4th century, and are quite unreliable in detail for the historian,[1] though they may throw some light on the conditions of life at Edessa under Roman government. There are also accounts of martyrdoms at Samosāta (Assemani, *Acta Mart.* ii. 123–147), including that of St Azazail recently published by Macler (Paris, 1902). But the great bulk of the Syriac martyrdoms have their scene farther east, within the Persian dominions.

The life and writings of Bardaiṣān, "the last of the gnostics," and in some sense the father of Syriac literature and especially of Syriac poetry, have been treated in a separate article. *The Book of the Laws of the Countries*, which embodies his teaching, was re-edited in 1907 by F. Nau (this also in the 2nd volume of Graffin's *Patrologia*).

An early Syriac document, probably of the 2nd or 3rd century, is the *Letter of Mārā son of Serapion*, which was edited by Cureton in his *Spicilegium Syriacum*. It is almost the only exception to the rule that all surviving Syriac literature is Christian. The author is in sympathy with Christianity, but is himself an adherent of the stoic philosophy. His home appears to have been at Samosāta.[2]

By the beginning of the 4th century much progress had been made with the organization of the Christian church not only within the Roman district of Mesopotamia, but also to the east and south-east within the Sasanian Empire, round such centres as Seleucia-Ctesiphon on the Tigris (near Baghdad), Karkā dĕ-Bēth Sĕlōkh (modern Kerkuk) and Bēth Lāpāt or Gundēshābhōr (in the modern province of Luristan).[3] The adoption of Christianity by Constantine as the official religion of the Roman Empire had an unfortunate effect on the position of the Christians in Persia. They were naturally suspected of sympathizing with the Roman enemies rather than with their own Persian rulers. Accordingly when Sapor II. (310–379) declared war on Rome about 337, there ensued almost immediately a somewhat violent persecution of the Persian Christians, which continued in varying degrees for about 40 years. One result of this and later persecutions of the same kind has been to enrich Syriac literature with a long series of *Acts of Persian Martyrs*, which, although in their existing form intermixed with much legendary matter, nevertheless throw valuable light on the history and geography of western Persia under Sasanian rule.[4] One of the earlier martyrs was Simeon bar Sabbā'ē, bishop (? catholicus) of Seleucia from about 326 to 341 in succession to Papa, who in the face of opposition from other bishops had organized the church of Persia under the primacy of Seleucia. The *Martyrdom* of Simeon exists in two recensions which have been separately edited by M. Kmosko.[5] Another early martyr was Millēs, bishop of Susa, who had distinguished himself in the opposition to Papa.[6]

The two most important 4th-century writers—Aphraates and Ephraim—are dealt with in separate articles. The importance of the former lies in the simple cast of his religious thought, his independence of theological formulas, his constant adherence to the letter of Scripture, his quaint exegesis, and the light he throws on the circumstances of his time, especially (1) the feeling between Jews and Christians, and (2) the position and sympathies of the Christian subjects of Sapor II. The position and character of Ephraim are very different. He is the typical exponent in Syriac of unbending Catholic orthodoxy. He impressed his countrymen more than any other single writer, partly no doubt by his enormous fecundity in writing, but more by the stern piety and uncompromising dogmatism which pervade his works.

In the 2nd half of the 4th century lived the monk Gregory, who wrote a treatise on the monastic life. He spent part of his life in Cyprus, and was a friend of Epiphanius, bishop of Salamis. To the information given by Assemani (*B.O.* i. 170 seq.) we can now add the statements of Īshō'-dĕnaḥ[7] that he was a Persian by birth, and after being a merchant was led by a series of visions to take monastic vows. After a training at Edessa, he lived for a long time at Mt Īzlā in Mesopotamia, whence he proceeded to Cyprus, but returned to Mt Īzlā shortly before his death. His book on the monastic life mentioned by 'Abhdīshō' is not known to survive; but some discourses and a letter of his are still extant.

Before leaving the 4th century we may mention two other writers who probably both lived on into the 5th—Balai and Cyrillōnā. The former was the author of a good many poems; the longest—which is however by some attributed to Ephraim[8]—is the work in 12 books on the history of Joseph, of which a complete edition was published by Bedjan in 1901. Other poems of his were edited by Overbeck in *S. Ephraemi Syri*, &c., *opera selecta*, pp. 251–336; and these have since been supplemented by Zetterstéen's edition of a large number of his religious poems or metrical prayers (*Beiträge zur Kenntniss der religiösen Dichtung Balais*, Leipzig, 1902). His favourite metre was the pentasyllabic. Cyrillōnā composed a poem on the invasion of the Huns in 395,[9] and is by some regarded as identical with Ephraim's nephew Abhsamyā, who in 403–404 "composed hymns and discourses on the invasion of the Roman empire by the Huns."[10]

The 5th century was a time of storm and conflict in the churches of Mesopotamia and Persia, as in other parts of the Christian world. The teaching of Apollinarius that in Christ the Divine Word took the place of the human rational soul, thus seeming to do away with his possession of a true humanity, had led to a reaction by Paul of Samosāta, Diodore of Tarsus, Theodore of Mopsuestia, and Nestorius of Constantinople. Though with some points of difference, they agreed in emphasizing the permanence of the two separate natures in Christ, united but not mingled or confused, and laid stress on the reality of our Lord's human experience. One question on which great contention arose was as to the propriety of applying to the Divine nature attributes which belonged to the human nature—*e.g.* birth from a human mother—and vice versa. Hence the great dispute about the application to the Virgin Mary of the epithet θεοτόκος. It seems to have been the objection of Nestorius to the use of this expression which mainly led to his condemnation and deposition at the Council of Ephesus (431) under the influence of Cyril, when as patriarch of Constantinople (428–431) he had distinguished himself by his zeal for Nicene orthodoxy.[11]

At Edessa the result of the conflict between the Nestorians and their opponents was long doubtful. When Rabbūlā, the fierce anti-Nestorian and friend of Cyril, died in 435, he was succeeded in the bishopric by Ibas, who as head of the famous "Persian

[1] Burkitt (*op. cit.* p. 21 seq.) endeavours to claim a higher value for the narratives about Guryā, Shāmōnā and Habbībh, on the ground that these have left more trace in the later literature; but it is to be feared that all five martyrdoms are turned out in the same legendary mould.

[2] Cf. Duval, *Litt. Syr.*[3] p. 241 seq.

[3] On the origin and early history of Persian Christianity see especially J. Labourt, *Le Christianisme dans l'empire Perse* (Paris, 1904), chaps. i. and ii.

[4] See many of the texts in Bedjan's *Acta martyrum et sanctorum* (Paris, 1890–1896). The valuable geographical results are exhibited in G. Hoffmann's *Auszüge aus syrischen Akten persischer Märtyrer* (Leipzig, 1880).

[5] Graffin's *Patrologia*, ii. 661–1045. Of the epistles, hymns, &c., attributed to Simeon nothing appears to survive but one or two hymns (ibid. 1048–1055). The *Martyrdom* had been previously edited by Assemani and by Bedjan.

[6] His history is in Assemani, *Acta mart.* i. 66 sqq., and Bedjan, ii. 260 sqq.

[7] *Book of Chastity*, par. 12.

[8] It is in Ephraim's favourite metre, the heptasyllabic, and all the MSS. but one attribute it to him.

[9] *Chron. Edess.* par. 40.

[10] Ibid. par. 47.

[11] New light on the theological position of Nestorius is to be obtained from the long-lost *Book of Heraclides*, a work of his own which has turned up in a Syriac version and has just been published by Bedjan.

school " in the city had done much to inculcate on his pupils the doctrines of Theodore of Mopsuestia. But the feeling against the Nestorian party grew in strength, till on the death of Ibas in 457 the leading Nestorian teachers were driven out of Edessa. The Persian school continued to exist for another 32 years, but was finally closed and destroyed by order of the emperor Zeno in 489. The Nestorian teachers then started a great school at Nisībis (which had been under Persian rule since Jovian's humiliating treaty of 363). By the energetic efforts of Barṣāumā, bishop of that city, practically the whole church of Persia was won over to the Nestorian creed. Western Syria, on the contrary, had partaken with Alexandria in the reaction from Nestorianism which finally crystallized in the Monophysite doctrine, that spread so widely through Egypt and Western Asia towards the end of the 5th century.

At the beginning of this century one of the most able and influential men in the Syriac-speaking church was Mārūthā, bishop of Maiperḳaṭ or Martyropolis. Without entering on the details of his ecclesiastical activity,[1] we may note that he was twice associated with embassies from the Roman emperor to Yazdegerd I. (399–420); that along with Isaac, patriarch of Seleucia (390–410), he obtained from the Persian monarch a concordat which secured a period of religious toleration; and that he arranged for and presided at the Council of Seleucia in 410, which adopted the full Nicene creed and organized the hierarchy of the Persian Church. As a writer he is chiefly known as the reputed author of a collection of martyrologies which cover the reigns of Sapor II., Yazdegerd I. and Bahram V.[2] By his history of the Council of Nicaea he made a great contribution to the education of the Persian Church in the development of Christian doctrine.

Rabbūlā, the powerful and energetic bishop of Edessa who withstood the beginnings of Nestorianism, and who gave currency to the Peshitta text of the four Gospels, abolishing the use of the Diatessaron, is dealt with in a separate article.

The next bishop of Edessa, Ibas, who succeeded in 435 at the death of Rabbūlā, proved himself a follower of the Nestorian doctrine (see above). As a teacher in the Persian school of Edessa he had translated, probably with the help of his pupils, certain works of " the Interpreter," *i.e.* Theodore of Mopsuestia. Among these may have been the commentary on St John of which the complete Syriac version was published by Chabot in 1897. He may possibly have translated a work of Aristotle.[3] To the Nestorian movement in Persia he rendered useful service by his letter to Mārī of Bēth Hardashēr, in which he maintained the tenets of Diodore and Theodore, while allowing that Nestorius had erred.[4] On the ground of his writings he was condemned and deposed by the " robber synod " of Ephesus (449), but was restored by the Council of Chalcedon (451), after he had anathematized Nestorius. His death in 457 was followed by a strong anti-Nestorian reaction at Edessa, which led to the expulsion of many of the leading teachers.

On Isaac of Antioch, " one of the stars of Syriac literature," see the special article. In spite of his over-diffuseness, he is one of the most readable of Syriac authors.

A Nestorian contemporary of Isaac, Dādhīshō', who was catholicus of Seleucia from 421 to 456, composed commentaries on Daniel, Kings and Ecclesiasticus. His chief importance in the history of the Persian Church lies in his having induced a synod of bishops to declare that church independent of the see of Antioch and of the " Western Fathers " (Labourt, p. 122 sqq.).

The most powerful missionary of Nestorianism during the 2nd half of the 5th century was Barṣāumā of Nisībis, whom his opponents called " the swimmer among the reeds," *i.e.* the wild boar. Born probably between 415 and 420 he imbibed Nestorian doctrine from Ibas at the Persian school of Edessa, but was driven out in 457 on the death of his master, and went to be bishop of Nisībis. In a succession of missionary journeys he succeeded, partly by persuasion and partly (if his enemies are to be believed) by violence, in attaching to Nestorianism nearly all the Christian communities of Persia, with the exception of Taghrīth, which was always strongly Monophysite. He had many quarrels with his ecclesiastical superior the catholicus of Seleucia, but finally made peace with Acacius soon after the accession of the latter in 484. Among other severities towards the Monophysites, he persuaded the Persian king Pērōz (457–484) to banish many of them into the Roman dominions. One of his great aims was to secure for the Nestorian clergy freedom to marry, and this was finally sanctioned by a council at Seleucia in 486 (Labourt, *op. cit.*, chap. vi.). Barṣāumā must have been bishop of Nisībis for nearly 40 years, but was dead by 496. His writings seem to have been chiefly liturgical: he gave the first set of statutes to the school of Nisībis, which was founded during his bishopric.

His fellow-worker Narsai, whom the Jacobites called " the leper," but the Nestorians " the harp of the Holy Spirit," apparently accompanied Barṣāumā from Edessa to Nisībis, where according to Barhebraeus he lived for 50 years. Barṣāumā appointed him head of the new school, where he taught rigidly Nestorian doctrine. He was a copious writer, especially in verse. Many of his poems have now been published.[5] His theological position is clearly defined in a homily on the three doctors—Diodore, Theodore and Nestorius—published by the Abbé Martin in the *Journal asiatique* for July 1900.

On the less important companions of Barṣāumā and Narsai-Mārī, Acacius and Mīkhā, see Wright (*op. cit.* pp. 59 seq., 63 seq.). The M'anā who accompanied them and became bishop of Rēwardashēr in Persia was not, as Barhebraeus supposed, the catholicus of Seleucia who held office in 420, but a much younger man. Like Ibas he had been employed at Edessa in translating the commentaries of Theodore.

Among the early Monophysites were two of the best of Syriac writers—Jacob of Sĕrūgh and Philoxenus of Mabbōgh, who have been treated in special articles. The one wrote mainly in verse, the other in prose. See also JOSHUA THE STYLITE.

Another early Monophysite was Simeon of Bēth Arshām, who by a series of journeys and disputations within the Persian empire did all he could to prevent the triumph of Nestorianism among the Persian Christians. He had considerable success at the time, but the ground he had won was soon reconquered by his opponents, except at Taghrīth and the surrounding district. It was after a successful disputation in presence of the Nestorian catholicus Bābhai (497–502/3) that Simeon was made bishop of Bēth Arshām, a town near Seleucia. He made several journeys to Constantinople, where he enjoyed the favour of the empress Theodora. It was there he died, probably about 532–533. His biography was written by John of Asia in the collection of lives of eastern saints which has been edited by Land (*Anecd. syr.* vol. ii.). His literary productions consist only of a liturgy and two exceedingly interesting letters. The one has for its subject Barṣāumā and the other Nestorian leaders in Persia, and gives a highly malicious account of their proceedings. The other, which has been often edited,[6] is an account of a severe persecution which the Himyarite Christians of Najrān in south-west Arabia underwent in 523, at the hands of the king of Yemen. As Simeon had repeatedly visited al-Ḥirah and was in touch with the Arab kingdom which centred there, his letter is a document of first-rate historical importance.

Mention should be made of two other early Monophysite leaders who suffered persecution at the hands of the emperor Justin I. (518–527). The one is John of Tellā, author of 538 canons,[7] answers to questions by the priest Sergius, a creed and an exposition of the Trisagion. His life was written by his disciple Elias, and also by John of Asia. The other, John bar Aphtōnyā, was the founder of the famous monastery of Ḳenneshrē, opposite

[1] See Labourt, *op. cit.*, especially pp. 87–90, 92–99.

[2] Some of these refer to events so late that they cannot be from his pen.

[3] See Duval, *Litt. syr.*[3], p. 247.

[4] Labourt, *op. cit.* p. 254 sqq.

[5] See Feldmann, *Syrische Wechsellieder von Narses* (Leipzig, 1896); Mingana, *Narsai, homiliae et carmina* (2 vols., Mosul, 1905); and other editions of which a list is given by Duval, p. 344 seq. Four of the homilies which deal with liturgical matters have been given in an English translation, accompanied with valuable notes, by R. H. Connolly (Cambridge, 1909).

[6] The best edition is Guidi's *La Lettera di Simeone Vescovo di Bēth-Arśām sopra i martiri omeriti* (Rome, 1881).

[7] Edited by Kuberczyk (Leipzig, 1901).

Jerābīs on the Euphrates, and wrote a commentary on the Song of Songs, a number of hymns and a biography of Severus, the Monophysite patriarch of Antioch (512–519).

The life of the great missionary bishop Jacob Burdĕ'ānā[1] or Baradaeus, from whom the Monophysite Church took its name of Jacobite, belongs rather to ecclesiastical than to literary history. A native of Tellā in Mesopotamia, he obtained the favour of the empress Theodora while on a mission to Constantinople, and resided in that city for fifteen years (528–543). At the request of the Arab king of Ghassān he was sent on a mission to the East after being consecrated bishop of Edessa; and the rest of his life was spent in organizing the Monophysite Church of eastern Syria. We possess two lives of him—one by John of Asia in his collection of biographies, and another which may have been written by a priest of Jacob's original monastery of Pĕsīltā. Both are to be found in the 2nd volume of Laud's *Anecdota syriaca*. An excellent modern biography and estimate of Jacob has been written by Kleyn.[2] A Syriac account of the removal of his remains from Alexandria, where he died in 578, to his old monastery of Pĕsīltā has been edited by Kugener in the *Bibliothèque hagiographique orientale*, pp. 1–26 (Paris, 1902). The activity of his life left him little time for writing, but he was the author of "an anaphora, sundry letters, a creed or confession of faith, preserved in Arabic and a secondary Ethiopic translation, and a homily for the Feast of the Annunciation, also extant only in an Arabic translation" (Wright).

A very different character from Jacob's was that of Sergius of Rās'ain, one of the best Greek scholars and ablest translators whom Syria has produced. Of his life little is known, and that little not wholly creditable. He wavered curiously in his ecclesiastical views, and ended by helping the persecutors of the Monophysite Church, to which he himself had belonged. He seems to have lived as a priest and physician at Rās'ain in Mesopotamia most of his life. About 535 he travelled on various ecclesiastical missions, and finally made a journey to Rome and thence to Constantinople (in this latter accompanied by the pope Agapetus). The result was to bring about the deposition and banishment of the Monophysites from the latter city. Sergius died almost immediately afterwards, in 536. Among the works which he translated into Syriac and of which his versions survive are treatises of Aristotle, Porphyry and Galen,[3] the *Ars grammatica* of Dionysius Thrax, the works of Dionysius the Areopagite, and possibly two or three treatises of Plutarch.[4] His own original works are less important, but include a "treatise on logic, addressed to Theodore (of Merv), which is unfortunately imperfect, a tract on negation and affirmation; a treatise, likewise addressed to Theodore, *On the Causes of the Universe, according to the Views of Aristotle, showing how it is a Circle*; a tract *On Genus, Species and Individuality*; and a third tract addressed to Theodore, *On the Action and Influence of the Moon*, explanatory and illustrative of Galen's Περὶ κρισίμων ἡμερῶν, bk. iii., with a short appendix 'On the Motion of the Sun'" (Wright). According to the historical compilation which passes under the name of Zacharias Rhetor, he also wrote a treatise on the faith.[5] Some of his translations were revised at a later time by Ḥonain ibn Isḥāḳ (†873).

Another translator from Greek was Paul, Monophysite bishop of Callinīcus or ar-Raḳḳah, who, being expelled from his diocese in 519, retired to Edessa and there occupied himself in translating into Syriac the works of Severus, the Monophysite champion who was patriarch of Antioch from 512 to 519. This version appears to be quite distinct from that used by the compiler of the chronicle of Zacharias,[6] and also from the version of "the 6th book of the select letters of Severus" which was made by Athanasius "presbyter of Nisībis" in 669 and has been edited by E. W. Brooks (London, 1902–1904).

That important legal work, *The Laws of the Emperors Constantine, Theodosius and Leo*, which was composed in Greek about 475, and "which lies at the root of all subsequent Christian Oriental legislation in ecclesiastical, judicial and private matters" (Wright), must have been repeatedly translated into Syriac. The oldest form is contained in a British Museum MS. which dates from the earlier part of the 6th century, and this was edited by Land (*Anecd. syr.* i. 30–64). A latter (probably Nestorian) recension is contained in a Paris MS., which was used along with the other by Bruns and Sachau in their exhaustive edition (*Syrisch-römisches, Rechtsbuch*, Leipzig, 1880). In *Notulae syriacae* (privately printed 1887) Wright edited the surviving fragment of a 3rd recension which is preserved in a 13th-century MS. at Cambridge. Finally Sachau has published three new redactions of the treatise from a MS. found at Rome in 1894 (*Syrische Rechtsbücher*, vol. i., Leipzig, 1907).

The last 5th-century author to be mentioned here is Aḥūdhemmēh, who was Jacobite metropolitan of Taghrīth from 559 till he was martyred by Khosrau Anōsharwān in 575. He wrote various philosophical works, also a treatise on grammar which is quoted by the later grammarian, John bar Zō'bi. A Syriac life of him has been published by F. Nau, who appends to it the surviving fragment of his treatise on the composition of man as consisting of soul and body.[7]

We may here take note of three important anonymous works, of which the first probably and the other two certainly belong to the 6th century.

The Mĕ'arrath gazzē or *Cave of Treasures*, translated and edited by C. Bezold (Leipzig, 1883–1888), is akin (as Duval remarks) to the *Book of Jubilees*. It is an imaginary history of the patriarchs and their descendants. The work derives its name from the picturesque story of the cave where Adam deposited the treasure of gold, myrrh and incense which he had brought away from paradise: the cave was used as a burying-place by him and his descendants until the deluge. After the precious relics together with the bones of Adam had been saved in the ark, they were transported by Shem and Melchizedek to Golgotha under the guidance of an angel.[8]

The tripartite narrative which is known as the *Romance of Julian* (the Apostate) has no claim to be regarded as an historical document. Its hero is Jovian, one of the feeblest of Roman emperors, and Julian is everywhere exhibited in flaming colours as the villain of the story. But as an example of Syriac prose style it is of the best, and the author at times shows considerable dramatic power.

A valuable historical source, though of small dimensions, is the *Chronicle of Edessa*, which gives a record of events from 132–131 B.C. to A.D. 540—at first exceedingly brief, but becoming somewhat fuller for the later years. It appears to be thoroughly reliable wherever it can be tested. It has been three times edited—first by Assemani in the *Bibliotheca orientalis* (i. 388–417), secondly by L. Hallier (Leipzig, 1892) with a translation, introduction and abundant notes, and thirdly by Guidi with a Latin version (in *Chronica minora*, Paris, 1903).

On John of Asia or Ephesus, the eminent Monophysite bishop and earliest Syriac church historian, see the separate article.

An historical work of somewhat similar character to John's is the compilation in 12 books which is generally known by the name of Zacharias Rhetor,[9] because the anonymous Syriac compiler has incorporated the Syriac version or epitome of a lost

[1] So called "because his dress consisted of a barda'thā, or coarse horse-cloth, which he never changed till it became quite ragged" (Wright).

[2] *Jacobus Baradaeus, de Stichter der syrische monophysietische Kerk* (Leiden, 1882).

[3] See the details in Wright, pp. 90 sqq.; and cf. especially A. Baumstark, *Aristoteles bei den Syrern vom V.–VIII. Jahrhundert* (Leipzig, 1900); and V. Ryssel, *Über den textkritischen Werth der syrischen Uebersetzungen griechischer Klassiker* (Leipzig, 1880–1881). The latter singles out the version of the pseudo-Aristotelian Περὶ κόσμου as a model of excellence in translation.

[4] On these last see Baumstark, *Lucubrationes syro-graecae* pp. 405 sqq. (Leipzig, 1894); and Duval, *Litt. syr.*[3] pp. 266 seq.

[5] Land, *Anecd. syr.* iii. 289.

[6] See Brooks and Hamilton's translation of the latter, p. 234.

[7] *Patrologia orientalis*, iii. 1 (Paris, 1906).

[8] Bezold's edition contains also an Arabic version.

[9] This author has hitherto been identified with Zacharias Scholasticus, who afterwards became bishop of Mitylene, but according to M. A. Kugener, *La Compilation historique de pseudo-Zacharie le Rhéteur* (Paris, 1900), this identification is a mistake.

Greek history written by that author. The Syriac work exists (not quite complete) in a British Museum MS. of about the beginning of the 7th century: this can be in part supplemented by an 8th-century MS. at the Vatican. From the latter Guidi published the interesting chapter (X. 16) which contains the description of Rome. The entire text of the London MS. was published by Land in the third volume of his *Anecdota syriaca*; and there is now an English translation by Hamilton and Brooks (London, 1899), and a German one by Ahrens and Krüger (Leipzig, 1899).

Of the other 6th-century Jacobite writers we need mention only Moses of Aggēl (*fl. c.* 550–570) who translated into Syriac some of the writings of Cyril, and Peter of Callinīcus, Jacobite patriarch of Antioch 578–591, who wrote a huge controversial treatise in 4 books, each of 25 chapters, against Damian, patriarch of Alexandria, as well as other less important works.

The Nestorian writers of the 6th century were numerous, but as yet we know little of their works, beyond what ʽAbhdīshoʽ tells us in his *Catalogue*. It will be sufficient to mention one or two. Joseph Hūzāyā (*i.e.* of al-Ahwāz or Khūzistan), who came third in succession to Narsai as head of the school of Nisībis, was the first Syriac grammarian and invented various signs of interpunction. Mārūthā, who was Nestorian catholicus of Seleucia from about 540 to 552[1] and a man of exceptional energy, made the only known attempt, which was, however, unsuccessful, to provide the Nestorians with a Bible version of their own. He was the author of many commentaries, homilies, epistles, canons and hymns. Paul the Persian, a courtier of Khosrau Anōsharwān, dedicated to the king a treatise on logic which has been published from a London MS. by Land in the 4th volume of his *Anecdota*. Bōdh the periodeutes is credited with a philosophical work which has perished, but is best known as the author of the old Syriac version of the collection of Indian tales called *Kalīlah and Dimnah*. He made it doubtless from a Pahlavī version. His translation, which was edited by Bickell with an introduction by Benfey, must be distinguished from the much later Syriac translation made from the secondary Arabic version and edited by Wright in 1884.[2] Ḥannānā of Ḥedhaiyabh, who nearly produced a disruption of the Nestorian Church by his attempt to bridge over the interval which separated the Nestorians from Catholic orthodoxy, was the author of many commentaries and other writings, in some of which he attacked the teaching of Theodore of Mopsuestia. An account of his theological position, derived from the treatise of Bābhai *De unione*, will be found in Labourt, *op. cit.* pp. 279 sqq. One of his followers, Joseph Ḥazzaya, was also a prolific writer.

"With the 7th century," as Wright remarks, "begins the slow decay of the native literature of the Syrians, to which the frightful sufferings of the people during the great war with the Persians in its first quarter largely contributed." The same process of decay was greatly promoted by the Arab conquest of Persia, achieved through the victory of Ḳādisīya in 636-637. The gradual replacement of Syriac by Arabic as the vernacular language of Mesopotamia by degrees transformed the Syriac from a living to a dead language. Apart from a few leading writers—such as Jacob of Edessa, the anonymous historian whose work has passed under the name of Dionysius of Tell-Maḥrē, Thomas of Margā, Dionysius Bar Ṣalībī, and Barhebraeus[3]—there are not enough names of interest to make it worth while to continue our chronological catalogue. It will be sufficient to group the more important contributors to each of the chief branches of literature.

1. *Theology.*—Here we may first mention George, Bishop of the Arabs (†724), who wrote commentaries on Scripture, and tracts and homilies on church sacraments, and finished the *Hexaēmeron* of Jacob of Edessa.[4] Bābhai the Elder, a leading Nestorian in the beginning of the 7th century and a prolific author, wrote many commentaries and theological discourses. Īshōʽyabh III., Nestorian catholicus from 647 to 657/8, wrote controversial tracts, religious discourses and liturgical works. Elias of Merv, who belongs to the 2nd half of the 7th century, compiled a *Catena patrum* on the Gospels and wrote many commentaries. Timothy I., catholicus 779–823, wrote synodical epistles and other works bearing on church law.[5] Moses bar Kēphā (†903), one of the most fertile of 9th-century authors, wrote commentaries, theological treatises and many liturgical works. Other important contributors to this sphere of literature were Ishōʽ bar Nōn (†827/8), John bar Zōʽbī (beginning of the 13th century), Jacob bar Shakkō (†1241), and the great Nestorian scholar ʽAbhdīshōʽ (†1318).

2. *History.*—Besides the important writers treated in separate articles, we need mention only four. Elias bar Shīnāyā, who in 1008 became Nestorian bishop of Nisībis, was the author of a valuable *Chronicle*, to which are prefixed numerous chronological tables, lists of popes, patriarchs, &c., and which covers by its narrative the period from A.D. 25 to 1018. Of this work, which exists in only one imperfect copy, the later portion was edited by Baethgen in 1884, and the earlier by Lamy in 1888. Another important *Chronicle* is that of Michael I., who was Jacobite patriarch from 1166 to 1199. Its range extends from the Creation to the author's own day, and it was largely used by Barhebraeus in compiling his own *Chronicle*. Till recently it was known only in an abridged Armenian version which was translated into French by V. Langlois (Venice, 1868): but the Syriac text has now been found in a MS. belonging to the library of the church at Edessa, and is in course of publication by J. B. Chabot. A work rather legendary than historical is the *Book of the Bee*, by Solomon of al-Baṣrah, who lived early in the 13th century.[6] Lastly, acknowledgment must be made of the great value of the Catalogue of Nestorian writers, by ʽAbhdīshōʽ of Nisībis, the latest important writer in Syriac. It was edited by Assemani in the 3rd part of his *Bibliotheca orientalis*, and has been translated into English by Badger.

3. *Biography, Monastic History, &c.*—Besides the important work by Thomas of Margā (*q.v.*) the following deserve special mention. Sāhdōnā, who was a monk in the Nestorian monastery of Bēth ʽĀbhē (the same to which Thomas of Margā belonged two centuries later) and afterwards a bishop early in the 7th century, wrote a biography of and a funeral sermon on his superior Mār Jacob who founded the monastery, and also a long treatise in two parts on the monastic life, of which all that survives has been edited by P. Bedjan (Paris, 1902). Whilst accompanying the catholicus Ishōʼyabh II. (628–644) on a mission to Heraclius, Sāhdōnā was converted, apparently to catholicism,[7] and thereby caused much scandal in the East. The chief events in his life are narrated by Ishōʽdĕnaḥ.[8] Another, Nestorian who, a few years later, wrote ecclesiastical biographies and other theological works was Sabhrīshōʽ Rusṭam, who lived at Mount Izlā and other monasteries. In the beginning of the 8th century David of Bēth Rabban, also a Nestorian monk, wrote, besides a geographical work, "a monastic history, called *The Little Paradise*, which is frequently cited by Thomas of Margā." A more important work is *The Book of Chastity*, by Ishōʽdĕnaḥ, who according to ʽAbhdīshōʽ was bishop of Ḳaṣrā—but read Baṣrā—about the end of the 8th century. This work is a collection of lives of holy men who founded monasteries in the East, and is a valuable historical source. The work itself, or an abridgment of it, was discovered and published for the first time by J. B. Chabot (Rome, 1896).[9] As the last under this head we may mention a late anonymous biography, that of the catholicus Yabhalāhā III. (1281–1317), which throws much light on the relations of the early Mongol kings with the heads of the church in their dominions. Among other interesting features it contains information about the Nestorian Church of China in the 13th century—Yabhalāhā was a native of Peking—an account of a journey through Central Asia, and a description of a visit to Europe by Rabban Ṣaumā, the friend of the catholicus.[10]

4. *Philosophy and Science.*—Special mention may be made of ʽĀnānīshōʽ of Ḥedhaiyabh (middle of 7th century) well known as the author of a new recension of the *Paradise* of Palladius, and also the author of a volume on philosophical divisions and definitions; Romanus the physician (†896), who wrote a medical compilation, a commentary on the Book of Hierotheus, a collection of Pythagorean maxims and other works; Moses bar Kēphā, the voluminous writer above referred to; the famous physician Ḥonain ibn Iṣḥāḳ

1 See a full account of his career in Labourt, *Le Christianisme dans l'empire perse*, pp. 163–191.

2 Of this there is an English translation by Keith Falconer (Oxford, 1884).

3 These have all been dealt with in separate articles.

4 George's part has been translated into German by V. Ryssel (Leipzig, 1891).

5 See O. Braun's article in *Oriens christianus*, i. 138–152; and Labourt, *De Timotheo I. Nestorianorum patriarcha* (Paris, 1904).

6 Text and translation, by E. A. W. Budge (Oxford, 1886).

7 See H. Goussen, *Martyrius-Sahdonas Leben und Werke* (Leipzig, 1897).

8 *Le Livre de la chasteté* (ed. Chabot, pp. 67 sqq.).

9 A fresh edition by Bedjan forms an appendix to his edition of Thomas of Margā (Paris, 1901).

10 The text has been twice edited by Bedjan (Paris, 1888 and 1895), and there is a French translation, with copious notes, by Chabot (Paris, 1895); cf. also *Journ. As.* (1889), pp. 313 sqq., and *Eng. Hist. Rev.* xiv. 299 sqq.

(†873), who wrote chiefly in Arabic, but deserves mention here by his services to Syriac grammar and lexicography, and still more by his translations of Greek philosophical and scientific works into Syriac[1] and from Syriac into Arabic, becoming in a sense the founder of a school of translators; and Jacob bar Shakkō, whose work called the *Dialogues* treats of grammar, rhetoric, poetry, logic, philosophy and science.

5. *Grammar and Lexicography.*—Several of the authors in this department have already been mentioned. The more important, besides Jacob of Edessa and Barhebraeus, are 'Ānānīshō' of Ḥēdhaiyabh, Ḥonain ibn Iṣḥāḳ, his pupil Bar 'Alī, Bar Sarōshwai (early 10th century), Bar Bahlūl (middle of 10th century), Elias of Ṭirhān (†1049), Elias bar Shīnāyā (above), John Bar Zō'bī (beginning of 13th century) and Jacob bar Shakkō.

Apart from the numerous editions of Syriac texts by M. Paul Bedjan, most of which have been cited above, nearly all the texts recently edited are included in one or other of three comprehensive series now running—viz. (1) *Patrologia syriaca* (Paris, 1894); (2) *Corpus scriptorum christianorum orientalium—scriptores syriaci* (Paris, 1907); (3) *Patrologia orientalis* (Paris, 1907). (N. M.)

SYRIANUS, a Greek Neoplatonist philosopher, and head of the school at Athens in succession to Plutarch. He is important as the teacher of Proclus, and, like Plutarch and Proclus, as a commentator on Plato and Aristotle. His best-known extant work is a commentary on the *Metaphysics* of Aristotle. He is said to have written also on the *De coelo* and the *De interpretatione* of Aristotle and on Plato's *Timaeus*. A treatise on the *Staseis* of Hermogenes was published under his name by Walz in 1833. His views were identical with those of Proclus, who regarded him with great affection and left orders that he should be buried in the same tomb.

SYRINGE (Gr. σῦριγξ, reed, pipe), a hydraulic instrument, based on the principle of the pump, for the drawing up and ejecting of liquids. The ordinary form is that of a glass or metal tube ending in a pointed nozzle and fitted with an air-tight piston-rod and handle. The nozzle is inserted in the liquid, which enters the cylinder by atmospheric pressure when the piston-rod is drawn up. On pushing back the piston the fluid is ejected in a jet through the nozzle. In sizes varying from the needle-pointed hypodermic syringe to the abdominal syringe, it is a common surgical implement used for the injection of fluids into the body or for the washing of wounds and cavities. The smaller syringes are made of glass, the larger of metal; the most common medical syringes consist of a length of india-rubber tubing, one end terminating in a nozzle of ivory or other easily cleaned material, in the centre is a bulb or ball which under pressure draws up the liquid through the free end of the tube which is placed in the vessel containing it. There are a very large number of different types of syringe used in surgical practice. A larger syringe of metal, with a flat perforated nozzle is used as a garden implement for watering plants.

SYRINX (σῦριγξ), the Greek name for the pan-pipes. The principle on which it works is that of the stopped pipe, but it is blown in the same manner as the ancient Egyptian nay or oblique flute. The pipes composing it were stopped at one end, so that the sound waves had to travel twice the length of the pipe, giving out a note nearly an octave lower than that produced by an open pipe of equal length. The breath directed horizontally across the open end, impinged against the sharp inner edge of the pipes, creating the regular series of pulses which generate the sound waves within the tubes. The syrinx consisted of a varying number of reeds, having their open ends or embouchures in a horizontal line and their stopped ends, formed by the knots in the reed, gradually decreasing in length from left to right. Each pipe gave out one note, but by overblowing, *i.e.* increased pressure of breath and tension of lips, harmonies could be obtained.

The syrinx or pan pipes owes its double name to ancient Greek tradition, ascribing its invention to Pan in connection with a well-known legend of the Arcadian water-nymph "Syrinx."[2] The exact form of the instrument and the number of pipes (10) at the beginning of the third century B.C. is shown in one of the Idyllia figurata,[3] in which the legend is repeated. The pandean pipes continued in favour with the rustic populations of the West long after the organ evolved from it had eclipsed this humble prototype. The syrinx was in use during the middle ages, and was known in France as *frestel* or *frêtiau*, in medieval Latin as *fistula panis*, and in Germany as *Pansflöte* or *Hirtenpfeife* (now *Papagenoflöte*). At the beginning of the 19th century a revival of the popularity of this instrument took place, and quartets were played on four sets of pipes of different sizes and pitch. The modern mouth-organ is the representative of the syrinx, although blown by means of a free reed.

SYRUP (O. Fr. *ysserop*, mod. *sirop*, Span. *xarope*, for *axarope*, Arab. *al*, the, and *sharab*, drink; cf. "Sherbet" and "Shrub"), the name given to a thick, viscid liquid, containing much dissolved (generally crystalline) matter, but showing little tendency to deposit crystals. The "syrup" employed for medicinal purposes consists of a concentrated or saturated solution of refined sugar in distilled water. The simple "syrup" of the British Pharmacopoeia is prepared by adding 1000 grams (or 5 lb) of refined sugar to 500 cubic centimetres (or two pints) of boiling distilled water, heating until it is dissolved and subsequently adding boiling distilled water until the weight of the whole is 1500 grams (or $7\frac{1}{2}$ lb). The specific gravity of the syrup should be 1·33. *Flavoured syrups* are made by adding flavouring matter to a simple syrup. For instance, *syrupus aromaticus* is prepared by adding certain quantities of orange and cinnamon water to simple syrup. Similarly, *medicated syrups* are prepared by adding medicaments to, or dissolving them in, the simple syrup. *Golden syrup* is the uncrystallizable fluid drained off in the process of obtaining refined crystallized sugar. *Treacle* and molasses are syrups obtained in the earlier stages of refining. Technically and scientifically the term syrup is also employed to denote viscid, generally residual, liquids, containing substances other than sugar in solution.

SYRYENIANS (also Sirianian, Syrjenian, Zyrenian, Zirianian, Zyrian and Zirian), a tribe belonging to the Permian division of the eastern Finns. They are said to number about 85,000 on the west side of the Urals in the governments of Perm, Vologda and Archangel, and there are also about 1000 on the Siberian side of the lower Ob. Their headquarters are at Ust-Ishma, at the junction of the Ishma and Pechora. Formerly they spread farther to the west. They are of moderate stature, blond, and grey-eyed, and more energetic and inclined to trade than most of the allied tribes. They were converted to Christianity about 1350 and their language was reduced to writing. They call themselves Komi and are not sharply distinguished from the tribes known as Permian, the languages being mutually intelligible. The archaeological remains in the governments of Perm and Vatyka called Chudish by Russians are probably Syryenian. A grammar of the language was published by Castrén, and linguistic and other notices of the tribe are contained in the *Journal de la société finno-ougrienne*, especially for 1903. (See FINNO-UGRIAN.)

SYSTYLE (Gr. σύν, together with, and στῦλος, a column), in architecture, a term meaning having columns rather thickly set—an intercolumniation to which two diameters are assigned.

SYZRAÑ, a town of Russia, in the government of Simbirsk, 156 m. E. of the town of Penza, and a short distance from the Volga. Pop. (1882), 24,500; (1900), 33,046. Syzrañ originated in a fort, erected in 1683, to protect the district from the Tatars and Circassians. Most of its inhabitants are engaged in gardening and tillage. In the large villages of the surrounding district various petty trades are carried on. The town has long been in repute for its tanneries and its manufactures of leather. Several flour-mills and other factories have recently sprung up. Much grain is exported; timber is brought from the upper Volga, and manufactured wares from Nizhniy Novgorod.

SYZYGY (Gr. συζυγία, a yoking together, from σύν, together, and root ζυγ-, yoke), in astronomy, either of the points at which the moon is most nearly in a line with the sun. The moon passes her syzygies, or is in a syzygy, at new and full moon.

[1] The Syriac versions made by him and his successors have unfortunately perished (see Wright, p. 213).

[2] See Serv. ad Virgil, *Ecloga*, ii. 31; and Ovid, *Metam.* i. 691, &c.

[3] Theocritus, Brunck, *Analecta veto. poet. graec.* i. 304.

SZABADKA (Ger. *Maria-Theresiopel*), a town of Hungary, in the county of Bács-Bodrog, 109 m. S.S.E. of Budapest by rail. Pop. (1900), 81,464. It is situated in the great Hungarian plain between the Danube and the Theiss, and is the centre of an immense agricultural district. To the town belongs a large territory (369 sq. m.) of the adjoining Puszta Telecska, where large herds of cattle are reared. In this territory is situated Lake Palics, a favourite watering-place and summer resort.

SZABÓ VON SZENTMIKLÓS, JOZSEF (1822–1894), Hungarian geologist, was born at Kalocsa, on the 14th of March 1822. His first contribution to science was an essay on metallurgy, in which subject he had received special training. Afterwards he settled at Budapest and investigated the geology of the district, the results of which were published in a geological map (1858). In 1859 he joined the staff of the Austrian Geological Survey, as a volunteer member, and paid attention to the economic as well as to the purely scientific aspects of the work. He also arranged for surveys having special reference to agricultural geology to be undertaken by the Hungarian Geological Institute. In 1862 he became professor of geology and mineralogy in the university of Budapest. In later years he devoted himself largely to petrology, and published memoirs on the trachytes of Hungary and Transylvania; on a new method of determining the species of felspars in rocks, depending on fusibility and flame-coloration; on the geology and petrology of the district of Schemnitz; and on Santorin Island. He died at Budapest on the 12th of April 1894.

He was author of *Geologie mit besonderer Rücksicht auf die Petrographie, den Vulkanismus u. die Hydrographie* (1883).

SZALAY, LADISLAS (1813–1864), Hungarian statesman and historian, was born at Buda on the 18th of April 1813. After the completion of his studies, he became a member of the Hungarian parliament, and in 1848 he represented Hungary in the German national parliament at Frankfort. He took part in the revolution of 1848–49, and was obliged to seek refuge in Switzerland, where he wrote his history of Hungary. This important work, published at Budapest (1856–1860), extends to 1707. Szalay also wrote remarkable studies on Pitt, Fox, Mirabeau and other statesmen, and contributed very considerably to the codification of Magyar law. In later life he returned to Hungary, but he died at Salzburg on the 17th of July 1864.

See Alexander Flegler, *L. von Szalay* (Leipzig, 1866).

SZÉCHENYI, ISTVAN, Count (1791–1860), Hungarian statesman, the son of Ferencz Széchenyi and the countess Juliana Festetics, was born at Vienna on the 21st of September 1791. Very carefully educated at home till his seventeenth year, when he entered the army, he fought with distinction at the battle of Raab (June 14, 1809), and on the 19th of July brought about the subsequent junction of the two Austrian armies by conveying a message across the Danube to General J. G. Chasteler at the risk of his life. Equally memorable was his famous ride, through the enemy's lines on the night of the 16th-17th of October 1813, to convey to Blücher and Bernadotte the wishes of the two emperors that they should participate in the battle of Leipzig on the following day, at a given time and place. In May 1815 he was transferred to Italy, and at the battle of Tolentino scattered Murat's bodyguard by a dashing cavalry charge. From September 1815 to 1821 he visited France, England, Italy, Greece and the Levant, carefully studying the institutions of the countries through which he passed, and everywhere winning admirers and friends. A second—scientific—tour with his friend, Baron Miklos Wesselényi, taught him much about trade and industry, which knowledge he subsequently applied to his country's needs. In 1825, when he went to France in the suite of Prince Pàl Esterházy, to attend the coronation of Charles X., the canal du Midi especially attracted his attention and suggested to him the idea of regulating the rivers Danube and Theiss. At the Diet of 1825, when the motion for founding a Hungarian academy was made by Pál Nagy, who bitterly reproached the Magyar nobles for so long neglecting their mother-tongue, Széchenyi offered to contribute a whole year's income (60,000 florins) towards it. His example was followed by three other magnates who contributed between them 58,000 florins more. A commission was thereupon appointed to settle the details, and on the 18th of August the project received the royal assent. Another of his great projects was the opening up of the Danube for trade from Buda to the Black Sea. He satisfied himself of the practicability of the scheme by a personally conducted naval expedition from Pest to Constantinople. The Palatine Joseph was then won over, and on the 20th of June 1833 a Danube Navigation Committee was formed which completed its work in ten years. Széchenyi was also the first to start steamboats on the Theiss, the Danube and the lake of Balaton. It was now, too, that he published his famous work *Stadium*, suggesting a whole series of useful and indeed indispensable reforms (1833), which was followed by *Hunnia* (1834), which advocated the extension and beautifying of Budapest so as to make it the worthy capital of a future great power. His *A Few Words on Horse-racing*, a sport which he did so much to introduce and ennoble, appeared in 1839.

All this time Széchenyi had been following, with some anxiety, the political course of Kossuth. He sincerely believed that the exaggeration and exaltation of the popular editor of the *Pesti Hirlap* would cast the nation back into the old evil conditions from which it had only just been raised, mainly by Széchenyi's own extraordinary efforts, and in *Kelet népe*, which is also an autobiography, he prophetically hinted at an approaching revolution. "Trample on me without ceremony," he wrote to Kossuth on this occasion, "but for God's sake don't use the nimbus of your popularity to plunge Hungary into chaos." On this very point of reform the nation was already divided into two parties, though only the minority held with Széchenyi. But neither this fact nor the gradual loss of his popularity restrained Széchenyi, both in the Diet and at county meetings, from fulminating conscientiously against the extreme demands of Kossuth. His views at this period are expounded in the pamphlet *Politikai programm töredékek* ("Fragments of a Political Programme"). He held the portfolio of ways and communications in the first responsible Magyar administration (March 23, 1848) under Bátthyány, but his increasing apprehension of a revolution, with its inevitable corollaries of civil war and a rupture with the dynasty, finally affected his mind, and on the 5th of September he was removed to an asylum. Here he remained for many years, but recovered sufficiently to correspond with his friends and even to meditate writing fresh books. In 1859 he published the pamphlet *Ein Blick* in which he implored his countrymen to accept the Bach system as the best constitution attainable in the circumstances. The sudden death of his old friend Baron Samuel Jósika and the once more darkening political horizon led him, in a moment of despair, to take his own life (April 8, 1860). He richly deserved the epithet "the greatest of the Magyars" bestowed upon him by his political antagonist Kossuth.

Most of his numerous works on political and economical subjects have been translated into German. The best complete edition of his writings has been published, in nine volumes, by the Hungarian Academy (Pest, 1884–1896). See *Life of Széchenyi*, by Zsigmond Kemény (Hung.; Pest, 1870); Aurel Kecskeméthy, *The Last Years and Death of Count Széchenyi* (Hung.; Pest, 1866); Menyhert Lonyai, *Count Széchenyi and his Posthumous Writings* (Hung.; Budapest, 1875); Max Falk, "Der Graf Stephen Széchenyi und seine Zeit" (in the *Oesterreichische Revue*, Vienna, 1867); Antál Zichy, *Count Széchenyi as a Pedagogue* (Hung.; Budapest, 1876); Pál Gyulai, *Széchenyi as a Writer* (Hung.; Budapest, 1892); Antál Zichy, *Biographical Sketch of Count Stephen Széchenyi* (Hung.; 2 vols., Budapest, 1896–1897). (R. N. B.)

SZE-CH'UEN (Four Rivers), a western province of China, bounded N. by Kokonor, Kan-suh and Shen-si, E. by Hu-peh and Hu-nan, S. by Kwei-chow and Yun-nan, and W. by Tibet. Estimates of its population vary from 45,000,000 to 68,000,000; estimates of its area from 185,000 to 218,000 sq. m. It is considerably larger than any other province of China, Yun-nan, which comes next in size, covering less than 150,000 sq. m. Sze-ch'uen contains twelve prefectual cities, inclusive of Ch'êng-tu Fu, the provincial capital. The western portion forms part of the mountain-lands of Central Asia and much of it is over 10,000 ft. high, while heights of 16,000 to 19,000 ft. occur. The northern portion is also mountainous, but the east central part of Sze-ch'uen consists of a red sandstone table-land (see CHINA, § 1). Towards the north-east end of this plateau, commonly known as "the red basin," is Ch'ĕng-tu Fu (pop. 450,000–500,000), the provincial capital. The plain in which the city stands is about 70 m. long and 30 wide, and is noted for the density of its population (about 5,000,000), its wealth, and its splendid irrigation works.

The fauna includes bears, yaks, various kinds of antelope, monkeys and parrots. The flora includes magnificent yews, a great variety of bamboos, tallow, varnish, soap, and wax trees, rhododendrons and giant azaleas. The ethnological and commercial boundaries are sharply defined by the physical features. The mountain districts are poorly cultivated, and are inhabited by *Ijin* or barbarians, who are distinguished under the tribal names of Si-fan, Lo-lo and Man-tsze, and who maintain a semi-independence. Tibetans are also scattered over the western region and are numerous in the district of Pa-tang. The table-land is inhabited by Chinese, and is one of the most thriving and populous regions in the empire. These Chinese exhibit great diversity of type, due in part to immigration from other provinces in the 17th century—three fourths of the inhabitants having, it is said, been exterminated towards the close of the Ming dynasty.

Through the southern portion of Sze-ch'uen runs the Yangtsze-kiang, which is there navigable throughout the year, while the province is traversed by three large rivers, the Min-kiang, the Fu-sung-ho and the Kialing-kiang, all of which take their rise in the mountains on its north-west border, and empty into the Yangtsze-kiang at Su-chow Fu, Lu Chow and Chung-k'ing Fu respectively. A series of rapids disturb the waters of the Yangtsze-kiang between I-ch'ang and Chung-k'ing, a distance of about 500 m. According to the native authorities there are 13 big rapids and 72 smaller ones on these waters. In ordinary circumstances it takes about six weeks to traverse the distance. In 1898 Mr A. Little took a steamer, which had been built for the purpose, up the rapids, and since then one or more of these boats have ascended them. The province is intersected by numerous but difficult roads. The Ta-pei-lu, or great north road, leads from Ch'ĕng-tu Fu to Peking. From the same centre there branch roads to Chung-k'ing Fu, to Pao-ning Fu and to Ya-chow Fu, while another road connects Chung-k'ing Fu with Kwei-chow Fu on the Yangtsze-kiang and beyond with I-ch'ang Fu in Hu-peh. From Ya-chow Fu, again, start two important roads, one leading into Tibet by way of Yung-king, Ts'ing-k'i Hien, Ta-chien-lu, Li-tang, Pa-tang and Chiamdo, and the other to Western Yun-nan via Ts'ing-k'i Hien, Ning-yuen Fu, and Yen-yuen Hien to Ta-li Fu. From Ta-li Fu this road continues through Momein to Bhamo in Burma. Another road connects Pa-tang and Li-kiang Fu with Ta-li Fu, and yet another crosses the southernmost corner of the province connecting Tung-ch'uen Fu in Yun-nan with Ta-li Fu in the same province. In 1910 a loan of £6,000,000 was arranged for the construction of a railway from Hankow through the provinces of Hu-peh and Sze-ch'uen to Ch'eng-tu Fu.

The products of Sze-ch'uen include silk, tea, rice, sugar, hemp, vegetable wax, tobacco, timber and oranges. A larger quantity of silk is produced in eastern Sze-ch'uen than in any other province of the empire. Large quantities are exported to Shen-si, Shan-si, Kan-suh, Peking, Yun-nan, Tibet, Kwei-chow, Kwang-si, Hu-nan and Hu-peh.

Wax. White wax is another valuable article of the Sze-ch'uen trade. It is made exclusively in the department of Kia-ting Fu, the climate of which appears to favour the propagation of the disease among the insects which is said by the natives to be the cause of the plentiful secretion of wax. This belief is borne out by the fact, that in the districts where the insects breed only a small quantity of wax is produced, and experience has taught the natives the advantage of breeding the insects in one district and producing the wax in another. The region of Kien-chang in the south of the province has been found most suitable for breeding purposes, and it is there, therefore, on the insect trees, which are evergreens with large and pointed ovate leaves, that the breeding processes are carried on. At the end of April the producers start each with a load of the eggs of the insects for the district of Kia-ting Fu, a journey which on foot occupies about a fortnight. The road between the two districts is very mountainous, and as exposure to the heat of the sun would hatch the eggs too rapidly, the travellers journey only during the night. At Kia-ting Fu the eggs are eagerly bought up, and are at once put upon the wax tree. Baron von Richthofen thus describes the subsequent process:—

"When the egg balls are procured they are folded up, six or seven together in a bag of palm leaf. These bags are suspended on the twigs of the trees. This is all the human labour required. After a few days the insects commence coming out. They spread as a brownish film over the twigs, but do not touch the leaves. The Chinese describe them as having neither shape, nor head, nor eyes, nor feet. It is known that the insect is a species of coccus. Gradually, while the insect is growing, the surface of the twigs becomes encrustated with a white substance; this is the wax. No care whatever is required. The insect has no enemy, and is not even touched by ants. In the latter half of August the twigs are cut off and boiled in water, when the wax rises to the surface. It is then melted and poured into deep pans. It cools down to a translucent and highly crystalline substance."

Tobacco is grown very generally throughout the province, and is exported in large quantites to Si-fan, Tibet, Yun-nan, Hu-nan, and the export to Hankow alone is estimated at 6½ million lb annually. The best is grown in the district of P'i Hien; the next quality is said to come from Kin-t'ang Hien, and the third quality from Shih-fang Hien, all these districts being in the plain of Ch'ĕng-tu Fu. The habit, which is unknown in other provinces, of smoking the tobacco leaves rolled up in the shape of cigars obtains largely in Sze-ch'uen. Salt is also produced in Sze-ch'uen in large quantities from brine, which is raised from wells. Tsze-liu-tsing, in Tsze Chow, Wu-tung-kiao, hear Kia-ting Fu, Pao-ning Fu, and T'ung-ch'uen Fu, are the districts where the wells are most abundant. The brine is raised from the well with long bamboo tubes and bamboo ropes, and is then led to large pans for evaporation. In the district of Tsze-liu-tsing petroleum is struck at a depth of from 1800 to 2000 ft., and is used for evaporating the brine. Coal, iron and copper are found in many parts. The only coal worked is of an inferior quality, and the iron is smelted with wood alone. Ning-yuen Fu is the principal district from which the copper is produced. Wheat, barley, beans, rice, Indian corn, potatoes, &c., are among the other products of Sze-ch'uen.

Chung-K'ing Fu (pop. about 600,000) is the principal treaty port. It imports textiles, aniline dyes, metals, soap, petroleum &c., and exports silk, wax, tobacco, sugar, oil, musk, medicinal plants, &c. By the terms of the Mackay Treaty, signed at Shanghai in 1902, the port of Wan Hien (pop. 140,000), which is situated on the Yangtsze-kiang, 200 m. below Chung-K'ing Fu, was opened to trade in 1905. Both Protestant and Roman Catholic missions are at work in the province; the Protestants opening their first mission station, at Chung-K'ing, in 1877.

See L. Richard, *Comprehensive Geography of the Chinese Empire*, pp. 104–119 and the authorities there cited (Shanghai, 1908); also "The Province of Sze-ch'uen," in *The Chinese Empire* (M. Broomhall ed.; London, 1907); and Colonel C. C. Manifold, "Recent Exploration and Economic Development in Central and Western China," in *Geog. Journ.* (1904), vol. xxiii.

SZEGED (Ger., *Szegedin*), the capital of the county of Csongrád in Hungary, 118 m. S.E. of Budapest by rail. Pop. (1900), 100,270. It is situated on both banks of the Theiss just below the confluence of the Maros, and contains the inner town and four suburbs. It is the second town in Hungary as regards population, and since the disastrous inundation of the Theiss on the night of the 11th of March 1879, which almost completely destroyed it, Szeged has been rebuilt. It is now one of the handsomest towns of Hungary, and has several large squares, broad avenues, boulevards and many palatial buildings. It has also been encircled with a strong dam in order to protect it from floods. Among the principal buildings are a Franciscan convent, with a rich library and an interesting collection of antiquities and ecclesiastical objects; a Piarist and a Minorite convent; a handsome new town-hall; and a natural history and historical museum to which is attached a public library. Szeged is the chief seat of the manufacture of paprica, a kind of red pepper largely used in Hungary, and of a pastry called *tarhonya*; and has factories of soap, leather, boots, saw-mills and distilleries. Szeged is the centre of the commerce and industry of the great Hungarian Alföld, being an important railway junction and the principal port on the Theiss.

Since the 15th century Szeged has been one of the most prominent cities in Hungary. From 1541 till 1686 it was in possession of the Turks, who fortified it. It is also notorious for its many witchcraft trials. In 1848 it sent strong detachments to the national Hungarian army. In July 1849 the seat of the government was transferred hither for a short time.

SZÉKESFEHÉRVÁR (Ger., *Stuhlweissenburg*, Lat., *Alba Regalis* or *Alba Regia*), a town of Hungary, capital of the county of Fejér, 41 m. S.W. of Budapest by rail. Pop. (1900), 30,451. It is situated in a marshy plain and is a well-built and prosperous town. Székesfehérvár is the seat of a Roman Catholic bishopric, one of the oldest in the country, and was formerly a town of great importance, being the coronation and burial place of the Hungarian kings from the 10th to the 16th century. Amongst its principal buildings are the cathedral, the episcopal palace, several convents, of which the most noteworthy is the Jesuit convent, now a Cistercian secondary school with a handsome church, and the county hall. The town carries on a brisk trade in wine, fruit and horses, and is one of the principal centres of horse-breeding in Hungary. Székesfehérvár is one of the oldest towns of Hungary, in which St Stephen, the first king of Hungary, built a church, which served as the coronation church for the Hungarian kings. In the same church some fifteen kings were buried. In 1543 it fell into the hands of the Turks, under whom it remained until 1686. Before evacuating it, the Turks plundered the tombs of the kings, destroyed the old church and several other buildings, and burnt the archives. Several sarcophagi of the kings, and the foundations of the old church, have been found by excavation beneath the cathedral.

SZEKLERS, or SZEKELS (*Szekely*, Lat. *Siculi*), a Finno-Ugrian people of Transylvania, akin to the Magyars. They form a compact mass of rather more than 450,000, extending from near Kronstadt on the south to Maros-Vásárhely and Gyergó St Miklós on the north. Their origin is unknown and has been the subject of much learned debate. Their own ancient tradition affirms their descent from Attila's Huns. According to Procopius (*De bello gothico*, iv. 18) 3000 Huns entered Transylvania (*Erdeleu*, *i.e.* the Magyar *Erdély*) after their defeat "calling themselves, not Hungarians, but Zekul," and the Szeklers were the descendants of the Huns who stayed in Transylvania till the return of their kinsmen under Árpád; the anonymous scribe of King Béla speaks of them as "formerly Attila's folk." Von Rethy (*Ung. Rev.* vii. 812) suggests that they were originally a band of Black Ugrians who sought refuge in Transylvania after their defeat by the Pechenegs. Timon, however (*Magyar Alkotmány és Jogtörténet*, p. 75), points out that their language proves that their separation from the main Magyar stock must have taken place after the Magyar tongue had been fully developed (see also Hunfalvy, *Magyarország Ethnographiája*, 200). According to another theory they were Magyars transplanted by St Ladislaus to Transylvania in order to form a permanent frontier guard. Some such origin would, indeed, seem to be implied by the name Szekel, if this be derived, as Czetneki surmises ("Die Szeklerfrage," *Ung. Rev.* i. 411–428), from *szek*, seat, *i.e.* an administrative district (cf. the *Stuhl* of the Transylvanian Saxons); *Szekely* would thus mean simply "frontier-guards."

SZIGLIGETI, EDE (1814–1878), Hungarian dramatist, whose original name was József Szathmáry, was born at Nagyvárad-Olaszi, on the 8th of March 1814. His parents would have made him a priest; he wanted to be a great doctor; finally he entered the office of an engineer. But his heart was already devoted to the drama and, on the 15th of August 1834, despite the prohibition of his tyrannical father, he actually appeared upon the stage at Budapest. His father thereupon forbade him to bear his name in future, and the younger Szathmáry henceforth adopted instead the name of Ede Szigligeti, the hero of one of Sandor Kisfaludy's romances. He supported himself for the next few years precariously enough, earning as he did little more than twelve florins a month, but at the same time he sedulously devoted himself to the theatre and sketched several plays, which differed so completely from the "original" plays then in vogue (*The Played-out Trick* actually appeared upon the boards) that they attracted the attention of such connoisseurs as Vörösmarty and Bajza, who warmly encouraged the young writer. In 1840 the newly founded Hungarian Academy crowned his five-act drama *Rosa*, the title-rôle of which was brilliantly acted by Rosa Laborfalvy, the great actress, who subsequently married Maurus Jókai. Szigligeti was now a celebrity. In 1840 he was elected a member of the Academy and in 1845 a member of the Kisfaludy Society. He was now the leading Hungarian dramatist. Three of his plays were crowned by the National Theatre and sixteen by the Academy. His verdict on all dramatic subjects was for years regarded as final, and he was the mentor of all the rising young dramatists of the 'sixties. During the half-century of his dramatic career Szigligeti wrote no fewer than a hundred original pieces, all of them remarkable for the inexhaustible ingenuity of their plots, their up-to-date technique and the consummate skill with which the author used striking and unexpected effects to produce his *dénouement*. He wrote, perhaps, no work of genius, but he amused and enthralled the Magyar playgoing public for a generation and a half. Szigligeti's most successful tragedies were *Gritti* (1844), *Paul Beldi* (1856), *Light's Shadows* (1865), *Struensee* (1871), *Valeria* and *The Pretender* (1868). His tragedies, as a rule, lack pathos and sublimity. Much more remarkable are his comedies. He is a perfect master of the art of weaving complications, and he prefers to select his subjects from the daily life of the upper and upper-middle classes. The best of these comedies are *The Three Commands of Matrimony* (1850), *Tuneful Stevey* (1855), *Mamma* (1857), *The Reign of Woman* (1862), and especially the farce *Young Lilly* (1849). He also translated Goethe's *Egmont* and Shakespeare's *Richard III.*, and wrote a dramaturgical work entitled *The Drama and its Varieties*. A few of his plays have appeared in German.

See P. Rakodczay, *Edward Szigligeti's Life and Works* (Hung.; Pressburg, 1901); Pál Gyulai, *Memorial Speeches* (Hung.; Budapest, 1879 and 1890). (R. N. B.)

SZOMBATHELY (Ger., *Steinamanger*), the capital of the Hungarian county of Vas, 162 m. W. of Budapest by rail. Pop. (1900), 23,309. It is the seat of a Roman Catholic bishop, and possesses a beautiful cathedral (1797–1821) with two towers, 180 ft. high. Other buildings are the episcopal palace, to which is attached a museum of Roman antiquities, the county hall, the convent of the Dominicans and the seminary for Roman Catholic priests. Szombathely is an important railway and industrial centre, and has a state railway workshop, manufactories for agricultural machinery, foundries and steam mills.

About 5 m. south of Szombathely lies the small village of Jaák, with a Dominican convent from the 11th century, which has a remarkably beautiful church, one of the best specimens of Romanesque architecture in the country. About 16 m. by rail south of the town is Körmend (pop. 6171), with a beautiful castle belonging to Count Bathyanyi. About 16 m. by rail, west of Körmend is the small town of Szent Gotthard (pop., 2055, mostly Germans), with a Cistercian abbey, founded by King Béla III. in 1183, where General Montecucculi gained a decisive victory over the Turks in 1664.

Szombathely occupies the site of the Roman town *Sabaria* *Savaria*), which was the capital of Pannonia. Here in A.D. 193 Septimius Severus was proclaimed emperor by his legions. Many remains from the Roman period have been excavated, such as traces of an amphitheatre, a triumphal arch, the old fortifications, an aqueduct, &c. The remains are preserved partly in the museum at Budapest, and partly in the municipal museum. The bishopric was created in 1777.

T the last letter in the Semitic alphabet, where, however, its form in the earliest inscriptions is that of a St Andrew's Cross X. In both Greek and Latin, however, although the upright and cross stroke are frequently not exactly at right angles and the upright often projects beyond the cross stroke, the forms approach more nearly to the modern than to the Semitic shape. The name *Tāw* was taken over in the Greek *ταῦ*. The sound was that of the unvoiced dental stop. The English *t*, however, is not dental but alveolar, being pronounced, as *d* also, not by putting the tongue against the teeth but against their sockets. This difference is marked in the phonetic differentiation of the dental and the alveolar *t* by writing them respectively *t* and *ṭ*. The alveolar sound is frequent also in the languages of India, which possess both this and the dental sound. The Indian *ṭ*, however, is probably produced still farther from the teeth than is the English sound. In the middle of words when *t* precedes a palatal sound like *i* (*y*) which is not syllabic, it coalesces with it into the sound of *sh* as in *position*, *nation*, &c. The change to a sibilant in these cases took place in late Latin, but in Middle English the *i* following the *t* was still pronounced as a separate syllable. A later change is that which is seen in the pronunciation of *nature* as *neitṣ°*. This arises from the pronunciation of *u* as *yu*, and does not affect the English dialects which have not thus modified the *u* sound. Similar changes had taken place in some of the local dialects of Italy before the Christian era. At the end of words the English *t* is really aspirated, a breath being audible after the *t* in words like *bit*, *hit*, *pit*. This is the sound that in ancient Greek was represented by θ. In medieval and modern Greek, however, this has become the unvoiced sound represented in English by *th* in *thin*, *thick*, *pith*. Though represented in English by two symbols this is a single sound, which may be either interdental or, as frequently in English, produced "by keeping the tongue loosely behind the upper front teeth, so that the breath escapes partly between the tongue and the teeth, and partly, if the teeth are not very closely set, through the interstices between them" (Jespersen). In English *th* represents both the unvoiced sound þ as in *thin*, &c., and the voiced sound ð, which is found initially only in pronominal words like *this*, *that*, *there*, *then*, *those*, is commonest medially as in *father*, *bother*, *smother*, *either*, and is found also finally in words like *with* (the preposition), *both*. Early English used þ and ð indiscriminately for both voiced and unvoiced sounds, in Middle English ð disappeared and þ was gradually assimilated in form to *y*, which is often found for it in early printing. It is, however, to be regretted that English has not kept the old symbols for sounds which are very characteristic of the language. In modern Greek the ancient δ (*d*) has become the voiced spirant (ð), though it is still written δ. Hence to represent D, Greek has now to resort to the clumsy device of writing NT instead. (P. Gi.)

TAAFFE, EDUARD FRANZ JOSEPH VON, Count [11th Viscount Taaffe and Baron of Ballymote, in the peerage of Ireland] (1833–1895), Austrian statesman, was born at Vienna on 24th February 1833. He was the second son of Count Ludwig Patrick Taaffe (1791–1855), a distinguished public man who was minister of justice in 1848 and president of the court of appeal. As a child Taaffe was one of the chosen companions of the young archduke, afterwards emperor, Francis Joseph. In 1852 he entered the public service; in 1867 he was Statthalter of Upper Austria, and the emperor offered him the post of minister of the interior in Beust's administration. In June he became vice-president of the ministry, and at the end of the year he entered the first ministry of the newly organized Austrian portion of the monarchy. For the next three years he took a very important part in the confused political changes, and probably more than any other politician represented the wishes of the emperor. He had entered the ministry as a German Liberal, but he soon took an intermediate position between the Liberal majority of the Berger ministry and the party which desired a federalistic amendment of the constitution and which was strongly supported at court. From September 1868 to January 1870, after the retirement of Auersperg, he was president of the cabinet. In 1870 the government broke up on the question of the revision of the constitution: Taaffe with Potocki and Berger wished to make some concessions to the Federalists; the Liberal majority wished to preserve undiminished the authority of the Reichsrath. The two parties presented memoranda to the emperor, each defending their view, and offering their resignation: after some hesitation the emperor accepted the policy of the majority, and Taaffe with his friends resigned. The Liberals, however, failed to carry on the government, as the representatives of most of the territories refused to appear in the Reichsrath: they resigned, and in the month of April Potocki and Taaffe returned to office. The latter failed, however, in the attempt to come to some understanding with the Czechs, and in their turn had to make way for the Clerical and Federalist cabinet of Hohenwart. Taaffe now became Statthalter of Tirol, but once more on the breakdown of the Liberal government in 1879 he was called to office. At first he attempted to carry on the government without change of principles, but he soon found it necessary to come to an understanding with the Feudal and Federal parties, and he was responsible for the conduct of the negotiations which in the elections of this year gave a majority to the different groups of the National and Clerical opposition. In July he became minister president: at first he still continued to govern with the Liberals, but this was soon made impossible, and he was obliged to turn for support to the Conservatives. It was his great achievement that he persuaded the Czechs to abandon the policy of abstention and to take part in the parliament. It was on the support of them, the Poles, and the Clericals that his majority depended. His avowed intention was to unite the nationalities of Austria: Germans and Slavs were, as he said, equally integral parts of Austria; neither must be oppressed; both must unite to form an Austrian parliament. Notwithstanding the growing opposition of the German Liberals, who refused to accept the equality of the nationalities, he kept his position for thirteen years. Not a great creative statesman, he had singular capacity for managing men; a very poor orator, he had in private intercourse an urbanity and quickness of humour which showed his Irish ancestry. For the history of his administration see AUSTRIA-HUNGARY, *History* (Sec. II. "*Austria Proper*"). Beneath an apparent cynicism and frivolity Taaffe hid a strong feeling of patriotism to his country and loyalty to the emperor. It was no small service to both that for so long, during very critical years in European history, he maintained harmony between the two parts of the monarchy and preserved constitutional government in Austria. The necessities of the parliamentary situation compelled him sometimes to go farther in meeting the demands of the Conservatives and Czechs than he would probably have wished, but he was essentially an opportunist: in no way a party man, he recognized that the government must be carried on, and he cared little by the aid of what party the necessary majority was maintained. In 1893 he was defeated on a proposal for the revision of the franchise, and resigned. He retired into private life, and died two years later at his country residence, Ellerschau, in Bohemia, on 29th November 1895.

By the death of his elder brother Charles (1823–1873), a colonel in the Austrian army, Taaffe succeeded to the Austrian and Irish titles. He married in 1862 Countess Irma Tsaky, by whom he left four daughters and one son, Henry. The family history presents points of unusual interest. From the 13th century the Taaffes had been one of the leading families in the north of Ireland. In 1628 Sir John Taaffe was raised to the peerage as Baron Ballymote and Viscount Taaffe of Corven. He left fifteen children, of whom the eldest, Theobald, took a prominent part in the Civil War, accompanied Charles II. in exile, and on the Restoration was created earl of Carlingford. He was sent on missions to the duke of Lorraine and to the emperor, by which was established the connexion of his family with the house of Habsburg and Lorraine, which has continued to this day. His eldest son was killed in the Turkish wars. He was succeeded in the title by his second son Nicholas, who had served in the Spanish wars and was killed at the Boyne. The next brother, Francis, the third earl, was one of the most celebrated men of his time: he was brought up at Olmütz, at the imperial court, and in the service of Duke Charles of Lorraine, whose most intimate friend he became. He rose to the highest rank in the Austrian army, having greatly distinguished himself at the siege of Vienna and in the other Turkish campaigns, and was a member of the Order of the Golden Fleece. He was sent on many important diplomatic missions, and at the end of his life was chancellor and chief minister to the duke of Lorraine. Notwithstanding the Jacobite connexions of his family, his title to the earldom of Carlingford was confirmed by William III., and the attainder and forfeiture of the estates incurred by his brother was repealed. This favour he owed to his position at the court of the emperor, William's most important ally. On his death the title and estates went to his nephew Theobald, whose father had fallen during the siege of Derry, and who himself had served with distinction in the Austrian army. On his death the title of earl of Carlingford became extinct; both the Austrian and Irish estates as well as the Irish viscountcy went to a cousin Nicholas (1677–1769). Like so many of his family, he was brought up in Lorraine and passed into the Austrian army; he fought in the Silesian war, rose to be field-marshal, and was made a count of the Empire. His Irish estates were, however, claimed under the Act of 1703 by a Protestant heir: a lawsuit followed, which was ended by a compromise embodied in a private act of parliament, by which the estates were sold and one-third of the value given to him. With the money he acquired the castle of Ellerschau, in Bohemia; he had also inherited other property in the Austrian dominions. He was naturalized in Bohemia, and left on record that the reason for this step was that he did not wish his descendants to be exposed to the temptation of becoming Protestants so as to avoid the operation of the penal laws. His great-grandson was the father of the subject of this article. A Committee of Privileges of the House of Lords in 1860 recognized the right of the family to hold the Irish title.

See Wurzbach, *Biographisches Lexicon Oesterreichs*. *Memoirs of the Family of Taaffe* (Vienna, 1856), privately printed; article in the *Contemporary Review* (1893), by E. B. Lanin. The Prague *Politik* published in December 1904 contains some interesting correspondence collected from Taaffe's papers. (J. W. He.)

TAAL, a town of the province of Batangas, Luzon, Philippine Islands, on the Pansipit river, opposite Lemery, with which it is connected by a bridge, and about 50 m. S. of Manila. Pop. of the municipality (1903) 17,525. Taal is built, chiefly of stone, on the summit and terraced slopes of a hill overlooking the Gulf of Balayan into which the Pansipit river flows. It has a cool and healthy climate, is an important military station, and a port for coastwise vessels. Extensive agricultural lands in the vicinity produce rice, Indian corn, sugar-cane, pepper, cacao, and cotton, but the great coffee plantations which were formerly to be seen in its vicinity have been destroyed by insects. The inhabitants are also engaged in raising horses and cattle, in fishing, and in carrying on a considerable trade in cotton goods, sugar, coffee, &c. Taal is the only town in the Philippines where effective efforts have been made to exclude the Chinese. The hostility of the inhabitants toward them was such that none succeeded in establishing a residence here until the latter days of the revolution against the American government. The town was founded in 1754 after the destruction by Taal volcano of an old town of the same name on Lake Taal. The language is Tagalog.

TABACO, a town and port of entry of the province of Albay, Luzon, Philippine Islands, on Tabaco bay, about 20 m. N. of the town of Albay. Pop. (1903) 21,946. The men of Tabaco are largely engaged in the cultivation of hemp; the women in weaving cloth, baskets and mats. The town has a deep and well-protected harbour, and its shipping is extensive. The language is Bicol.

TABARD, a short coat, either sleeveless, or with short sleeves or shoulder pieces, emblazoned on the front and back with the arms of the sovereign, and worn, as their distinctive garment, by heralds and pursuivants. A similar garment with short sleeves or without sleeves was worn in the middle ages by knights over their armour, and was also emblazoned with their arms or worn plain. The name was also given in earlier days to a much humbler similar garment of rough frieze worn by peasants; the ploughman wears a "tabard" in the Prologue to the *Canterbury Tales*. Similarly at Queen's College, Oxford, the scholars on the foundation were called "tabarders," from the tabard, obviously not an emblazoned garment, which they wore. The word itself appears in Fr. *tabard* or *tabart*, &c., Ital. *tabarro*, Ger. *taphart*, Med. Lat. *tabbardus*, *tabardium*, &c. It is of doubtful origin, but has usually been connected with "tippet," "tapestry," from Lat. *tapete*, hangings, painted cloths; Gr. *τάπης*, carpet.

ṬABARĪ [Abū Ja'far Mahommed ibn Jarīr uṭ-Ṭabarī] (838–923), Arabian historian and theologian, was born at Amol in Tabaristan (south of the Caspian), and studied at Rei (Rai), Bagdad, and in Syria and Egypt. Cast upon his own resources after his father's death, he was reduced to great poverty until he was appointed tutor to the son of the vizier 'Ubaidallāh ibn Yaḥyā. He afterwards journeyed to Egypt, but soon returned to Bagdad, where he remained as a teacher of tradition and law until his death. His life was simple and dignified, and characterized by extreme diligence. He is said to have often refused valuable gifts. A Shāfi'ite in law, he claimed the right to criticize all schools, and ended by establishing a school of his own, in which, however, he incurred the violent wrath of the Hanbalites.

His works are not numerous, but two of them are very extensive. The one is the *Tārīkh ur-Rusul wal-Mulūk* (History of the Prophets and Kings), generally known as the *Annals* (cf. ARABIA, *Literature*, "History"). This is a history from the Creation to A.D. 915, and is renowned for its detail and accuracy. It has been published under the editorship of M. J. de Goeje in three series, comprising thirteen volumes, with two extra volumes containing indices, introduction and glossary (Leiden, 1879–1901). A Persian digest of this work, made in 963 by the Samanid vizier al-Bal'amī, has been translated into French by H. Zotenberg (vols. i.–iv., Paris, 1867–1874). A Turkish translation of this was published at Constantinople (1844). His second great work was the commentary on the Koran, which was marked by the same fullness of detail as the *Annals*. The size of the work and the independence of judgment in it seem to have prevented it from having a large circulation, but scholars such as Baghawī and Suyūṭī used it largely. It has been published in thirty vols. (with extra index volume) at Cairo, 1902–1903. An account of it, with brief extracts, has been given by O. Loth in the *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, vol. xxxv. (1881), pp. 588–628. Persian and Turkish translations of the commentary exist in manuscript. A third great work was projected by Ṭabarī. This was to be on the traditions of the Companions, &c., of Mahomet. It was not, however, completed. Other smaller works are mentioned in the *Fihrist*, pp. 234–235. (G. W. T.)

TABARIN (Fr. *tabard*, Ital. *tabarrino*, a small cloak), the name assumed by Jean Salomon (*c.* 1584–1633), a Parisian street charlatan, who amused his audiences in the Place Dauphine by farcical dialogue with his partner Mondor (Phillippe Girard), with whom he reaped a golden harvest by the sale of quack medicines. A contemporary portrait shows him in the dress of a clown, but with a moustache and pointed beard, carrying a wooden sword and wearing a soft grey felt hat capable of assuming countless amusing shapes in his deft fingers. His regular evening antics were varied by more elaborate weekly performances in which others appeared, notably his wife. In these he took the part of a fat old fool, but his jokes, while usually coarse, were frequently clever, and his extemporized speeches were full of originality. He is said to have influenced both Molière and La Fontaine. The latter praises him, and he is also well spoken of by Boileau and Voltaire. He retired about 1628, and died on the 16th of August 1633. Numerous farces and dialogues, partly or wholly his, or in his *répertoire*, were credited to him, and long series of cheap leaflets purporting to be his complete works began to appear as early as 1622. Two rival editions, in two volumes and one volume respectively, were published as late as 1858. The word *Tabarin*, spelt with a capital, has been adopted into the French language to designate the comic performer of a street booth.

TABASCO, a state of Mexico, bounded N. by the Gulf of Mexico, E. by the state of Campeche and Guatemala, S. by Guatemala and Chiapas, and W. by Vera Cruz. Area 10,072 sq. m. Pop. (1900) 159,834. The surface is generally low and flat, largely covered with lagoons, watercourses and swamps. In the S. and S.E. there is an area belonging to the rough higher formation of Chiapas. Dense forests cover the whole region, and there are valuable fine woods and dye-woods. There are several large lagoons on the coast, two of which are called Sant' Ana and Tupilco bays. Two large rivers, the Grijalva and Usumacinta, traverse its territory. The Grijalva, also called Tabasco, the upper course of which is known as the Chiapas, has its most distant sources in western Guatemala and flows N.W. across Chiapas to the frontier of Oaxaca, thence N. to the frontier of Tabasco, and thence N.E. to the coast; it is navigable for 93 m. The Usumacinta likewise has its sources in western Guatemala. It forms the boundary between Guatemala and Chiapas until the frontier of Tabasco is reached, where its N.W. course turns to the N. and then N.W. to a junction with the Grijalva—the two rivers having a common outlet. The Usumacinta, including its head streams, is about 500 m. long; excluding them about 330 m. long; for about 270 m. it is navigable, for about 180 m. for large steamers. There are no railways and no good roads, and these rivers and the navigable channels of the Cuxcuchopa, Soledad, Cocohital, Tular, and Tortuguero, are the principal practical thoroughfares in the state. The capital is San Juan Bautista (pop., 1900, 10,548), formerly called Villa Hermosa, on the Grijalva river, about 70 m. above its mouth. The next most important town is Frontera (pop., 1895, 6794), a port 3 m. within the mouth of the Grijalva.

TABERNACLE (Lat. *tabernaculum*, a hut, tent), specifically the name given in the English Bible to the portable sanctuary which, according to the priestly sources of the Pentateuch, was erected by Moses in the wilderness as the place of worship of the Hebrew tribes (Exodus xxv. ff.).

(1) *The Tabernacle and its Furniture.*—The Tabernacle proper is represented as standing within a rectangular area, measuring 100 cubits by 50, approximately 150 feet by 75, which formed the centre of the camp in the wilderness. This area, termed the "court of the tabernacle," was fenced off from the rest of the encampment by a series of curtains suspended from 100 pillars standing at intervals of 5 cubits, and lay east and west with its entrance on the eastern side. Of the two squares, each measuring 50 cubits by 50, into which the court may be divided, the more easterly was that in which the worshippers assembled. In the centre of this square stood the altar of burnt-offering, a hollow chest of acacia wood overlaid with bronze. The tabernacle itself also stood east and west, with its entrance towards the east, on the edge of the second square. The essential part of the structure, to which everything else was subsidiary, was that termed in the original the *mishkān, i.e.* dwelling (Eng. Vers. tabernacle, but see Exod. xxv. 9, Rev. Vers. margin). It was formed of ten curtains, in two sets of five, of the finest linen with inwoven coloured figures of cherubim, the whole making an artistic covering measuring 40 cubits by 28. Instead of being suspended on poles after the manner of an ordinary tent, the curtains of the dwelling were spread over a series of open frames of acacia wood overlaid with gold, each 10 cubits in height by $1\frac{1}{2}$ in breadth.[1] These frames, 48 in all, were so arranged as to form the southern, western and northern sides of a rectangular structure, 30 cubits in length and 10 cubits in breadth and height. Over the frames, as has been said, were thrown the two sets of tapestry curtains above described, while the eastern end, forming the entrance, was closed by a special portière suspended from five pillars. The dwelling was divided into two parts by a second hanging, the "veil," 10 cubits from the western end. These two parts were termed respectively the holy place, and the most holy place or "holy of holies." Within the latter stood, in solitary majesty, the ark of God, in which were deposited the two stone tables of the decalogue or "testimony." On the ark lay a solid slab of the finest gold, the propitiatory or mercy-seat, from which rose the figures of two golden cherubim. The propitiatory with its over-arching cherubim formed the innermost shrine of the wilderness sanctuary, the earthly throne of the God of heaven.

The furniture of the holy place consisted of the table of shewbread, the altar of incense—both, like the ark, of acacia wood overlaid with gold—and the golden "candlestick," the latter in reality a seven-branched lamp-stand. As a protection the delicate and artistic curtains of the dwelling were covered by two similar sets of goats'-hair curtains, which together measured 44 cubits by 30; these, in their turn, were protected by a double covering, the one of rams' skins dyed red, the other made of the skins of a Red Sea mammal, probably the dugong (Exod. xxvi. 14).

(2) *The Religious Significance of the Tabernacle.*—The aim of the priestly school, to whom we owe the conception of the tabernacle as above described, was to provide a sanctuary and a ritual worthy of the higher conceptions of the Deity, which had grown up as the fruit of the discipline of the exile. The ideal relation of Jehovah (Yahweh) to the theocratic community of Israel had already been described by Ezekiel in the words "my dwelling shall be with them, and I will be their God, and they shall be my people" (xxxvii. 27). That this was the religious ideal in the mind of the author of Exodus xxv. ff. is evident from the characteristic name which he gives to the essential part of the tabernacle, the *dwelling* (see above, and cf. Exod. xxv. 8). All the arrangements of the camp and of the tabernacle are intended to secure the presence of a holy God in the midst of a holy people. The thought of the almost unapproachable holiness of the Deity underlies not only the gradation of the parts of the tabernacle—court, holy place and holy of holies being each marked by an ascending degree of sanctity—but also the careful gradation of the materials employed in its construction. In the proportion and symmetry, which are strongly marked features of the tabernacle, we may further trace the earnest endeavour to reflect the harmony and perfection of the Deity whose glory filled the dwelling (Exod. xl. 34).

(3) As regards the historicity of this elaborate sanctuary modern historical criticism has pronounced a negative judgment. This verdict is based not so much on the many difficulties presented by the narrative itself, or suggested by the unexpected wealth of material and artistic skill, as on the impossibility of reconciling the picture of the tabernacle and its worship, which is found in the middle books of the Pentateuch, with the religious history of Israel as reflected in the older historical books. There is absolutely no place for the tabernacle of the Priests' Code in the history of the worship of the Hebrews before the exile. It cannot be reconciled with the account of the historical "tent of meeting" (Auth. Vers. tabernacle of the congregation) of the oldest Pentateuch sources in any particular except the common designation, and in the later history of the ark, whether at Shiloh or at Jerusalem, the older records of Samuel and Kings are silent as to the tabernacle.

The sections of the Pentateuch devoted to the tabernacle and its worship, therefore, are not to be treated as history but as the expression of a religious ideal. Building on the traditions of the simple Mosaic "tent of meeting" (Exodus xxxiii. 7 ff. and elsewhere), and believing that the temple of Solomon was its replica on a larger scale and in more solid materials, the priestly idealists followed the example of Ezekiel, and elaborated an ideal sanctuary to serve as the model for the worship of the theocratic community of the future. "Let them make me a sanctuary, that I may dwell among them" (Exod. xxv. 8).

See "Tabernacle" in Hastings's *Dictionary of the Bible*, vol. iv., with which may be compared the corresponding articles in Cheyne and Black's *Encycl. Biblica* by Benzinger, and in the *Jewish Encyclopedia* by König. The views of the first-named article, summarised above, as to the framework of the Tabernacle, have been adopted and reinforced by A. H. M'Neile in his Commentary on *The Book of Exodus* (1908), pp. lxxiii. ff. (A. R. S. K.)

[1] For the philological and other arguments in favour of open frames in place of the traditional solid beams—the "boards" of the English version—as supports of the curtains, see the writer's article "Tabernacle" in Hastings's *Dict. of the Bible*, iv. 659 f., with illustrative diagrams.

TABERNACLE, as a general term in architecture, a species of niche or recess in which an image may be placed. In Norman work there are but few remains, and these generally over doorways. They are shallow and comparatively plain, and the figures are often only in low relief, and not detached statues. In Early English work they are deeper, and instead of simple arches there is often a canopy over the figure, which was placed on a small, low pedestal. Later in the style the heads of the tabernacles became cusped, either as trefoils or cinquefoils, and they are often placed in pairs side by side, or in ranges, as at Wells cathedral. Decorated tabernacles are still deeper and more ornamented, the heads are sometimes richly cusped and surmounted with crocketed gables, as at York, or with projecting canopies, very much like the arcade at Lichfield. In this case the under side of the canopy is carved to imitate groined ribs, and the figures stand either on high pedestals, or on corbels. Perpendicular tabernacles possess much the same features, but the work is generally more elaborate (see CORBEL, CANOPY, NICHE, &c.). The word tabernacle is also often used for the receptacle for relics, which was often made in the form of a small house or church (see SHRINE). The term "tabernacle work" is given, in architecture, to the richly sculptured tracery, similar to that employed on the upper part of a tabernacle, decorated with canopied niches which contain statues. The Eleanor crosses in England are enriched with tabernacle work over the niches, as also the chapels of Bishops Nicholas West (1461–1533), and John Alcock (1430–1500) in Ely cathedral, both dating from the beginning of the 16th century.

TABERNACLES, FEAST OF, the autumn festival of the Israelites, beginning on the 15th of Tishri and celebrated by residing for the seven succeeding days in rustic booths (Heb. *Sukkoth*, in the Vulgate *Tabernacula*, whence the English name of the feast). Among the Hebrews it was the third and chief of the three annual pilgrimage festivals connected respectively with the harvesting of the barley (Passover), of wheat (Pentecost), and of the vine (Tabernacles). Hence it is referred to as "the Feast" *par excellence* (Heb. *Heḥag*, cf. Arab. *Hajj*) even as late as 2 Chron. vii. 9. Being of the nature of a pilgrimage feast the booths were temporary erections for the accommodation of the pilgrims. But in early Jewish tradition, in both Yahvist and Elohist sources of the Pentateuch (Exod. xxxiv. 22, xxiii. 16) it is called simply the Harvest Feast (A.V. "Feast of Ingathering") and is to be observed "at the end of the year," *i.e.* of the agricultural year. In Deut. xvi. 13 seq., it is termed the Feast of Tabernacles and is to be kept seven days after the produce of the threshing-floor and winepress has been gathered in. In the Holiness Code (Lev. xxiii. 39) it is to be kept for seven days after the first, the first of which is to be "a sabbath," and the eighth "a sabbath" (possibly originally a lunar quarter-day): branches of four trees are to be taken. In the Priestly Code (Lev. xxiii. 33 seq.; Num. xxix. 12–38) the first and eighth day are to be days of holy assembly, and in the latter passage elaborate details are given of the sacrifices to be presented, including a series of bullocks, thirteen on the first day, twelve on the next, and so on down to seven on the seventh day. Only one is to be sacrificed on the concluding feast (Heb. *'Aẓereth*) of the eighth day.

The higher criticism sees, in these successive enactments of the various codes included in the Pentateuch (*q.v.*), a development in the character of the festival. At first held at any of the local shrines, such as Gilgal, Bethel, Shiloh, as well as Jerusalem, it was held at an indefinite date during the harvest in the fall of the year. Then with the concentration of the cultus at Jerusalem represented by Deuteronomy, the celebration was restricted to the Judean capital, and its duration fixed at seven days, though its date was still left indeterminate. This was fixed in the Priestly Code at the 15th of the seventh month, and an eighth day of solemn assembly added after the return from the exile.

Against this hypothetical reconstruction is the fact that Solomon appears to have selected the occasion of the feast for the dedication of the temple, and that it lasted, even in his time, seven days (1 Kings viii. 2, 65). Jeroboam arranged for a similar feast in the northern kingdom on the 15th day of the eighth month, "like unto the feast in Judah" (*ibid.* xii. 32). The determination of a fixed date must therefore have been much earlier than Deuteronomy or the alleged period of the Priestly Code. A pilgrimage feast must be fixed in date to ensure the simultaneous presence of the pilgrims. There are, besides, seeming references to the feast in the early prophets, as Hosea xii. 9, Amos v. 21, as well as in Isaiah ix. 2 (Heb.). The concluding feast does not seem to refer to tabernacles *per se*, but to be distinct from it, as is shown by the break in the descending series of the sacrifices of bullocks as given in Numbers. In Jewish practice the concluding feast is not held in booths, and Maimonides (*Moreh*, iii. 42) suggests that its object was to give opportunity for final proceedings in assembly halls.

The existence, therefore, of much variation in the practice of the festival in historic times is scarcely proved by the seeming variations of the enactments concerning it in the Pentateuch. It is possible, however, that there may have been differences of custom in the carrying out of the feast. In Neh. xiii. 15 the trees whose branches were used for making the booths appear to differ from those mentioned in Lev. xxiii. 40, though in Jewish tradition the latter passage was taken to refer to the *Lulab*, or a combination of twigs of willow and myrtle, with a palm branch, which, together with a citron, are held in the hand during processions in the synagogue. The Sadducees and Karaites did not carry these in their hand, but used them as decorations of the booths. In the second temple there was a water libation every morning of the festival, and on the evening of the first day the great golden candelabrum was lit up and the men danced a torch dance around it (Mishnah, *Sukkah*, v. 2–4). It is reported by Josephus that, when Alexander Jannaeus, in the year 95 B.C., was acting as high-priest in the temple on the Feast of Tabernacles, instead of pouring the water libation on the altar, according to the Pharisaic custom, he poured it at his feet, giving rise to a riot in which 6000 men are said to have lost their lives (*Ant.* xii., xiii., 5; Talmud, *Sukkah*, 48 b).

The festival is certainly an agricultural one, and is so termed in the Pentateuch. Whether it was derived from the Canaanites, who had similar festivals (Judges xxix. 27), is uncertain. All nations have similar harvest homes, especially with reference to the vintage feasts; as, for instance, the Athenian Oschophoria. The Syrians celebrated every three years a "Booth Festival." At the Hindu Festival of *Dasara*, which lasted nine days from the new moon of October, tents made of canvas or booths made of branches were erected in front of the temples. The Spartans had a nine days' festival termed Carnea, during which they dwelt in pavilions and tents in memory of their old camp life (Athenaeus, iv. 19). The Feast of Tabernacles is one of the few Jewish festivals described in classical writers. Plutarch (*Symposium* iv., vi. 2) compares Tabernacles with the Bacchic rites. It was pre-eminently the period of exultation in ancient Jewish rite, and the Mishnah declares that "He who has not seen the joy of the libations of Tabernacles has never in his life witnessed joy." So much importance was attributed to this festival that it was chosen as the occasion on which the Law should be recited during the sabbatical year (Deut. xxxi. 9–12), and the Messianic vision of Zechariah xiv. 16 sees the remnant of all the nations coming up to Jerusalem to worship the Lord of Hosts, and to keep the Feast of Tabernacles.

In later Jewish custom the one-year cycle of reading of sections from the Pentateuch ends on the concluding day of Tabernacles, which is therefore known as the Rejoicing of the Law (*Simḥat Torah*). The custom of dwelling, for part of the day at least, in booths, is still kept up by orthodox Jews, who have temporary huts covered with branches erected in their courtyards, and those who are not in possession of a house with a backyard often go to pathetic extremes in order to fulfil the law by making holes in roofs, across which branches are placed. (J. JA.)

TABLE (Lat. *tabula*), a flat, oblong slab supported upon legs or pillars; originally anything flat.[1] As one of the few indispensable pieces of domestic furniture, the table is of great antiquity. It was known, in a small and rudimentary form, to the Egyptians, who used wood for its construction; the Assyrians certainly employed metal and possibly other materials in its manufacture. Grecian tables were also often of metal, with three or four legs and of considerable variety of form; they were small and low. By Roman times the table had apparently become somewhat more common. The favourite form was the tripod, but one and four legs were also used. Already the shape varied considerably, and in addition to wood, there were tables of marble, ivory, bronze and the precious metals. The more costly examples were carved, inlaid or otherwise ornamented; cedar and the finely marked or grained woods generally were much sought after. As in Greece the tables were low; they were intended for reclining, rather than sitting; their legs were those of wild beasts, or were formed of sphinxes, termini and other figures. Some of those which remain are of extreme grace and most delicate workmanship; to them the Empire style is enormously indebted. In antiquity tables of any kind can only have been the appanage of the rich. In the early middle ages, although there was variety of form—the circular, semicircular, oval and oblong were all in use—tables appear, save in rare instances, to have been portable and supported upon trestles fixed or folding, which were cleared out of the way at the end of a meal. The custom of serving dinner at several small tables, which is often supposed to be a very modern refinement, was certainly followed in the French châteaux, and probably also in the English castles, as early as the 13th century. For persons of high degree, fixed tables were reserved. Even at a period when domestic furniture was of a very primitive character and few modern conveniences had been evolved, costly tables were by no means unknown—some dim traditions of Rome's refinements must necessarily have filtered through the centuries. Thus Charlemagne possessed three tables of silver and one of gold—no doubt they were of wood covered with plates of the precious metals. Before the 16th century the number of tables properly so called was small; hence very few of earlier date than the middle of that century have come down to us. In the chapter-house of Salisbury cathedral is a restored 13th-century example which stands practically alone. In point of age it is most nearly approached by the famous pair of trestle tables in the great hall at Penshurst.

When the table became a fixed and permanent piece of furniture the word "board," which had long connoted it, fell into disuse save in an allusive sense, and its place was taken by such phrases as "joyned table" and "framed table"—that is, jointed or framed together by a joiner; sometimes people spoke of a "standing" or "dormant" table. They were most frequently oblong, some two feet or two feet six inches wide, and the guests sat with their backs to the wall, the other side of the table being left free for service. Sometimes they were used as side-tables, or furnished with a cupboard beneath the board; they were supported on quadrangular legs or massive ends and feet full of Gothic feeling, and were several inches higher than the dining-table of the 20th century. Heavy stretchers or foot-rails were fixed close to the floor—for the avoidance, no doubt, of draughts. Oak was the usual material, but elm, cherry and other woods were sometimes used. Soon the legs became bulbous, and were gadrooned or otherwise ornamented, and the frame began to be carved. The introduction, before the 16th century closed, of the "drawing table" marked the rapidity with which this piece of furniture was developed. This was the forerunner of the "extending dining-table." Of the three leaves of which these tables were composed two were below the other; they drew out and were supported by brackets, while the slab proper dropped to the same level. Somewhat later legs became excessively bulbous; this ugly form gave place soon after the middle of the 17th century to baluster-shaped legs. Hitherto tables had, generally speaking, been large and massive—little in the nature of what is now called the "occasional table" seems to have been provided until some years after the Restoration. About that time small tables of varying sizes and shapes, but still of substantial weight, began to be made; many of them were flap-tables, which took up little room when they were not in use. These, however, had been known at an earlier date. Charles II. had not long been on the throne when the idea of the flap-table was amplified in a peculiarly graceful fashion. Two flaps were provided instead of one, the result being the rather large oval table of the "gate-leg" variety that has remained in use ever since, in which the open "gate" supports the flap. Towards the end of the reign tables began to have the graceful twisted legs joined to the flat serpentine stretchers, which produced, almost for the first time in English furniture, a sense of lightness and gaiety. The walnut tables of the end of the Stuart period were often inlaid with marquetry of great excellence. The number and variety of the tables in well-to-do households were now increasing rapidly, and the console-table was imported from the Continent contemporaneously with the common use of the mahogany side-table.

As mahogany came into general use, about the beginning of the second quarter of the 18th century, an enormous number of card-tables were made with plain or cabriole legs and spade or claw and ball feet, often with lions' heads carved upon the knees; the top folded up to half its size when open. The Chippendale school introduced small tables with carved openwork "galleries" round the edges (to protect china and other small objects), and clustered legs; Gothic forms and Chinese frets were for a time fashionable. Later in this century, so prolific in new forms of furniture, tables were frequently made of rosewood and satinwood; side-tables, often highly elaborate, adorned with swags and festoons and other classical motives, supported by termini or richly carved legs, were gilded and topped with marble slabs or inlaid wood. The Pembroke table, of oblong form, with two semi-circular or oblong leaves, with edgings of marquetry, was a characteristic feature of late 18th-century English furniture, and still retains its popularity. Then came the Empire period; the taper was replaced by the round leg, rosewood grew commoner, and brass mountings the rule. For illustrations see FURNITURE.

[1] For mathematical tables see next article. This use of the word comes from the analogy of the laying out of objects on an ordinary table.

TABLE, MATHEMATICAL. In any table the results tabulated are termed the "tabular results" or "respondents," and the corresponding numbers by which the table is entered are termed the "arguments." A table is said to be of single or double entry according as there are one or two arguments. For example, a table of logarithms is a table of single entry, the numbers being the arguments and the logarithms the tabular results; an ordinary multiplication table is a table of double entry, giving xy as tabular result for x and y as arguments. The intrinsic value of a table may be estimated by the actual amount of time saved by consulting it; for example, a table of square roots to ten decimals is more valuable than a table of squares, as the extraction of the root would occupy more time than the multiplication of the number by itself. The value of a table does not depend upon the difficulty of calculating it; for, once made, it is made for ever, and as far as the user is concerned the amount of labour devoted to its original construction is immaterial. In some tables the labour required in the construction is the same as if all the tabular results had been calculated separately; but in the majority of instances a table can be formed by expeditious methods which are inapplicable to the calculation of an individual result. This is the case with tables of a continuous quantity, which may frequently be constructed by differences. The most striking instance perhaps is afforded by a factor table or a table of primes; for, if it is required to determine whether a given number is prime or not, the only universally available method (in the absence of tables) is to divide it by every prime less than its square root or until one is found that divides it without remainder. But to form a table of prime numbers the process is theoretically simple and rapid, for we have only to range all the numbers in a line and strike out every second number beginning from 2, every third beginning from 3, and so on, those that remain being primes. Even when the tabular results are constructed separately, the method of differences or other methods connecting together different tabular results may afford valuable verifications. By having recourse to tables not only does the computer save time and labour, but he also obtains the certainty of accuracy.

The invention of logarithms in 1614, followed immediately by the calculation of logarithmic tables, revolutionized all the methods of calculation; and the original work performed by Henry Briggs and Adrian Vlacq in calculating logarithms in the early part of the 17th century has in effect formed a portion of every arithmetical operation that has since been carried out by means of logarithms. And not only has an incredible amount of labour been saved,[1] but a vast number of calculations and researches have been rendered practicable which otherwise would have been beyond human reach. The mathematical process that underlies the tabular method of obtaining a result may be indirect and complicated; for example, the logarithmic method would be quite unsuitable for the multiplication of two numbers if the logarithms had to be calculated specially for the purpose and were not already tabulated for use. The arrangement of a table on the page and all typographical details—such as the shape of the figures, their spacing, the thickness and placing of the rules, the colour and quality of the paper, &c.—are of the highest importance, as the computer has to spend hours with his eyes fixed upon the book; and the efforts of eye and brain required in finding the right numbers amidst a mass of figures on a page and in taking them out accurately, when the computer is tired as well as when he is fresh, are far more trying than the mechanical action of simple reading. Moreover, the trouble required by the computer to *learn* the use of a table need scarcely be considered; the important matter is the time and labour saved by it after he *has* learned its use.

In the following descriptions of tables an attempt is made to give an account of all those that a computer of the present day is likely to use in carrying out arithmetical calculations. Tables relating to ordinary arithmetical operations are first described, and afterwards an account is given of the most useful and least technical of the more strictly mathematical tables, such as factorials, gamma functions, integrals, Bessel's functions, &c. Nearly all modern tables are stereotyped, and in giving their titles the accompanying date is either that of the original stereotyping or of the *tirage* in question. In tables that have passed through many editions the date given is that of the edition described. A much fuller account of general tables published previously to 1872, by the present writer, is contained in the British Association *Report* for 1873, pp. 1–175.

Tables of Divisors (Factor Tables) and Tables of Primes.—The existing factor tables extend to 10,000,000. In 1811 L. Chernac published at Deventer his *Cribrum arithmeticum*, which gives all the prime divisors of every number not divisible by 2, 3, or 5 up to 1,020,000. In 1814–1817 J. C. Burckhardt published at Paris his *Tables des diviseurs*, giving the least divisor of every number not divisible by 2, 3, or 5 up to 3,036,000. The second million was issued in 1814, the third in 1816, and the first in 1817. The corresponding tables for the seventh, eighth, and ninth millions were calculated by Z. Dase and issued at Hamburg in 1862, 1863, and 1865. Dase died suddenly in 1861 during the progress of the work, and it was completed by H. Rosenberg. Dase's calculation was performed at the instigation of Gauss, and he began at 6,000,000 because the Berlin Academy was in possession of a manuscript presented by Crelle extending Burckhardt's tables from 3,000,000 to 6,000,000. This manuscript was found on examination to be so inaccurate that the publication was not desirable, and accordingly the three intervening millions were calculated and published by James Glaisher, the *Factor Table for the Fourth Million* appearing at London in 1879, and those for the fifth and sixth millions in 1880 and 1883 respectively (all three millions stereotyped). The tenth million, though calculated by Dase and Rosenberg, has not been published. The nine quarto volumes (*Tables des diviseurs*, Paris, 1814–1817; *Factor Tables*, London, 1879–1883; *Factoren-Tafeln*, Hamburg, 1862–1865) thus form one uniform table, giving the least divisor of every number not divisible by 2, 3, or 5, from unity to nine millions. The arrangement of the results on the page, which is due to Burckhardt, is admirable for its clearness and condensation, the least factors for 9000 numbers being given on each page. The tabular portion of each million occupies 112 pages. The first three millions were issued separately, and also bound in one volume, but the other six millions are all separate. Burckhardt began the publication of his tables with the second million instead of the first, as Chernac's factor table for the first million was already in existence. Burckhardt's first million does not supersede Chernac's, as the latter gives all the prime divisors of numbers not divisible by 2, 3, or 5 up to 1,020,000. It occupies 1020 pages, and Burckhardt found it very accurate; he detected only thirty-eight errors, of which nine were due to the author, the remaining twenty-nine having been caused by the slipping of type in the printing. The errata thus discovered are given in Burckhardt's first million. Other errata are contained in Allan Cunningham's paper referred to below.

Burckhardt gives but a very brief account of the method by which he constructed his table; and the introduction to Dase's millions merely consists of Gauss's letter suggesting their construction. The Introduction to the *Fourth Million* (pp. 52) contains a full account of the method of construction and a history of factor tables, with a bibliography of writings on the subject. The Introduction (pp. 103) to the *Sixth Million* contains an enumeration of primes and a great number of tables relating to the distribution of primes in the whole nine millions, portions of which had been published in the *Cambridge Philosophical Proceedings* and elsewhere. A complete list of errors in the nine millions was published by J. P. Gram (*Acta mathematica*, 1893, 17, p. 310). These errors, 141 in number, and which affect principally the second, third, eighth, and ninth millions, should be carefully corrected in all the tables. In 1909 the Carnegie Institution of Washington published a factor table by Prof. D. N. Lehmer which gives the least factor of all numbers not divisible by 2, 3, 5, or 7, up to ten millions. This table, which covers a range of 21,000 numbers on a single page, was reproduced by photography from a typewritten copy of the author's original manuscript. The introduction contains a list of errata in the nine millions previously published, completely confirming Gram's list.

The factor tables which have just been described greatly exceed both in extent and accuracy any others of the same kind, the largest of which only reaches 408,000. This is the limit of Anton Felkel's *Tafel aller einfachen Factoren* (Vienna, 1776), a remarkable and extremely rare book,[2] nearly all the copies having been destroyed. Georg Vega (*Tabulae*, 1797) gave a table showing all the divisors of numbers not divisible by 2, 3, or 5 up to 102,000, followed by a list of primes from 102,000 to 400,313. In the earlier editions of this work there are several errors in the list, but these are no doubt corrected in J. A. Hülsse's edition (1840). J. Salomon (Vienna, 1827) gives the least divisor of all numbers not divisible by 2, 3, or 5, up to 102,011, and B. Goldberg (*Primzahlen und Factoren-Tafeln*, Leipzig, 1862) gives all factors of numbers not divisible by 2, 3, or 5 up to 251,650. H. G. Köhler (*Logarithmisch-trigonometrisches Handbuch*, 1848 and subsequent editions) gives all factors of numbers not prime or divisible by 2, 3, 5, or 11 up to 21,525. Peter Barlow (*Tables*, 1814) and F. Schaller (*Primzahlen-Tafel*, Weimar, 1855) give all factors of *all* numbers up to 10,000. Barlow's work also contains a list of primes up to 100,103. Both the factor table and the list of primes are omitted in the stereotyped (1840) reprint. Full lists of errata in Chernac (1811), Barlow (1814), Hülsse's Vega (1840), Köhler (1848), Schaller (1855), and Goldberg (1862) are contained in a paper by Allan Cunningham (*Mess. of Math.*, 1904, 34, p. 24; 1905, 35, p. 24). V. A. Le Besgue (*Tables diverses pour la décomposition des nombres*, Paris, 1864) gives in a table of twenty pages, the least factor of numbers not divisible by 2, 3, or 5 up to 115,500. In Rees's *Cyclopaedia* (1819), article "Prime Numbers," there is a list of primes to 217,219 arranged in decades. The *Fourth Million* (1879) contains a list of primes up to 30,341. The fourth edition of the *Logarithmic Tables* (London, and Ithaca, N.Y., 1893) of G. W. Jones of Cornell University contains a table of all the factors of numbers not divisible by 2 or 5 up to 20,000. In the case of primes the ten-place logarithm is given. This table does not occur in the third edition (Ithaca, N.Y., 1891). On the first page of the *Second Million* Burckhardt gives the first nine multiples of the primes to 1423; and a smaller table of the same kind, extending only to 313, occurs in Lambert's *Supplementa* (1798). Several papers contain lists of high primes (*i.e.* beyond the range of the

[1] Referring to factor tables, J. H. Lambert wrote (*Supplementa tabularum*, 1798, p. xv.): "Universalis finis talium tabularum est ut semel pro semper computetur quod saepius de novo computandum foret, et ut pro omni casu computetur quod in futurum pro quovis casu computatum desiderabitur." This applies to all tables.

[2] For information about it, see a paper on "Factor Tables," in *Camb. Phil. Proc.* (1878), iii. 99–138, or the Introduction to the *Fourth Million*.

factor tables). Among these may be mentioned two, by Allan Cunningham and H. J. Woodall jointly, in the *Mess. of Math.*, 1902, 31, p. 165; 1905, 34, p. 72. See also the papers on factorizations of high numbers referred to under *Tables relating to the Theory of Numbers*. The Vienna Academy possesses the manuscript of an immense factor table extending to 100,000,000, constructed many years ago by J. P. Kulik (1793–1863) (see *Ency. math. Wiss.*, 1900–1904, i. 952, and Lehmer's *Factor Table*, p. ix.).

Multiplication Tables.—A multiplication table is usually of double entry, the two arguments being the two factors; when so arranged it is frequently called a Pythagorean table. The largest and most useful work is A. L. Crelle's *Rechentafeln* (Bremiker's edition, 1857, stereotyped; many subsequent editions with German, French, and English title-pages), which gives in one volume all the products up to 1000×1000, so arranged that all the multiples of any one number appear on the same page. The original edition was published in 1820 and consisted of two thick octavo volumes. The second (stereotyped) edition is a convenient folio volume of 450 pages.[1] In 1908 an entirely new edition, edited by O. Seeliger, was published in which the multiples of 10, 20, ..., 990 (omitted in previous editions) are included. This adds 50 pages to the volume, but removes what has been a great drawback to the use of the tables. Other improvements are that the tables are divided off horizontally and vertically by lines and spaces, and that, for calculations in which the last two figures are rejected, a mark has been placed to show when the last figure retained should be increased. Two other tables of the same extent (1000×1000), but more condensed in arrangement, are H. C. Schmidt's *Zahlenbuch* (Aschersleben, 1896), and A. Henselin's *Rechentafel* (Berlin, 1897). An anonymous table, published at Oldenburg in 1860, gives products up to 500×509, and M. Cordier, *Le Multiplicateur de trois cents carrés* (Paris, 1872), gives a multiplication table to 300×300 (intended for commercial use). In both these works the product is printed in full. The four following tables are for the multiplication of a number by a single digit. (1) A. L. Crelle, *Erleichterungstafel für jeden, der zu rechnen hat* (Berlin, 1836), a work extending to 1000 pages, gives the product of a number of seven figures by a single digit, by means of a double operation of entry. Each page is divided into two tables: for example, to multiply 9382477 by 7 we turn to page 825, and enter the right-hand table at line 77, column 7, where we find 77339; we then enter the left-hand table on the same page at line 93, column 7, and find 656, so that the product required is 65677339. (2) C. A. Bretschneider, *Produktentafel* (Hamburg and Gotha, 1841), is somewhat similar to Crelle's table, but smaller, the number of figures in the multiplicand being five instead of seven. (3) In S. L. Laundy, *A Table of Products* (London, 1865), the product of any five-figure number by a single digit is given by a double arrangement. The extent of the table is the same as that of Bretschneider's, as also is the principle, but the arrangement is different, Laundy's table occupying only 10 pages and Bretschneider's 99 pages. (4) G. Diakow's *Multiplikations-Tabelle* (St Petersburg, 1897) is of the same extent as Bretschneider's table but occupies 1000 pages. Among tables extending to 100×1000 (*i.e.* giving the products of two figures by three) may be mentioned C. A. Müller's *Multiplications-Tabellen* (Karlsruhe, 1891). The tables of L. Zimmermann (*Rechentafeln*, Liebenwerda, 1896) and J. Riem (*Rechentabellen für Multiplication*, Basel, 1897) extend to 100×10,000. In a folio volume of 500 pages J. Peters (*Rechentafeln für Multiplikation und Division mit ein- bis vierstelligen Zahlen*, Berlin, 1909) gives products of four figures by two. The entry is by the last three figures of the multiplicand, and there are 2000 products on each page. Among earlier tables, the interest of which is mainly historical, mention may be made of C. Hutton's *Table of Products and Powers of Numbers* (London, 1781), which contains a table up to 100×1000, and J. P. Gruson's *Grosses Einmaleins von Eins bis Hunderttausend* (Berlin, 1799)—a table of products up to 9×10,000. The author's intention was to extend it to 100,000, but only the first part was published. In this book there is no condensation or double arrangement; the pages are very large, each containing 125 lines.

Quarter-Squares.—Multiplication may be performed by means of a table of single entry in the manner indicated by the formula—

$$ab=\tfrac{1}{4}(a+b)^2-\tfrac{1}{4}(a-b)^2.$$

Thus with a table of quarter-squares we can multiply together any two numbers by subtracting the quarter-square of their difference from the quarter-square of their sum. The largest table of quarter-squares is J. Blater's *Table of Quarter-Squares of all whole numbers from 1 to 200,000* (London, 1888),[2] which gives quarter-squares of every number up to 200,000 and thus yields directly the product of any two five-figure numbers. This fine table is well printed and arranged. Previous to its publication the largest table was S. L. Laundy's *Table of Quarter-Squares of all numbers up to* 100,000 (London, 1856), which is of only half the extent, and therefore is only directly available when the sum of the two numbers to be multiplied does not exceed 100,000.

Smaller works are J. J. Centnerschwer, *Neuerfundene Multiplications- und Quadrat-Tafeln* (Berlin, 1825), which extends to 20,000, and J. M. Merpaut, *Tables arithmonomiques* (Vannes, 1832), which extends to 40,000. In Merpaut's work the quarter-square is termed the "arithmone." L. J. Ludolf, who published in 1690 a table of squares to 100,000 (see next paragraph), explains in his introduction how his table may be used to effect multiplications by means of the above formula; but the earliest book on quarter-squares is A. Voisin, *Tables des multiplications, ou logarithmes des nombres entiers depuis* 1 *jusqu'à* 20,000 (Paris, 1817). By a logarithm Voisin means a quarter-square, *i.e.* he calls a a root and $\frac{1}{4}a^2$ its logarithm. On the subject of quarter-squares, &c., see *Phil. Mag.* [v.] 6, p. 331.

Squares, Cubes, &c., and Square Roots and Cube Roots.—The most convenient table for general use is P. Barlow's *Tables* (Useful Knowledge Society, London, from the stereotyped plates of 1840), which gives squares, cubes, square roots, cube roots, and reciprocals to 10,000. These tables also occur in the original edition of 1814. The largest table of squares and cubes is J. P. Kulik, *Tafeln der Quadrat- und Kubik-Zahlen* (Leipzig, 1848), which gives both as far as 100,000. Blater's table of quarter-squares already mentioned gives squares of numbers up to 100,000 by dividing the number by 2; and up to 200,000 by multiplying the tabular result by 4. Two early tables give squares as far as 100,000, viz. Maginus, *Tabula tetragonica* (Venice, 1592), and Ludolf, *Tetragonometria tabularia* (Amsterdam, 1690); G. A. Jahn, *Tafel der Quadrat- und Kubikwurzeln* (Leipzig, 1839), gives squares to 27,000, cubes to 24,000, and square and cube roots to 25,500, at first to fourteen decimals and above 1010 to five. E. Gélin (*Recueil de tables numériques*, Huy, 1894) gives square roots (to 15 places) and cube roots (to 10 places) of numbers up to 100. C. Hutton, *Tables of Products and Powers of Numbers* (London, 1781), gives squares up to 25,400, cubes to 10,000, and the first ten powers of the first hundred numbers. P. Barlow, *Mathematical Tables* (original edition, 1814), gives the first ten powers of the first hundred numbers. The first nine or ten powers are given in Vega, *Tabulae* (1797), and in Hülsse's edition of the same (1840), in Köhler, *Handbuch* (1848), and in other collections. C. F. Faà de Bruno, *Calcul des erreurs* (Paris, 1869), and J. H. T. Müller, *Vierstellige Logarithmen* (1844), give squares for use in connexion with the method of least squares. Four-place tables of squares are frequently given in five- and four-figure collections of tables. Small tables often occur in books intended for engineers and practical men. S. M. Drach (*Messenger of Math.*, 1878, 7, p. 87) has given to 33 places the cube roots (and the cube roots of the squares) of primes up to 127. Small tables of powers of 2, 3, 5, 7 occur in various collections. In Vega's *Tabulae* (1797, and the subsequent editions, including Hülsse's) the powers of 2, 3, 5 as far as the 45th, 36th, and 27th respectively are given; they also occur in Köhler's *Handbuch* (1848). The first 25 powers of 2, 3, 5, 7 are given in Salomon, *Logarithmische Tafeln* (1827). W. Shanks, *Rectification of the Circle* (1853), gives every 12th power of 2 up to 2^{721}. A very valuable paper ("Power-tables, Errata") published by Allan Cunningham in the *Messenger of Math.*, 1906, 35, p. 13, contains the results of a careful examination of 27 tables containing powers higher than the cube, with lists of errata found in each. Before using any power table this list should be consulted, not only in order to correct the errata, but for the sake of references and general information in regard to such tables. In an appendix (p. 23) Cunningham gives errata in the tables of squares and cubes of Barlow (1814), Jahn (1839), and Kulik (1848).

Triangular Numbers.—E. de Joncourt, *De natura et praeclaro usu simplicissimae speciei numerorum trigonalium* (The Hague, 1762), contains a table of triangular numbers up to 20,000: viz. $\frac{1}{2}n(n+1)$ is given for all numbers from $n=1$ to 20,000. The table occupies 224 pages.

Reciprocals.—P. Barlow's *Tables* (1814 and 1840) give reciprocals up to 10,000 to 9 or 10 places; and a table of ten times this extent is given by W. H. Oakes, *Table of the Reciprocals of Numbers from 1 to 100,000* (London, 1865). This table gives seven figures of the reciprocal, and is arranged like a table of seven-figure logarithms, differences being added at the side of the page. The reciprocal

[1] Only one other multiplication table of the same extent as Crelle's had appeared previously, viz. Herwart von Hohenburg's *Tabulae arithmeticae προσθαφαιρέσεως universales* (Munich, 1610), a huge folio volume of more than a thousand pages. It appears from a correspondence between Kepler and von Hohenburg, which took place at the end of 1608, that the latter used his table when in manuscript for the performance of multiplications in general, and that the occurrence of the word *prosthaphaeresis* on the title is due to Kepler, who pointed out that by means of the table spherical triangles could be solved more easily than by Wittich's prosthaphaeresis. The invention of logarithms four years later afforded another means of performing multiplications, and von Hohenburg's work never became generally known. On the method of prosthaphaeresis, see NAPIER, JOHN, and on von Hohenburg's table, see a paper "On multiplication by a Table of Single Entry," *Phil. Mag.*, 1878, ser. v., 6, p. 331.

[2] The actual place of publication (with a German title, &c.) is Vienna. The copies with an English title, &c., were issued by Trübner; and those with a French title, &c., by Gauthier-Villars. All bear the date 1888.

of a number of five figures is therefore taken out at once, and two more figures may be interpolated for as in logarithms. R. Picarte, *La Division réduite à une addition* (Paris, 1861), gives to ten significant figures the reciprocals of the numbers from 10,000 to 100,000, and also the first nine multiples of these reciprocals. J. C. Houzeau gives the reciprocals of numbers up to 100 to 20 places and their first nine multiples to 12 places in the *Bulletin of the Brussels Academy*, 1875, 40, p. 107. E. Gélin (*Recueil de tables numériques*, Huy, 1894) gives reciprocals of numbers to 1000 to 10 places.

Tables for the Expression of Vulgar Fractions as Decimals.—Tables of this kind have been given by Wucherer, Goodwyn and Gauss. W. F. Wucherer, *Beyträge zum allgemeinern Gebrauch der Decimalbrüche* (Carlsruhe, 1796), gives the decimal fractions (to 5 places) for all vulgar fractions whose numerator and denominator are each less than 50 and prime to one another, arranged according to denominators. The most extensive and elaborate tables that have been published are contained in Henry Goodwyn's *First Centenary of Tables of all Decimal Quotients* (London, 1816), *A Tabular Series of Decimal Quotients* (1823), and *A Table of the Circles arising from the Division of a Unit or any other Whole Number by all the Integers from 1 to 1024* (1823). The *Tabular Series* (1823), which occupies 153 pages, gives to 8 places the decimal corresponding to every vulgar fraction less than $\frac{99}{991}$ whose numerator and denominator do not surpass 1000. The arguments are not arranged according to their numerators or denominators, but according to their magnitude, so that the tabular results exhibit a steady increase from ·001 ($=\frac{1}{1000}$) to ·09989909 ($=\frac{99}{991}$). The author intended the table to include all fractions whose numerator and denominator were each less than 1000, but no more was ever published. The *Table of Circles* (1823) gives all the periods of the circulating decimals that can arise from the division of any integer by another integer less than 1024. Thus for 13 we find $\cdot\dot{0}7692\dot{3}$ and $\cdot\dot{1}5384\dot{6}$, which are the only periods in which a fraction whose denominator is 13 can circulate. The table occupies 107 pages, some of the periods being of course very long (*e.g.*, for 1021 the period contains 1020 figures). The *First Centenary* (1816) gives the complete periods of the reciprocals of the numbers from 1 to 100. Goodwyn's tables are very scarce, but as they are nearly unique of their kind they deserve special notice. A second edition of the *First Centenary* was issued in 1818 with the addition of some of the *Tabular Series*, the numerator not exceeding 50 and the denominator not exceeding 100. A posthumous table of C. F. Gauss's, entitled "Tafel zur Verwandlung gemeiner Brüche mit Nennern aus dem ersten Tausend in Decimalbrüche," occurs in vol. ii. pp. 412–434 of his *Gesammelte Werke* (Göttingen, 1863), and resembles Goodwyn's *Table of Circles*. On this subject see a paper "On Circulating Decimals, with special reference to Henry Goodwyn's *Table of Circles* and *Tabular Series of Decimal Quotients*," in *Camb. Phil. Proc.*, 1878, 3, p. 185, where is also given a table of the numbers of digits in the periods of fractions corresponding to denominators prime to 10 from 1 to 1024 obtained by counting from Goodwyn's table. See also under *Circulating Decimals* (below).

Sexagesimal and Sexcentenary Tables.—Originally all calculations were sexagesimal; and the relics of the system still exist in the division of the degree into 60 minutes and the minute into 60 seconds. To facilitate interpolation, therefore, in trigonometrical and other tables the following large sexagesimal tables were constructed. John Bernoulli, *A Sexcentenary Table* (London, 1779), gives at once the fourth term of any proportion of which the first term is 600″ and each of the other two is less than 600″; the table is of double entry, and may be described as giving the value of $xy/600$ correct to tenths of a second, x and y each containing a number of seconds less than 600. Michael Taylor, *A Sexagesimal Table* (London, 1780), exhibits at sight the fourth term of any proportion where the first term is 60 minutes, the second any number of minutes less than 60, and the third any number of minutes and seconds under 60 minutes; there is also another table in which the third term is any absolute number under 1000. Not much use seems to have been made of these tables, both of which were published by the Commissioners of Longitude. Small tables for the conversion of sexagesimals into centesimals and vice versa are given in a few collections, such as Hülsse's edition of Vega. H. Schubert's *Fünfstellige Tafeln und Gegentafeln* (Leipzig, 1897) contains a sexagesimal table giving $xy/60$ for $x=1$ to 59 and $y=1$ to 150.

Trigonometrical Tables (Natural).—Peter Apian published in 1533 a table of sines with the radius divided decimally. The first complete canon giving all the six ratios of the sides of a right-angled triangle is due to Rheticus (1551), who also introduced the semiquadrantal arrangement. Rheticus's canon was calculated for every ten minutes to 7 places, and Vieta extended it to every minute (1579). In 1554 Reinhold published a table of tangents to every minute. The first complete canon published in England was by Thomas Blundeville (1594), although a table of sines had appeared four years earlier. Regiomontanus called his table of tangents (or rather cotangents) *tabula foecunda* on account of its great use; and till the introduction of the word "tangent" by Thomas Finck (*Geometriae rotundi libri XIV.*, Basel, 1583) a table of tangents was called a *tabula foecunda* or *canon foecundus*. Besides "tangent," Finck also introduced the word "secant," the table of secants having previously been called *tabula benefica* by Maurolycus (1558) and *tabula foecundissima* by Vieta.

By far the greatest computer of pure trigonometrical tables is George Joachim Rheticus, whose work has never been superseded. His celebrated ten-decimal canon, the *Opus palatinum*, was published by Valentine Otho at Neustadt in 1596, and in 1613 his fifteen-decimal table of sines by Pitiscus at Frankfort under the title *Thesaurus mathematicus*. The *Opus palatinum* contains a complete ten-decimal trigonometrical canon for every ten seconds of the quadrant, semiquadrantally arranged, with differences for all the tabular results throughout. Sines, cosines, and secants are given on the left-hand pages in columns headed respectively "Perpendiculum," "Basis," "Hypotenusa," and on the right-hand pages appear tangents, cosecants, and cotangents in columns headed respectively "Perpendiculum," "Hypotenusa," "Basis." At his death Rheticus left the canon nearly complete, and the trigonometry was finished and the whole edited by Valentine Otho; it was named in honour of the elector palatine Frederick IV., who bore the expense of publication. The *Thesaurus* of 1613 gives natural sines for every ten seconds throughout the quadrant, to 15 places, semiquadrantally arranged, with first, second, and third differences. Natural sines are also given for every second from 0° to 1° and from 89° to 90°, to 15 places, with first and second differences. The rescue of the manuscript of this work by Pitiscus forms a striking episode in the history of mathematical tables. The alterations and emendations in the earlier part of the corrected edition of the *Opus palatinum* were made by Pitiscus, who had his suspicions that Rheticus had himself calculated a ten-second table of sines to 15 decimal places; but it could not be found. Eventually the lost canon was discovered amongst the papers of Rheticus which had passed from Otho to James Christmann on the death of the former. Amongst these Pitiscus found (1) the ten-second table of sines to 15 places, with first, second, and third differences (printed in the *Thesaurus*); (2) sines for every second of the first and last degrees of the quadrant, also to 15 places, with first and second differences; (3) the commencement of a canon of tangents and secants, to the same number of decimal places, for every ten seconds, with first and second differences; (4) a complete minute canon of sines, tangents, and secants, also to 15 decimal places. This list, taken in connexion with the *Opus palatinum*, gives an idea of the enormous labours undertaken by Rheticus; his tables not only remain to this day the ultimate authorities but formed the data from which Vlacq calculated his logarithmic canon. Pitiscus says that for twelve years Rheticus constantly had computers at work.

A history of trigonometrical tables by Charles Hutton was prefixed to all the early editions of his *Tables of Logarithms*, and forms Tract xix. of his *Mathematical Tracts*, vol. i. p. 278, 1812. A good deal of bibliographical information about the *Opus palatinum* and earlier trigonometrical tables is given in A. De Morgan's article "Tables" in the *English Cyclopaedia*. The invention of logarithms the year after the publication of Rheticus's volume by Pitiscus changed all the methods of calculation; and it is worthy of note that John Napier's original table of 1614 was a logarithmic canon of sines and not a table of the logarithms of numbers. The logarithmic canon at once superseded the natural canon; and since Pitiscus's time no really extensive table of pure trigonometrical functions has appeared. In recent years the employment of calculating machines has revived the use of tables of natural trigonometrical functions, it being found convenient for some purposes to employ such a machine in connexion with a natural canon instead of using a logarithmic canon. A. Junge's *Tafel der wirklichen Länge der Sinus und Cosinus* (Leipzig, 1864) was published with this object. It gives natural sines and cosines for every ten seconds of the quadrant to 6 places. F. M. Clouth, *Tables pour le calcul des coordonnées goniométriques* (Mainz, n.d.), gives natural sines and cosines (to 6 places) and their first nine multiples (to 4 places) for every centesimal minute of the quadrant. Tables of natural functions occur in many collections, the natural and logarithmic values being sometimes given on opposite pages, sometimes side by side on the same page.

The following works contain tables of trigonometrical functions other than sines, cosines, and tangents. J. Pasquich, *Tabulae logarithmico-trigonometricae* (Leipzig, 1817), contains a table of $\sin^2 x$, $\cos^2 x$, $\tan^2 x$, $\cot^2 x$ from $x=1°$ to $45°$ at intervals of 1′ to 5 places. J. Andrew, *Astronomical and Nautical Tables* (London, 1805), contains a table of "squares of natural semichords," *i.e.* of $\sin^2 \frac{1}{2}x$ from $x=0°$ to $120°$ at intervals of 10″ to 7 places. This table was greatly extended by Major-General Hannyngton in his *Haversines, Natural and Logarithmic, used in computing Lunar Distances for the Nautical Almanac* (London, 1876). The name "haversine," frequently used in works upon navigation, is an abbreviation of "half versed sine"; viz., the haversine of x is equal to $\frac{1}{2}(1-\cos x)$, that is, to $\sin^2\frac{1}{2}x$. The table gives logarithmic haversines for every 15″ from 0° to 180°, and natural haversines for every 10″ from 0° to 180°, to 7 places, except near the beginnng, where the logarithms are given to only 5 or 6 places. It occupies

327 folio pages, and was suggested by Andrew's work, a copy of which by chance fell into Hannyngton's hands. Hannyngton recomputed the whole of it by a partly mechanical method, a combination of two arithmometers being employed. A table of haversines is useful for the solution of spherical triangles when two sides and the included angle are given, and in other problems in spherical trigonometry. Andrew's original table seems to have attracted very little notice. Hannyngton's was printed, on the recommendation of the superintendent of the *Nautical Almanac* office, at the public cost. Before the calculation of Hannyngton's table R. Farley's *Natural Versed Sines* (London, 1856) was used in the *Nautical Almanac* office in computing lunar distances. This fine table contains natural versed sines from 0° to 125° at intervals of 10″ to 7 places, with proportional parts, and log versed sines from 0° to 135° at intervals of 15″ to 7 places. The arguments are also given in time. The manuscript was used in the office for twenty-five years before it was printed. Traverse tables, which occur in most collections of navigation tables, contain multiples of sines and cosines.

Common or Briggian Logarithms of Numbers and Trigonometrical Ratios.—For an account of the invention and history of logarithms, see LOGARITHM. The following are the fundamental works which contain the results of the original calculations of logarithms of numbers and trigonometrical ratios:—Briggs, *Arithmetica logarithmica* (London, 1624), logarithms of numbers from 1 to 20,000 and from 90,000 to 100,000 to 14 places, with interscript differences; Vlacq, *Arithmetica logarithmica* (Gouda, 1628, also an English edition, London, 1631, the tables being the same), ten-figure logarithms of numbers from 1 to 100,000, with differences, also log sines, tangents, and secants for every minute of the quadrant to 10 places, with interscript differences; Vlacq, *Trigonometria artificialis* (Gouda, 1633), log sines and tangents to every ten seconds of the quadrant to 10 places, with differences, and ten-figure logarithms of numbers up to 20,000, with differences; Briggs, *Trigonometria Britannica* (London, 1633), natural sines to 15 places, tangents and secants to 10 places, log sines to 14 places, and tangents to 10 places, at intervals of a hundredth of a degree from 0° to 45°, with interscript differences for all the functions. In 1794 Vega reprinted at Leipzig Vlacq's two works in a single folio volume, *Thesaurus logarithmorum completus*. The arrangement of the table of logarithms of numbers is more compendious than in Vlacq, being similar to that of an ordinary seven-figure table, but it is not so convenient, as mistakes in taking out the differences are more liable to occur. The trigonometrical canon gives log sines, cosines, tangents, and cotangents, from 0° to 2° at intervals of one second, to 10 places, without differences, and for the rest of the quadrant at intervals of ten seconds. The trigonometrical canon is not wholly reprinted from the *Trigonometria artificialis*, as the logarithms for every second of the first two degrees, which do not occur in Vlacq, were calculated for the work by Lieutenant Dorfmund. Vega devoted great attention to the detection of errors in Vlacq's logarithms of numbers, and has given several important errata lists. F. Lefort (*Annales de l'Observatoire de Paris*, vol. iv.) has given a full errata list in Vlacq's and Vega's logarithms of numbers, obtained by comparison with the great French manuscript *Tables du cadastre* (see LOGARITHM; comp. also *Monthly Notices R.A.S.*, 32, pp. 255, 288; 33, p. 330; 34, p. 447). Vega seems not to have bestowed on the trigonometrical canon anything like the care that he devoted to the logarithms of numbers, as Gauss[1] estimates the total number of last-figure errors at from 31,983 to 47,746, most of them only amounting to a unit, but some to as much as 3 or 4.

A copy of Vlacq's *Arithmetica logarithmica* (1628 or 1631), with the errors in numbers, logarithms, and differences corrected, is still the best table for a calculator who has to perform work requiring ten-figure logarithms of numbers, but the book is not easy to procure, and Vega's *Thesaurus* has the advantage of having log sines, &c., in the same volume. The latter work also has been made more accessible by a photographic reproduction by the Italian government (*Riproduzione fotozincografica dell' Istituto Geografico Militare*, Florence, 1896). In 1897 Max Edler von Leber published tables for facilitating interpolations in Vega's *Thesaurus* (*Tabularum ad faciliorem et breviorem in Georgii Vegae "Thesauri logarithmorum" magnis canonibus interpolationis computationem utilium Trias*, Vienna, 1897). The object of these tables is to take account of second differences. Prefixed to the tables is a long list of errors in the *Thesaurus*, occupying twelve pages. From an examination of the tabular results in the trigonometrical canon corresponding to 1060 angles von Leber estimates that out of the 90,720 tabular results 40,396 are in error by ± 1, 2793 by ±2, and 191 by ±3. Thus his estimated value of the total number of last-figure errors is 43,326, which is in accordance with Gauss's estimate. A table of ten-figure logarithms of numbers up to 100,009, the result of a new calculation, was published in the *Report of the U.S. Coast and Geodetic Survey for* 1895–6 (appendix 12, pp. 395–722) by W. W. Duffield, superintendent of the survey. The table was compared with Vega's *Thesaurus* before publication.

S. Pineto's *Tables de logarithmes vulgaires à dix décimales, construites d'après un nouveau mode* (St Petersburg, 1871), though a tract of only 80 pages, may be usefully employed when Vlacq and Vega are unprocurable. Pineto's work consists of three tables: the first, or auxiliary table, contains a series of factors by which the numbers whose logarithms are required are to be multiplied to bring them within the range of table 2; it also gives the logarithms of the reciprocals of these factors to 12 places. Table 1 merely gives logarithms to 1000 to 10 places. Table 2 gives logarithms from 1,000,000 to 1,011,000, with proportional parts to hundredths. The mode of using these tables is as follows. If the logarithm cannot be taken out directly from table 2, a factor M is found from the auxiliary table by which the number must be multiplied to bring it within the range of table 2. Then the logarithm can be taken out, and, to neutralize the effect of the multiplication, so far as the result is concerned, log $1/M$ must be added; this quantity is therefore given in an adjoining column to M in the auxiliary table. A similar procedure gives the number answering to any logarithm, another factor (approximately the reciprocal of M) being given, so that in both cases multiplication is used. The laborious part of the work is the multiplication by M; but this is somewhat compensated for by the ease with which, by means of the proportional parts, the logarithm is taken out. The factors are 300 in number, and are chosen so as to minimize the labour, only 25 of the 300 consisting of three figures all different and not involving 0 or 1. The principle of multiplying by a factor which is subsequently cancelled by subtracting its logarithm is used also in a tract, containing only ten pages, published by A. Namur and P. Mansion at Brussels in 1877 under the title *Tables de logarithmes à 12 décimales jusqu'à 434 milliards.* Here a table is given of logarithms of numbers near to 434,294, and other numbers are brought within the range of the table by multiplication by one or two factors. The logarithms of the numbers near to 434,294 are selected for tabulation because their differences commence with the figures 100 . . . and the presence of the zeros in the difference renders the interpolation easy.

The tables of S. Gundelfinger and A. Nell (*Tafeln zur Berechnung neunstelliger Logarithmen*, Darmstadt, 1891) afford an easy means of obtaining nine-figure logarithms, though of course they are far less convenient than a nine-figure table itself. The method in effect consists in the use of Gaussian logarithms, viz., if $N = n + p$, $\log N = \log n + \log(1 + p/n) = \log n + B$ where B is $\log(1 + p/n)$ to argument $A = \log p - \log n$. The tables give $\log n$ from $n = 1000$ to $n = 10{,}000$, and values of B for argument A.[2]

Until 1891, when the eight-decimal tables, referred to further on, were published by the French government, the computer who could not obtain sufficiently accurate results from seven-figure logarithms was obliged to have recourse to ten-figure tables, for, with only one exception, there existed no tables giving eight or nine figures. This exception is John Newton's *Trigonometria Britannica* (London, 1658), which gives logarithms of numbers to 100,000 to 8 places, and also log sines and tangents for every centesimal minute (*i.e.* the nine-thousandth part of a right angle), and also log sines and tangents for the first three degrees of the quadrant to 5 places, the interval being the one-thousandth part of a degree. This table is also remarkable for giving the logarithms of the differences instead of the actual differences. The arrangement of the page now universal in seven-figure tables—with the fifth figures running horizontally along the top line of the page—is due to John Newton.

As a rule seven-figure logarithms of numbers are not published separately, most tables of logarithms containing both the logarithms of numbers and a trigonometrical canon. Babbage's and Sang's logarithms are exceptional and give logarithms of numbers only. C. Babbage, *Table of the Logarithms of the Natural Numbers from 1 to* 108,000 (London, stereotyped in 1827; there are many tirages of later dates), is the best for ordinary use. Great pains were taken to get the maximum of clearness. The change of figure in the middle of the block of numbers is marked by a change of type in the fourth figure, which (with the sole exception of the asterisk) is probably the best method that has been used. Copies of the book were printed on paper of different colours—yellow, brown, green, &c.—as it was considered that black on a white ground was a fatiguing combination for the eye. The tables were also issued with title-pages and introductions in other languages. In 1871 E. Sang published *A New Table of Seven-place Logarithms of all Numbers from* 20,000 to 200,000 (London). In an ordinary table extending from 10,000 to 100,000 the differences near the beginning are so numerous that the proportional parts are either very crowded or some of them omitted; by making the table extend from 20,000 to 200,000 instead of from 10,000 to 100,000 the differences are halved in magnitude, while there are only one-fourth as many in a page. There is also greater accuracy. A

[1] See his "Einige Bemerkungen zu Vega's *Thesaurus logarithmorum*," in *Astronomische Nachrichten* for 1851 (reprinted in his *Werke*, vol. iii. pp. 257–64); also *Monthly Notices R.A.S.*, 33, p. 440.

[2] A seven-figure table of the same kind is contained in S. Gundelfinger's *Sechsstellige Gaussische und siebenstellige gemeine Logarithmen* (Leipzig, 1902).

further peculiarity of this table is that multiples of the differences, instead of proportional parts, are given at the side of the page. Typographically the table is exceptional, as there are no rules, the numbers being separated from the logarithms by reversed commas —a doubtful advantage. This work was to a great extent the result of an original calculation; see *Trans. Roy. Soc. Edin.*, 1871, 26. Sang proposed to publish a nine-figure table from 1 to 1,000,000, but the requisite support was not obtained. Various papers of Sang's relating to his logarithmic calculations will be found in the *Proc. Roy. Soc. Edin.* subsequent to 1872. Reference should here be made to Abraham Sharp's table of logarithms of numbers from 1 to 100 and of primes from 100 to 1100 to 61 places, also of numbers from 999,990 to 1,000,010 to 63 places. These first appeared in *Geometry Improv'd . . . by A. S. Philomath* (London, 1717). They have been republished in Sherwin's, Callet's, and the earlier editions of Hutton's tables. H. M. Parkhurst, *Astronomical Tables* (New York, 1871), gives logarithms of numbers from 1 to 109 to 102 places.[1]

In many seven-figure tables of logarithms of numbers the values of S and T are given at the top of the page, with V, the variation of each, for the purpose of deducing log sines and tangents. S and T denote log (sin x/x) and log (tan x/x) respectively, the argument being the number of seconds denoted by certain numbers (sometimes only the first, sometimes every tenth) in the number column on each page. Thus, in Callet's tables, on the page on which the first number is 67200, $S=$log (sin 6720″/6720) and $T=$log (tan 6720″/6720), while the V's are the variations of each for 10″. To find, for example, log sin 1°52′12″·7, or log sin 6732″·7, we have $S=$4·6854980 and log 6732·7 = 3,8281893, whence, by addition, we obtain 8·5136873; but V for 10″ is − 2·29, whence the variation for 12″·7 is −3, and the log sine required is 8·5136870. Tables of S and T are frequently called, after their inventor, "Delambre's tables."

Some seven-figure tables extend to 100,000, and others to 108,000, the last 8000 logarithms, to 8 places, being given to ensure greater accuracy, as near the beginning of the numbers the differences are large and the interpolations more laborious and less exact than in the rest of the table. The eight-figure logarithms, however, at the end of a seven-figure table are liable to occasion error; for the computer who is accustomed to three leading figures, common to the block of figures, may fail to notice that in this part of the table there are four, and so a figure (the fourth) is sometimes omitted in taking out the logarithm. In the ordinary method of arranging a seven-figure table the change in the fourth figure, when it occurs in the course of the line, is a source of frequent error unless it is very clearly indicated. In the earlier tables the change was not marked at all, and the computer had to decide for himself, each time he took out a logarithm, whether the third figure had to be increased. In some tables the line is broken where the change occurs; but the dislocation of the figures and the corresponding irregularity in the lines are very awkward. Babbage printed the fourth figure in small type after a change; and Bremiker placed a bar over it. The best method seems to be that of prefixing an asterisk to the fourth figure of each logarithm after the change, as is done in Schrön's and many other modern tables. This is beautifully clear and the asterisk at once catches the eye. Shortrede and Sang replace 0 after a change by a *nokta* (resembling a diamond in a pack of cards). This is very clear in the case of the 0's, but leaves unmarked the cases in which the fourth figure is 1 or 2. A method which finds favour in some recent tables is to underline all the figures after the increase, or to place a line over them.

Babbage printed a subscript point under the last figure of each logarithm that had been increased. Schrön used a bar subscript, which, being more obtrusive, seems less satisfactory. In some tables the increase of the last figure is only marked when the figure is increased to a 5, and then a Roman five (v) is used in place of the Arabic figure.

Hereditary errors in logarithmic tables are considered in two papers "On the Progress to Accuracy of Logarithmic Tables" and "On Logarithmic Tables," in *Monthly Notices R.A.S.*, 33, pp. 330, 440. See also vol. 34, p. 447; and a paper by Gernerth, *Ztsch. f. d. österr. Gymm.*, Heft vi. p. 407.

Passing now to the logarithmic trigonometrical canon, the first great advance after the publication of the *Trigonometria artificialis* in 1633 was made in Michael Taylor's *Tables of Logarithms* (London, 1792), which give log sines and tangents to every second of the quadrant to 7 places. This table contains about 450 pages with an average number of 7750 figures to the page, so that there are altogether nearly three millions and a half of figures. The change in the leading figures, when it occurs in a column, is not marked at all; and the table must be used with very great caution. In fact it is advisable to go through the whole of it, and fill in with ink the first 0 after the change, as well as make some mark that will catch the eye at the head of every column containing a change. The table was calculated by interpolation from the *Trigonometria artificialis* to 10 places and then reduced to 7, so that the last figure should always be correct. Partly on account of the absence of a mark to denote the change of figure in the column and partly on account of the size of the table and a somewhat inconvenient arrangement, the work seems never to have come into general use. Computers have always preferred V. Bagay's *Nouvelles Tables astronomiques et hydrographiques* (Paris, 1829), which also contains a complete logarithmic canon to every second. The change in the column is very clearly marked by a large black nucleus, surrounded by a circle, printed instead of 0. Bagay's work having become rare and costly was reprinted with the errors corrected. The reprint, however, bears the original title-page and date 1829, and there appears to be no means of distinguishing it from the original work except by turning to one of the errata in the original edition and examining whether the correction has been made.

The only other canon to every second that has been published is contained in R. Shortrede's *Logarithmic Tables* (Edinburgh). This work was originally issued in 1844 in one volume, but being dissatisfied with it Shortrede issued a new edition in 1849 in two volumes. The first volume contains logarithms of numbers, antilogarithms, &c., and the second the trigonometrical canon to every second. The volumes are sold separately, and may be regarded as independent works; they are not even described on their title-pages as vol. i. and vol. ii. The trigonometrical canon is very complete in every respect, the arguments being given in time as well as in arc, full proportional parts being added, &c. The change of figure in the column is denoted by a nokta, printed instead of 0 where the change occurs. The page is crowded and the print not very clear, so that Bagay is to be preferred for regular use.

Previous to 1891 the only important tables in which the quadrant is divided centesimally were J. P. Hobert and L. Ideler, *Nouvelles tables trigonométriques* (Berlin, 1799), and C. Borda and J. B. J. Delambre, *Tables trigonométriques décimales* (Paris, 1801). The former give, among other tables, natural and log sines, cosines, tangents, and cotangents, to 7 places, the arguments proceeding to 3° at intervals of 10″ and thence to 50° at intervals of 1′ (centesimal), and also natural sines and tangents for the first hundred ten-thousandths of a right angle to 10 places. The latter gives long sines, cosines, tangents, cotangents, secants, and cosecants from 0° to 3° at intervals of 10″ (with full proportional parts for every second), and thence to 50° at intervals of 1′ (centesimal) to 7 places. There is also a table of log sines, cosines, tangents, and cotangents from 0′ to 10′ at intervals of 10″ and from 0° to 50° at intervals of 10′ (centesimal) to 11 places. Hobert and Ideler give a natural as well as a logarithmic canon; but Borda and Delambre give only the latter. Borda and Delambre give seven-figure logarithms of numbers to 10,000, the line being broken when a change of figure takes place in it.

The tables of Borda and Delambre having become difficult to procure, and seven-figure tables being no longer sufficient for the accuracy required in astronomy and geodesy, the French government in 1891 issued an eight-figure table containing (besides logarithms of numbers to 120,000) log sines and tangents for every ten seconds (centesimal) of the quadrant, the latter being extracted from the *Tables du cadastre* of Prony (see LOGARITHM). The title of this fine and handsomely printed work is *Service géographique de l'armée: Tables des logarithmes à huit décimales . . . publiées par ordre du ministre de la guerre* (Paris, Imprimerie Nationale, 1891). These tables are now in common use where eight figures are required.

In Brigg's *Trigonometria Britannica* of 1633 the degree is divided centesimally, and but for the appearance in the same year of Vlacq's *Trigonometria artificialis*, in which the degree is divided sexagesimally, this reform might have been effected. It is clear that the most suitable time for making such a change was when the natural canon was replaced by the logarithmic canon, and Briggs took advantage of this opportunity. He left the degree unaltered, but divided it centesimally instead of sexagesimally, thus ensuring the advantages of decimal division (a saving of work in interpolations, multiplications, &c.) with the minimum of change. The French mathematicians at the end of the 18th century divided the right angle centesimally, completely changing the whole system, with no appreciable advantages over Briggs's system. In fact the centesimal degree is as arbitrary a unit as the nonagesimal and it is only the non-centesimal subdivision of the degree that gives rise to inconvenience. Briggs's example was followed by Roe, Oughtred, and other 17th-century writers; but the centesimal division of the degree seemed to have entirely passed out of use, till it was revived by C. Bremiker in his *Logarithmisch-trigonometrische Tafeln mit fünf Decimalstellen* (Berlin, 1872, 10th ed. revised by A. Kallius, 1906). This little book of 158 pages gives a five-figure canon to every hundredth of a degree with proportional parts, besides logarithms of numbers, addition and subtraction logarithms, &c.

The eight-figure table of 1891 has now made the use of a centesimal table compulsory, if this number of figures is required.

[1] Legendre (*Traité des fonctions elliptiques*, vol. ii., 1826) gives a table of natural sines to 15 places, and of log sines to 14 places, for every 15″ of the quadrant, and also a table of logarithms of uneven numbers from 1163 to 1501, and of primes from 1501 to 10,000 to 19 places. The latter, which was extracted from the *Tables du cadastre*, is a continuation of a table in W. Gardiner's *Tables of Logarithms* (London, 1742; reprinted at Avignon, 1770), which gives logarithms of all numbers to 1000, and of uneven numbers from 1000 to 1143. Legendre's tables also appeared in his *Exercices de calcul intégral*, vol. iii. (1816).

The *Astronomische Gesellschaft* are, however, publishing an eight-figure table on the sexagesimal system, under the charge of Dr. J. Bauschinger, the director of the k. Recheninstitut at Berlin. The arrangement is to be in groups of three as in Bremiker's tables.

Collections of Tables.—For a computer who requires in one volume logarithms of numbers and a ten-second logarithmic canon, perhaps the two best books are L. Schrön, *Seven-Figure Logarithms* (London, 1865, stereotyped, an English edition of the German work published at Brunswick), and C. Bruhns, *A New Manual of Logarithms to Seven Places of Decimals* (Leipzig, 1870). Both these works (of which there have been numerous editions) give logarithms of numbers and a complete ten-second canon to 7 places; Bruhns also gives log sines, cosines, tangents, and cotangents to every second up to 6° with proportional parts. Schrön contains an interpolation table, of 75 pages, giving the first 100 multiples of all numbers from 40 to 420. The logarithms of numbers extend to 108,000 in Schrön and to 100,000 in Bruhns. Almost equally convenient is Bremiker's edition of Vega's *Logarithmic Tables* (Berlin, stereotyped; the English edition was translated from the fortieth edition of Bremiker's by W. L. F. Fischer). This book gives a canon to every ten seconds, and for the first five degrees to every second, with logarithms of numbers to 100,000. Schrön, Bruhns, and Bremiker all give the proportional parts for all the differences in the logarithms of numbers. In Babbage's, Callet's, and many other tables only every other table of proportional parts is given near the beginning for want of space. Schrön, Bruhns, and most modern tables published in Germany have title-pages and introductions in different languages. J. Dupuis, *Tables de logarithmes à sept décimales* (stereotyped, third tirage, 1868, Paris), is also very convenient, containing a ten-second canon, besides logarithms of numbers to 100,000, hyperbolic logarithms of numbers to 1000, to 7 places, &c. In this work negative characteristics are printed throughout in the tables of circular functions, the minus sign being placed above the figure; for the mathematical calculator these are preferable to the ordinary characteristics that are increased by 10. The edges of the pages containing the circular functions are red, the rest being grey. Dupuis also edited Callet's logarithms in 1862, with which this work must not be confounded. J. Salomon, *Logarithmische Tafeln* (Vienna, 1827), contains a ten-second canon (the intervals being one second for the first two degrees), logarithms of numbers to 108,000, squares, cubes, square roots, and cube roots to 1000, a factor table to 102,011, ten-place Briggian and hyperbolic logarithms of numbers to 1000 and of primes to 10,333, and many other useful tables. The work, which is scarce, is a well-printed small quarto volume.

Of collections of general tables among the most useful and accessible are Hutton, Callet, Vega, and Köhler. C. Hutton's well-known *Mathematical Tables* (London) was first issued in 1785, but considerable additions were made in the fifth edition (1811). The tables contain seven-figure logarithms to 108,000, and to 1200 to 20 places, some antilogarithms to 20 places, hyperbolic logarithms from 1 to 10 at intervals of ·01 and to 1200 at intervals of unity to 7 places, logistic logarithms, log sines and tangents to every second of the first two degrees, and natural and log sines, tangents, secants, and versed sines for every minute of the quadrant to 7 places. The natural functions occupy the left-hand pages and the logarithmic the right-hand. The first six editions, published in Hutton's lifetime (d. 1823), contain Abraham Sharp's 61-figure logarithms of numbers. Olinthus Gregory, who brought out the 1830 and succeeding editions, omitted these tables and Hutton's introduction, which contains a history of logarithms, the methods of constructing them, &c. F. Callet's *Tables portatives de logarithmes* (stereotyped, Paris) seems to have been first issued in 1783, and has since passed through a great many editions. In that of 1853 the contents are seven-figure logarithms to 108,000, Briggian and hyperbolic logarithms to 48 places of numbers to 100 and of primes to 1097, log sines and tangents for minutes (centesimal) throughout the quadrant to 7 places, natural and log sines to 15 places for every ten minutes (centesimal) of the quadrant, log sines and tangents for every second of the first five degrees (sexagesimal) and for every ten seconds of the quadrant (sexagesimal) to 7 places, besides logistic logarithms, the first hundred multiples of the modulus to 24 places and the first ten to 70 places, and other tables. This is one of the most complete and practically useful collections of logarithms that have been published, and it is peculiar in giving a centesimally divided canon. The size of the page in the editions published in the 19th century is larger than that of the earlier editions, the type having been reset. G. Vega's *Tabulae logarithmo-trigonometricae* was first published in 1797 in two volumes. The first contains seven-figure logarithms to 101,000, log sines, &c., for every tenth of a second to 1′, for every second to 1° 30′, for every 10″ to 6° 3′, and thence at intervals of a minute, also natural sines and tangents to every minute, all to 7 places. The second volume gives simple divisors of all numbers up to 102,000, a list of primes from 102,000 to 400,313, hyperbolic logarithms of numbers to 1000 and of primes to 10,000, to 8 places, e^x and $\log_{10}e^x$ to $x=10$ at intervals of ·01 to 7 figures and 7 places respectively, the first nine powers of the numbers from 1 to 100, squares and cubes to 1000, logistic logarithms, binomial theorem coefficients, &c. Vega also published *Manuale logarithmico-trigonometricum* (Leipzig, 1800), the tables in which are identical with a portion of those contained in the first volume of the *Tabulae*. The *Tabulae* went through many editions, a stereotyped issue being brought out by J. A. Hülsse (*Sammlung mathematischer Tafeln*, Leipzig) in one volume in 1840. The contents are nearly the same as those of the original work, the chief difference being that a large table of Gaussian logarithms is added. Vega differs from Hutton and Callet in giving so many useful non-logarithmic tables, and his collection is in many respects complementary to theirs. J. C. Schulze, *Neue und erweiterte Sammlung logarithmischer, trigonometrischer, und anderer Tafeln* (2 vols. Berlin, 1778), is a valuable collection, and contains seven-figure logarithms to 101,000, log sines and tangents to 2° at intervals of a second, and natural sines, tangents, and secants to 7 places, log sines and tangents and *Napierian* log sines and tangents to 8 places, all for every ten seconds to 4° and thence for every minute to 45°, besides squares, cubes, square roots, and cube roots to 1000, binomial theorem coefficients, powers of e, and other small tables. Wolfram's hyperbolic logarithms of numbers below 10,000 to 48 places first appeared in this work. J. H. Lambert's *Supplementa tabularum logarithmicarum et trigonometricarum* (Lisbon, 1798) contains a number of useful and curious non-logarithmic tables and bears a general resemblance to the second volume of Vega, but there are also other small tables of a more strictly mathematical character. A very useful collection of non-logarithmic tables is contained in Peter Barlow's *New Mathematical Tables* (London, 1814). It gives squares, cubes, square roots, and cube roots (to 7 places), reciprocals to 9 or 10 places, and resolutions into their prime factors of all numbers from 1 to 10,000, the first ten powers of numbers to 100, fourth and fifth powers of numbers from 100 to 1000, prime numbers from 1 to 100,103, eight-place hyperbolic logarithms to 10,000, tables for the solution of the irreducible case in cubic equations, &c. In the stereotyped reprint of 1840 only the squares, cubes, square roots, cube roots, and reciprocals are retained. The first volume of Shortrede's tables, in addition to the trigonometrical canon to every second, contains antilogarithms and Gaussian logarithms. F. R. Hassler, *Tabulae logarithmicae et trigonometricae* (New York, 1830, stereotyped), gives seven-figure logarithms to 100,000, log sines and tangents for every second to 1°, and log sines, cosines, tangents, and cotangents from 1° to 3° at intervals of 10″ and thence to 45° at intervals of 30″. Every effort has been made to reduce the size of the tables without loss of distinctness, the page being only about 3 by 5 inches. Copies of the work were published with the introduction and title-page in different languages. A. D. Stanley, *Tables of Logarithms* (New Haven, U.S., 1860), gives seven-figure logarithms to 100,000, and log sines, cosines, tangents, cotangents, secants, and cosecants at intervals of ten seconds to 15° and thence at intervals of a minute to 45° to 7 places, besides natural sines and cosines, antilogarithms, and other tables. This collection owed its origin to the fact that Hassler's tables were found to be inconvenient owing to the smallness of the type. G. Luvini, *Tables of Logarithms* (London, 1866, stereotyped, printed at Turin), gives seven-figure logarithms to 20,040, Briggian and hyperbolic logarithms of primes to 1200 to 20 places, log sines and tangents for each second to 9′, at intervals of 10″ to 2°, of 30″ to 9°, of 1′ to 45° to 7 places, besides square and cube roots up to 625. The book, which is intended for schools, engineers, &c., has a peculiar arrangement of the logarithms and proportional parts on the pages. *Mathematical Tables* (W. & R. Chambers, Edinburgh), containing logarithms of numbers to 100,000, and a canon to every minute of log sines, tangents, and secants and of natural sines to 7 places, besides proportional logarithms and other small tables, is cheap and suitable for schools, though not to be compared as regards matter or typography to the best tables described above.

Of six-figure tables C. Bremiker's *Logarithmorum VI. decimalium nova tabula Berolinensis* (Berlin 1852) is probably one of the best. It gives logarithms of numbers to 100,000, with proportional parts, and log sines and tangents for every second to 5°, and beyond 5° for every ten seconds, with proportional parts. J. Hantschl, *Logarithmisch-trigonometrisches Handbuch* (Vienna, 1827), gives five-figure logarithms to 10,000, log sines and tangents for every ten seconds to 6 places, natural sines, tangents, secants, and versed sines for every minute to 7 places, logarithms of primes to 15,391, hyperbolic logarithms of numbers to 11,273 to 8 places, least divisors of numbers to 18,277, binomial theorem coefficients, &c. R. Farley's *Six-Figure Logarithms* (London, stereotyped, 1840), gives six-figure logarithms to 10,000 and log sines and tangents for every minute to 6 places.

Coming now to five-figure tables a very convenient little book is *Tables of Logarithms* (Useful Knowledge Society, London, from the stereotyped plates of 1839), which was prepared by De Morgan, though it has no name on the title-page. It contains five-figure logarithms to 10,000, log sines and tangents to every minute to 5 places, besides a few smaller tables. J. de Lalande's *Tables de logarithmes* is a five-figure table with nearly the same contents as De Morgan's, first published in 1805. It has since passed through many editions, and, after being extended from 5 to 7 places, passed through several more. J. Galbraith and S. Haughton, *Manual of Mathematical Tables* (London, 1860), give five-figure logarithms to 10,000 and log sines and tangents for every minute, also a small table of Gaussian logarithms. J. Houël, *Tables de logarithmes à cinq décimales* (Paris, 1871; new edition 1907), is a very convenient collection of five-figure tables; besides logarithms of numbers and circular functions, there are Gaussian logarithms, least divisors of numbers to 10,841, antilogarithms, &c. The work (118 pp.) is printed on thin paper. A. Gernerth, *Fünfstellige gemeine Logarithmen* (Vienna, 1866), gives logarithms to 10,800 and a ten-second canon. There are sixty lines on the page, so that the double page contains log sines, cosines, tangents, and cotangents extending over a minute. C. Bremiker, *Logarithmisch-trigonometrische Tafeln mit fünf Decimalstellen* (10th edition by A. Kallius, Berlin, 1906), which has been already referred to, gives logarithms to 10,009 and a logarithmic canon to *every hundredth* of a degree (sexagesimal), in a handy volume; the lines are divided into groups of three, an arrangement about the convenience of which there is a difference of opinion. H. Gravelius, *Fünfstellige logarithmisch-trigonometrische Tafeln für die Decimalteilung des Quadranten* (Berlin, 1886), is a well-printed five-figure table giving logarithms to 10,009, a logarithmic canon to every centesimal minute (*i.e.* ten-thousandth part of a right angle), and an extensive table (40 pp.) for the conversion of centesimally expressed arcs into sexagesimally expressed arcs and vice versa. Among the other tables is a four-place table of squares from 0 to 10 at intervals of ·001 with proportional parts. E. Becker, *Logarithmisch-trigonometrisches Handbuch auf fünf Decimalen* (2nd stereo. ed., Leipzig, 1897), gives logarithms to 10,009 and a logarithmic canon for every tenth of a minute to 6° and thence to 45° for every minute. There are also Gaussian logarithms. V. E. Gamborg, *Logaritmetabel* (Copenhagen, 1897), is a well-printed collection of tables, which contains a five-figure logarithmic canon to every minute, five-figure logarithms of numbers to 10,000, and five-figure antilogarithms, viz., five-figure numbers answering to four-figure mantissae from ·0000 to ·9999 at intervals of ·0001. H. Schubert, *Fünfstellige Tafeln und Gegentafeln* (Leipzig, 1896), is peculiar in giving, besides logarithms of numbers and a logarithmic and natural canon, the three converse tables of numbers answering to logarithms, and angles answering to logarithmic and natural trigonometrical functions. The five-figure tables of F. G. Gauss (Berlin, 1870) have passed through very many editions, and mention should also be made of those of T. Wittstein (Hanover, 1859) and F. W. Rex (Stuttgart, 1884). S. W. Holman, *Computation Rules and Logarithms* (New York, 1896), contains a well-printed and convenient set of tables including five-figure logarithms of numbers to 10,000 and a five-figure logarithmic canon to every minute, the actual characteristics (with the negative sign above the number) being printed, as in the tables of Dupuis, 1868, referred to above. There is also a four-place trigonometrical canon and four-place antilogarithms, reciprocals, square and cube roots, &c. G. W. Jones, *Logarithmic Tables* (4th ed., London, and Ithaca, N.Y., 1893), contains a five-place natural trigonometrical canon and a six-place logarithmic canon to every minute, six-place Gaussian and hyperbolic logarithms, besides a variety of four-place tables, including squares, cubes, quarter-squares, reciprocals, &c. The factor table has been already noticed. It is to be observed that the fourth edition is quite a distinct work from the third, which contained much fewer tables. J. B. Dale, *Five-figure Tables of Mathematical Functions* (London, 1903), is a book of 92 pages containing a number of small five-figure tables of functions which are not elsewhere to be found in one volume. Among the functions tabulated are elliptic functions of the first and second kind, the gamma function, Legendre's coefficients, Bessel's functions, sine, cosine, and exponential integrals, &c. J. Houël's *Recueil de formules et de tables numériques* (Paris, 1868) contains 19 tables, occupying 62 pages, most of them giving results to 4 places; they relate to very varied subjects—antilogarithms, Gaussian logarithms, logarithms of $1+x/1-x$ elliptic integrals, squares for use in the method of least squares, &c. C. Bremiker, *Tafel vierstelliger Logarithmen* (Berlin, 1874), gives four-figure logarithms, of numbers to 2009, log sines, cosines, tangents, and cotangents to 8° for every hundredth of a degree, and thence to 45° for every tenth of a degree, to 4 places. There are also Gaussian logarithms, squares from 0·000 to 13,500, antilogarithms, &c. The book contains 60 pages. It is not worth while to give a list of four-figure tables or other tables of small extent, which are very numerous, but mention may be made of J. M. Peirce, *Mathematical Tables chiefly to Four Figures* (Boston, U.S., 1879), 42 pp., containing also hyperbolic functions; W. Hall, *Four-figure Tables and Constants* (Cambridge, 1905), 60 pp., chiefly for nautical computation; A. du P. Denning, *Five-figure Mathematical Tables for School and Laboratory Purposes* (12 pp. of tables, large octavo); A. R. Hinks, *Cambridge Four-figure Mathematical Tables* (12 pp.). C. M. Willich, *Popular Tables* (London, 1853), is a useful book for an amateur; it gives Briggian and hyperbolic logarithms to 1200 to 7 places, squares, &c., to 343, &c.

Hyperbolic or Napierian or Natural Logarithms.—The logarithms invented by Napier and explained by him in the *Descriptio* (1614) were not the same as those now called natural or hyperbolic (viz., to base e), and very frequently also Napierian, logarithms. Napierian logarithms, strictly so called, have entirely passed out of use and are of purely historic interest; it is therefore sufficient to refer to the article LOGARITHM, where a full account is given. Apart from the inventor's own publications, the only strictly Napierian tables of importance are contained in Ursinus's *Trigonometria* (Cologne, 1624–1625) and Schulze's *Sammlung* (Berlin, 1778), the former being the largest that has been constructed. Logarithms to the base e, where e denotes 2·71828 . . ., were first published by J. Speidell, *New Logarithmes* (1619).

The most copious table of hyperbolic logarithms is Z. Dase, *Tafel der natürlichen Logarithmen* (Vienna, 1850), which extends from 1 to 1000 at intervals of unity and from 1000 to 10,500 at intervals of ·1 to 7 places, with differences and proportional parts, arranged as in an ordinary seven-figure table. By adding log 10 to the results the range is from 10,000 to 105,000 at intervals of unity. The table formed part of the *Annals of the Vienna Observatory* for 1851, but separate copies were printed. The most elaborate table of hyperbolic logarithms is due to Wolfram, who calculated to 48 places the logarithms of all numbers up to 2200, and of all primes (also of a great many composite numbers) between this limit and 10,009. Wolfram's results first appeared in Schulze's *Sammlung* (1778). Six logarithms which Wolfram had been prevented from computing by a serious illness were supplied in the *Berliner Jahrbuch*, 1783, p. 191. The complete table was reproduced in Vega's *Thesaurus* (1794), where several errors were corrected. Tables of hyperbolic logarithms are contained in the following collections:—Callet, all numbers to 100 and primes to 1097 to 48 places; Borda and Delambre (1801), all numbers to 1200 to 11 places; Salomon (1827), all numbers to 1000 and primes to 10,333 to 10 places; Vega, *Tabulae* (including Hülsse's edition, 1840), and Köhler (1848), all numbers to 1000 and primes to 10,000 to 8 places; Barlow (1814), all numbers to 10,000; Hutton, *Mathematical Tables*, and Willich (1853), all numbers to 1200 to 7 places; Dupuis (1868), all numbers to 1000 to 7 places. Hutton also gives hyperbolic logarithms from 1 to 10 at intervals of ·01 to 7 places. *Rees's Cyclopaedia* (1819), art, "Hyperbolic Logarithms," contains a table of hyperbolic logarithms of all numbers to 10,000 to 8 places.

Logarithms to base e are generally termed *Napierian* by English writers, and *natural* by foreign writers. There seems no objection to the former name, though the logarithms actually invented by Napier depended on the base e^{-1}, but it should be mentioned in text-books that so-called Napierian logarithms are not identical with those originally devised and calculated by Napier.

Tables to convert Briggian into Hyperbolic Logarithms, and vice versa.—Such tables merely consist of the first hundred (sometimes only the first ten) multiples of the modulus ·43429 44819 . . . and its reciprocal 2·30258 50929 . . . to 5, 6, 8, 10, or more places. They are generally to be found in collections of logarithmic tables, but rarely exceed a page in extent, and are very easy to construct. Schrön and Bruhns both give the first hundred multiples of the modulus and its reciprocal to 10 places, and Bremiker (in his edition of Vega and in his six-figure tables) and Dupuis to 7 places. C. F. Degen, *Tabularum Enneas* (Copenhagen, 1824), gives the first hundred multiples of the modulus to 30 places.

Antilogarithms.—In the ordinary tables of logarithms the natural numbers are integers, while the logarithms are incommensurable. In an antilogarithmic canon the logarithms are exact quantities, such as ·00001, ·00002, &c., and the corresponding numbers are incommensurable. The largest and earliest work of this kind is J. Dodson's *Antilogarithmic Canon* (London, 1742), which gives numbers to 11 places corresponding to logarithms from 0 to 1 at intervals of ·00001, arranged like a seven-figure logarithmic table, with interscript differences and proportional parts at the bottom of the page. This work was the only large antilogarithmic canon for more than a century, till in 1844 Shortrede published the first edition of his tables; in 1849 he published the second edition, and in the same year Filipowski's tables appeared. Both these works contain seven-figure antilogarithms: Shortrede gives numbers to logarithms from 0 to 1 at intervals of ·00001, with differences and multiples at the top of the page, and H. E. Filipowski, *A Table of Antilogarithms* (London, 1849), contains a table of the same extent, the proportional parts being given to hundredths.

Small tables of antilogarithms to 20 places occur in several collections of tables, as Gardiner (1742), Callet, and Hutton. Four- and five-place tables are not uncommon in recent works, as *e.g.* in Houël (1871), Gamborg (1897), Schubert (1896), Holman (1896).

Addition and Subtraction, or Gaussian Logarithms.—The object of such tables is to give log $(a \pm b)$ by only one entry when log a and log b are given. Let

$$A = \log x,\ B = \log(1+x^{-1}),\ C = \log(1+x).$$

Leaving out the specimen table in Z. Leonelli's *Théorie des logarithmes additionnels et déductifs* (Bordeaux, 1803), in which the first suggestion was made,[1] the principal tables are the following: Gauss, in Zach's *Monatliche Correspondenz* (1812), gives B and C for argument A from 0 to 2 at intervals of ·001, thence to 3·40

[1] Leonelli's original work of 1803, which is extremely scarce, was reprinted by J. Houël at Paris in 1875.

at intervals of ·01, and to 5 at intervals of ·1, all to 5 places. This table is reprinted in Gauss's *Werke*, vol. iii. p. 244. E. A. Matthiessen, *Tafel zur bequemern Berechnung* (Altona, 1818), gives B and C to 7 places for argument A from 0 to 2 at intervals of ·0001, thence to 3 at intervals of ·001, to 4 at intervals of ·01, and to 5 at intervals of ·1; the table is not conveniently arranged. Peter Gray, *Tables and Formulae* (London, 1849, and "Addendum," 1870), gives C for argument A from -3 to -1 at intervals of ·001 and from -1 to 2 at intervals of ·0001, to 6 places, with proportional parts to hundredths, and log $(1-x)$ for argument A from -3 to -1 at intervals of ·001 and from $\bar{1}$ to $\bar{1}$8999 at intervals of ·0001, to 6 places, with proportional parts. J. Zech, *Tafeln der Additions- und Subtractions-Logarithmen* (Leipzig, 1849), gives B for argument A from 0 to 2 at intervals of ·0001, thence to 4 at intervals of ·001 and to 6 at intervals of ·01; also C for argument A from 0 to ·0003 at intervals of ·0000001, thence to ·05 at intervals of ·000001 and to ·303 at intervals of ·00001, all to 7 places, with proportional parts. These tables are reprinted from Hülsse's edition of Vega (1849); the 1840 edition of Hülsse's Vega contained a reprint of Gauss's original table. T. Wittstein, *Logarithmes de Gauss à sept décimales* (Hanover, 1866), gives B for argument A from 3 to 4 at intervals of ·1, from 4 to 6 at intervals of ·01, from 6 to 8 at intervals of ·001, from 8 to 10 at intervals of ·0001, also from 0 to 4 at the same intervals. In this handsome work the arrangement is similar to that in a seven-figure logarithmic table. Gauss's original five-place table was reprinted in Pasquich, *Tabulae* (Leipzig, 1817); Köhler, *Jerome de la Lande's Tafeln* (Leipzig, 1832), and *Handbuch* (Leipzig, 1848); and Galbraith and Haughton, *Manual* (London, 1860). Houël, *Tables de logarithmes* (1871), also gives a small five-place table of Gaussian logarithms, the addition and subtraction logarithms being separated as in Zech. Modified Gaussian logarithms are given by J. H. T. Müller, *Vierstellige Logarithmen* (Gotha, 1844), viz., a four-place table of B and $-\log(1-x^{-1})$ from $A=0$ to ·03 at intervals of ·0001, thence to ·23 at intervals of ·001, to 2 at intervals of ·01, and to 4 at intervals of ·1; and by Shortrede, *Logarithmic Tables* (vol. i., 1849), viz., a five-place table of B and $\log(1+x)$ from $A=5$ to 3 at intervals of ·1, from $A=\bar{3}$ to $\bar{2}$·7 at intervals of ·01, to 1·3 at intervals of ·001, to 3 at intervals of ·01, and to 5 at intervals of ·1. Filipowski's *Antilogarithms* (1849) contains Gaussian logarithms arranged in a new way. The principal table gives log $(x+1)$ as tabular result for log x as argument from 8 to 14 at intervals of ·001 to 5 places. Weidenbach, *Tafel um den Logarithmen* . . . (Copenhagen, 1829), gives $\log\frac{x+1}{x-1}$ for argument A from ·382 to 2·002 at intervals of ·001, to 3·6 at intervals of ·01, and to 5·5 at intervals of ·1 to 5 places. J. Houël's *Recueil de formules et de tables numériques* (2nd ed., Paris, 1868) contains tables of $\log_{10}(x+1)$, $\log_{10}\frac{1}{1-x}$, and $\log_{10}\frac{1+x}{1-x}$ from $\log x = -5$ to -3 at intervals of ·1, from $\log x = -3$ to -1 at intervals of ·01, from $\log x = -1$ to 0 at intervals of ·001. F. W. Rex (*Fünfstellige Logarithmen-Tafeln*, Stuttgart, 1884) gives also a five-figure table of $\log\frac{1+x}{1-x}$, and E. Hammer in his *Sechsstellige Tafel der Werthe für jeden Wert des Arguments log x* (Leipzig, 1902) gives a six-figure table of this function from $\log x=\bar{7}$ to $\bar{1}$·99000, and thence to 1·999700 to 5 places. S. Gundelfinger's *Sechsstellige Gaussische und siebenstellige gemeine Logarithmen* (Leipzig, 1902) contains a table of $\log_{10}(1+x)$ to 6 places from $\log x = -2$ to 2 at intervals of ·001. G. W. Jones's *Logarithmic Tables* (4th ed., London, and Ithaca, N.Y., 1893) contain 17 pages of Gaussian six-figure tables; the principal of which give $\log(1+x)$ to argument log x from $\log x = -2$ ·80 to 0 at intervals of ·001, and thence to ·1999 at intervals of ·0001, and $\log(1-x^{-1})$ to argument log x from log $x=$·4 to ·5 at intervals of ·0001, and thence to 2·8 at intervals of ·001. Gaussian logarithms to 5 or 4 places occur in many collections of five-figure or four-figure tables.

Quadratic Logarithms.—In a pamphlet *Saggio di tavole dei logaritmi quadratici* (Udine, 1885) Conte A. di Prampero has described a method of obtaining fractional powers (positive or negative) of any number by means of tables contained in the work. If

$$a^{b^x}=\mathrm{N},\ \text{then}\ x=\frac{\log\log \mathrm{N}-\log\log a}{\log b},$$

and if the logarithms are taken to be Briggian and $a=10^{\frac{1}{1024}}$ and $b=2$, then $x=\log_{10}\log_{10}N/\log 2+10$.

This quantity the author defines as the quadratic logarithm of N and denotes by $\mathrm{L_q}N$. It follows from this definition that $\mathrm{L_q}N^r=\mathrm{L_q}N+\log_{10}r/\log_{10}2$. Thus the quadratic logarithms of N and N^s where s is any power (positive or negative) of 2 have the same mantissa.

A subsidiary table contains the values of the constant $\log_{10}r/\log_{10}2$ for 204 fractional values of r. The main table contains the values of 1000 mantissae corresponding to arguments N, $N^{\frac{1}{2}}$, $N^{\frac{1}{4}}$, . . . (which all have the same mantissae). Among the arguments are the quantities 10·0, 10·1, 10·2, . . . 99·9 (the interval being ·1) and 10·00, 10·01, . . . 10·99 (the interval being ·01). As an example, to obtain the value of $12^{\frac{2}{3}}$ we take from the first table the constant -0·584962, which belongs to $\frac{2}{3}$, and entering the main table with 12 we take out the quadratic logarithm 10·109937 which, by applying the constant, gives 9·524975 the quadratic logarithm of the quantity required.

An appendix (*Tavola degli esponenti*) gives the Briggian logarithms of the first 57 numbers to the first 50 numbers as base, viz. $\log_x N$ for $N=2, 3, \ldots, 57$ and $x=2, 3, \ldots, 50$. The results are generally given to 6 places.

Logistic and Proportional Logarithms.—In most collections of tables of logarithms a five-place table of logistic logarithms for every second to 1° is given. Logistic tables give log 3600 − log x at intervals of a second, x being expressed in degrees, minutes, and seconds. In Schulze (1778) and Vega (1797) the table extends to $x=3600''$ and in Callet and Hutton to $x=5280''$. Proportional logarithms for every second to 3° (*i.e.* log 10,800 − log x) form part of nearly all collections of tables relating to navigation, generally to 4 places, sometimes to 5. Bagay, *Tables* (1829), gives a five-place table, but such are not often to be found in collections of mathematical tables. The same remark applies to tables of proportional logarithms for every minute to 24^{h}, which give to 4 or 5 places the values of log 1440 − log x. The object of a proportional or logistic table, or a table of log a − log x, is to facilitate the calculation of proportions in which the third term is a.

Interpolation Tables.—All tables of proportional parts may be regarded as interpolation tables. C. Bremiker, *Tafel der Proportionalteile* (Berlin, 1843), gives proportional parts to hundredths of all numbers from 70 to 699. Schrön, *Logarithms*, contains an interpolation table giving the first hundred multiples of all numbers from 40 to 410. Sexagesimal tables, already described, are interpolation tables where the denominator is 60 or 600. Tables of the values of binomial theorem coefficients, which are required when second and higher orders of differences are used, are described below. W. S. B. Woolhouse, *On Interpolation, Summation, and the Adjustment of Numerical Tables* (London, 1865), contains nine pages of interpolation tables. The book consists of papers extracted from vols. 11 and 12 of the *Assurance Magazine*.

Dual Logarithms.—This term was used by Oliver Byrne in his *Dual Arithmetic*, *Young Dual Arithmetician*, *Tables of Dual Logarithms*, &c. (London, 1863–67). A dual number of the ascending branch is a continued product of powers of 1·1, 1·01, 1·001, &c., taken in order, the powers only being expressed; thus ↓ 6,9,7,8 denotes $(1{\cdot}1)^6(1{\cdot}01)^9(1{\cdot}001)^7(1{\cdot}0001)^8$, the numbers following the ↓ being called dual digits. A dual number which has all but the last digit zeros is called a dual logarithm; the author uses dual logarithms in which there are seven ciphers between the ↓ and the logarithm. Thus since 1·00601502 is equal to ↓ 0,0,0,0,0,0,0,599702 the whole number 599702 is the dual logarithm of the natural number 1·00601502.

A dual number of the descending branch is a continued product of powers of ·9, ·99, &c.: for instance, $({\cdot}9)^3({\cdot}99)^2$ is denoted by '3 '2 ↑. The *Tables*, which occupy 112 pages, give dual numbers and logarithms, both of the ascending and descending branches, and the corresponding natural numbers. The author claimed that his tables were superior to those of common logarithms.

Constants.—In nearly all tables of logarithms there is a page devoted to certain frequently used constants and their logarithms, such as π, π^{-1}, π^2, $\sqrt{\pi}$. A specially good collection is printed in W. Templeton's *Millwright's and Engineer's Pocket Companion* (corrected by S. Maynard, London, 1871), which gives 58 constants involving π and their logarithms, generally to 30 places, and 13 others that may be properly called mathematical. A good list of constants involving π is given in Salomon (1827). A paper by G. Paucker in *Grunert's Archiv* (vol. i. p. 9) has a number of constants involving π given to a great many places, and Gauss's memoir on the lemniscate function (*Werke*, vol. iii.) has $e^{-\pi}$, $e^{-\frac{1}{2}\pi}$, $e^{-\frac{1}{4}\pi}$, &c., calculated to about 50 places. The quantity π has been worked out to 707 places (Shanks, *Proc. Roy. Soc.*, 21, p. 319).

J. C. Adams has calculated Euler's constant to 263 places (*Proc. Roy. Soc.*, 27, p. 88) and the modulus ·43429 . . . to 272 places (*Id.* 42, p. 22). The latter value is quoted in *extenso* under LOGARITHM. J. Burgess on p. 23 of his paper of 1888, referred to under *Tables of e^x*, has given a number of constants involving π and ρ (the constant ·476936 . . . occurring in the *Theory of Errors*), and their Briggian logarithms, to 23 places.

Tables for the Solution of Cubic Equations.—Lambert, *Supplementa* (1798), gives $\pm(x-x^3)$ from $x=$·001 to 1·155 as intervals of ·001 to 7 places, and Barlow (1814) gives x^3-x from $x=1$ to 1·1549 at intervals of ·0001 to 8 places. Very extensive tables for the solution of cubic equations are contained in a memoir "Beiträge zur Auflösung höherer Gleichungen" by J. P. Kulik in the *Abh. der k. Böhm. Ges. der Wiss.* (Prague, 1860), 11, pp. 1–123. The principal tables (pp. 58–123) give to 7 (or 6) places the values of $\pm(x-x^3)$ from $x=0$ to $x=3{\cdot}2800$ at intervals of ·001. There are also tables of the even and uneven determinants of cubic equations, &c. Other tables for the solution of equations are by A. S. Guldberg in the *Forhand.* of the *Videns-Selskab* of Christiania for 1871 and 1872 (equations of the 3rd and 5th order), by S. Gundelfinger, *Tafeln zur Berechnung der reellen Wurzeln sämtlicher trinomischen Gleichungen* (Leipzig, 1897), which depend on the use of Gaussian logarithms, and by R. Mehme, *Schlömilch's Zeitschrift*, 1898, 43, p. 80 (quadratic equations).

Binomial Theorem Coefficients.—Tables of the values of

$$\frac{x(x-1)}{1.2},\ \frac{x(x-1)(x-2)}{1.2.3},\ldots\frac{x(x-1)\ldots(x-5)}{1.2\ldots6}$$

from $x=\cdot01$ to $x=1$ at intervals of ·01 to 7 places (which are useful in interpolation by second and higher orders of differences), occur in Schulze (1778), Barlow (1814), Vega (1797 and succeeding editions), Hantschl (1827), and Köhler (1848). W. Rouse, *Doctrine of Chances* (London, n.d.), gives on a folding sheet $(a+b)^n$ for $n=1, 2,\ldots 20$.

H. Gyldén (*Recueil des Tables*, Stockholm, 1880) gives binomial coefficients to $n=40$ and their logarithms to 7 places. Lambert, *Supplementa* (1798), has the coefficients of the first 16 terms in $(1+x)^{\frac{1}{2}}$ and $(1-x)^{\frac{1}{2}}$, their values being given accurately as decimals. Vega (1797) has a page of tables giving $\frac{1}{2.4}, \frac{1.3}{2.4.6},\ldots\frac{1}{2.3},\ldots$ and similar quantities to 10 places, with their logarithms to 7 places, and a page of this kind occurs in other collections. Köhler (1848) gives the values of 40 such quantities.

Figurate Numbers.—Denoting $n(n+1)\ldots(n+i-1)/i!$ by $[n]_i$, Lambert, *Supplementa*, 1798, gives $[n]_i$ from $n=1$ to $n=30$ and from $i=1$ to $i=12$; and G. W. Hill (*Amer. Jour. Math.*, 1884, 6, p. 130) gives $\log_{10}[n]_i$ for $n=\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}$, and from $i=1$ to $i=30$.

Trigonometrical Quadratic Surds.—The surd values of the sines of every third degree of the quadrant are given in some tables of logarithms; *e.g.*, in Hutton's (p. xxxix., ed. 1855), we find $\sin 3^\circ=\frac{1}{8}\{\sqrt{(5+\sqrt5)}+\sqrt{\tfrac{15}{2}}+\sqrt{\tfrac{5}{2}}-\sqrt{(15+3\sqrt5)}-\sqrt{\tfrac{3}{2}}-\sqrt{\tfrac{1}{2}}\}$; and the numerical values of the surds $\sqrt{(5+\sqrt5)}$, $\sqrt{(\frac{15}{2})}$, &c., are given to 10 places. These values were extended to 20 places by Peter Gray, *Mess. of Math.*, 1877, 6, p. 105.

Circulating Decimals.—Goodwyn's tables have been described already. Several others have been published giving the numbers of digits in the periods of the reciprocals of primes: Burckhardt, *Tables des diviseurs du premier million* (Paris, 1814–1817), gave one for all primes up to 2543 and for 22 primes exceeding that limit. E. Desmarest, *Théorie des nombres* (Paris, 1852), included all primes up to 10,000. C. G. Reuschle, *Mathematische Abhandlung, enthaltend neue zahlentheoretische Tabellen* (1856), contains a similar table to 15,000. This W. Shanks extended to 60,000; the portion from 1 to 30,000 is printed in the *Proc. Roy. Soc.*, 22, p. 200, and the remainder is preserved in the archives of the society (*Id.*, 23, p. 260 and 24, p. 392). The number of digits in the decimal period of $1/p$, is the same as the exponent to which 10 belongs for modulus p, so that, whenever the period has $p-1$ digits, 10 is a primitive root of p. Tables of primes having a given number, n, of digits in their periods, *i.e.* tables of the resolutions of 10^n-1 into factors and, as far as known, into prime factors, have been given by W. Looff (in *Grunert's Archiv*, 16, p. 54; reprinted in *Nouv. annales*, 14, p. 115) and by Shanks (*Proc. Roy. Soc.*, 22, p. 381). The former extends to $n=60$ and the latter to $n=100$, but there are gaps in both. Reuschle's tract also contains resolutions of 10^n-1.

There is a similar table by C. E. Bickmore in *Mess. of Math.*, 1896, 25, p. 43. A full account of all tables connecting n and p where $10^n=1$, mod p, 10^n being the least power for which this congruence holds good, is given by Allan Cunningham (*Id.*, 1904, 33, p. 145). The paper by the same author, "Period-lengths of Circulates" (*Id.* 1900, 29, p. 145) relates to circulators in the scale of radix a. See also tables of the resolutions of a^n-1 into factors under *Tables relating to the Theory of Numbers* (below). Some further references on circulating decimals are given in *Proc. Camb. Phil. Soc.*, 1878, 3, p. 185.

Pythagorean Triangles.—Right-angled triangles in which the sides and hypothenuse are all rational integers are frequently termed Pythagorean triangles, as, for example, the triangles 3, 4, 5, and 5, 12, 13. Schulze, *Sammlung* (1778), contains a table of such triangles subject to the condition $\tan\frac{1}{2}\omega > \frac{1}{25}$($\omega$ being one of the acute angles). About 100 triangles are given, but some occur twice. Large tables of right-angled rational triangles were given by C. A. Bretschneider, in *Grunert's Archiv*, 1841, 1, p. 96, and by Sang, *Trans. Roy. Soc. Edin.*, 1864, 33, p. 727. In these tables the triangles are arranged according to hypothenuses and extend to 1201, 1200, 49, and 1105, 1073, 264 respectively. W. A. Whitworth, in a paper read before the Lit. and Phil. Society of Liverpool in 1875, carried his list as far as 2465, 2337, 784. See also H. Rath, "Die rationalen Dreiecke," in *Grunert's Archiv*, 1874, 56, p. 188. Sang's paper also contains a table of triangles having an angle of 120° and their sides integers.

Powers of π.—G. Paucker, in *Grunert's Archiv*, p. 10, gives π^{-1} and $\pi^{\frac{1}{2}}$ to 140 places, and $\pi^{-2}, \pi^{-\frac{1}{2}}, \pi^{\frac{1}{3}}, \pi^{\frac{2}{3}}$ to about 50 places; J. Burgess (*Trans. Roy. Soc. Edin.*, 1898, 39, II., No. 9, p. 23) gives $(\frac{1}{2}\pi)^{-\frac{1}{2}}$, $2^{\frac{1}{2}}\pi^{-\frac{1}{2}}$, and some other constants involving π as well as their Briggian logarithms to 23 places, and in Maynard's list of constants (see *Constants*, above) π^2 is given to 31 places. The first twelve powers of π and π^{-1} to 22 or more places were given by Glaisher, in *Proc. Lond. Math. Soc.*, 8, p. 140, and the first hundred multiples of π and π^{-1} to 12 places by J. P. Kulik, *Tafel der Quadrat- und Kubik-Zahlen* (Leipzig, 1848).

The Series $1^{-n}+2^{-n}+3^{-n}+$&c.—Let S_n, s_n, σ_n denote respectively the sums of the series $1^{-n}+2^{-n}+3^{-n}+$ &c., $1^{-n}-2^{-n}+3^{-n}-$&c., $1^{-n}+3^{-n}+5^{-n}+$ &c. Legendre (*Traité des fonctions elliptiques*, vol. 2, p. 432) computed S_n to 16 places from $n=1$ to 35, and Glaisher (*Proc. Lond. Math. Soc.*, 4, p. 48) deduced s_n and σ_n for the same arguments and to the same number of places. The latter also gave S_n, s_n, σ_n for $n=2, 4, 6,\ldots 12$ to 22 or more places (*Proc. Lond. Math. Soc.*, 8, p. 140), and the values of Σ_n, where $\Sigma_n=2^{-n}+3^{-n}+5^{-n}+$&c. (prime numbers only involved), for $n=2, 4, 6, \ldots 36$ to 15 places (*Compte rendu de l'Assoc. Française*, 1878, p. 172).

C. W. Merrifield (*Proc. Roy. Soc.*, 1881, 33, p. 4) gave the values of $\log_e S_n$ and Σ_n for $n=1,2,3,\ldots, 35$ to 15 places, and Glaisher (*Quar. Jour. Math.*, 1891, 25, p. 347) gave the values of the same quantities for $n=2,4,6,\ldots, 80$ to 24 places (last figure uncertain). Merrifield's table was reprinted by J. P. Gram on p. 269 of the paper of 1884, referred to under *Sine-integral, &c.*, who also added the values of $\log_{10} S_n$ for the same arguments to 15 places. An error in Σ_8 in Merrifield's table is pointed out in *Quar. Jour. Math.*, 25, p. 373. This quantity is correctly given in Gram's reprint. T. J. Stieljes has greatly extended Legendre's table of S_n. His table (*Acta math.*, 1887, 10, p. 299) gives S_n for all values of n up to $n=70$ to 32 places. Except for six errors of a unit in the last figure he found Legendre's table to be correct. Legendre's table was reprinted in De Morgan's *Diff. and Int. Calc.* (1842), p. 554. Various small tables of other series, involving inverse powers of prime numbers, such as $3^{-n}-5^{-n}+7^{-n}+11^{n}-13^{n}+\ldots$, are given in vols. 25 and 26 of the *Quar. Jour. Math.*

Tables of e^x and e^{-x}, or Hyperbolic Antilogarithms.—The largest tables are the following: C. Gudermann, *Theorie der potenzial- oder cyklisch-hyperbolischen Functionen* (Berlin, 1833), which consists of papers reprinted from vols. 8 and 9 of *Crelle's Journal*, and gives $\log_{10}\sinh x$, $\log_{10}\cosh x$, and $\log_{10}\tanh x$ from $x=2$ to 5 at intervals of ·001 to 9 places and from $x=5$ to 12 at intervals of ·01 to 10 places. Since $\sinh x=\frac{1}{2}(e^x-e^{-x})$ and $\cosh x=\frac{1}{2}(e^x+e^{-x})$, the values of e^x and e^{-x} are deducible at once by addition and subtraction. F. W. Newman, in *Camb. Phil. Trans.*, 13, p. 145, gives values of e^{-x} from $x=0$ to $15\cdot349$ at intervals of ·001 to 12 places, from $x=15\cdot350$ to $17\cdot298$ at intervals of ·002, and from $x=17\cdot300$ to $27\cdot635$ at intervals of ·005, to 14 places. Glaisher, in *Camb. Phil. Trans.*, 13, p. 243, gives four tables of e^x, e^{-x}, $\log_{10}e^x$, $\log_{10}e^{-x}$, their ranges being from $x=\cdot001$ to $\cdot1$ at intervals of ·001, from ·01 to 2 at intervals of ·01, from ·1 to 10 at intervals of ·1, from 1 to 500 at intervals of unity. Vega, *Tabulae* (1797 and later ed.), has $\log_{10}e^x$ to 7 places and e^x to 7 figures from $x=\cdot01$ to 10 at intervals of ·01. Köhler's *Handbuch* contains a small table of e^x. In Schulze's *Sammlung* (1778) e^x is given for $x=1, 2, 3,\ldots$ 24 to 28 or 29 figures and for $x=25$, 30, and 60 to 32 or 33 figures; this table is reprinted in Glaisher's paper (loc. cit.). In Salomon's *Tafeln* (1827) the values of e^n, $e^{\cdot n}$, $e^{\cdot0n}$, $e^{\cdot00n},\ldots$ $e^{\cdot000000n}$, where n has the values $1, 2,\ldots 9$, are given to 12 places. Bretschneider, in *Grunert's Archiv*, 3, p. 33, gave e^x and e^{-x} and also $\sin x$ and $\cos x$ for $x=1, 2,\ldots 10$ to 20 places, and J. P. Gram (in his paper of 1884, referred to under *Sine-integral, &c.*), gives e^x for $x=10, 11,\ldots 20$ to 24 places, and from $x=7$ to $x=20$ at intervals of 0·2 to 10, 13, 14, or 15 places. J. Burgess (*Trans. Roy. Soc. Edin.*, 1888, 39, II. No. 9) has given (p. 26) the values of e^{-x} and $\sqrt{\frac{2}{\pi}}e^{-x}$ for $x=\frac{1}{2}$ and for $x=1, 2,\ldots,$ 10 to 30 places. In the same paper he also gives the values of $\sqrt{\frac{2}{\pi}}e^{-x^2}$ from $x=0$ to $x=1\cdot250$ to 9 places, and from $x=1\cdot25$ to $x=1\cdot50$ at intervals of ·01, and thence at various intervals to $x=6$ to 15 places, and the values of $\log_{10}\sqrt{\frac{2}{\pi}}e^{-x^2}$ from $x=1$ tc $x=3$ at intervals of ·001 to 16 places.

Factorials.—The values of $\log_{10}(n!)$, where $n!$ denotes $1\,.\,2\,.\,3\ldots n$, from $n=1$ to 1200 to 18 places, are given by C. F. Degen, *Tabularum Enneas* (Copenhagen, 1824), and reprinted, to 6 places, at the end of De Morgan's article "Probabilities" in the *Encyclopaedia Metropolitana*. Shortrede, *Tables* (1849, vol. i.), gives $\log(n!)$ to $n=1000$ to 5 places, and for the arguments ending in 0 to 8 places. Degen also gives the complements of the logarithms. The first 20 figures of the values of $n\times n!$ and the values of $-\log(n\times n!)$ to 10 places are given by Glaisher as far as $n=71$ in the *Phil. Trans.* for 1870 (p. 370), and the values of $1/n!$ to 28 significant figures as far as $n=50$ in *Camb. Phil. Trans.*, 13, p. 246.

Bernoullian Numbers.—The first fifteen Bernoullian numbers were given by Euler, *Inst. Calc. Diff.*, part ii. ch. v. Sixteen more were calculated by Rothe, and the first thirty-one were published by M. Ohm in *Crelle's Journal*, 20, p. 11. J. C. Adams calculated the next thirty-one, and a table of the first sixty-two was published by him in the *Brit. Ass. Report* for 1877 and in *Crelle's Journal*, 85, p. 269. In the *Brit. Ass. Report* the numbers are given not only as vulgar fractions, but also expressed in integers and circulating decimals. The first nine figures of the values of the first 250 Bernoullian numbers, and their Briggian logarithms to 10 places, have been published by Glaisher, *Camb. Phil. Trans.*, 12, p. 384.

Tables of log tan $(\frac{1}{4}\pi+\frac{1}{2}\phi)$.—C. Gudermann, *Theorie der potenzial- oder cyklisch-hyperbolischen Functionen* (Berlin, 1833), gives (in 100 pages) $\log\tan(\frac{1}{4}\pi+\frac{1}{2}\phi)$ for every centesimal minute of the quadrant to 7 places. Another table contains the values of this function, also at intervals of a minute, from 88° to 100° (centesimal) to 11 places. A. M. Legendre, *Traité des fonctions elliptiques* (vol. ii. p. 256), gives the same function for every half degree (sexagesimal) of the quadrant to 12 places.

The Gamma Function.—Legendre's great table appeared in vol. ii. of his *Exercices de calcul intégral* (1816), p. 85, and in vol. ii. of his *Traité des fonctions elliptiques* (1826), p. 489. $\log_{10}\Gamma(x)$ is given from $x=1$ to 2 at intervals of ·001 to 12 places, with differences to the third order. This table is reprinted in full in O. Schlömilch, *Analytische Studien* (1848), p. 183; an abridgment in which the arguments differ by ·01 is given by De Morgan, *Diff. and Int. Calc.*, p. 587. The last figures of the values omitted are also supplied, so that the full table can be reproduced. A seven-place abridgment (without differences) is published in J. Bertrand, *Calcul intégral* (1870), p. 285, and a six-figure abridgment in B. Williamson, *Integral Calculus* (1884), p. 169. In vol. i. of his *Exercices* (1811), Legendre had previously published a seven-place table of $\log_{10}\Gamma(x)$, without differences.

Tables connected with Elliptic Functions.—Legendre published elaborate tables of the elliptic integrals in vol. ii. of his *Traité des fonctions elliptiques* (1826). Denoting the modular angle by θ, the amplitude by ϕ, the incomplete integral of the first and second kind by $F(\phi)$ and $F_1(\phi)$, and the complete integrals by K and E, the tables are:—(1) $\log_{10}E$ and $\log_{10}K$ from $\theta=0°$ to 90° at intervals of 0°·1 to 12 or 14 places, with differences to the third order; (2) $E_1(\phi)$ and $F(\phi)$, the modular angle being 45°, from $\phi=0°$ to 90° at intervals of 0°·5 to 12 places, with differences to the fifth order; (3) $E_1(45°)$ and $F(45°)$ from $\theta=0°$ to 90° at intervals of 1°, with differences to the sixth order, also E and K for the same arguments, all to 12 places; (4) $E_1(\phi)$ and $F(\phi)$ for every degree of both the amplitude and the argument to 9 or 10 places. The first three tables had been published previously in vol. iii. of the *Exercices de calcul intégral* (1816).

Tables involving q.—P. F. Verhulst, *Traité des fonctions elliptiques* (Brussels, 1841), contains a table of $\log_{10}(\log_{10})q^{-1}$ for argument θ at intervals of 0°·1 to 12 or 14 places. C. G. J. Jacobi, in *Crelle's Journal*, 26, p. 93, gives $\log_{10} q$ from $\theta=0°$ to 90° at intervals of 0°·1 to 5 places. E. D. F. Meissel's *Sammlung mathematischer Tafeln*, i. (Iserlohn, 1860), consists of a table of $\log_{10} q$ at intervals of 1′ from $\theta=0°$ to 90° to 8 places. Glaisher, in *Month. Not. R.A.S.*, 1877, 37, p. 372, gives $\log_{10} q$ to 10 places and q to 9 places for every degree. In J. Bertrand's *Calcul Intégral* (1870), a table of $\log_{10} q$ from $\theta=0°$ to 90° at intervals of 5′ to 5 places is accompanied by tables of $\log_{10}\sqrt{(2K/\pi)}$ and $\log_{10}\log_{10} q^{-1}$ and by abridgments of Legendre's tables of the elliptic integrals. O. Schlömilch, *Vorlesungen der höheren Analysis* (Brunswick, 1879), p. 448, gives a small table of $\log_{10} q$ for every degree to 5 places.

Legendrian Coefficients (Zonal Harmonies).—The values of $P^n(x)$ for $n=1, 2, 3, \dots 7$ from $x=0$ to 1 at intervals of ·01 are given by Glaisher, in *Brit. Ass. Rep.*, 1879, pp. 54–57. The functions tabulated are $P^1(x)=x$, $P^2(x)=\frac{1}{2}(3x^2-1)$, $P^3(x)=\frac{1}{2}(5x^3-3x)$, $P^4(x)=\frac{1}{8}(35x^4-30x^2+3)$, $P^5(x)=\frac{1}{8}(63x^5-70x^3+15x)$, $P^6(x)=\frac{1}{16}(231x^6-315x^4+105x^2-5)$, $P^7(x)=\frac{1}{16}(429x^7-693x^5+315x^3-35x)$.

The values of $P^n(\cos\theta)$ for $n=1, 2, \dots 7$ for $\theta=0°, 1°, 2°, \dots 90°$ to 4 places are given by J. Perry in the *Proc. Phys. Soc.*, 1892, 11, p. 221, and in the *Phil. Mag.*, 1891, ser. 6, 32, p. 512. The functions P^n occur in connexion with the theory of interpolation, the attraction of spheroids, and other physical theories.

Bessel's Functions.—F. W. Bessel's original table appeared at the end of his memoir, "Untersuchung des planetarischen Teils der Störungen, welche aus der Bewegung der Sonne entstehen" (in *Abh. d. Berl. Akad.* 1824; reprinted in vol. i. of his *Abhandlungen*, p. 84). It gives $J_0(x)$ and $J_1(x)$ from $x=0$ to 3·2 at intervals of ·01. More extensive tables were calculated by P. A. Hansen in "Ermittelung der absoluten Störungen in Ellipsen von beliebiger Excentricität und Neigung" (in *Schriften der Sternwarte Seeberg*, part i., Gotha, 1843). They include an extension of Bessel's original table to $x=20$, besides smaller tables of $J_n(x)$ for certain values of n as far as $n=28$, all to 7 places. Hansen's table was reproduced by O. Schlömilch, in *Zeitschr. für Math.*, 2, p. 158, and by E. Lommel, *Studien über die Bessel'schen Functionen* (Leipzig, 1868), p. 127. Hansen's notation is slightly different from Bessel's; the change amounts to halving each argument. Schlömilch gives the table in Hansen's form; Lommel expresses it in Bessel's.

Lord Rayleigh's *Theory of Sound* (1894), 1, p. 321, gives $J_0(x)$ and $J_1(x)$ from $x=0$ to $x=13·4$ at intervals of 0·1 to 4 places, taken from Lommel. A large table of the same functions was given by E. D. F. Meissel in the *Abh. d. Berlin Akad.* for 1888 (published also separately). It contains the values of $J_0(x)$ and $J_1(x)$ from $x=0$ to $x=15·50$ at intervals of ·01. A. Lodge has calculated the values of the function $I_n(x)$ where

$$I_n(x)=i^{-n}J_n(ix)=\frac{x^n}{2^n n!}\left\{1+\frac{x^2}{2(2n+2)}+\frac{x^4}{2\cdot4\cdot(2n+2)(2n+4)}+\dots\right\}$$

His tables give $I_n(x)$ for $n=0, 1, 2, \dots, 11$ from $x=0$ to $x=6$ at intervals of 0·2 to 11 or 12 places (*Brit. Ass. Rep.*, 1889, p. 29), $I_1(x)$ and $I_0(x)$ from $x=0$ to $x=5·100$ at intervals of ·001 to 9 places (*Id.*, 1893, p. 229, and 1896, p. 99), and of $J_0(x\sqrt{i})$ from $x=0$ to $x=6$ at intervals of 0·2 (*Id.*, 1893, p. 228) to 9 places. In all the tables the last figure is uncertain. Subsidiary tables for the calculation of Bessel's functions are given by L. N. G. Filon and A. Lodge in *Brit. Ass. Rep.*, 1907, p. 94. The work is being continued, the object being to obtain the values of $J_n(x)$ for $n=0, \frac{1}{2}, 1, 1\frac{1}{2}, \dots, 6\frac{1}{2}$. A table by E. Jahnke has been announced, which, besides tables of other mathematical functions, is to contain values of Bessel's functions of order $\frac{1}{2}$ and roots of functions derived from Bessel's functions.

Sine, Cosine, Exponential, and Logarithm Integrals.—The functions so named are the integrals $\int_0^x \frac{\sin x}{x}dx$, $\int_\infty^x \frac{\cos x}{x}dx$, $\int_{-\infty}^x \frac{e^x}{x}dx$, $\int_0^x \frac{dx}{\log x}$, which are denoted by the functional signs Si x, Ci x, Ei x, li x respectively, so that Ei $x=$ li e^x. J. von Soldner, *Théorie et tables d'une nouvelle fonction transcendante* (Munich, 1809), gave the values of li x from $x=0$ to 1 at intervals of ·1 to 7 places, and thence at various intervals to 1220 to 5 or more places. This table is reprinted in De Morgan's *Diff. and Int. Calc.*, p. 662. Bretschneider, in *Grunert's Archiv*, 3, p. 33, calculated Ei $(\pm x)$, Si x, Ci x for $x=1, 2, \dots 10$ to 20 places, and subsequently (in Schlömilch's *Zeitschrift*, 6) worked out the values of the same functions from $x=0$ to 1 at intervals of ·01 and from 1 to 7·5 at intervals of ·1 to 10 places. Two tracts by L. Stenberg, *Tabulae logarithmi integralis* (Malmö, part i. 1861 and part ii. 1867), give the values of li 10^x from $x=-15$ to 3·5 at intervals of ·01 to 18 places. Glaisher, in *Phil. Trans.*, 1870, p. 367, gives Ei $(\pm x)$, Si x, Ci x from $x=0$ to 1 at intervals of ·01 to 18 places, from $x=1$ to 5 at intervals of ·1 and thence to 15 at intervals of unity, and for $x=20$ to 11 places, besides seven-place tables of Si x and Ci x and tables of their maximum and minimum values. See also Bellavitis, "Tavole numeriche logaritmo-integrale" (a paper in *Memoirs of the Venetian Institute*, 1874). F. W. Bessel calculated the values of li 1000, li 10,000, li 100,000, li 200,000, . . . li 600,000, and li 1,000,000 (see *Abhandlungen*, 2, p. 339). In Glaisher, *Factor Table for the Sixth Million* (1883), § iii., the values of li x are given from $x=0$ to 9,000,000 at intervals of 50,000 to the nearest integer. J. P. Gram in the publications of the Copenhagen Academy, 1884, 2, No. 6 (pp. 268–272), has given to 20 places the values of Ei x from $x=10$ to $x=20$ at intervals of a unit (thus carrying Bretschneider's table to this extent) and to 8, 9, or 10 places, the values of the same function from $x=5$ to $x=20$ at intervals of 0·2 (thus extending Glaisher's table in the *Phil. Trans.*).

Values of $\int_0^x e^{-x^2}dx$ *and* $e^{x^2}\int_0^x e^{-x^2}dx$.—These functions are employed in researches connected with refractions, theory of errors, conduction of heat, &c. Let $\int_0^x e^{-x^2}dx$ and $\int_x^\infty e^{-x^2}dx$ be denoted by erf x and erfc x respectively, standing for "error function" and "error function complement," so that erf $x+$erfc $x=\frac{1}{2}\sqrt{\pi}$ (*Phil. Mag.*, Dec. 1871; it has since been found convenient to transpose as above the definitions there given of erf and erfc). The tables of the functions, and of the functions multiplied by e^{x^2}, are as follows. C. Kramp, *Analyse des Réfractions* (Strasbourg, 1798), has erfc x from $x=0$ to 3 at intervals of ·01 to 8 or more places, also $\log_{10}$ (erfc x) and $\log_{10}$ (e^{x^2}erfc x) for the same values to 7 places. F. W. Bessel, *Fundamenta astronomiae* (Königsberg, 1818), has $\log_{10}$ (e^{x^2}erfc x) from $x=0$ to 1 at intervals of ·01 to 7 places, likewise for argument $\log_{10} x$, the arguments increasing from 0 to 1 at intervals of ·01. A. M. Legendre, *Traité des fonctions elliptiques* (1826), 2, p. 520, contains $\Gamma(\frac{1}{2}, e-x^2)$, that is, 2 erfc x from $x=0$ to ·5 at intervals of ·01 to 10 places. J. F. Encke, *Berliner ast. Jahrbuch* for 1834, gives $\frac{2}{\sqrt{\pi}}$ erf x from $x=0$ to 2 at intervals of ·01 to 7 places and $\frac{2}{\sqrt{\pi}}$ erf (ρx) from $x=0$ to 3·4 at intervals of ·01 and thence to 5 at intervals of ·1 to 5 places, ρ being ·4769360. Glaisher, in *Phil. Mag.*, December 1871, gives erfc x from $x=3$ to 4·5 at intervals of ·01 to 11, 13, or 14 places. Encke's tables and two of Kramp's were reprinted in the *Encyclopaedia Metropolitana*, art. "Probabilities." These tables have also been reprinted in many foreign works on probabilities, errors of observations, &c. In vol. 2 (1880) of his *Lehrbuch zur Bahnbestimmung der Kometen und Planeten* T. R. v. Oppolzer gives (p. 587) a table of erf x from $x=0$ to 4·52 at intervals of ·01 to 10 places, and (p. 603) a table of $\frac{2}{\sqrt{\pi}}$ erf x from $x=0$ to 2 at intervals of ·01 to 5 places. Both tables were the result of original calculations. A very large table of $\log_{10} e^{x^2}$ erfc x was calculated by R. Radau and published in the *Annales de l'observatoire de Paris* (*Mémoires*, 1888, 18, B. 1–25). It contains the values of $\log_{10} e^{x^2}$ erfc x from $x=-0·120$ to 1·000 at intervals of ·001 to 7 places, with differences. A. Markoff in a separate publication, *Table des valeurs de l'intégrale* $\int_x^\infty e^{-t^2}dt$ (St Petersburg, 1888), gives erfc x from $x=0$ to 3 at intervals of ·001 and from $x=3$ to 4·80 at intervals of ·01, with first, second, and third differences to 11 places. He also gives a table of $\frac{2}{\sqrt{\pi}}$ erf x from $x=0$ to $x=2·499$ at intervals of ·001 and thence to 3·79 at intervals of ·01. J. Burgess, *Trans. Roy. Soc. Edin.*, 1888, 39, II., No. 9, published very extensive tables of $\frac{2}{\sqrt{\pi}}$ erf x, which were entirely the result of a new calculation. His tables give the values of this function from $x=0$ to $1\cdot250$ at intervals of $\cdot001$ to 9 places with first and second differences, from $x=1$ to 3 at intervals of $\cdot001$ to 15 places with differences to the fourth order, and from $x=3$ to 5 at intervals of $\cdot1$ to 15 places. He also gives erfc x from $x=0$ to $x=5$ at intervals of $\cdot1$ to 15 places. B. Kämpfe in Wundt's *Phil. Stud.*, 1893, p. 147, gives $\frac{2}{\sqrt{\pi}}$ erf x from $x=0$ to $x=1\cdot509$ at intervals of $\cdot001$, and from $x=1\cdot50$ to $x=2\cdot88$ at intervals of $\cdot01$ to 4 places. G. T. Fechner's *Elemente der Psychophysik* (Leipzig, 1860) contains (pp. 108, 110) some small four-place tables connecting r/n (as argument) and hD where $\frac{r}{n}=\frac{1}{2}+\frac{1}{\sqrt{\pi}}\mathrm{erf}\,\frac{hD}{2}$. A more detailed account of tables of erf x, e^{x^2} erf x, &c., is given in *Mess. of Math.*, 1908, 38, p. 117.

Values of $\int_0^x e^{x^2}dx$.—The values of this integral have been calculated by H. G. Dawson from $x=0$ to $x=2$ to 7 places (last figure uncertain). The table is published in the *Proc. Lond. Math. Soc.*, 1898, 29, p. 521.

Tables of Integrals, not Numerical.—Meyer Hirsch, *Integraltafeln* (1810; Eng. trans., 1823), and Minding, *Integraltafeln* (Berlin, 1849), give values of indefinite integrals and formulae of reduction; both are useful and valuable works. De Haan, *Nouvelles tables d'intégrales définies* (Leyden, 1867), is a quarto volume of 727 pages containing evaluations of definite integrals, arranged in 485 tables. The first edition appeared in vol. 4 of the *Transactions* of the Amsterdam Academy of Sciences. This edition, though not so full and accurate as the second, gives references to the original memoirs in which the different integrals are considered. B. O. Peirce's *A Short Table of Integrals* (Boston, U.S.A., 1899) contains integrals, formulae, expansions, &c., as well as some four-place numerical tables, including those of hyperbolic sines and cosines and their logarithms.

Tables relating to the Theory of Numbers.—These are of so technical a character and so numerous that a comprehensive account cannot be attempted here. The reader is referred to Cayley's report in the *Brit.Ass. Rep.* for 1875, p. 305, where a full description with references is given. Three tables published before that date may, however, be briefly noticed on account of their importance and because they form separate volumes: (1) C. F. Degen, *Canon Pellianus* (Copenhagen, 1817), relates to the indeterminate equation $y^2-ax^2=1$ for values of a from 1 to 1000. It in fact gives the expression for $\sqrt{a}$ as a continued fraction; (2) C. G. J. Jacobi, *Canon arithmeticus* (Berlin, 1839), is a quarto work containing 240 pages of tables, where we find for each prime up to 1000 the numbers corresponding to given indices and the indices corresponding to given numbers, a certain primitive root (10 is taken whenever it is a primitive root) of the prime being selected as base; (3) C. G. Reuschle, *Tafeln complexer Primzahlen, welche aus Wurzeln der Einheit gebildet sind* (Berlin, 18/5), includes an enormous mass of results relating to the higher complex theories.

Passing now to tables published since the date of Cayley's report, the two most important works are (1) Col. Allan Cunningham's *Binary Canon*, (London, 1900), a quarto volume similar in construction, arrangement, purpose, and extent to Jacobi's *Canon arithmeticus*, but differing from it in using the base 2 throughout, *i.e.* in Jacobi's *Canon* the base of each table is always a primitive root of the modulus, while in Cunningham's it is always 2. The latter tables in fact give the residues R of 2^x (where $x=0, 1, 2, \ldots$) for every prime p or power of a prime, p^x, up to 1000, and also the indices x of 2^x, which yield the residues R to the same moduli. This work contains a list of errors found in the *Canon arithmeticus*. (2) The same author's *Quadratic Partitions* (London, 1904). These tables give for every prime p up to 100,000 the values of a, b; c, d; A, B; and L, M where $p=a^2+b^2=c^2+2d^2=A^2+3B^2=\frac{1}{4}(L^2+27M^2)$. They also give e, f where $p=e^2-2f^2$ up to 25,000 and resolutions of p into the forms x^2-5y^2, $\frac{1}{4}(X^2-5Y^2)$, t^2+7u^2, $\frac{1}{4}(v^2+11w^2)$, $A'^2-3B'^2$, $x'^2+5y'^2$, G^2+6H^2, $G'^2-6H'^2$, $t'^2-7u'^2$, $\xi^2+10\eta^2$, $\xi'^2-10\eta'^2$, $v'^2-11w'^2$ up to 10,000; as well as the least solutions of $\tau^2-Dv^2=\pm1$ up to $D=100$ and least solutions of other similar equations. A complete list of errata in the previous partition tables of Jacobi, Reuschle, Lloyd Tanner, and in this table is given by Allan Cunningham in *Mess. of Math.*, 1904, 34, p. 132. The resolution of a^n-1 into its numerical factors is treated in detail by C. E. Bickmore in *Mess. of Math.*, 1896, 25, p. 1, and 1897, 26, p. 1. On p. 43 of the former volume he gives a table of the known factors of a^n-1 for $a=2, 3, 5, 6, 7, 10, 11, 12$ and from $n=1$ to $n=50$. Other papers on the same subject contained in the same periodical are by Allan Cunningham, 1900, 29, p. 145; 1904, 33, p. 95; and F. B. Escott, *ibid.*, p. 49. These papers contain references to other writings. Tables of the resolutions of 10^n-1 are referred to separately in this article under *Circulating Decimals*. If a^x is the smallest power of a for which the congruence $a^x\equiv1$ (mod. p) is satisfied, then a is said to belong to the exponent x for modulus p, and x may be called the chief exponent (*Haupt-exponent* by Allan Cunningham) of the base a for the modulus p; so that (1) this exponent is the number of figures in the circulating period of the fraction $1/p$ in the scale of radix a, and (2) when $x=p-1$, a is a primitive root of p. In *Mess. of Math.*, 1904, 33, p. 145, Allan Cunningham has given a complete list of Haupt-exponent tables with lists of errata in them; and in *Quar. Jour. Math.*, 1906, 37, p. 122, he gives a table of Haupt-exponents of 2 for all primes up to 10,000. In *Acta Math.* (1893, 17, p. 315; 1897, 20, p. 153; 1899, 22, p. 200) G. Wertheim has given the least primitive root of primes up to 5000. The following papers contain lists of high primes or factorizations of high numbers: Allan Cunningham, *Mess. of Math.*, 1906, 35, p. 166 (Pellian factorizations); 1907, 36, p. 145 (Quartan factorizations); 1908, 37, p. 65 (Trinomial binary factorizations); 1909, 38, pp. 81, 145 (Diophantine factorization of quartans); 1910, 39, pp. 33, 97; 1911, 40, p. 1 (Sextan factorizations); 1902, 31, p. 165; 1905, 34, p. 72 (High primes). The last three are joint papers by Cunningham and H. J. Woodall. Tables relating to the distribution of primes are contained in the introduction to the *Sixth Million* (see under *Factor Tables*), in J. P. Gram's paper on the number of primes inferior to a given limit in the *Vidensk. Selsk. Skr.*, 1884, II. 6, Copenhagen, and in *Mess. of Math.*, 1902, 31, p. 172. A table of $\chi(n)$, the sum of the complex numbers having n for norm, for primes and powers of primes up to $n=13{,}000$ by Glaisher, was published in *Quar. Jour. Math.*, 1885, 20, p. 152, and a seven-place table of $f(x)$ and $\log_{10} f(x)$, where $f(x)$ denotes $\frac{1}{2}\cdot\frac{2}{3}\cdot\frac{4}{5}\cdots\frac{x-1}{x}$, the denominators being the series of prime numbers up to 10,000, in *Mess. of Math.*, 1899, 28, p. 1.

Bibliography.—Bibliographical and historical information relating to tables is collected in *Brit. Ass. Rep.* for 1873, p. 6. The principal works are:—J. C. Heilbronner, *Historia Matheseos* (Leipzig, 1742), the arithmetical portion being at the end, J. E. Scheibel, *Einleitung zur mathematischen Bücherkenntniss* (Breslau, 1771–84); A. G. Kästner, *Geschichte der Mathematik* (Göttingen, 1796–1800), vol. iii.; F. G. A. Murhard, *Bibliotheca Mathematica* (Leipzig, 1797–1804), vol. ii.; J. Rogg, *Bibliotheca Mathematica* (Tübingen, 1830), and continuation from 1830 to 1854 by L. A. Sohnke (Leipzig and London, 1854); J. de Lalande, *Bibliographie astronomique* (Paris, 1803), a separate index on p. 960. A great deal of information upon early tables is given by J. B. J. Delambre, *Histoire de l'astronomie moderne* (Paris, 1821), vol. i.; and in Nos. xix. and xx. of C. Hutton's *Mathematical Tracts* (1812). For lists of logarithmic tables of all kinds see De Haan, *Verslagen en Mededeelingen* of the Amsterdam Academy of Sciences (*Abt. Natuurkunde*) 1862, xiv. 15, and *Verhandelingen* of the same academy, 1875, xv. separately paged.

De Morgan's article "Tables," which appeared first in the *Penny Cyclopaedia*, and afterwards with additions in the *English Cyclopaedia*, gives not only a good deal of bibliographical information, but also an account of tables relating to life assurance and annuities, astronomical tables, commercial tables, &c.

Reference should also be made to R. Mehmke's valuable article "Numerisches Rechnen" in vol. i. pt. ii. pp. 941–1079 of the *Encyk. der math. Wiss.* (Leipzig, 1900–4), which besides tables includes calculating machines, graphical methods, &c. (J. W. L. G.)

TABLE MOUNTAIN (Dutch *Tafelberg*), a name frequently given in South Africa to flat-topped hills and mountains, there a characteristic feature of the scenery. Occasionally such hills are called *plat, i.e.* flat, *bergen*. Specifically Table Mountain is the mountain which arises behind Table Bay, in the Cape Peninsula, Cape Town lying at its seaward base and on its adjacent lower slopes. The mountain forms the northern end of a range of hills which terminates southward in the Cape of Good Hope. The northern face of the mountain, overlooking Table Bay, extends like a great wall some two miles in length, and rises precipitously to a height of over 3500 ft. The face is scored with ravines, a particularly deep cleft, known as The Gorge, affording the shortest means of access to the summit. East and west of the mountain and a little in advance of it are lesser hills, the Devil's Peak (3300 ft.) being to the east and Lion's Head (2100 ft.) to the west. Lion's Head ends seaward in Signal Hill (1100 ft.). The western side of Table Mountain faces the Atlantic, and is flanked by the hills known as The Twelve Apostles; to the south Hout's Bay Nek connects it with the remainder of the range; on the east the mountain overlooks the Cape Flats. On this side its slopes are less steep, and at its foot are Rondebosch, Newlands, Wynberg, and other residential suburbs of Cape Town. The ascent of the mountain from Wynberg by Hout's Bay Nek is practicable for horses. The surface of the summit (the highest point is variously stated at 3549, 3582 and 3850 ft.) is broken into small valleys and hills, and is covered with luxuriant vegetation, its flora including the superb orchid *Disa grandiflora* and the well-known silver tree. The Kasteel-Berg (Castle Mount), a northern buttress of the mountain, has its own peculiar flora. Table Mountain and its connected hills are famous for the magnificence of their scenery. The kloof between the mountain and Lion's Head is of singular beauty. The view from the summit overlooking Table Bay is also one of much grandeur.

The south-east winds which sweep over Table Mountain frequently cause the phenomenon known as "The Table-cloth." The summit of the mountain is then covered by a whitish-grey cloud, which is being constantly forced down the northern face towards Cape Town, but never reaches the lower slopes. The clouds (not always caused by the south-easter) form very suddenly, and the weather on the mountain is exceedingly changeable. The rainfall on the summit is heavy, 72·14 inches a year being the average of twelve years' observations. This compares with an average of 54·63 inches at Bishop's Court, Newlands, at the foot of the mountain on the east and with 25·43 inches at Cape Town at the northern foot of the mountain. The relative luxuriance of the vegetation on the upper part of the mountain, compared with that of its lower slopes, is due not only to the rainfall, but to the large additional moisture condensed from clouds. The result of experiments conducted by Dr Marloth (*Trans. S. Afrn. Phil. Soc.* for 1903 and 1905) goes to show that during cloudy weather the summit of the mountain resembles an immense sponge, and that this condensation of moisture considerably influences the yield of the springs in the lower part of the mountain.

TABLE-TURNING. When the movement of modern spiritualism first reached Europe from America in the winter of 1852–3, the most popular method of consulting the "spirits" was for several persons to sit round a table, with their hands resting on it, and wait for the table to move. If the experiment was successful the table would rotate with considerable rapidity, and would occasionally rise in the air, or perform other movements. Whilst by many the movements were ascribed to the agency of spirits, two investigators—count de Gasparin and Professor Thury of Geneva—conducted a careful series of experiments by which they claimed to have demonstrated that the movements of the table were due to a physical force emanating from the bodies of the sitters, for which they proposed the name "ectenic force." Their conclusion rested on the supposed elimination of all known physical causes for the movements; but it is doubtful from the description of the experiments whether the precautions taken were sufficient to exclude unconscious muscular action or even deliberate fraud.

In England table-turning became a fashionable diversion and was practised all over the country in the year 1853. Dr John Elliotson and his followers attributed the phenomena to mesmerism. The general public were content to find the explanation of the movements in spirits, animal magnetism, odic force, galvanism, electricity, or even the rotation of the earth. James Braid, W. B. Carpenter and others pointed out, however, that the phenomena obviously depended upon the expectation of the sitters, and could be stopped altogether by appropriate suggestion. And Faraday devised some simple apparatus which conclusively demonstrated that the movements were due to unconscious muscular action. The apparatus consisted of two small boards, with glass rollers between them, the whole fastened together by indiarubber bands in such a manner that the upper board could slide under lateral pressure to a limited extent over the lower one. The occurrence of such lateral movement was at once indicated by means of an upright haystalk fastened to the apparatus. When by this means it was made clear to the experimenters that it was the fingers which moved the table, not the table the fingers, the phenomena generally ceased. The movements were in fact simply an illustration of automatism. But Faraday's demonstration did little to stop the popular craze.

By believers the table was made to serve as a means of communicating with the spirits; the alphabet would be slowly called over and the table would tilt at the appropriate letter, thus spelling out words and sentences. Some Evangelical clergymen discovered by this means that the spirits who caused the movements were of a diabolic nature, and some amazing accounts were published in 1853 and 1854 of the revelations obtained from the talking tables.

Table-turning is still in vogue amongst spiritualist circles. The device was employed with success by Professor Charles Richet and others in thought-transference experiments.

See A. E. de Gasparin, *Des Tables tournantes, du Surnaturel*, &c. (Paris, 1854); Thury, *Des Tables tournantes* (Geneva, 1855); Faraday's letter on Table-turning in *The Times*, 30th June 1853. *Quarterly Review*, Sept. 1853—article by Carpenter on Spiritualism, &c.; Mrs De Morgan, *From Matter to Spirit* (London, 1863); Ch. Richet, *Proceedings S.P.R.*, vol. v. F. Podmore, *Modern Spiritualism* (London, 1902), ii. 7-21, gives an account of the movement in 1853, with references to contemporary pamphlets and newspaper articles. (F. P.)

TABLINUM (or *tabulinum*, from *tabula*, board, picture), in Roman architecture, the name given to an apartment generally situated on one side of the atrium and opposite to the entrance; it opened in the rear on to the peristyle, with either a large window or only an anteroom or curtain. The walls were richly decorated with fresco pictures, and busts of the family were arranged on pedestals on the two sides of the room.

TABOO (also written *tapu* and *tabu*), the Polynesian name given to prohibitions enforced by religious or magical sanctions. As a verb it means to "prohibit," as an adjective "prohibited, sacred, dangerous, unclean."

1. The word "taboo" or its dialectical forms are found throughout Polynesia; in Melanesia the term is *tambu;* in various parts of Malaysia and the East Indies *pantang*, *bobosso*, *pamalli*, &c.; in Madagascar *fadi* includes taboo; in North America the Dakota term *wakan* bears a similar meaning. Taboo is perhaps derived from *ta*, to mark, and *pu*, an adverb of intensity.

2. *Fundamental Ideas.*—In *taboo* proper are combined two notions which with the progress of civilization have become differentiated—(i) sacred and (ii.) impure, or unclean; it must be borne in mind that the impurity is sacred, and is not derived from contact with common things. It does not imply any moral quality; it has been defined as an indication of "a connexion with the gods, or a separation from ordinary purposes and exclusive appropriation to persons or things considered sacred; sometimes it means devoted by a vow." This definition does not cover the whole connotation of taboo as it is employed at the present day, but it indicates clearly the non-moral character of the idea. The ordinary usage is perhaps best defined—the statement that taboo is "negative magic," *i.e.* abstinence from certain acts, in order that undesired magical results may not follow; in this sense a taboo is simply a ritual prohibition. Properly speaking taboo includes only (*a*) the sacred (or unclean) character of persons or things, (*b*) the kind of prohibition which results from this character, and (*c*) the sanctity (or uncleanness) which results from a violation of the prohibition. The converse of taboo in Polynesia is *noa* and allied forms, which mean "*general*" or "common"; by a curious coincidence *noa* is the term used in Central Australia to express the relation of persons of opposite sexes on whose intercourse there is no restriction.

3. *Classification.*—Various classes of taboo in the wider sense may be distinguished: (i) natural or direct, the result of *mana* (mysterious power) inherent in a person or thing; (ii.) communicated or indirect, equally the result of *mana*, but (*a*) acquired or (*b*) imposed by a priest, chief or other person; (iii.) intermediate, where both factors are present, as in the appropriation of a wife to her husband. These three classes are those of taboo proper. The term taboo is also applied to ritual prohibitions of a different nature; but its use in these senses is better avoided. It might be argued that the term should be extended to embrace cases in which the sanction of the prohibition is the creation of a god or spirit, *i.e.* to religious interdictions as distinguished from magical, but there is neither automatic action nor contagion in such a case, and a better term for it is Religious interdiction.

4. *Objects.*—The objects of taboo are many: (i.) direct taboos aim at (*a*) the protection of important persons—chiefs, priests, &c.—and things against harm; (*b*) the safeguarding

of the weak—women, children and common people generally—from the powerful *mana* (magical influence) of chiefs and priests; (*c*) the provision against the dangers incurred by handling or coming in contact with corpses, by eating certain foods, &c.; (*d*) the guarding the chief acts of life—birth, initiation, marriage and sexual functions, &c., against interference; (*e*) the securing of human beings against the wrath or power of gods and spirits; (*f*) the securing of unborn infants and young children, who stand in a specially sympathetic relation with one or both parents, from the consequences of certain actions, and more especially from the communication of qualities supposed to be derived from certain foods. (ii.) Taboos are imposed in order to secure against thieves the property of an individual, his fields, tools, &c.

5. *Sanctions.*—The sanctions of taboo may be (i.) natural or direct; (ii.) social or indirect. Natural sanctions are (*a*) automatic. where the punishment of the offender results from the operation of natural laws without any element of volition, just as some kinds of magic are held to bring about their results without the intervention of a spirit; (*b*) animistic, where the penalty results from the wrath of a god, deceased human being, or other spirit. The motive of the social sanction is ultimately religious or magical, but the penalties incurred by the violator of a taboo are social; they are inflicted by other members of the community, firstly, as a means of averting the supernatural sanctions, which, not having fallen on the actual offender, may visit his innocent fellows; and secondly, as a means of discouraging other offenders; in these cases the criminal is not himself taboo, but, thanks to his *mana*, braves the supernatural consequences; the social penalty is also inflicted on those who, like mourners, are themselves taboo and refuse to take steps to seclude themselves, in defence of the community; in the first class the social penalty is at once repressive and prophylactic, saving the innocent by punishing the guilty, and thus averting by a piaculum the vengeance which would otherwise fall somewhere; in the second the penalty is purely repressive.

The violation of a taboo makes the offender himself taboo; other penalties are not unkown: thus a man who partakes of a forbidden animal will break out in sores or the animal will reproduce itself within him and devour his vitals. Sometimes it is thought that the penalty falls on the kinswomen of the offender and that they produce, instead of children, animals of the taboo species. In Melanesia burial-grounds are taboo, and if the shadow of a passer-by falls on one, this entails upon him the loss of his soul; sometimes misfortune is held to dog the footsteps of the offender in this life and the next. But in some of these cases the observer who reports them has probably confused taboos proper with negative magic. The social sanctions range from the death penalty down to the infliction of a fine or exaction of money compensation; the Polynesian custom of despoiling a man who breaks a taboo is perhaps a special case of this penalty, but the practice of ceremonial plundering cannot always be so explained, and may perhaps in this case too be capable of an entirely different explanation.

Possibly the savage is more susceptible to suggestion than civilized man; at any rate, cases are not unknown in which the violation of a taboo has been followed by illness or even death, when the offender discovers his error. Not unnaturally rites of purification act as counter suggestions and save the offender from the effects of his erroneous beliefs.

6. *Mana.*—In the case of automatic taboos, and to some extent of other ritual prohibitions, the penalties for violation are unequal; they may be regarded as varying with the relation between the *mana* of the person or object and the *mana* of the offender against the prohibition. In the words of Dr R. H. Codrington, *mana* "is a power or influence, not physical and in a way supernatural; but it shows itself in physical force or in any kind of power or excellence which a man possesses. This *mana* is not fixed in anything, and can be conveyed in almost anything; but spirits, whether disembodied souls or supernatural (*i.e.* non-human) beings, have it and can impart it; and it essentially belongs to personal beings to originate it, though it may act through the medium of water, or a stone or a bone" (cf. the *suhman* of West Africa, in Fetishism). Persons or things which are regarded as taboo may be compared to objects charged with electricity; they are the seat of a tremendous power which is transmissible by contact, and may be liberated with destructive effect if the organisms which provoke its discharge are too weak to resist it; the result of a violation of a taboo depends partly on the strength of the magical influence inherent in the taboo object or person, partly on the strength of the opposing *mana* of the violator of the taboo. Thus, kings and chiefs are possessed of great power, and it is death for their subjects to address them directly; but a minister or other person of greater *mana* than common can approach them unharmed, and can in turn be approached by their inferiors without risk. The burial-place is often taboo for the common people, save when they are actually engaged in funeral rites; but the sorcerer, thanks to his indwelling power, can resist the deadly influences which would destroy the common folk, and may enter a cemetery for ritual or other purposes. So too indirect taboos depend for their strength on the *mana* of him who imposes them; if it is a chief or a priest, they are more powerful than those imposed by a common person. The *mana* of the priest, or chief, does not depend on his position; on the contrary, it is thanks to his *mana* that he has risen above the common herd.

7. *Transmissibility.*—It is characteristic of taboo proper that it is transmissible; as a logical corollary of this idea, acquired taboo may be thrown off by suitable magical or purificatory ceremonies; the mourner, or he who takes part in funeral ceremonies; was perhaps at the outset regarded as a person charged with death-dealing power, and fear of the spirit of the dead may well have been secondary; however this may be, we can distinguish taboos, the violation of which charges with supernatural power the human being who violates them, thus rendering him directly dangerous to the community, from ritual prohibitions the violation of which makes him an outcast, not as himself dangerous, but as a person obnoxious to the gods. The ritual prohibitions of pregnancy, and the restrictions imposed on the parents during the early childhood of their offspring, are not taboos proper; though they are transmissible, they do not depend on the transmission of an undifferentiated *mana*; what the parents seek to avoid is often the transmission of specific qualities, conceived as inherent in certain animals, *e.g.* cowardice in the hare, slowness in the tortoise; the animal is not necessarily in any sense sacred, nor are the parents, if they disregard the prohibition, liable to any penalty, direct or indirect; neither they nor the child are rendered taboo by any violation; finally, save that the child acquires its qualities by a sympathetic process, the abstinence of the parents is correlative to the converse operation of eating an animal or otherwise acquiring by a magical process the good qualities inherent in anything.

8. *Duration of Taboos, Imposition, and Abrogation.*—Taboo is properly sanctity and the kind of interdict which it entrains; by a transference of meaning it is sometimes used of a period of time during which ritual prohibitions of a religious nature are enforced; these periods were proclaimed in Polynesia on important occasions and sometimes lasted for many years; they may be termed interdicts. Many persons and things are permanently taboo; among them may be mentioned kings and chiefs, the property of dead persons and, a fortiori, their bodies or anything in contact with them. Other taboos are temporary. Temporary direct taboos, whether natural or acquired, may be removed by a process of desacralization or of purification. Thus, new crops are frequently taboo till the chief has partaken of them; his *mana* enables him to run risks which would be fatal to ordinary people, and the crops thus desacralized become free to all; perhaps, however, we may regard the practice as a case of sacralization, in which the chief, like a sacrificing priest, acquires special sanctity, and in so doing fortifies his people by a sympathetic process against supernatural dangers. A

new-born child may also make the crops *noa*, just as it may remove the taboo from a temporarily affected person.

In the Tonga Islands a person who became taboo by touching a chief or his property had to put away his sacred character, before he was allowed to make use of his lands, by touching the soles of a higher chief's feet and washing in water. Strangers before penetrating into a village, priests after a sacrifice, warriors, women after child-birth, at puberty, the menstrual period, &c., must submit to lustration. Sometimes the purification was effected by inhaling the sacred contagion; in New Zealand a chief who touched his own head had to apply his fingers to his nose and snuff up the sanctity abstracted from his head. In other cases mere lapse of time suffices to cause the removal of a taboo; in Melanesia, where taboos are largely animistic, mourners go away for some months and on their return are free from taboo, the explanation given being that the spirit has got tired of waiting for them.

Indirect taboos are imposed in various ways, and unless they are removed may be as permanent as direct taboos, save that the death of the persons by whom they are imposed must result in their abrogation. In Polynesia a general taboo was imposed by proclamation; a chief might also taboo particular objects to his own use by naming them after a part of his person; more permanent was the taboo imposed by touching an object, but this too could be removed by proper ceremonies. In Melanesia, corresponding to the animistic character of *tambu*, a method of imposing taboo is to mention the name of some spirit.

Taboo objects were marked in various ways: a piece of white cloth, a bunch of leaves, a bundle of branches (in Melanesia) painted red and white, a stick with dry leaves, are among the methods in common use; in Samoa one mark of a taboo was to set up the image of a shark; in New Zealand it sufficed to give a chop with an axe to make a tree taboo. Particular taboos thus imposed seem to be abrogated by the declaration of the person who imposes them; on the other hand, he, no less than others, is bound by the taboo until it is abrogated.

9. *Taboo and the Evolution of Punishment.*—Penal codes may be largely, if not wholly, traced to religious sources of which taboo is certainly one; the violation of any taboo may imperil the life or health of other members of the community besides the offender; it calls for measures intended to discourage others, as well as for steps to avert the immediate evil; if a taboo imposed by a chief is disregarded, not only has his authority been set at nought, but he, and in the second place, other members of the community may suffer if the real offender gets off scot free, thanks to the *mana* which enables him to defy supernatural sanctions. The importance of this in the evolution of law and order is manifest; for whereas a chief would not intervene to protect the property of an individual simply to punish what we regard as a transgression, he is bound to do so when a taboo is broken. That the taboo may be of his own imposition does not affect the question, for he is bound to observe it himself, and conversely may suffer supernatural penalties when it is violated by another. Just as blood-guiltiness may be wiped out by composition, the violation of a taboo may be atoned for by a money payment or similar consideration for the revocation of the taboo; this compensation seems to have a retrospective effect, and thereby removes the dangers brought into existence by the violation.

10. *Taboo and Moral Obligation.*—In proportion as a taboo becomes a custom and its sanctions fall into the background and are forgotten, its obligations thus transformed are one source of the categorical imperative, the distinguishing feature of which is that it is non-rational and instinctive. We are ignorant of the origin of exogamy and the prohibition of incest, the sanctions of which in Australia and among other peoples of low culture seem to be purely social, for as a rule irregular marriages seem to be regarded simply as offences against tribal morality; if the rules were originally of the nature of taboos, the transformation into customs must have been very early, and the same may be said of the rules by which the relations of members of the same kin are regulated.

11. *Royal and Priestly Taboos.*—Among people of low culture the chief, and in higher cultures the king, is sometimes held responsible for the order of nature, the increase of the crops, and the welfare of his people generally; it is therefore of the highest importance that nothing should diminish or perturb his influence, and, as a logical consequence, the life of the king, and to a less degree of the chief, is surrounded with a complicated system of taboos and ritual prohibitions. Even where this idea of the magician-king or chief is not found, his position is an expression of the more powerful *mana* dwelling within him; consequently the king or chief may not come in contact with the common folk, for fear his touch should blast them, as lightning withers the life of the oak. We can usually see why a king or chief must hold aloof from those whom he might injure, but it is not always easy to see the basic idea of the taboos, if such they be, which aim at protecting the potentate, or ensuring his due regulation of the course of nature. Some African kings may not see the sea; another may not lie down to sleep; in the Mentawei Islands the chief will die who during an interdict eats at the same time as common people; it is frequently forbidden to see the king partake of food. At a further stage of evolution these taboos degenerate into mere rules of etiquette, the violation of which involves the punishment of the offender, but the punishment is justified on formal grounds only. In early society the king and the priest often stand very near together; just as we find a war chief and a peace chief, so we meet with political and religious sovereigns. Sometimes the political king is also the priest and therefore sacred; the web of ritual prohibition woven round him may result in the creation of a secular authority like the Tycoon in Japan, who can rule the state without reference to the ceremonial observances prescribed for the nominal sovereign. Sometimes, on the other hand, the priest bears the title of king, but has lost even the shadow of political power and is free to perform his priestly functions. In these, however, as we see by the example of the flamen dialis at Rome, or the kings of fire and water in Cambodia, he is still hedged round by manifold restrictions as a person who must be protected from doing harm to others or suffering harm himself. In the exercise of his priestly functions he is called upon to offer sacrifice; before fulfilling his office he is often required to submit to additional ritual prohibitions; his personal sanctity, already great, is augmented, and his approach to the sanctuary facilitated. Conversely, the sacrifice over, he performs lustral rites, in part to free himself from the taint of errors of ritual, but also to desacralize himself.

12. *Funerary and Allied Taboos.*—Taboos of mourners, widows, and of the dead are common all the world over, but they are especially prominent in Melanesia. These are explained on an animistic hypothesis as due to the fear of the dead man's spirit, but we seem to see traces, *e.g.* in Madagascar, of the idea that the contagion of death and not the wrath of the dead is the underlying motive; for it is not clear why the soul of a dead kinsman should necessarily be hostile. With funerary taboos may be compared taboos of warriors both on and after an expedition, taboos of hunters during the chase and especially after killing a dangerous animal, taboos of cannibals, and on participants in all other ceremonies which involve contact with death or the dead. Temporary seclusion and lustration before return to ordinary life are commonly prescribed for all in this category, even though their connexion with the dead be no closer than is implied in consanguinity. The property of the dead man is commonly burnt or deposited with him in the grave, in part as a protective measure, in part under the influence of belief in the continuity of this and the future life, and the need of supplying him with necessaries. Burial grounds are avoided, animals or plants from the neighbourhood are not used as food. Finally the name of the dead is not used, partly for fear of summoning him by the power of the word, but partly also from a conviction that, like the name of a king or chief, it is too holy or too dangerous for common use.

13. *Taboos of the Sick.*—Both disease and death are unnatural in the eyes of the savage; they are often the result of the magic

of some enemy; but they may also be the result of an infraction of a taboo. Some part of the funerary taboos may perhaps be referred to this belief; whatever be the case with taboos of the dead, there can be no question that the sick are secluded or even abandoned, subjected to rites of purification and to restrictions of various sorts, not because their malady is contagious in our sense, but because they are temporarily taboo and dangerous to the health of the community. The sick have imposed on them curative as well as prophylactic taboos; in Madagascar the sun is said to "die" when it sets; therefore it is forbidden to a sick man to look upon it as it goes down.

14. *Taboos of Women, Sexual Taboos, Avoidance.*—The age of puberty is especially dangerous for both sexes; in the case of a woman the danger is not so much for herself as for others, and results from her physiological state; this danger is renewed with each successive menstrual period, and the frequently long seclusion at puberty finds a parallel in the universal practice in lower stages of culture of separating adult females, not only from males, but from the whole of the community at such periods. At puberty girls are confined for months or even years; they may not see the sun nor touch the earth; many foods are forbidden them, and special costumes are prescribed for them, as for mourners. The expectant mother is taboo for months before the birth of her child, and her disabilities are not removed for a long period after delivery. Women may not look upon the performance of rites of initiation nor of secret societies; they may not eat new crops in New Caledonia till long after the men have partaken of them; they may often not approach the men's club-house. Both parents, but especially the mother, are subjected to restrictions, having for their object the preservation of the health of the unborn or newly born child. Women are often forbidden to eat with their husbands; nor may they share his labours, especially at sea.

The relations of the sexes are regulated by complicated rules, but they are not necessarily taboos. In the first place, laws of exogamy and similar regulations limit the field of choice; even where no obstacle on this side is present the intercourse of the sexes is often, especially at first, hedged round with numberless interdictions and rites. Connected with the rules of exogamy are the customs of avoidance, which prescribe that a man may not speak to nor even look at his mother-in-law, sometimes also his father-in-law, daughter, and other relatives; in like manner the wife must avoid the husband's relatives, and the brother may often not speak to the sister.

15. *Other Taboos.*—Taboos of various kinds are imposed on strangers, on sorcerers, and on children. Certain places are taboo; taboos protect the crops and ensure that landmarks are not removed. In fact the number of taboos is so great that it is impossible to mention them in detail.

16. *Distribution.*—Although taboo is a Polynesian word the institution is far from being restricted to Oceania. Similar prohibitions, though they seldom reached the Polynesian level, are found in America, Africa, and especially Madagascar, North and Central Asia, and among the non-Aryan tribes of India. But taboo and its survivals are not confined to the uncivilized.

17. *Developments of Taboo.*—It would be remarkable if a feature which has taken such deep root in the custom and belief of savage and barbarous peoples did not leave a marked impress on the faiths of higher cultures. Just as the gods have become moral *pari passu* with mankind, so the ceremonially clean has become the physically and morally clean, the pure has become the moral, and taboo has changed its name to holiness. At a certain point in evolution the notion of unclean, sometimes positive and implying the possession of dangerous properties, sometimes negative and connoting no more than mere absence of holiness, which is in this case indistinguishable from *mana*, becomes a prominent element in religion. At a later stage and as a result of the greater weight attached to morality, the positive uncleanness falls into the background, leaving only the negatively unclean, the unholy, which is not in itself death-dealing, but may, like its savage analogue, call down on the community, innocent and guilty alike, the wrath of higher powers, the remedy being, not so much the punishment of the offender, still less mere physical purification, but their moralized analogues, prayer, fasting and repentance.

18. *Among the Greeks.*—The general word for taboo among the Greeks in ἄγος, which may bear the sense of "sacredness" or "pollution"; derivatives occur in the same meanings. Usually, however, the notions of sacred and unclean are distinguished by the use of different terms from this root, ἁγνός for sacred, ἐναγής for unclean or accursed. The rules of the Greek ἁγνεία (season of taboo) do not differ markedly from those of the Polynesian. Corresponding to the war-taboo of Oceania we find in Homer that the army (*Od.* xxiv. 81) and the sentinel (*Il.* x. 56, xxiv. 681) are sacred; and we learn from Plato that warriors never eat fish, from which indeed there was a general custom of abstinence except under the pressure of famine. The epithets ἱερός, δῖος, &c., which may point to beliefs similar to those of Polynesia, are applied to chiefs and kings, and further to the swineherd, thus suggesting that the pig, which bore a mixed reputation for holiness and uncleanness (ceremonial) both in Egypt and west Asia, was similarly regarded in Greece.

19. *Among the Romans.*—The term for taboo is *sacer;* any one who removed a landmark became *sacer* and was outlawed, any citizen having the right to kill him. *Consecratio capitis et bonorum* was the term for devotion to the nether gods. The flamen dialis and his wife were hedged in by a perfect network of ritual prohibitions; he might not ride upon nor even touch a horse; his eyes might not fall on an army under arms; he might not walk under a vine; he might not name a goat, raw meat, beans, ivy, a dog, and so on; his hair might be cut only by a freeman; he might not touch a corpse. The flaminica might not comb her hair at certain festivals; she was taboo (feriata) after hearing thunder till she had purified herself by a sacrifice. The Roman *feriae* were periods of taboo.

20. *Among the Jews.*—The Hebrew for holy is קדש which means "separated, cut off," while its correlative חל means "open for common use"; another sense of *sacer* is conveyed by חרם "accursed, devoted to destruction." Holiness is transmissible by contact (Ezek. xliv. 19, xlvi. 20; Ex. xxix. 37; Lev. vi. 27). It is distinct from purity in the moral sense; the names of the hieroduli קדשים and hierodula קדשה are connected with the word קדש. Taboo among the Jews are: (1) things connected with Jehovah, his name is holy and terrible; his arm is holy; holy places are taboo (see SANCTUARY); the ark is actively dangerous, and Uzzah, no less than the men of Bethshemesh, pays the penalty for too nearly approaching it; (2) the Nazarite might not partake of certain foods, nor touch a dead body nor shave his head, which was specially sacred; (3) in fact any one who touched a dead body was unclean and could communicate his uncleanness to others; (4) the birth of a child made the mother taboo; she was required to purify herself; (5) leprosy, menstruation, and sexual functions generally occasioned longer or shorter periods of uncleanness; and warriors, who were taboo on a campaign, were required to observe continence; (6) certain foods were taboo, and the uncleanness might be communicated to an earthen vessel, which, under certain circumstances, would be broken, like a pot in Polynesia; (7) the use of iron was forbidden in the construction of the temple; (8) a field sown with different kinds of herbs "becomes holy"; and (9) bystanders are warned not to approach a heathen rite, lest they be "sanctified"; (10) to the Polynesian interdicts, often termed taboos, corresponded certain periods of time, such as the Sabbath and the Jubilee year, but these are not connected with taboo proper.

BIBLIOGRAPHY.—For the definition of taboo see E. Tregear, *Maori Comparative Dictionary*, s.v. On the Polynesian taboo see Waitz-Gerland, *Anthropologie der Natur-Völker*, vi. 343–363 and the authorities there quoted; Ellis, *Polynesian Researches*, iv. 385, sq. of the 2nd ed.; Turner, *Nineteen Years in Polynesia*, p. 294 sq.; do., *Samoa*, p. 185 sq.; *Old New Zealand*, by a Pakeha *Maori*, vii.–xii.; Cook, *Voyages* (1809), v. 427 sq., vii. 146 sq., &c. On Melanesia see Marillier in *Bibliothèque de l'École des Hautes Études Religieuses*, vii. 35–74; Codrington, *The Melanesians*, *passim*. On Micronesia see Waitz-Gerland, op. cit. v., ii. 147 sq. On the Malays

see Skeat, *Malay Magic*, pp. 33–42, 57–59, 191–193, 225–228, 254, 259, 263–265, 344–351, &c. On Madagascar see v. Gennep, *Tabou et totémisme*; for the Jews see Hastings, *Dictionary of the Bible*, ii. 38, 394; iv. 825. For the Semites see Robertson Smith, *Religion of the Semites, passim*. For a general discussion of taboo see Marillier, loc. cit., v. Gennep, do. For sexual taboos see Crawley, *Mystic Rose*, and in *Journ. Anth. Inst.* xxiv. 116, 219, 430. For taboos of commensality see Crawley in *Folklore*, vi. 130. See also Hubert and Mauss in *Année Sociologique*, ii. 29–138 on sacrifice; and vii. 108, on *mana*; Durkheim, *ib.* i. 38–70 on incest and exogamy; Mauss in *Revue de l'histoire des religions*, xxxv. 49–60 on taboo and penal law; J. G. Frazer, *Golden Bough*, i. 297–464 on royal and priestly taboos, also iii. 1–134, 201–236, 463–467; J. Tuchmann, articles on "La Fascination" in *Mélusine*, 1881, &c.; J. G. Frazer, on burial rites, in *Journ. Anth. Inst.*, xv. 64 sq. For purity and holiness in the Old Testament see Baudissin, *Studien*, ii. 3–142; for *mana* see *Internationales Archiv für Ethnographie*, vii. 232. (N. W. T.)

TABOR, a town in western Bohemia, on the Francis-Joseph railway, 104 kilometres from Prague. Pop. (1908) 10,703. It is the chief town of a government district and the seat of a provincial law-court, and also of an industrial school. The town was founded in 1420 by the more advanced party of the church-reformers or Hussites, who, as it became their centre, soon began to be known as the Taborites. The town is situated on the summit of an isolated hill separated from the surrounding country by the Luznice stream and by an extensive pond, to which the Hussites gave the biblical name of Jordan. The historical importance of the city of Tabor only ceased when it was captured by King George of Poděbrad in 1452. Though a large part of the ancient fortifications has recently been demolished, Tabor—or Hradiste Hory Tabor, the castle of the Tabor Hill, as it was called in the Hussite period—has still preserved many memorials of its past fame. In the centre of the city is the market-place (*rynk*). Only very narrow streets lead to it, to render the approach to it more difficult in time of war. In the centre of the market-place is the statue of Žižka, the greatest of the Taborite leaders. Here also is the diaconal church, built in 1516 in the style of the Bohemian Renaissance, and the town hall, in connexion with which a museum has been founded, which contains interesting memorials of the Hussite period. Some parts of the ancient fortifications and the very ancient Kotnov tower also still exist.

See Thir, *Hradiste Hory Tabor* (1895).

TABRIZ, the capital of the province of Azerbaijan in Persia, situated in the valley of the Aji Chai, "Bitter River," at an elevation of 4400 ft. in 38° 4′ N., 46° 18′ E. Based on a census taken in 1871 the population of Tabriz was in 1881 estimated at 165,000, and is now said to be about 200,000.

The popular etymology of the name Tabriz from *tab*=fever, *rīz*=pourer away (verb, *rīkhtan*=pour away, flow; German *rieseln?*), hence "fever-destroying," is erroneous and was invented in modern times. It is related that Zobeideh, the wife of Harun-al-Rashid, founded the town in 791 after recovering there from fever, but the earlier chronicles give no support to this statement, and it is nowhere recorded that Zobeideh ever visited Azerbaijan, and the name Tabriz was known many centuries before her time. In 1842 Hammer-Purgstall correctly explained the name as meaning the "warm-flowing" (*tab*= warm, same root as *tep* in "tepid") from some warm mineral springs in the neighbourhood, and compared it with the synonymous Teplitz in Bohemia. In old Armenian histories the name is Tavresh, which means the same. The popular pronunciation *to* and *tau* for *tab* has given rise to the spellings Toris and Tauris met with in older travellers and used even now.

Overlooking the valley on the N.E. and N. are bold bare rocks, while to the S. rises the majestic cone of Sahand (12,000 ft.). The town possesses few buildings of note, and of the extensive ruins few merit attention. The ark, or citadel, in the south-west extremity of the city, now used as an arsenal, is a noble building of burnt brick with mighty walls and a tower 120 ft. in height. Among the ruins of old Tabriz the sepulchre of the Mongol king, Ghazan Khan (1295–1304), in a quarter once known as Shanb (generally pronounced Sham and Shām) i Ghazan, is no longer to be distinguished except as part of a huge tumulus. The great shanb (cupola or dome) and other buildings erected by Ghazan have also disappeared. They stood about 2 m. S.W. from the modern town, but far within the original boundaries. The "spacious arches of stone and other vestiges of departed majesty," with which Ker Porter found it surrounded in 1818, were possibly remains of the college (*medresseh*) and monastery (*zavīeh*) where Ibn Batūta found shelter during his visit to the locality. On the eastern side of the city stand the ruins of the Masjed i Jehan Shah, commonly known as the Masjed i Kebud, or "Blue Mosque," from the blue glazed tiles which cover its walls. It was built by Jehan Shah of the Kara Kuyunli, or Black Sheep dynasty (1437–1467).[1] Tabriz is celebrated as one of the most healthy cities in Persia.

Tabriz was for a long period the emporium for the trade of Persia on the west, but since the opening of the railway through the Caucasus and greater facilities for transport on the Caspian, much of its trade with Russia has been diverted to Astara and Resht, while the insecurity on the Tabriz-Trebizond route since 1878 has diverted much commerce to the Bagdad road. According to consular reports the value of the exports and imports which passed through the Tabriz custom-house during the years 1867–73 averaged £593,800 and £1,226,660 (total for the year, £1,820,460); the averages for the six years 1893–9 were £212,880 and £544,530. There are reasons to believe that these values were considerably understated. For the year 1898–9 the present writer obtained figures directly from the books kept by the custom-house official at Tabriz, and although, as this official informed him, some important items had not been entered at all, the value of the exports and imports shown in the books exceeded that of the consular reports by about 10 per cent. Since that time the customs of Azerbaijan have been taken over by the central customs department under Belgian officials, and it is stated that the trade has not decreased. British, Russian, French, Turkish and Austrian consulates and a few European commercial firms are established at Tabriz; there are also post and telegraph offices. Tabriz has suffered much from earthquakes, notably in 858, 1042 and 1721, each time with almost complete destruction of the city. (A. H.-S.)

TABULARIUM (*tabula*, board, picture, also archives, records), the architectural term given to the Record office in ancient Rome, which was built by Q. Lutatius Catulus, the conqueror of the Cimbri. It was situated on the west side of the Forum Romanum, and its great corridor, 220 ft. long, raised 50 ft. above the forum on a massive substructure, is still partly preserved. This corridor was lighted through a series of arches divided by semi-detached columns of the Doric order, the earliest example of this class of decoration, which in the Theatre of Marcellus, the Colosseum, and all the great amphitheatres throughout the Roman empire constituted the decorative treatment of the wall surface and gave scale to the structure. Traces of an upper corridor with semi-detached columns of the Ionic order have been found in the Tabularium, but this structure was much changed in the 13th century, when the Palace of the Senators was built.

TACHEOMETRY (from Gr. ταχύς, quick; μέτρον, a measure), a system of rapid surveying, by which the positions, both horizontal and vertical, of points on the earth's surface relatively to one another are determined without using a chain or tape or a separate levelling instrument. The ordinary methods of surveying with a theodolite, chain, and levelling instrument (see SURVEYING) are fairly satisfactory when the ground is pretty clear of obstructions and not very precipitous, but it becomes extremely cumbrous when the ground is much covered with bush, or broken up by ravines. Chain measurements are then both slow and liable to considerable error; the levelling, too, is carried on at great disadvantage in point of speed, though without serious loss of accuracy. These difficulties led to the introduction of tacheometry, in which, instead of the pole formerly employed to mark a point, a staff similar to a level staff is used. This is marked with heights from the foot, and is graduated according to the form of tacheometer in use. The azimuth angle is determined as formerly. The horizontal distance is

[1] This mosque is popularly attributed to Ghazan Khan (end of 13th century).

inferred either from the vertical angle included between two well-defined points on the staff and the known distance between them, or by readings of the staff indicated by two fixed wires in the diaphragm of the telescope. The difference of height is computed from the angle of depression or elevation of a fixed point on the staff and the horizontal distance already obtained. Thus all the measurements requisite to locate a point both vertically and horizontally with reference to the point where the tacheometer is centred are determined by an observer at the instrument without any assistance beyond that of a man to hold the staff.

Subtense method. The simplest system of tacheometry employs a theodolite without additions of any kind, and the horizontal and vertical distances are obtained from the angles of depression or elevation of two well-defined points on a staff at known heights from the foot, the staff being held vertically. In fig. 1 let T be the telescope of a theodolite centred over the point C, and let AB be the staff held truly vertical on the ground at A. Let P and P′ be the two well-defined marks on the face of the staff,

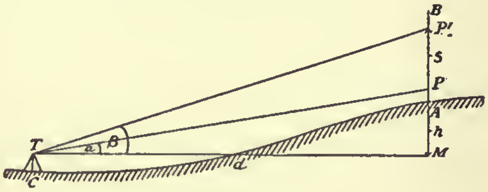

FIG. 1.

both of them at known heights above A, and enclosing a distance PP′ $=s$ between them. Let α and β be the measured angles of elevation of P and P′, and let d be the horizontal distance TM of the staff from the theodolite, and h the height PM of P above T. Then since

$$\mathrm{P'M}=d\tan\beta \text{ and } \mathrm{PM}=d\tan\alpha,$$

we have
$$s=\mathrm{P'M}-\mathrm{PM}=d(\tan\beta-\tan\alpha).$$

Therefore
$$d=\frac{s}{\tan\beta-\tan\alpha};\qquad h=\frac{s\tan\alpha}{\tan\beta-\tan\alpha}.$$

If TC, the height of the rotation axis of the telescope above the ground, $=q$, and if AP $=p$, then the height of A above C is $h-p+q$. If, as is usually the case, a number of points are determined from one station of the theodolite, and h_1, h_2, h_3, &c., be the values of h for the different points A_1, A_2, A_3, &c., then the difference of level of A_1 and A_2 will be h_2-h_1, that of A_1 and A_3 will be h_3-h_1, and so on. To ensure the essential condition that the staff is held vertical, it is usually provided with a small circular spirit-level, and the staff-holder must always keep the bubble in the centre of its run. No graduation of the staff is required beyond two well-defined black lines across the white face at P and P′, but the marks can be very usefully supplemented by wings fastened on the two sides of the staff, having their tops at right angles to the staff, at the same height as the points P and P′, and forming a continuation of the black lines. A convenient length for the staff is 12 ft., with the point P 2 ft. from the foot, and the point P′ at the top of the staff, so that $s=10$ ft.

With the above arrangement the staff can easily be read with a 5-inch theodolite at half a mile distance. But while it is frequently very useful to determine approximately points a long way off, the determinations will not be nearly so accurate as those of near points. Thus suppose that the distance of the staff is d, and the intercept on the staff is s, and suppose that the personal and instrumental error is $\delta\alpha$ (α being the angle subtended by s at the telescope); then since

$$d=\frac{s}{\tan\alpha},\frac{d(d)}{d\alpha}=-\frac{s}{\sin^2\alpha}=-s\frac{1+\tan^2\alpha}{\tan^2\alpha},\text{ or }\frac{d(d)}{d\alpha}=-s\frac{1+s^2/d^2}{s^2/d^2}=-\frac{1}{s}(s^2+d^2).$$

Therefore δd, the distance error, is given by the equation $\delta d=-\delta\alpha(s^2+d^2)/s$. But at distances of 5 chains or more s^2 will be very small compared with d^2 and may be neglected, so that $\delta d=-\delta\alpha.d^2/s$. Since $\delta\alpha$ may be considered as constant for all distances where the staff can be distinctly read, the distance error increases as the square of the distance. With small theodolites, where special care has not been given to the graduating and reading of the vertical circle, $\delta\alpha$ will probably amount to about 20″. At a quarter of a mile excellent work can be done. In carrying on a traverse line by this method with stations 10 or 12 chains apart, the theodolite being set up at points about midway between the stations, the probable distance error in a mile is about $3\frac{1}{2}$ ft., and the probable level error about 4 in. In 25 miles these probable errors would correspond to about 18 ft. and 20 in. respectively. This system of tacheometry is well adapted for distant readings, and from the great simplicity of the observations there is little likelihood of errors in the field. But the reduction work is rather heavier than is the case with some of the tacheometers described below. Since the accuracy of the method depends entirely upon the accuracy with which the vertical angles are measured, it is advisable that the vertical circle should be as large as possible, very finely and accurately divided, and fitted with good verniers and microscopes.

In Eckhold's omnimeter the vertical circle of the theodolite is dispensed with, and a saving of reduction work is effected by reading, not the vertical angles themselves, but the tangents of the angles.

In the Ziegler-Hager tacheograph the tangents are read not horizontally but vertically, and the arrangement is as follows:—In fig. 2 O is the axis of rotation of the telescope; mn is the axial line of a steel bolt, which carries on its top a knife-edge, on which the telescope rests by means of an agate plate. The bolt is carried by a slide in which it can be raised or lowered by a micrometer screw fitted with a graduated head. The slide plays between the vertical cheeks of a standard rigidly attached to the frame of the instrument, and it can be raised or lowered by a rack and pinion. The telescope, which rests on the knife-edge, follows the movement of the bolt. The slide carries on one side a vernier by which to read the divisions on a scale fixed to one of the vertical legs of the standard, and the zero point o of the scale is the point where the horizontal plane through O cuts the scale when the plane-table or upper plate of the theodolite is truly level. The scale is graduated in divisions, each of which is the $\frac{1}{100}$th part of the distance Oo, or h. The head of the micrometer screw which raises or lowers the steel bolt in the slide is graduated with a zero mark and with marks corresponding to a vertical movement of the knife-edge of $\frac{1}{100}h$, $\frac{1}{50}h$, &c. The instrument is used as follows:—Let AB be the surface of the ground, and BC a staff held vertically at B, and let CB be produced to meet the horizontal line through O in M. Let the head of the micrometer screw be turned till the zero division is exactly under the pointer. Let p be the zero division on the staff, and let the slide and bolt be raised by the rack and pinion movement till the axis of the telescope is directed towards p. Let v be the point where the line Op cuts mn, and let the tangent reading ov be taken on the scale. Then let the telescope be lowered by the micrometer screw in the slide till the division on the head of the screw marked 1 is exactly under the pointer; the knife-edge of the bolt has then been lowered through a distance vt equal to $h/100$. Let q be the point on the staff where the line Ot cuts it, and let the reading at q be taken. Then since the triangles between O and mn and O and CM are similar to each other, and vt is $\frac{1}{100}$th of Oo, therefore pq will be $\frac{1}{100}$th of OM, or OM $=100\times pq$. This gives the horizontal distance of the staff from O, and the vertical distance pM of p above O is OM tan MOp = OM × ov/Oo, and since ov has been read in

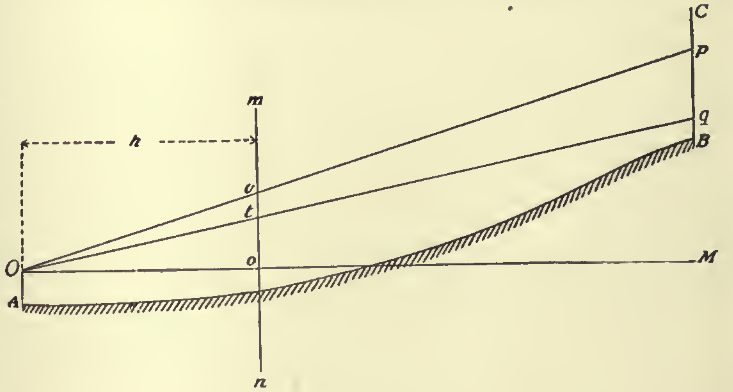

FIG. 2.

parts of which Oo contains 100, the distance pM is readily obtained. If the difference of elevation of B and A be required, the height pM must be reduced by pB and increased by OA, both known quantities. By this arrangement the reduction work of the observations is rendered extremely simple, and can readily be performed in the field. The instrument is well adapted for use with the plane-table.

Stadia method. Tacheometers in which the horizontal distance of the staff from the telescope is deduced from the readings of the staff indicated by two fixed wires in the diaphragm of the telescope will now be considered. In fig. 3 BC is a diaphragm fixed in a tube having fine horizontal wires at B and C. Let the end E of the tube be closed by a disk which has a minute hole at E, to which the eye can be applied. If P and D be the points on a vertical staff at which the lines EB and EC are observed to cut the staff, so that the intercept PD is known, then from similar triangles ED = (EC/BC)PD, and since EC and BC are constant, ED varies as PD. If, for instance, PD has a certain observed value when the staff is held at a certain distance ED, and has exactly half that value when the staff is held at another distance ED′, then the distance

ED′ is one-half of the distance ED, and so on in proportion. The distance ED can be instantly inferred from the readings of the staff, if the latter be suitably graduated. If, for example, it be desired to know the distance ED in yards, and by construction the proportion EC/BC = 50, then the intercept on the staff at 1 yard from E would be $\frac{1}{50}$th of a yard, or ·72 inch, the intercept at 2 yards from E would be 2×·72 inches, and so on. If therefore the staff be graduated with divisions of ·72 inch, and the intercept be 45 of such divisions, it would be inferred that the distance of the staff from E was 45 yards. The constant proportion EC/BC can be checked by measuring 100 yards from E and observing whether

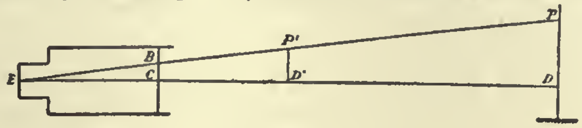

FIG. 3.

the intercept is exactly 100 divisions or not. If it is not, the wire diaphragm must be shifted in the tube until it is. In figs. 3, 4, 5 and 6 the distances are deduced from the readings of a central wire in the optical axis of the telescope and of a wire above it, for the sake of simplicity. The usual arrangement is to fit the diaphragm with a central wire and with one or two wires above and below it at equal distances from the central wire. The vertical angle of depression or elevation is fixed by directing the central wire to a well-defined division on the staff, and the distance of the staff is inferred from the readings given by the corresponding wires above and below the central wire.

The elementary form of tacheometer given above illustrates the general principle of the class of tacheometers now under consideration, and as leading up to the practical form, in which the staff is viewed with a telescope mounted in the manner of a theodolite. The simplest form is Reichenbach's tacheometer, which may be investigated as follows:—In fig. 4 let A be the object glass by which an image of the staff ST is formed at HK. The wire diaphragm is moved in the tube so as to coincide with the image,

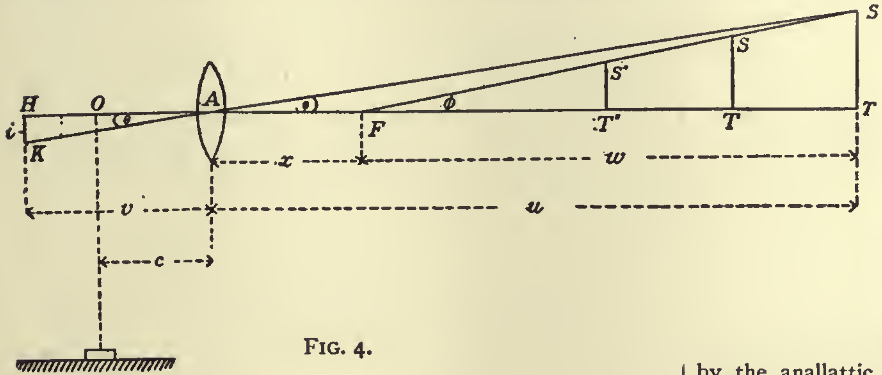

FIG. 4.

and the image and wires are viewed with an eye-piece (not shown) in the usual way. Let O be the point where the vertical axis of the instrument cuts the axis of the telescope, the instrument being centred over a peg, from which the distance to the staff is required. The object glass (of focal length $=f$) is at a distance c from O. Let AT $=u$ and AH $=v$, and the angle SAT = HAK $=\theta$. Then if i be the height of the image HK, $i=v\tan\theta$. Since $1/v+1/u=1/f$, we have $v=-uf/(u-f)$, and hence $i=uf\tan\theta/(u-f)$. Let F be some point on AT such that AF $=x$ and FT $=u'$. And let the angle SFT $=\phi$. Then $u=u'+x$ and $\tan\theta=u'\tan\phi/(u'+x)$, and therefore

$$i=\frac{(u'+x)f}{u'+x-f}\,\frac{u'}{u'+x}\cdot\tan\phi=\frac{fu'}{u'+x-f}\tan\phi;\text{ and, if } x=f,\ i=f\tan\phi.$$

If therefore the point F be taken at a distance f from the object glass, every intercept of the staff for positions between T and F, such as S′T′, S″T″, &c., which are bounded by the line FS, and for which consequently θ is the same, will have the same height of image at the diaphragm. Conversely, if K be a wire in the diaphragm it will cut the image of the staff for all positions of the staff between T and F in points that lie on the line FS. Now the intercept S″T″, half-way between F and T, will be one-half of ST, and therefore if the reading on the staff indicated by the wire in question be one-half of ST, it may be inferred that the position of the staff is half-way between F and T, and similarly for other distances. If the distance of ST from O is required, as is usually the case, a quantity $f+c$ must be added to every distance from F determined as above.

It is very seldom that the line of sight AT of the telescope is at right angles to the staff. In general it is more or less inclined to the staff, which is almost always held vertical, and the horizontal and vertical distances of the staff from the axis of rotation of the telescope are found thus:—In fig. 5 let ST be the observed intercept on the staff when the telescope is inclined at an angle α to the horizontal. Draw TS′ at right angles to OT. The angle TS′S will be very nearly a right angle, and STS′ may be taken as equal to α. If there were n graduations (each corresponding to 1 yard in distance) in ST, there would be $n\cos\alpha$ graduations in

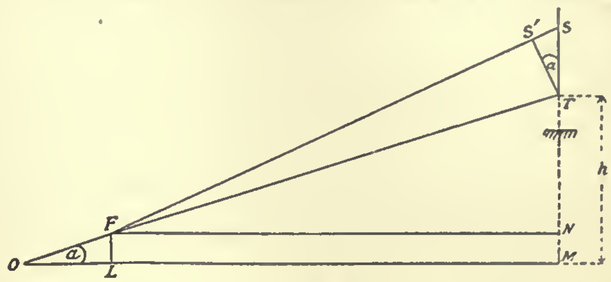

FIG. 5.

S′T, and therefore the distance of the staff from F, as inferred from the observed number of graduations in ST, must be multiplied by $\cos\alpha$ to give the true distance FT. Again FN = FT $\cos\alpha$, so that the distance inferred from the observed number of graduations in ST must be multiplied by $\cos^2\alpha$ to give the horizontal distance of F from T. To this must be added the distance OL = OF $\cos\alpha=(f+c)\cos\alpha$ to get the horizontal distance, OM, of O (the vertical axis of the instrument) from T. This value of OM must be multiplied by $\tan\alpha$ to obtain the value of h, the vertical distance of T from O. Tables of the value of $\cos\alpha$, $\cos^2\alpha$, and $\tan\alpha$ are necessary to facilitate these calculations.

In this tacheometer the distances as inferred from the readings of the staff are the distances of the staff from F and not from O. This defect was remedied by Porro, who added a lens (called the anallattic lens) to the telescope. The arrangement of the telescope as manufactured by Messrs Troughton and Simms, is as follows:—In fig. 6 O is the point where the vertical axis of the instrument cuts the axis of the telescope. The object glass is fixed at a distance c from O, and the anallattic lens at a distance d from the object glass. The distances c and d are chosen to suit the constructive conveniences of the instrument. The diaphragm at K is movable so that it can be made to coincide with the image of the staff. The focal length f_1 of the object glass is arbitrary, and the focal length f_2 of the anallattic lens is determined from an equation of condition between c, d, f_1, and f_2. The image of the staff ST would be formed by the object glass at H, at a distance v_1 from the object glass, were it not that the rays, after passing through the object glass, are received by the anallattic lens and the image of the staff is formed at K on the wire diaphragm, which is slid in the tube till it coincides with the position of the image. The image at K is viewed by an eye-piece in the usual way. Let T be the point where the image of the staff is cut by the central wire of the diaphragm, and S the point where the image is cut by one of the outer wires of the diaphragm. If θ and ϕ be the angles subtended by ST at the object glass and at the point O respectively, and if i be the height of the image at K, h the height of the virtual image at H, then by elementary geometry and from optical considerations, we obtain

$$i=\frac{u'f_1f_2}{u'(f_1-d+f_2)-\{cf_1-(c+f_1)(d-f_2)\}}\cdot\tan\phi$$

Let f_2 be made such that $cf_1-(c+f_1)(d-f_2)=0$, the equation of condition above mentioned. Then $f_2=\{d(c+f_1)-cf_1\}/(c+f_1)$.

And $i=\dfrac{f_1f_2}{f_1-d+f_2}\cdot\tan\phi=\dfrac{d(c+f_1)-cf_1}{f_1}\cdot\tan\phi$.

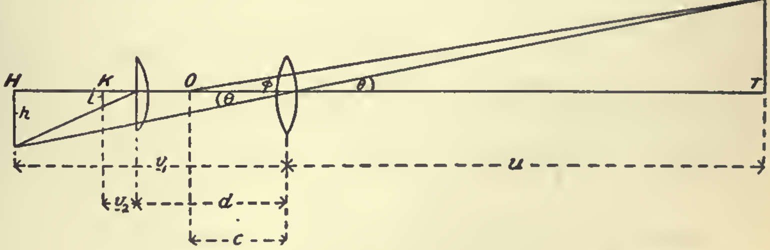

FIG. 6.

Therefore all the readings of the staff which would be given by the outer wire of the diaphragm will lie on the line OS (for all of which ϕ is the same), and the distance from O along OT will be proportional to the reading on the staff. Thus if the staff be suitably graduated, the distance from O can be immediately deduced from the reading. Also, as before, if the telescope be inclined at an angle α to the horizontal, the distance OT inferred from the number of graduations in ST must be multiplied by $\cos^2 \alpha$ to give the horizontal distance of O from T, and the horizontal distance so obtained must be multiplied by $\tan \alpha$ to obtain the vertical distance of T from O.

The inconvenience of the reduction work necessary to obtain the horizontal and vertical distances produced the Wagner-Feunel tacheometer, by which the distances can be read directly from the instrument. As is seen from fig. 7, three scales are provided, to measure the inclined distance, the horizontal distance, and the vertical distance respectively. All three are arranged in a plane parallel to the plane in which the telescope turns. The inclined scale is attached to the telescope exactly parallel to its line of collimation, and moves with it. The horizontal scale is fixed to the upper horizontal plate of the theodolite. The vertical scale is on the vertical edge of a right-angled triangle, which can be slid along on the top of the horizontal scale. The inclined scale carries a slide which is provided with two verniers. One of these is parallel to the inclined scale, and is for the purpose of setting off on the scale (in terms of the divisions on the scale) the inclined distance of the staff from the axis of rotation of the telescope. The other turns on a pivot whose centre is accurately in the edge of the inclined scale at the point where the zero division of the inclined vernier

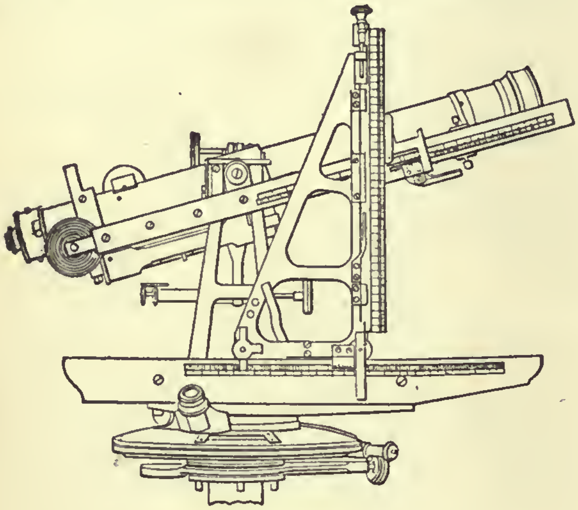

FIG. 7.

cuts the edge, and is for the purpose of reading the vertical scale; it can be turned on its pivot so as to be vertical whatever may be the inclination of the telescope. Moreover, since the distance from the centre of the pivot to the zero of the vernier is always constant and known, the vertical scale can be graduated so that the reading of the vernier gives the height (in terms of the division on the scale) of the staff above the axis of rotation of the telescope. The horizontal scale attached to the horizontal plate of the theodolite is read by means of a vernier carried by the triangle. To ascertain the horizontal and vertical distances of the point on the staff which is cut by the middle wire in the diaphragm of the telescope from the rotation axis of the telescope, the inclined distance of the point on the staff is read by means of the wires, as in Porro's tacheometer. This distance (in terms of the divisions) is then set off on the inclined scale by means of the inclined vernier, and the vertical scale on the triangle is moved up to the vertical vernier, which is adjusted to its edge. With proper graduation of the horizontal and vertical scales the horizontal and vertical distances can be at once read off on the scales. This method, however, requires that the staff be held so that its face is perpendicular to the line of sight, which is more troublesome than holding the staff vertical.

AUTHORITIES.—Brough on "Tacheometry," *Proc. Inst. C.E.*, vol. xci. Pierce on the "Use of the Plane Table," *ibid.* vol. xcii. Kennedy on the "Tacheometer," *ibid.* vol. xcix. Airy on the "Probable Errors of Surveying by Vertical Angles," *ibid.* vol. ci. Middleton on "Observations in Tacheometry," *ibid.* vol. cxvi. Young on "Surveying with the Omnimeter," *ibid.* vol. cxvii. J. Bridges Lee on "Photographic Surveying," *Trans. Soc. Engin.*, vol. for 1899. "The Ziegler-Hager Tacheograph," *Engineering*, vol. lxv. (W. AY.)

TACHIENLU, a town of China, in the province of Sze-ch 'uen. It is the great tea mart for Tibet, and from Tachienlu the two trade-routes. the Gya lam and the Chang lam, diverge, the former to Ladakh and the latter to Kashgar.

TACHYLYTES, or TACHYLITES (from Gr. *ταχύς*, swift, *λύειν*, to dissolve, meaning "easily fused," though some have erroneously interpreted it as "easily soluble in acids"), in petrology, the vitreous forms of the basic igneous rocks; in other words, they are basaltic obsidians. They are black in colour, dark brown in the thinnest sections, with a resinous lustre and the appearance of pitch, often more or less vesicular and sometimes spherulitic. They are very brittle, and break down readily under the hammer. Small crystals of felspar or of olivine are sometimes visible in them with the unaided eye. All tachylytes weather rather easily, and by oxidation of their iron become dark brown or red. Three modes of occurrence characterize this rock. In all cases they are found under conditions which imply rapid cooling, but they are much less common than acid volcanic glasses (or obsidians), the reason being apparently that the basic rocks have a stronger tendency to crystallize, partly because they are more liquid and the molecules have more freedom to arrange themselves in crystalline order.

The fine scoria ashes or "cinders" thrown out by basaltic volcanoes are often spongy masses of tachylyte with only a few larger crystals or phenocrysts imbedded in black glass. Such tachylyte bombs and scoria are frequent in Iceland, Auvergne, Stromboli, Etna, and are very common also in the ash beds or tuffs of older date, such as occur in Skye, Midlothian and Fife, Derbyshire, and elsewhere. Basic pumices of this kind are exceedingly wide-spread on the bottom of the sea, either dispersed in the "red clay" and other deposits or forming layers coated with oxides of manganese, precipitated on them from the sea water. These tachylyte fragments, which are usually much decomposed by the oxidation and hydration of their ferrous compounds, have taken on a dark red colour. This altered basic glass is known as "palagonite"; concentric bands of it often surround kernels of unaltered tachylyte, and are so soft that they are easily cut with a knife. In the palagonite the minerals also are decomposed, and are represented only by pseudomorphs. The fresh tachylyte glass, however, often contains lozenge-shaped crystals of plagioclase felspar and small prisms of augite and olivine, but all these minerals very frequently occur mainly as microlites or as beautiful skeletal growths with sharply-pointed corners or ramifying processes. Palagonite tuffs are found also among the older volcanic rocks. In Iceland a broad stretch of these rocks, described as "the palagonite formation," is said to cross the island from south-west to north-east. Some of these tuffs are fossiliferous; others are intercalated with glacial deposits. The lavas with which they occur are mostly olivine-basalts. Palagonite tuffs are found in Sicily, the Eifel, Hungary, Canary Islands, &c.

A second mode of occurrence of tachylyte is in the form of lava flows. Basaltic rocks often contain a small amount of glassy ground-mass, and in the limburgites this becomes more important and conspicuous, but vitreous types are far less common in these than in the acid lavas. In the Hawaiian Islands, however, the volcanoes have poured out vast floods of black basalt, containing felspar, augite, olivine, and iron ores in a black glassy base. They are highly liquid when discharged, and the rapid cooling which ensues on their emergence to the air prevents crystallization taking place completely. Many of them are spongy or vesicular, and their upper surfaces are often exceedingly rough and jagged, while at other times they assume rounded wave-like forms on solidification. Great caves are found where the crust has solidified and the liquid interior has subsequently flowed away, and stalactites and stalagmites of black tachylyte adorn the roofs and floors. On section these growths show usually a central cavity enclosed by walls of dark brown glass in which skeletons and microliths of augite, olivine and felspar lie imbedded. From the crater of Kilauea thin clouds of steam rise constantly, and as the bubbles of vapour are liberated from the molten rock they carry into the air with them thin fibres of basalt which solidify at once and assume the form of tachylyte threads. Under the microscope they prove to be nearly completely glassy with small circular air vesicles sometimes drawn out to long tubes. Only in the Hawaiian Islands are glassy basaltic lavas of this kind at all common.

A third mode of occurrence of tachylyte is as the margins and thin offshoots of dikes or sills of basalt, dolerite and diabase. They are sometimes only a fraction of an inch in thickness, resembling a thin layer of pitch or tar on the edge of a crystalline dolerite dike, but veins several inches thick are sometimes met with. In these situations tachylyte is rarely vesicular, but it often shows very pronounced fluxion banding accentuated by the presence of rows of spherulites which are visible as dark brown rounded spots. The spherulites have a distinct radiate structure and sometimes exhibit zones of varying colour. The non-spherulitic glassy portion is sometimes perlitic and these rocks are always brittle. The commonest crystals are olivine, augite and felspar, with swarms of minute dusty black grains of magnetite. At the extreme edges the glass is often perfectly free from crystalline products, but it merges rapidly into the ordinary crystalline dolerite, which in a very short distance may contain no vitreous base whatever. The spherulites may form the greater part of the mass, they may be a quarter of an inch in diameter and are occasionally much larger than this. These coarsely spherulitic rocks pass over into the variolites (*q.v.*) by increasing coarseness in the fibres of their spherulites, which soon become recognizable as needles of felspar or feathery growths of augite. The ultimate product of decomposition in this case also is a red palagonitic substance, but owing to the absence of steam cavities the tachylyte selvages of dikes are more often found in a fresh state than the basic lapilli in ash-beds. Many occurrences of basaltic pitchstones have been reported from Skye, Mull, and the western part of Scotland; they are found also in connexion with the intrusive dolerite sills of the north of England and the centre of Scotland. In the Saar district of Germany similar rocks occur, some of which have been described as weisselbergites (from Weisselberg).

Other localities for tachylytes of this group are Nassau, Silesia and Sweden.

The chemical composition of some of the rocks of this group is indicated by the analyses given below:—

	SiO_2.	Al_2O_3.	FeO.	Fe_2O_3.	CaO.	MgO.	Na_2O.	K_2O.	H_2O.
I. Palagonite. Seljadalr, Iceland	38·96	11·62	...	14·75	9·13	6·29	0·68	0·72	17·85
II. Palagonite from deep-sea deposits, Pacific Ocean (with 2·89 % MnO_2)	44·73	16·28	...	14·57	1·88	2·23	4·50	4·02	9·56
III. Palagonite. Franz Joseph Land	35·48	8·30	14·60	12·30	1·04	7·10	3·92	tr.	16·80
IV. Tachylyte. Ardtun, Mull, Scotland . .	53·03	20·09	...	9·53	6·05	2·63	4·52	1·27	2·64
V. Tachylyte. The Beal, Portree, Skye . .	52·59	17·33	...	11·14	6·47	2·62	4·24	2·40	3·27

(J. S. F.)

TACITUS, CORNELIUS (*c.* 55–120), Roman historian. Tacitus, who ranks beyond dispute in the highest place among men of letters of all ages, lived through the reigns of the emperors Nero, Galba, Otho, Vitellius, Vespasian, Titus, Domitian, Nerva and Trajan. All we know of his personal history is from allusions to himself in his own works, and from eleven letters addressed to him by his very intimate friend, the younger Pliny. The exact year of his birth is a matter of inference, but it may be approximately fixed near the close of the reign of Claudius. Pliny indeed, though himself born in 61 or 62, speaks of Tacitus and himself as being "much of an age,"[1] but he must have been some years junior to his friend, who began, he tells us, his official life under Vespasian,[2] no doubt as quaestor, and presumably tribune or aedile under Titus (80 or 81), at which time he must have been twenty-five years of age at least. Of his family and birthplace we know nothing certain; we can infer nothing from his name Cornelius, which was then very widely extended; but the fact of his early promotion seems to point to respectable antecedents, and it may be that his father was one Cornelius Tacitus, who had been a procurator in one of the divisions of Gaul, to whom allusion is made by the elder Pliny in his *Natural History* (vii. 76). But it is all matter of pure conjecture, as it also is whether his "praenomen" was Publius or Gaius. The most interesting facts about him to us are that he was an eminent pleader at the Roman bar, that he was an eye-witness of the "reign of terror" during the last three years of Domitian, and that he was the son-in-law of Julius Agricola. This honourable connexion, which testifies to his high moral character, may very possibly have accelerated his promotion, which he says[3] was begun by Vespasian, augmented by Titus, and still further advanced by Domitian, under whom we find him presiding as praetor at the celebration of the secular games in 88, and a member of one of the old priestly colleges, to which good family was an almost indispensable passport. Next year, it seems, he left Rome, and was absent till 93 on some provincial business, and it is possible that in these four years he may have made the acquaintance of Germany and its peoples. His father-in-law died in the year of his return to Rome. In the concluding passage of his *Life of Agricola* he tells us plainly that he witnessed the judicial murders of many of Rome's best citizens from 93 to 96, and that being himself a senator he felt almost a guilty complicity in them. With the emperor Nerva's accession his life became bright and prosperous, and so it continued through the reign of Nerva's successor, Trajan, he himself, in the opening passage of his *Agricola*, describing this as a "singularly blessed time," but the hideous reign of terror had stamped itself ineffaceably on his soul, and when he sat down to write his *History* he could see little but the darkest side of imperialism. To his friend the younger Pliny we are indebted for the little we know about his later life. He was advanced to the consulship in 97, in succession to a highly distinguished man, Verginius Rufus, on whom he delivered in the senate a funeral eulogy. In 99 he was associated with Pliny in the prosecution of a great political offender, Marius Priscus, under whom the provincials of Africa had suffered grievous wrongs. The prosecution was successful, and both Tacitus and Pliny received a special vote of thanks from the senate for their conduct of the case. It would seem that Tacitus lived to the close of Trajan's reign, as he seems[4] to hint at that emperor's extension of the empire by his successful Eastern campaigns from 115 to 117. Whether he outlived Trajan is matter of conjecture. It is worth noticing that the emperor Tacitus in the 3rd century claimed descent from him, and directed that ten copies of his works should be made every year and deposited in the public libraries. He also had a tomb built to his memory, which was destroyed by order of Pope Pius V. in the latter part of the 16th century.

Pliny, as we see clearly from several passages in his letters, had the highest opinion of his friend's ability and worth. He consults him about a school which he thinks of establishing at Comum (Como), his birthplace, and asks him to look out for suitable teachers and professors. And he pays[5] him the high compliment, "I know that your *Histories* will be immortal, and this makes me the more anxious that my name should appear in them."

The following is a list of Tacitus's remaining works, arranged in their probable chronological order, which may be approximately inferred from internal evidence:—(1) the *Dialogue on Orators*, about 76 or 77; (2) the *Life of Agricola*, 97 or 98; (3) the *Germany*, 98, published probably in 99; (4) the *Histories* (*Historiae*), completed probably by 115 or 116, the last years of Trajan's reign (he must have been at work on them for many years); (5) the *Annals*, his latest work probably, written in part perhaps along with the *Histories*, and completed subsequently to Trajan's reign, which he may very well have outlived.

The *Dialogue on Orators* discusses, in the form of a conversation which Tacitus professes to have heard (as a young man) between some eminent men at the Roman bar, the causes of the decay of eloquence under the empire. There are some interesting remarks in it on the change for the worse that had taken place in the education of Roman lads. The style of the *Dialogue* is far more Ciceronian than that of Tacitus's later work, and critics have attributed it to Quintilian; but its genuineness is now generally accepted. It is noticeable that the mannerisms of Tacitus appear to develop through his lifetime, and are most strongly marked in his latest books, the *Annals*.

The *Life of Agricola*, short as it is, has always been considered an admirable specimen of biography. The great man with all his grace and dignity is brought vividly before us, and the sketch we have of the history of our island under the Romans gives a special interest to this little work.

The *Germany*, the full title of which is "Concerning the geography, the manners and customs, and the tribes of Germany," describes with many suggestive hints the general

[1] Pliny, *Epp.* vii. 20. [2] *Hist.* i. 1. [3] *Ibid.*

[4] *Ann.* ii. 61; iv. 4. [5] *Epp.* vii. 33.

character of the German peoples, and dwells particularly on their fierce and independent spirit, which the author evidently felt to be a standing menace to the empire. The geography is its weak point; much of this was no doubt gathered from vague hearsay. Tacitus dwells on the contrast between barbarian freedom and simplicity on the one hand, and the servility and degeneracy of Roman life on the other.

The *Histories*, as originally composed in twelve books, brought the history of the empire from Galba in 69 down to the close of Domitian's reign in 97. The first four books, and a small fragment of the fifth, giving us a very minute account of the eventful year of revolution, 69, and the brief reigns of Galba, Otho and Vitellius, are all that remain to us. In the fragment of the fifth book we have a curious but entirely inaccurate account of the Jewish nation, of their character, customs and religion, from a cultivated Roman's point of view, which we see at once was a strongly prejudiced one.

The *Annals*—a title for which there is no ancient authority, and which there is no reason for supposing Tacitus gave distinctively to the work—record the history of the emperors of the Julian line from Tiberius to Nero, comprising thus a period from A.D. 14 to 68. Of these, nine books have come down to us entire; of books v., xi. and xvi. we have but fragments, and the whole of the reign of Gaius (Caligula), the first six years of Claudius, and the last three years of Nero are wanting. Out of a period of fifty-four years we thus have the history of forty years.

The principal MSS. of Tacitus are known as the "first" and "second" Medicean—both of the 10th or 11th centuries. The first six books of the *Annals* exist nowhere but in the "first Medicean" MS., and an attempt was made in 1878 to prove that the *Annals* are a forgery by Poggio Bracciolini, an Italian scholar of the 15th century, but their genuineness is confirmed by their agreement[1] in various minute details with coins and inscriptions discovered since that period. Moreover, Ruodolphus, a monk, writing in the 9th century, shows that he is acquainted with a MS. of Tacitus containing at least the two first books. Add to this the testimony of Jerome that Tacitus wrote in thirty books the lives of the Caesars and the evidence of style, and there can be no doubt that in the *Annals* we have a genuine work of Tacitus.

Much of the history of the period described by him, especially of the earlier Caesars, must have been obscure and locked up with the emperor's private papers and memoranda. As we should expect, there was a vast amount of floating gossip, which an historian would have to sift and utilize as best he might. Tacitus, as a man of good social position, no doubt had access to the best information, and must have talked matters over with the most eminent men of the day. There were several writers and chroniclers, whom he occasionally cites but not very often; there were memoirs of distinguished persons—those, for example, of the younger Agrippina, of Thrasea, and Helvidius. There were several collections of letters, like those of the younger Pliny; a number, too, of funeral orations; and the "acta senatus" and the "acta populi" or "acta diurna," the first a record of proceedings in the senate, the latter a kind of gazette or journal. Thus there were the materials for history in considerable abundance, and Tacitus was certainly a man who knew how to turn them to good account. He has given us a striking, and on the whole doubtless a true, picture of the empire in the 1st century. The rhetorical tendency which characterizes the "silver age" of Roman literature, gives perhaps exaggerated expression to his undoubtedly strong sense of the badness of individual emperors, but he assuredly wrote with a high aim, and we may accept his own account of it: "I regard[2] it as history's highest function to rescue merit from oblivion, and to hold up as a terror to base words and actions the reprobation of posterity." He is convinced of the degeneracy of the age, though it be relieved by the existence of truly noble virtues: and he connects this degeneracy more or less directly with the imperial régime. But it is difficult to dogmatize as to Tacitus's political ideals. He is primarily concerned rather with ethics than with politics; though he may feel that the world is out of joint—with whatever sentimental sympathy he may regard the age of "liberty," and admire the heroic epoch of the republic—yet he appears to realize that the empire is a practical necessity, and to the provinces even a benefit. Like the Stoics, with whom otherwise he has little in common, he censures rather individual rulers than the imperial system. But "the key to the interpretation of Tacitus," it has been well said,[3] "is to regard him as a moralist rather than a politician." Perhaps the strongest work in the *Annals* and *Histories* is the delineation of character.

Tacitus gives us no certain clue to his religious belief. His expressions of opinion about the government of the universe are difficult to reconcile with each other. There seems to have been a strange tinge of superstition about him, and he could not divest himself of some belief[4] in astrology and revelations of the future through omens and portents, though he held these were often misunderstood and misinterpreted by charlatans and impostors. On the whole he appears to have inclined to the philosophical theory of "necessitarianism," that every man's future is fixed from his birth; but we must not fasten on him any particular theory of the world or of the universe. Sometimes he speaks as a believer in a divine overruling Providence, and we may say confidently that with the Epicurean doctrine he had no sort of sympathy.

Tacitus's style is discussed in the article LATIN LANGUAGE. Whatever judgment may be passed on it, it is certainly that of a man of genius, and cannot fail to make a deep impression on the studious reader. Tacitean brevity has become proverbial, and with this are closely allied an occasional obscurity and a rhetorical affectation which his warmest admirers must admit. He has been compared to Carlyle: and both certainly affect singularity of expression. But they are alike only in the brevity of sentences; and the brevity of Carlyle is not that of an artist in epigram. Tacitus was probably never a popular author; to be understood and appreciated he must be read again and again, or the point of some of his acutest remarks will be quite missed.

Tacitus has been many times translated, in spite of the very great difficulty of the task; the number of versions of the whole or part is stated as 393.

Murphy's translation (we should call it a paraphrase) was for long one of the best known; it was published early in the 19th century. On this was based the so-called Oxford translation, published by Bohn in a revised edition. Messrs Church and Brodribb's translation, and Professor Ramsay's (1904) (the latter of *Annals* i.–iv.) are much better. The best known foreign translation is Davanzati's (Italian), printed about 1600 and frequently re-published. The French versions by Louandre and Burnouf (about the middle of the last century) are also good. Among the very numerous modern commentaries, the most important are Ruperti's (1839); Orelli's (1859: the *Histories*, *Germania*, *Agricola*, and *Dialogues* were revised and re-edited by Meiser and Andersen between 1877 and 1895); Ritter's (1864); Nipperdey's (1879); Heräus's (*Histories*, 1885); Furneaux's (*Annals*, i.–vi., 1884; xi.–xvi., 1891; *Germania*, 1894); Spooner's (*Histories*, 1891). The last two editors' introductions are particularly useful. Of works relating to Tacitean Latinity, Draeger's *Syntax und Stil des Tacitus* is the best.

(W. J. B.; A. D. G.).

TACITUS, MARCUS CLAUDIUS, Roman emperor from the 25th of September A.D. 275 to April 276, was a native of Interamna (Terni) in Umbria. In the course of his long life he held various civil offices, including that of consul in 273, with universal respect. Six months after the assassination of Aurelian he was chosen by the senate to succeed him, and the choice was cordially ratified by the army. During his brief reign he set on foot some domestic reforms, and sought to revive the authority of the senate, but, after a victory over the Goths in Cilicia, he succumbed to hardship and fatigue (or was slain by his own soldiers) at Tyana in Cappadocia. Tacitus, besides being a man of immense wealth (which he bequeathed to the state),

[1] See Introduction to vol. i. of Furneaux's edition of the *Annals* of Tacitus, Clarendon Press Series, 1884.

[2] *Ann.* iii. 65.

[3] Dill, *Roman Society from Nero to Marcus Aurelius*, Bk. i. ch. i

[4] *Ann.* vi. 21, 22.

had considerable literary culture, and was proud to claim descent from the historian, whose works he caused to be transcribed at the public expense and placed in the public libraries. Tacitus possessed many admirable qualities, but his gentle character and advanced age unfitted him for the throne in such lawless times.

See Life by Vopiscus in *Historiae Augustae Scriptores;* also Eutropius, ix. 10; Aurelius Victor, *Caesares*, 36; Zonaras xii. 28; H. Schiller, *Geschichte der römischen Kaiserzeit*, i. 1883; Pauly-Wissowa, *Realencyclopädie*, iii. 2871 ff.

TACNA, a northern province of Chile, in dispute with Peru from 1893 onwards, bounded N. by Peru, E. by Bolivia, S. by Tarapaca, and W. by the Pacific. Area, 9251 sq. m. Pop. (1895) 24,160. It belongs to the desert region of the Pacific coast, and is valuable because of its deposits of nitrate of soda and some undeveloped mineral resources. There are a few fertile spots near the mountains, where mountain streams afford irrigation and potable water, and support small populations, but in general Tacna is occupied for mining purposes only. None of its streams crosses the entire width of the province; they are all lost in its desert sands. The climate is hot, and earthquakes are frequent and sometimes violent. There is one railway in the province, running from the city of Tacna to Arica (*q.v.*), and in 1910 another from Arica to La Paz, Bolivia, was under construction by the Chilean government. The province consists of two departments, Tacna and Arica, which once formed part of the Peruvian department of Moquegua. Its capital is Tacna (pop. 1895, 9418; 1902, estimated 11,504), a small inland town 48 m. by rail from Arica, in a fertile valley among the foothills of the Andes. Existence is made possible in this oasis by a small mountain stream, also called Tacna, which supports a scanty vegetation. The town owes its existence to the Bolivian trade from La Paz and Oruro, and is the residence of a number of foreign merchants. Tacna was captured by a Chilean force under General Baquedano on the 27th of May 1880.

At the close of the war between Chile and Peru (1879–1883), the terms of the treaty of Ancon (signed by representatives of the two countries on the 20th of October 1883) were practically dictated by Chile, and by one of the provisions the Peruvian provinces of Tacna and Arica were to be occupied and exploited by Chile for a period of ten years, when a plebiscite should be taken of their inhabitants to determine whether they would remain with Chile or return to Peru, the country acquiring the two provinces in this manner to pay the other $10,000,000. At the termination of the period Peru wished the plebiscite to be left to the original population, while Chile wanted it to include the large number of Chilean labourers sent into the province. Chile refused to submit the dispute to arbitration, and it remained unsettled. Meanwhile Chile expelled the Peruvian priests, and treated the province more like a conquered territory than a temporary pledge.

TACOMA, a city and sub-port of entry, and the county-seat of Pierce county, Washington, U.S.A., on Commencement Bay of Puget Sound, at the mouth of Puyallup river, about 80 m. from the Pacific coast, and about 23 m. S.S.W. of Seattle. Pop. (1890) 36,006; (1900) 37,714, of whom 11,032 were foreign-born (including 1603 Swedes, 1534 English-Canadians, 1474 Norwegians, 1424 Germans, and 1323 English; (1910, U.S. census) 83,743. Tacoma is served by the Northern Pacific, the Chicago, Milwaukee & Puget Sound, and the Tacoma Eastern railways; the Chicago, Burlington & Quincy railway operates through trains to and from Missouri river points and Tacoma, over the Northern Pacific tracks, which are also used by the Great Northern and Oregon & Washington railways. There is electric railway connexion with Seattle. Tacoma is the starting-point of steamship lines to Alaska, to San Francisco, and to Seattle, Port Townsend, Olympia, Victoria, and other ports on Puget Sound. There are trans-oceanic lines to Japan and China, to the Philippines and Hawaii, and to London, Liverpool and Glasgow, by way of the Suez Canal. The city is situated on an excellent harbour and has 25 m. of waterfront. From the tidelands the city site slopes gradually to a plateau about 300 ft. high, commanding fine views of Puget Sound and its wooded islands, and parts of the Cascade and Olympic ranges. Tacoma is the seat of Whitworth College (1890, Presbyterian), the University of Puget Sound (1903, Methodist Episcopal), the Annie Wright Seminary (1884), a boarding and day school for girls, and the Pacific Lutheran Academy and Business College. The Tacoma High School has an excellent stadium for athletic contests, seating 25,000. The city has a Carnegie library (1899), with about 51,000 volumes. Among other public buildings are the court house, the city hall, in which are the rooms of the State Historical Society (organized, 1891; incorporated, 1897); the Federal Building; an armoury; the Chamber of Commerce, and several fine churches. The Ferry Museum, founded by Clinton P. Ferry, has interesting historical and ethnological collections. In 1910 the city had seven public parks (1120 acres), including Point Defiance, a thickly wooded park (about 640 acres), and, in the centre of the city, Wright Park, in which is the Seymour Conservatory. Tacoma is a sub-port of entry in the Puget Sound Customs district (of which Port Townsend is the official port), which is second only to San Francisco on the Pacific coast in the volume of foreign trade. The city has a large jobbing trade, a coal supply from rich deposits in Pierce county, and abundant water-power from swift mountain streams, which is used for generating electricity for municipal and industrial use. In 1900 and in 1905 Tacoma ranked second among the cities of the state in the value of factory products. Lead smelting and refining (by one establishment) was the most important industry in 1905; lumber, timber and planing mill products, valued at $3,407,951, were produced in that year, and flour and grist mill products, valued at $2,293,587. Other important manufactures were furniture, ships and boats, railway cars (the Chicago, Milwaukee & Puget Sound and the Northern Pacific systems having shops here), engines, machinery, shoes, water pipes, preserves and beer. In 1905 the total value of the factory products was $12,501,816, an increase of 121·4% since 1900. The assessed property valuation of the city in 1909 was $54,226,261, being about 42% of the actual valuation.

The site of Tacoma was visited by Captain George Vancouver in 1792; Commencement Bay was surveyed for the United States government by Lieutenant Charles Wilkes in 1841, and the present city was founded by General Morton Matthew McCarver in 1868 and was at first called Commencement City. That name was soon changed to Tacoma, said to be a corruption of *Ta-ho-ma* or *Ta-ho-bet*, Indian terms meaning "greatest white peak," the name of the peak (14,526 ft.), also called Mt. Rainier, about 50 m. S.E. of the city. General McCarver's original plat included what is now the first ward of the city, and is called the Old Town. In 1873 the Northern Pacific railway (completed in 1887) established its terminal on Commencement Bay, and named it New Tacoma. A town government was formed in 1874, the place became the county-seat in 1880, and in 1883 the two "towns" were consolidated and incorporated as a city under the name Tacoma. In 1909 a new city charter was adopted under which the city government is vested in five commissioners (one of whom acts as mayor), each in charge of a city department.

TACTICS (Gr. *τακτική*, sc. *τέχνη*, from *τάσσειν*, to arrange in order of battle).[1] It may perhaps seem superfluous at the present time to emphasize the distinction between strategy and tactics. Moreover, definitions are rarely quite satisfactory, for they can seldom be perfectly clear and at the same time perfectly comprehensive. Yet, since it is necessary that the parties to any discussion should have some common starting-point, it will be as well to begin by stating exactly what is meant to be included under the heading of this article.

Strategy (*q.v.*) is the art of bringing the enemy to battle on terms disadvantageous to him. Combined, or to use the phraseology of the Napoleonic era, "grand" tactics are the

[1] Unlike the French *tactique*, the German *Taktik*, and indeed all other forms, the English word is invariably treated as a plural noun.

methods employed for his destruction by a force of all arms, that is, of infantry (*q.v.*), artillery (*q.v.*) and cavalry (*q.v.*). Each of these possesses a power peculiar to itself, the full development of which depends to a greater or less degree upon the aid and co-operation of the other two. Now it is quite evident that the only force which can ensure this co-operation, and can produce harmonious working between the various components of that complex machine, a modern army, is the will-power of the supreme commander. It is, then, the sphere of the higher commander on the day of battle which is generally expressed by the term "combined tactics," and which will be dealt with in this article. Yet it must not be understood that because the term higher, or supreme, commander is used that the theory of combined tactics may be safely neglected by those soldiers whose ambitions or opportunities do not seem to lead to that position. In the British Army more than in any other, as the South African war showed, a comparatively junior officer may at any moment find himself placed in command of a mixed force of all arms, without any previous practical knowledge of how it should be handled. It will not then be possible to make the best use of such opportunities by the uneducated light of nature, and such theoretical knowledge as may have been gleaned from books and matured by thought will be of great value.

Necessity of study.

It is of the first importance that the commander of a mixed force should know exactly the powers and limitations of the units under his control. Should he not be a master of his profession, he will at times demand more from his subordinates than they can reasonably be expected to perform; at other times he will miss his chances by ignorance of their capabilities. An uneducated commander may indeed be likened to an indifferent mechanic, who sometimes places an undue strain upon the engine he is supposed to control, and sometimes allows its precious powers to run to waste.

There is, however, a still stronger reason why all officers should study the art of grand tactics. In every battle situations arise of which the issue is decided by the promptitude and efficiency of the co-operation between the three arms. At such moments, an officer in charge of a battery of artillery, or of a squadron of cavalry, may find an opportunity of rendering valuable aid to his own infantry; and a knowledge of the tactics and training of the other arms may then be essential, for it will probably be necessary to act without instructions from superior authority.

But although the importance of studying tactics may be readily allowed, there would appear to be considerable diversity of opinion as to the best method of conducting that study. It is often confidently asserted that tactics cannot be learnt from books; and in support of this theory it is customary to adduce Napoleon's well-known statement that tactics change every ten years. But if we examine the matter more closely, it will become evident that the changes which the great captain had in his mind were those of formations, due principally to improved weapons, rather than of the principles upon which combined tactics are based. Indeed, it could hardly be otherwise, for military history furnishes many instances of great battles which have been fought out on exactly the same lines, although separated in point of time by many centuries. The great similarity between Rossbach (*q.v.*), Austerlitz (*q.v.*) and Salamanca (*q.v.*) has often been quoted since Napoleon first drew attention to it, but a great deal more remarkable and instructive is the similarity between the battle on the Metaurus, which dealt the final blow to the hopes of Carthage in Italy, and Marlborough's masterpiece, the battle of Ramillies (*q.v.*). In both cases the battle was lost through faulty dispositions before it had been begun. In both cases the ultimate loser took up a position behind a stream, thereby losing his mobility and voluntarily surrendering the initiative to an enemy who was not slow to take advantage of it. Precisely the same error was committed time after time by the Austrian generals who fought against Frederick, notably at Leuthen (see SEVEN YEARS' WAR), a battle closely resembling both Ramillies and the Metaurus. Coming to a later date, we find the same error committed, with of course precisely the same result, in Manchuria, where the Russian generals repeatedly surrendered the initiative to their enterprising opponents, and allowed them to dictate the course of battle. It must not, however, be understood from this that no commander should ever stand upon the defensive; rather it is meant that we should learn from history the proper method of doing so. This we cannot do better than by studying Wellington's battles in the Peninsula, for never have tactics been brought to higher perfection. Although frequently compelled to adopt the defensive, he never surrendered the conduct of the battle to his enemy. Even when surprised and taken at great disadvantage by Soult at Maya (see PENINSULAR WAR), it can be seen how, while lesser men would have been content to reinforce the threatened points, Wellington's one thought was to discover where he could deal the most effective blow. Nearly a hundred years later and in a theatre of war many thousands of miles away, a very similar battle was fought out by Kuropatkin and Oyama, though on a vastly greater scale.

Continuity of military history.

But history teaches us more than the methods of the great captains; for from it we may learn those changes which have been introduced into both organization and tactics by the improved weapons which science has placed in our hands, and thence the tactician may deduce the changes of the future. Just as the "Old Dessauer" foresaw the advantage which the iron ramrod would give to the Prussian infantry, and as Wellington perceived that improved firearms would render possible the extended lines he adopted, so may the great generals of the future learn those lessons which are only brought home to others through the dire ordeal of battle. From the days of the long-bow to those of the Lee-Metford rifle, the changes in tactics have been brought about by the development of fire. It is therefore only natural that the introduction of small-bore rifles, quick-firing artillery, and smokeless powder should have revolutionized many of our ideas. Before the invention of the breech-loader and the rifled cannon, the three arms of the service employed very different methods of combat. The infantry depended principally on the bayonet, the cavalry on the lance or sabre, the artillery on fire. Now there is practically but one method common to all arms whether in attack or defence. The bayonet and the sabre still have their part to play; but in almost every phase of the combat their importance is diminishing, and infantry and cavalry must depend more and more upon fire to compass the enemy's overthrow. All the preliminary movement and manoeuvres have but one end in view, the development of fire in greater volume and more effectively directed than that of the opposing force; for it is "superiority of fire" that prepares the ground for the final decision.

Fire power.

Side by side with the improvement in firearms there has come another great change which, on the continent of Europe at all events, has had a marked effect on modern tactics. This is the improvement in communications, which has alone made it possible to use the vast numbers with which great battles have recently been fought. Without railways the power which universal service has placed in the hands of the generals of the 20th century could never have been fully developed, for the men could neither have been conveyed to the theatre of operations, nor could they have been fed even supposing they had been got there. Now all this is altered, and the first step towards the attainment of superiority of fire will be to bring as many men as possible on to the field of battle; the second step will be to place them in the position from which they can use their weapons to the very best advantage. From these premises it is not difficult to foresee the type of battle which will prevail, until some new discovery changes the military systems of the world. In the future, as in the past, it will be the duty of the strategist to mass superior numbers at the decisive point; but so soon as this has been effected there is only one method by which the tactician will be able to follow up the advantage. That is by bringing

Modern conditions.

more rifles into action than his opponent is able to do. From this it follows that the enveloping action will be the usual form of battle; and that although the extent of front may not always be so great, in proportion to the numbers engaged, as on the battlefields of South Africa or even of Manchuria, the general tendency of modern invention will undoubtedly be to increase the area of the battlefield.

If then we are right in supposing that the front of an army in action will cover many miles of country, it necessarily follows that in approaching the field many roads will be used. Here the duties of the cavalry will begin; for the commander who can discover earliest the approaches by which the flank detachments of his opponent are moving, is obviously in the best position to form his plans for envelopment. Here we are verging upon the strategic use of cavalry; but under modern conditions the tactical use of that arm is almost merged in the strategical use. No doubt it has always been the object of the wise commander to attain his enemy's flank; yet, since, owing to the increased range of small-bore rifles, turning movements like those which formed such a marked feature of Frederick the Great's battles can no longer be made after the infantry troops have come into contact, they must be prepared as soon as the necessary information has been obtained. Moreover, nothing must be left to chance, for it can hardly be denied that if the battle of Gravelotte were to be fought again to-morrow, the failure to locate the right flank of the French army would have even more serious consequences than were actually the case (see METZ: *Battles of 1870*). Such mistakes can only be avoided by obtaining good information, and thus it will be seen that the chances of bringing off a successful converging attack are greatly in favour of the commander who is best served by his cavalry. But, as the opposing forces draw near, a gradual change comes over the duties of the mounted arm, for it must then protect the troops in rear from observation, so that the preparations for envelopment may be concealed. To this end the occupation of points of tactical vantage, such as hills, woods and villages, behind which the main army can deploy or the outflanking columns march in security, becomes its chief aim. In the next stage, *i.e.*, when one or other army is forced to stand on the defensive, reconnaissance of the position held will be the duty of the cavalry of the attack.

Cavalry.

So far its functions are clear enough, but when the preparations for the infantry attack have been completed we have practically nothing to guide us. Unfortunately the two most recent wars, in South Africa and Manchuria, have taught us but little of the handling of cavalry in battle. In South Africa the peculiar characteristics of the Boers gave no scope for cavalry action; while in Manchuria the theatre of operations was practically a defile between the mountains and the Liao river, which afforded no room for manoeuvre. With regard to the handling of cavalry in conjunction with the other arms there is, therefore, more room for diversity of opinion than is the case with either infantry or artillery. Time alone will show the real capabilities of the cavalry of to-day, and the opening battles of the next great campaign in Europe will bring about many changes. Meanwhile such experience as we have to guide us seems to indicate that the development of fire has rendered cavalry, even when highly trained in the use of the rifle, less capable of acting independently against infantry than it was formerly. Throughout the war in Manchuria, we constantly find the Russian cavalry reconnaissance checked by Japanese infantry; and on the other hand the weak Japanese cavalry closely supported by infantry was fairly effective. The circumstances were of course peculiar, but the inference appears to be that unsupported mounted troops cannot be expected to achieve important results except when acting against similar bodies of the enemy; that is to say, under conditions which fall outside the province of combined tactics. Moreover, since well-posted infantry can easily hold in check greatly superior numbers of cavalry, it would certainly seem that wide tactical movements, intended to threaten the enemy's line of retreat, are more likely than not to result in prodigal waste of strength. This being the case it would seem that the best use of cavalry on the battlefield will be on the flanks of, and in close touch with, the infantry, where each arm can render support to the other. On the defensive the tactical action of cavalry is not less important than on the offensive. Accompanied and strengthened by horse artillery it may occupy tactical points either on the flanks of the main position or thrown out well to the front. Aided by smokeless powder, magazine rifles and quick-firing guns, numbers may be concealed and the attacking enemy may be induced to deploy his troops and to reveal his movements prematurely. Should he do so, much of his advantage will be gone, for the defender will be greatly helped in his preparations for the counter-attack, the most effective weapon at his command.

But when at last the slower moving bodies of infantry and artillery come into contact, the battle enters upon a new phase. It has long been recognized that the first step towards the attainment of fire superiority over a vigilant enemy is a vigorous artillery bombardment. For many years this action of the artillery was regarded merely as a preliminary to the infantry attack; and it was not until the rude awakening of the early battles of the Boer war, that it was realized in England that unless the infantry co-operate, the artillery is not likely to produce any result. If the attacking infantry is kept at such a distance from the position that it cannot pass quickly to the assault, the enemy will retain his troops under cover during the cannonade, perhaps even leaving his trenches unoccupied, and present no target to the guns. Indeed, a most instructive instance of this very line of action is furnished by the battle of Ta-shih-chiao. There the right of the Russian line was held by the infantry of the 1st Siberian army corps, supported throughout the greater part of the day by only two batteries of artillery. So heavy was the fire of the Japanese artillery in this portion of the field that General Stakelberg, the commander of the Russian corps, sent word to his superior officer that he had not considered it advisable to occupy his trenches, and that should he be compelled to do so his troops must suffer very heavy loss. As things turned out the Japanese infantry did not deliver any attack against the Russian right, the defenders remained under cover, and the losses inflicted by the bombardment were almost negligible. Other instances might be quoted, but enough has been said to prove that to render the artillery bombardment effective the infantry must co-operate; for by this means only will the enemy be compelled to man his defences, to show himself above his parapets, and to expose himself to shrapnel fire.

Artillery action.

Here arises one of those questions which are the outcome of modern science, but which have not been finally answered by modern war. As a result of improved ballistics, better methods of observation, and perfected methods of communication, it is now possible for field artillery to make use of indirect fire from behind cover. Against stationary objects, such as a battery in action, the results achieved by this method are as good as those which are obtained by firing directly over the sights. At the same time the control of indirect fire is slow, and it still remains to be proved whether it can be used satisfactorily against quickly moving targets. If it should be found that, in spite of scientific aids, the artillery of the defence can be made to leave its cover and to disclose its position by the advance of the infantry, the importance of the aid which one arm can render to the other needs no demonstration. After all, however, the silencing of the guns of the defence is but a means to an end, and the principal aim of the guns of the attack is to enable the infantry to get sufficiently close to the position to deliver an assault; for the infantry assault is the crowning act of battle. Similarly the gunners of the defence must never forget that their great object is to repel this same assault. The artillery duel, therefore, is but a phase. Sooner or later one side will gain the upper hand. Then it must be decided whether the inferior artillery can best serve the interests of the infantry by continuing the duel, or by ceasing to fire until it can find some more vulnerable target.

Should the guns of the defence have proved inferior to those of the attack, it will probably be wise for them to wait until the advancing columns of infantry have deployed; should the positions be reversed, it will be well for the gunners of the attack to leave their weapons and to remain under cover until such time as their opponent is compelled to turn his attention to repelling the infantry. So great is the power of the modern rifle and quick-firing gun that infantry, unsupported by artillery, has but little chance of carrying a position held by determined men, and it is for this reason, and not with a view to saving their own lives, that the gunners must reserve themselves until the last moment. They must be ready and alert when their services are most required; moreover their final positions should be selected with a view to keeping up their fire until the last possible moment. Indeed they must often run the risk of injuring some of their own troops when firing over their heads. Sometimes a favourable position may be found for the artillery upon the flank of the attack. Such positions have a double advantage. Not only do they bring enfilade or oblique fire to bear upon the enemy's trenches, but they are able to continue the bombardment much longer than is possible when posted directly in rear of the assaulting columns. But whatever the position of the artillery may be, one thing is certain: namely, that the infantry of the attack can hardly hope to succeed if its own guns have been disabled while striving to maintain an unequal duel. Thus in the earlier stages of battle the action of the artillery will be characterized by a certain degree of prudence. The commanders on either side will strive to conceal the numbers and positions of their batteries, and will not employ more guns than are absolutely necessary for the attainment of any particular object they may have in hand. But when the preliminary stages are over, and the infantry is finally committed to the assault, a change must come over the conduct of the artillery. In this final phase there is no longer room for prudence. Indirect fire is out of place, and the duty of the guns cannot be better described than in the words of the French text-books, "to follow the infantry in a series of rapid advances, by échelons, without hesitating to come into action within the shortest range of the hostile infantry." But when the time comes to follow up the infantry the skill and knowledge of the battery commander are most highly tried. Concealment is no longer his object, and he must trust all to his offensive power. To make the most of this power it is of the first importance that his guns should be brought at once into positions whence they can be effectively used; for, quoting again from the French instructions, "considerations of concealment lose their importance for artillery that is told off to follow up the movements of the infantry. In this case artillery must not fear to come into action in the open, although in this situation a battery usually forfeits its freedom of manoeuvre."

Even the introduction of shielded guns will not affect this loss of mobility, for batteries which are brought to within effective rifle range of the defence must expect to lose a considerable proportion of their horses. Hence it follows that although the position into which they are brought in support of infantry may prove to be unsatisfactory it cannot be changed; their assistance will be lost at the most critical moment, with the result that the attack, deprived of their support, will probably fail. In France, where artillery tactics have perhaps received even more attention than in other countries, the necessity for this close support by guns has been so far recognized that the batteries of the attack have been divided into two distinct portions. The duties of one section have already been described. Those of the second are:—(1) To continue to shell the enemy's position as long as possible without danger to the advancing infantry; (2) To engage the hostile infantry "avec la dernière énergie"; (3) To watch carefully for counter-attack.

It is perfectly clear that the performance of these duties, in fact, the application of the whole principle of co-operation between infantry and artillery, is intimately connected with the use of ground. The art of utilizing ground to the best advantage must therefore be deeply studied. If we look back upon history, we cannot but be struck by the important part that the appreciation or neglect of the capacities of the ground has played in almost every battle. The most brilliant victories have been won by manoeuvres which, if not suggested by the physical features of the battlefield, were deprived by the nature of the ground of half their risk. What was true of Austerlitz and Leuthen is true of Liao-yang and Mukden. Now, as in the past, battles resolve themselves into a series of struggles for certain localities, a methodical progression from point to point, each successive capture weakening the enemy's position until at last an overwhelming fire can be brought to bear upon some vital point. This method of attack is most distinctly seen in siege operations, such as those round Port Arthur, where the attack closed gradually in upon the defence until the possession of one or two points rendered the capture of the place a matter of time alone. Now the difference between the attack of a fortress and of a defended position is, in the main, one of degree rather than of kind. But there is no doubt that the chief point of difference is often overlooked, both by the amateur and by the uneducated professional soldier.

In staff rides and in war games, occasionally even in peace manoeuvres, it is usually assumed that the party who starts upon the defensive must remain in that unenviable position throughout. This, however, is not the teaching of history. If there is one lesson in tactics which stands out more clearly than all the others which may be learnt from the campaigns of the great commanders, it is that a defensive attitude should never be assumed except as a means of passing to the offensive under more favourable conditions than those which present themselves at the moment. In siege operations the rôles of the rival forces are more clearly defined; and until the operations are brought to a conclusion the relations of the two commanders remain unchanged. In the open field of battle, except in the case of a purely delaying or of a rearguard action, this is not the case. There both generals, if they understand their duties, are always striving to secure the offensive, for no battle has ever yet been won by purely defensive tactics. The defensive attitude is, therefore, only a phase of that manoeuvring to secure the upper hand which begins with the strategic concentration, almost, one might say, with the peace organization.

Offensive-defensive.

In spite of Moltke's oft-quoted saying that the combination of the tactical defensive with the strategical offensive is the strongest form of war, the very fact of one side adopting the defensive proves, in at least ninety-nine cases out of every hundred, that in earlier stages of the campaign the enemy has gained an advantage, either by his numbers, his strategy, or his readiness to act, which can only be counterbalanced by success in battle. Other things being equal, the side which is numerically the weaker is naturally the first to be forced to relinquish the initiative. But, whatever the cause, the aim of the commander will be to retrieve his fortunes by a tactical success. Perhaps the most striking example in history of its accomplishment is furnished by the campaign and battle of Salamanca. There, after weeks of marching and counter-marching, Wellington was finally out-manoeuvred by Marmont and forced to stand and fight under circumstances by no means favourable to the defence. His line of communication was in danger, and his trains were already being hurried to the rear. Then Marmont made a mistake; and in a few hours the French army was in full retreat. Never was the tactical genius of a commander more dramatically displayed; but we may well ask ourselves whether under modern conditions similar results would be possible. The point is, however, that to the true general the purely defensive battle is unknown; and in place of a single movement directed by a master mind we shall see in future a series of combats, each with its stroke and counter-stroke, taking place upon a front extending over many miles of country. Of this type of battle the Sha-ho is at present the best example. There the operations opened with an attack against the Japanese right, which was met by a similar attack delivered by the Japanese centre and left. A less able commander than Oyama might have attempted to check Kuropatkin's offensive movement by reinforcing his own threatened flank; that is to say, that he would have conformed to the movements of his adversary and permitted him to dictate the course of events. This was not the Japanese system. Oyama had no intention of fighting a purely defensive action. He knew that his opponent had massed his strength upon his left, and it was only reasonable to assume that if one portion of his line was strong, some other portion must be weak. The actual point first selected by Oyama for decisive attack was the centre of Kuropatkin's line. This effort failed, and the scales were ultimately turned by an almost unexpected success against the Russian right. The resulting victory was certainly less complete than would have been the case had the Japanese commander been able to carry through his original plan, but it is obvious that a force operating against the centre of a hostile line must itself be in danger of envelopment; and in this case it is interesting to note that the battle was really decided by an outflanking movement by a weak force, while the central attack in considerable strength achieved but little. Oyama's conduct of this battle has been much criticized. By some writers he has been blamed for leaving his own defensive line too weak; by others he has been accused of attempting too much. These are difficult questions, requiring detailed examination; for the present it is sufficient to note that, although inferior in numbers, he succeeded in accomplishing an enveloping movement which forced his enemy to retire. The fact is that by superior skill, although actually inferior in numbers, he succeeded in placing more rifles in the firing line than did his opponent. During a great part of this struggle, which lasted for five days, it would be difficult to say which side was on the defensive and which on the offensive. No doubt at the commencement Kuropatkin was the assailant; it is equally certain that in the end it was Oyama who attacked; yet it would be impossible to say, as at Austerlitz and Salamanca, exactly at what moment the rôles were exchanged.

If then we are justified in assuming that in the great battles of the future neither army will be acting entirely on the offensive or entirely on the defensive, it may seem idle to speculate as to whether the recent improvements in firearms and ballistics are in favour of one side or the other. In this connexion the lessons which may be learned from the South African and the Russo-Japanese wars are most instructive. After the former it was often urged that the conditions of modern battle are distinctly in favour of defensive tactics; in other words, that the force which awaits attack can develop the full power of each arm with greater facility than that which delivers it. This contention had much to support it, but it was not always realized that anything which gives new strength to the defence must at the same time add something to the advantages of the army which attacks. The outcome of the improvements in rifles, guns and powder is that far fewer men are required to hold a definite position than of old. To a certain extent this favours the defence. A much larger proportion of the available troops can be set free to act in reserve, and to deliver the counter-stroke, *i.e.* a much larger number than formerly can be employed by the defenders in attack. This is to the good. But the assailant profits in almost equal ratio. His strength has always lain in power of manoeuvring, of hiding his movements, and of massing suddenly against some weak point. To-day this power is greater than ever before. The increased power of the rifle renders it comparatively easy for him to form an impenetrable barrier with part of his force, perhaps with his cavalry supported only by a small proportion of his infantry, behind which the remainder can move unobserved. Moreover, the object of the assailant's manoeuvres will be to place portions of his forces on the flank or flanks of the position he is attacking. If he can accomplish this, the effect, moral and physical, of the enfilade fire which is brought to bear upon the enemy's front will be far greater than that which attended a similar operation when fire was of less account. In addition to this increased facility for manoeuvre, the great strength of the local defensive confers upon the assailant the power of denuding certain portions of his line of troops, in order that he may mass them for offensive action elsewhere. Here again the study of ground and a true knowledge of the capabilities of the various arms are of supreme importance. Well-placed artillery, aided by machine guns, may enable a comparatively weak force of infantry to hold a wide extent of front, provided that each arm is able to use its strength to the fullest extent. In this way the skilful commander can turn each feature of the battlefield to account and can release a greater number of his troops for the all-important enveloping movements. It was just this power which enabled Oyama to outflank the Russian XVII. Corps at the battle of Sha-ho, for he was able to weaken his own right to an extent which a very few years ago would have been impossible. In short, the process of envelopment is more easy than it used to be; and envelopment, which means that the enemy is under fire from several directions, is much more effective now than in the past.

In Germany this fact has long been recognized, and it was for this reason that German soldiers refused to accept the conclusions at which many English military critics arrived after the South African war. Under the influence of their German teachers the Japanese never hesitated to attack, even with inferior numbers, and to make the envelopment of the enemy more certain they went into battle practically without reserves.

In this respect the war in Manchuria marks an epoch in the history of tactics; and for that reason, if for no other, it should be carefully studied. Moreover, it emphasizes an important difference in the handling of large and small armies which is of quite recent origin. Until a few years ago all continental armies were organized in army corps. These corps were composed of two or three infantry divisions with a large body of corps troops, principally artillery. Now the *raison d'être* of this artillery was to form the nucleus of a reserve which could be retained under the hand of the corps commander to be used as required. That is to drive home the infantry attack, to deliver or repel a counter-attack, or, but very sparingly, to strengthen a weak point in the defensive line. With the development of the enveloping battle, it was soon realized in Germany that corps artillery was an anachronism, for the distances are now so great that reserve artillery can hardly be moved to the particular part of the battlefield where its services are required in time to be of any use. Thus the corps artillery was first split up among the divisions, and soon a number of divisional reserves took the place of the great central body, while the corps commander retained a comparatively small number of troops under his own hand. In this way the control of the supreme commander over the course of the battle is greatly weakened and the chance of correcting any error in the original plan is diminished. It had long been realized that errors in the strategic deployment of troops were almost impossible to correct; and now it came to be seen that this was equally true of the tactical deployment. Just as under modern conditions even Napoleon could hardly have recovered from errors like those which marked the opening phases of the Eckmühl campaign (see NAPOLEONIC CAMPAIGNS), so the most brilliant genius will no longer be sufficient to win battles if the original plan is not correct. It was upon this theory that the Japanese commanders planned their battles, and it was very soon proved that they had the courage of their convictions. For the first time it was seen that battles were no longer won by the general who husbanded his reserves, but by him who first got every available man into the firing line. But, while giving Oyama, Kuroki, Oku and the others every credit for the strength of mind which enabled them to divest themselves of reserves when their battles were far from being won, we must also remember that they were fighting an enemy who, like the Boers, were incapable of organizing a really decisive counter-stroke. For English soldiers this point has a peculiar interest, as it has a very distinct bearing upon the tactics of our own army. From what has already been said it is, or should be, clear that the value of numbers upon the battlefield is greater now than formerly; for, granting that the leadership on either side is equally skilful, the chances of envelopment are in favour of him who commands the greater number of men. Owing

Corps and divisional artillery.

to our geographical position and to the conditions under which we live, the number of British troops available for employment in any war against a continental Power will almost certainly be inferior to that which can be employed against us. It is of course true that we should never engage in operations on the continent of Europe except in alliance with some other Power; but it is quite possible that the British army might be entrusted with the execution of some definite task which, while part of a general strategical scheme, would involve completely independent action. It is under such circumstances as these that we must be prepared to encounter troops which in leadership and training will be at least the equal of our own, and in numbers will probably be superior to them. In these circumstances our chances of envelopment will not be great, but this must by no means be taken to mean that our chances of success are to be despaired of. Far from it. In the first place strategy may induce the enemy temporarily to divide his forces, and thus to afford favourable opportunity for an effective blow. Failing this, it remains to be considered how a general may best employ inferior numbers with a reasonable hope of gaining a tactical victory. To this the answer must be that his best, indeed his only, chance of victory lies in the counter-stroke.

In France this fact has received due recognition, and since that country is in the unfortunate position of having to be prepared to encounter superior numbers, the training and organization of her armies differ essentially from those of her most formidable neighbour. Acknowledging that at the outset of a war she must be placed at a grave disadvantage, she strives to develop her power of manoeuvre and of delivering a strategic counter-stroke. With this object her armies move in deep formations on a comparatively narrow front, covered by strong advanced guards. Thus, in the earlier stages, they are much less committed to a definite line of action than are armies moving upon a widely extended front, and, provided intelligence is received in time, they can be massed quickly against the enemy's flanks. Similarly in the later stages she trusts to the tactical counter-stroke, and hence the corps artillery, which has been abandoned in Germany for reasons which have already been given, is still retained in France.

The counter-stroke.

In the foregoing pages the question was raised as to whether the great tactical counter-strokes of the past are still possible under modern conditions. Unfortunately the battles in Manchuria afford no instance of a successful counter-stroke, for the Sha-ho is more an example of an encounter action than of a carefully conceived counter-attack. In these circumstances we are forced to rely upon theory; but theory based upon a correct understanding of the past should form no uncertain guide to the practice of the future. What then are the principles upon which our theory is to be based? First, that the defensive battle is only a step towards assuming the offensive. Secondly, that the only means of assuming the offensive with success is the counter-stroke. Thirdly, that the counter-stroke, in at least nine cases out of every ten, should aim at the envelopment of the attack. From these premises it follows that the most effective form of the defensive battle will be that which compels the enemy to deploy his forces and then uses the reserve to envelop one or both of his flanks. Since, however, modern battles are fought over a very wide extent of front, it necessarily follows that the possibility which the defence possesses of successfully enveloping the attack must depend to a very great extent upon the correct disposal of the reserves when drawing up the original line of battle. Just as the chances of making the best use of superior number in the attack depend upon a correct strategical deployment at the commencement of a campaign, so the chances of a successful counter-stroke depend upon a correct distribution of troops at the commencement of an action. Hence we see that the most important point which a general who finds himself compelled to take up a defensive position has to decide is where to place those troops by whose aid he hopes eventually to seize the offensive. One thing is clear, namely, that the worst place for men who are destined to envelop one or other flank of the attack must be behind the centre of the defensive line. Time alone must render such a position unsuitable, for it must entail a march of many hours, if not of days, before the troops can reach the point from which they are to be launched to the attack. This being so, it would seem that the right place for the general reserve of the defending army under modern conditions must be on one or other of the flanks; and, always bearing in mind that the chief object to be attained is regaining the initiative, we are driven to the conclusion that the best place is that flank from which an effective blow can be dealt at the assailant's most vulnerable point, that is to say, at the flank through which his line of communication may be most easily attained. If this theory be correct, yet another point has been established, namely, that the main plan of the decisive counter-stroke must be decided before, and not after, the first shot in the general engagement has been fired. Under the conditions which obtain to-day it is no use waiting for the enemy to make a mistake, for the odds against it being detected are great. A hundred years ago armies manoeuvred in full view of one another, and mistakes could be perceived by every company officer on either side. Now all this is changed, and the difficulties of the defence are increased by the fact that although the attack may make many blunders, it will do so at such a distance from the defence as to render them comparatively secure from detection. Having prepared his counter-stroke, the chief point towards which the commander of the defence must direct his attention after battle has been joined, is the exact moment at which it should be delivered. Needless to say that the chances of success will be enormously increased if the counter-stroke is unexpected, for in war the demands which surprise makes upon moral are quite out of proportion with the physical danger which men are called upon to undergo. If then defence is ever to be converted into attack, it would appear: (1) That the counter-stroke must be carefully planned, and must form an integral part of the *original* scheme of defence. (2) That it must be properly directed. (3) That it must be correctly timed. (4) That if possible it must come as a surprise. Of these conditions, the first three are dependent for their fulfilment upon good information, careful preparation, and correct appreciation of the enemy's plans; but it is in the fourth that the inspiration of the really great commander will be most conspicuously displayed on the day of battle, and the greater the numbers under his command the more difficult his task must be.

When, as at the Sha-ho and Mukden, the troops on either side are numbered by hundreds of thousands, the commander-in-chief cannot hope to keep the direction of events in his own hands for very long; but when tens of thousands only are engaged, the whole battle can be controlled as well now as in the past. The extent of front will certainly be greater than it was formerly, but against this may be set the fact that improved communications by telegraph and telephone enable the commander to keep in touch with events in a manner which until recently was quite impossible. It is for this reason that the earlier and smaller battles of the Russo-Japanese War contain many lessons which are of more use to British soldiers than are those which may be learned from the great struggles which took place later on. But in all battles, whether great or small, the first requirement is a commander who possesses sufficient steadfastness of character to carry out on the day of battle the plans he has formed beforehand. War is like a game of bridge, for the most successful player is not he who best remembers the fall of the cards or who knows the correct leads by heart, but he who can decide upon and carry out the plan best suited to the strength of his hand. In both cases a bad plan is better than none, and vacillation even between two good plans is fatal. In both cases side issues are constantly arising which tend to obscure the main issue. On the battlefield these side issues take the form of appeals for assistance from various quarters, all of which must tempt the supreme commander to weaken the general reserve which has been set aside for his decisive stroke. To such appeals he must turn

Economy of force.

a deaf ear, confident in the knowledge that the best way of assisting his sorely-pressed troops is by a vigorous blow at his enemy's weakest spot. Hence it follows that the force which is to deliver the blow must be kept perfectly distinct from the local reserves under subordinate commanders, which are held in readiness to strengthen weak places in the defensive line, or to deliver local counter-attacks. It also follows that this force must comprise every man who can be spared from the passive portion of the defence, and that to produce the fullest results there must be complete co-operation between the three arms.

It is here, in all probability, that cavalry will find its opportunity. On the one hand, the cavalry of the attack will strive to locate the hostile reserve which is preparing to deliver a counter-attack; failing this it will protect the flanks of its own infantry, ready to move to any threatened point and to assist with dismounted fire in repelling the advancing lines when the necessity arises. On the other hand, the cavalry of the defence will strive to conceal the movements of its own general reserve and will locate the flanks of the infantry against which the counter-attack is to be directed. The share of the artillery in this stage of the battle is sufficiently apparent, and it is obvious that the chances of success of one side or the other must depend largely upon the skill and self-sacrifice of the gunners. Should the commander of the defence, aided by his cavalry, have been successful in effecting a surprise, his chances of victory will be further increased if his infantry is supported closely by the artillery. Much also must depend upon the handling of the artillery which has suddenly been thrown upon the defensive. If the battery leaders are quick to realize the changed situation and to pick up new targets, perhaps leaving covered positions and firing over the sights, all may yet be well; but it is certain that if the surprise has really been complete the infantry will require all the assistance it can possibly derive from the other arms in order to avert defeat.

One more point remains to be noted. Since the object of tactics is to win battles, every effort should be directed to that single end. If certain formations are adopted with a view to avoiding losses, it must only be in order that more men may be brought up to the decisive point. The same principle holds good with regard to what are known as holding, or secondary, attacks whose rôle is frequently misunderstood. Indeed the names themselves are misleading, for they inevitably convey the impression that the duty of winning has been entrusted to some other body. For this reason the commander is apt to consider that he has fulfilled his task if he succeeds in getting to within reasonably close range of the enemy's position, where he can remain without suffering undue loss. Far from this being the case, the fact is that against an able opponent an attack of this nature is useless, for he will very soon detect which is the real and which is the secondary attack, and unless the two are pushed with equal vigour he will disregard the one and turn all his attention to the other. It may even happen that he will be able to take troops from that portion of his line which is only threatened and place them where he is really pressed, or even utilize them in counter-attack. In such a case it may happen that the so-called "holding" attack may itself be held by less than its own numbers, while the main attack is suffering defeat in some other quarter of the field. Here again there is much to be learnt from the past; and for the true conduct of these feint attacks we need not go outside the history of our own army. Many instances might be quoted, but none are more to the point than that of the assaulting columns at the capture of Badajoz. On that memorable occasion the British troops were divided into five columns, three of which were vainly hurled against the great breaches which had been made in the walls. But what the main assaults failed to do was accomplished by the attacks from which least had been expected; and Philippon with his gallant defenders was forced to surrender by the loss of the San Vincente bastion and the castle of San Roque, which had been considered to be impregnable. This is the spirit which must imbue the infantryman, the cavalryman, and the artilleryman alike. For without the fighting spirit, neither generalship, formations, nor weapons can prevail. (N. M.*)

Holding attacks.

TADPOLE, a term often, but wrongly, applied indiscriminately to all Batrachian larvae. It is absurd to call the larva of a newt or of a Caecilian a tadpole, nor is the free-swimming embryo of a frog as it leaves the egg a tadpole. A tadpole is the larva of a tailless Batrachian after the loss of the external gills and before the egress of the fore limbs (except in the aberrant *Xenopus*) and the resorption of the tail. What characterizes a tadpole is the conjoined globular head and body, so formed that it is practically impossible to discern the limit between the two, sharply set off from the more or less elongate compressed tail which is the organ of propulsion. In describing tadpoles, the term "body" is therefore used as meaning head and body. The tail consists of a fleshy muscular portion bordered above and below by membranous expansions, termed respectively the upper and lower crest, the former sometimes extending along the body.

Except in a few aberrant types, which are mentioned below, the mouth is surrounded by a much developed lip like a funnel directed downwards, and is armed with a horny beak not unlike that of a cuttle-fish. The characters offered by the circular lip are among the most important for the distinction of species. It may be entirely bordered by fleshy papillae, or these may be restricted to the sides, or to the sides and the lower border. Its inner surface is furnished with ridges beset with series of minute, bristle-like, erect, horny teeth, each of which, when strongly magnified, is seen to be formed of a column of superposed cones, hollowed out at the base and capping each other; the summit or crown of each of these cones is expanded, spatulate, hooked backwards, and often multicuspid. The number of these columns is very great. F. E. Schulze has counted as many as 1100 in the lip of *Pelobates fuscus*. The beak is made up of horny elements, like the labial teeth, fused together; its edge, when sufficiently magnified, is seen to be denticulate, each denticle representing the cusp of a single tooth. The gills, borne on four arches, are internal and enclosed in the branchial chambers. The arches bear on the convex outer side the delicate arborescent gills, and on the concave inner side develop a membranous septum with vermicular perforations, a special sifting or filtering contrivance through which the water absorbed by the mouth has to pass before reaching the respiratory organs of the branchial apparatus.

The water is expelled from the branchial chambers by one or two tubes opening by one orifice in most Batrachians. This orifice is the spiraculum, which is lateral, on the left side of the body, in most tadpoles, but median, on the breast or belly, in those of the *Discoglossidae* and of some of the *Engystomatidae*. All tadpoles are provided with more or less distinct lines of muciferous sensory crypts or canals, which stand in immediate relation to the nerve branches and are regarded as organs of a special sense possessed by aquatic vertebrates, feeling, in its broadest sense, having been admitted as their possible use, and the function of determining waves of vibration in the aqueous medium having been suggested. In addition to these lines, all tadpoles show more or less distinctly a small whitish gland in the middle of the head between the eyes, the so-called frontal gland or pineal gland, which in early stages is connected with the brain. A glandular streak extending from the nostril towards the eye is the lachrymal canal. The eyes are devoid of lids.

Owing to more or less herbivorous habits, the intestine is exceedingly elongate and much convoluted, being several times larger and of a greater calibre than after the metamorphosis. Its opening, the vent, is situated either on the middle line at the base of the tail, or on the right side, as if to balance the sinistral position of the spiraculum. The tail varies much in length and shape according to the species; sometimes it is rounded at the end, sometimes more or less acutely pointed, or even terminating in a filament. The skeleton is cartilaginous, and the skull is remarkable for the very elongate suspensorium of the lower jaw; the tail remains in the notochordal condition, no cartilages being formed in this organ, which is destined to disappear with the gills. The hind limbs appear as buds at the base of the tail, and gradually attain their full development during the tadpole life. The fore limbs grow simultaneously, and even more rapidly, but remain concealed within a diverticulum of the branchial chambers until fully formed, when they burst through the skin (unless the left spiraculum be utilized for the egress of the corresponding limb).

The above description applies to all European and North American tadpoles, and to the great majority of those known from the tropics. The following types are exceptional.

The circular lip is extremely developed in *Megalophrys montana*, and its funnel-shaped expansion, beset on the inner side with radiating series of horny teeth, acts as a surface-float, when the tadpole rests in a vertical position; the moment the tadpole sinks in the water the funnel collapses, taking on the form of a pair of horns, curling backwards along the side of the head; but, as they touch the surface again, it re-expands into a regular parachute.

In some species of *Rana* and *Staurois* inhabiting mountainous districts in south-eastern Asia, the larvae are adapted for life in torrents, being provided with a circular adhesive disk on the ventral surface behind the mouth, by means of which they are able to anchor themselves to stones.

In some Indian and Malay Engystomatids of the genera *Callula* and *Microhyla*, the tadpoles are remarkably transparent, and differ markedly in the structure of the buccal apparatus. There is no funnel-shaped lip, no horny teeth, and no beak. The spiraculum is median and opens far back, in front of the vent.

In the Aglossal *Xenopus*, the tadpoles are likewise devoid of circular lip, horny teeth, and beak, and they are further remarkable in the following respects: There is a long tentacle or barbel on each side of the mouth, which appears to represent the " balancer " of Urodele larvae; the spiraculum is paired, one on each side; the fore limbs develop externally, like the hind limbs.

Some tadpoles reach a very great size. The largest, that of *Pseudis paradoxa*, may measure a foot, the body being as large as a turkey's egg. The perfect frog, after transformation, is smaller than the larva. *Pseudis* was first described by Marie Sibylle de Mérian (1647–1717), in her work on the fauna of Surinam (published first in 1705 at Amsterdam, republished in Latin in 1719), as a frog changing into a fish. Among European forms, some tadpoles of *Pelobates* attain a length of seven inches, the body being of the size of a hen's egg. The tadpole of the North American bull-frog measures six inches, and that of the Chilian *Calyptocephalus gayi* seven and a half inches.

Authorities.—L. F. Héron-Royer and C. Van Bambeke, " Le vestibule de la bouche chez les têtards des batraciens anoures d'Europe," *Arch. Biol.*, ix. 1889, p. 185; F. E. Schulze, " Über die inneren Kiemen der Batrachierlarven," *Abh. Ak. Berl.*, 1888 and 1892; G. A. Boulenger, " A Synopsis of the Tadpoles of the European Batrachians," *P.Z.S.*, 1891, p. 593; F. E. Beddard, " Notes upon the Tadpole of *Xenopus laevis*," *P.Z.S.*, 1894, p. 101; S. Flower, " Batrachians of the Malay Peninsula and Siam," *P.Z.S.*, 1899, p. 885; H. S. Ferguson, "Travancore Batrachians," *J. Bombay N.H. Soc.*, xv. 1904, p. 499. (G. A. B.)

TAEL (Malay *tail*, *tahil*, weight, probably connected with Hind. *tola*, weight), the name current in European usage for the Chinese *liang* or ounce, the *liang* of fine uncoined silver being the monetary unit throughout the Chinese empire. The *tael* is not a coin, the only silver currency, apart from imported dollars, being the ingots of silver known as " sycee "; the only other native currency is the copper " cash." As a money of account the *tael* is divided into 10 *mace* (*tsien*), 100 *conderin* or *candereen* (*fun*), 1000 *li*. The value varies with the price of silver. The " Haikwan tael," *i.e.* the custom-house tael, that in which duties are paid to the Imperial Maritime Customs, is a weight of 58–77 grains Troy, the value of which varies; thus it was reckoned at 3s. $1\frac{1}{10}$d. in 1905, 3s. $3\frac{1}{2}$d. in 1906, 3s. 3d. in 1907, and 2s. 8d. in 1908 (see China: § *Finance*).

TAENIA (Gr. ταινία, ribbon, fillet), the term in architecture given to the projecting fillet which crowns the architrave of the Greek Doric order.

TAFILÁLT, or Tafilet (*i.e.* " The Country of the Filáli," as its inhabitants are called, because descended from the Arabian tribe of Hilál, settled here in the 11th century), the most important oasis of the Moroccan Sahara, ten days' journey south of Fez, across the Atlas. It is celebrated for its large and luscious dates, to the successful cultivation of which, soon after the arrival of an ancestor of the reigning dynasty of Morocco (hence called the Filáli Sharifs, *i.e.* descendants of Mahomet) *circ.* A.D. 1250, this dynasty owes its rise to power. Since 1648 it has been the custom of Moorish sultans to despatch superfluous sons and daughters to Tafilált, and as the males are all sharifs, the fanaticism against Europeans is comprehensible. Instead of living in towns its bellicose inhabitants occupy isolated fortified buildings, and are constantly at war. In Ifli, the central portion, formerly existed the town of Sagilmasa, founded by Miknása Berbers in 757 B.C. It was on the direct caravan route from the Niger to Tangier, and attained a considerable degree of prosperity. It was destroyed at the end of the 11th century, but its ruins still extend five miles along the river bank.

The first European to visit Tafilált was Rene Caillie (1828), the next Gerhard Rohlfs (1864). A later visit to the oasis by W. B. Harris is described in his book *Tafilet* (London, 1895).

TAFT, LORADO (1860–), American sculptor, was born at Elmwood, Illinois, on the 29th of April 1860. He graduated from the University of Illinois in 1879, and from 1880 to 1883 studied in the École des Beaux Arts, Paris. In 1886 he became instructor at the Art Institute, Chicago, lecturing there, at the Chicago University, and elsewhere in the United States. He is the author of an exhaustive and authoritative work, *The History of American Sculpture* (1903). Among his works, in addition to much portraiture, are: " Sleep of the Flowers " and " Awakening of the Flowers," both made for the Columbian Exposition; " Despair " (1898); " Solitude of the Soul " (1900), and " Fountain of the Lakes " (1903).

TAFT, WILLIAM HOWARD (1857–), the twenty-seventh President of the United States, was born in Cincinnati, Ohio, on the 15th of September 1857. His father, Alphonso Taft (1810–1891), born in Townshend, Vermont, graduated at Yale College in 1833, became a tutor there, studied law at the Yale Law School, was admitted to the Connecticut bar in 1838, removed to Cincinnati in 1839, and became one of the most influential citizens of Ohio. He served as judge of the Superior Court (1865–72), as secretary of war (1876) and as attorney-general of the United States (1876–77) in President Grant's cabinet; and as minister to Austria-Hungary (1882–84) and to Russia (1884–85).

William Howard Taft attended the public schools of Cincinnati, graduated at the Woodward High School of that city in 1874, and in the autumn entered Yale College, where he took high rank as a student and was prominent in athletics and in the social life of the institution. He graduated second (salutatorian) in his class in 1878, and began to study law in Cincinnati College, where he graduated in 1880, dividing the first prize for scholarship. He was admitted to the Ohio bar in 1880. For a few months he worked as a legal reporter for the Cincinnati *Times* (owned by his brother C. P. Taft), and then for the Cincinnati *Commercial*. Early in 1881 he was appointed assistant prosecuting attorney of Hamilton county (in which Cincinnati is situated), but resigned in 1882 on being appointed collector of internal revenue of the United States for the first district of Ohio. The work was distasteful, however, and in 1883 he resigned to return to the law. From 1885 to 1887 he served as assistant solicitor of Hamilton county, and in the latter year was appointed judge of the Superior Court of Ohio to fill a vacancy. He was elected by the people in the next year and served until 1890, when he was appointed solicitor-general of the United States by President Benjamin Harrison. His work in connexion with the drafting of the Sherman Anti-Trust Act and with the Bering Sea controversy attracted attention. In 1892 he was appointed a judge of the Sixth Circuit, United States Court, and became known as a fearless administrator of the law. Several decisions were particularly objectionable to organized labour. The first of these, decided in 1890, upheld the verdict of a jury awarding damages to the Moores Lime Company, which had sustained a secondary boycott because it had sold material to a contractor who had been boycotted by Bricklayers' Union No. 1. The second decision grew out of the attempt of the Brotherhood of Locomotive Engineers to prevent other roads from accepting freight from the Toledo, Ann Arbor & North Michigan railroad, against which a "legal" strike had been declared. Judge Taft granted an injunction (7th March 1893) against the Pennsylvania railroad, making P. M. Arthur, chief of the Brotherhood, a party, and called Rule 12, forbidding engineers to haul the freight, criminal. During the great railway strikes of 1894 Eugene V. Debs, president of the American Railway Union, sent one Frank W. Phelan to tie up traffic in and around Cincinnati. The receiver of the Cincinnati, New Orleans & Texas Pacific railway applied for an injunction against Phelan and others, which was granted. Phelan disobeyed the injunction and on the 13th of July 1894 was sentenced to jail for six months for contempt. The doctrine that "the starvation of a nation cannot be the lawful purpose of a combination" was announced, and Judge Taft said further that "if there is any power in the army of the United States to run those trains, the trains will be run." In 1896–1900 Judge Taft was professor and dean of the law department of the University of Cincinnati.

A movement to elect Mr Taft president of Yale University gained some strength in 1898–99, but was promptly checked by him, on the ground that the head of a great university should be primarily an educationalist. In 1900 he was asked by President McKinley to accept the presidency of the Philippine Commission charged with the administration of the islands. Though he had been opposed to the acquisition of the Philippines, he did not believe that the inhabitants were capable of self-government, and he foresaw some of the difficulties of the position. Yielding, however, to the urgent request of the president and his cabinet, he accepted and served from the 13th of March 1900 to the 1st of February 1904. On the establishment of civil government in the islands, on the 4th of July 1901, he became governor, *ex officio*. The task of constructing a system of government from the bottom, of reconciling the conflicting and often jealously sensitive elements, called for tact, firmness, industry and deep insight into human nature, all of which Governor Taft displayed in a marked degree. (See PHILIPPINE ISLANDS.) The religious orders had been driven out during the insurrection, but held title to large tracts of land which many Filipinos and some Americans wished to confiscate. This delicate matter was arranged by Mr Taft in a personal interview with Pope Leo XIII. in the summer of 1902. The pope sent a special delegate to appraise the lands, and the sum of $7,239,000 was paid in December 1903. Mr Taft gained great influence among the more conservative Filipinos, and their entreaties to him to remain influenced him to decline the offer of a place upon the Supreme bench offered by President Roosevelt in 1902.

Finally, feeling that his work was accomplished, Mr. Taft returned to the United States to become secretary of war from the 1st of February 1904. With a party of congressmen he visited the Philippines on a tour of inspection July-September 1905, and in September 1906, on the downfall of the Cuban republic and the intervention of America, he took temporary charge of affairs in that island (September–October). In the next year (March–April) he inspected the Panama Canal and also visited Cuba and Porto Rico. He again visited the Philippines to open the first legislative assembly (16th October 1907), and returned by way of the Trans-Siberian railway. On this tour he visited Japan, and on the 2nd of October, at Tokyo, made a speech which had an important effect in quieting the apprehensions of the Japanese on the score of the treatment of their people on the Pacific coast.

With the approach of the presidential election of 1908, President Roosevelt reiterated his pledge not to accept another nomination, and threw his immense influence in favour of Mr Taft. At the Republican convention held in Chicago, in June, Mr Taft was nominated on the first ballot, receiving 702 out of 980 votes cast. James S. Sherman of New York was nominated for Vice-President. During the campaign many prominent labour leaders opposed the election of Mr Taft, on the ground that his decisions while on the bench had been unfriendly to organized labour. In the campaign Mr Taft boldly defended his course from the platform, and apparently lost few votes on account of this opposition. At the ensuing election in November, Taft and Sherman received 321 electoral votes against 162 cast for William Jennings Bryan and John W. Kern, the Democratic candidates.

In his inaugural address (4th March 1909) President Taft announced himself as favouring the maintenance and enforcement of the reforms initiated by President Roosevelt (including a strict enforcement of the Sherman Anti-Trust Act, an effective measure for railway rate regulation, and the policy of conservation of natural resources); the revision of the tariff on the basis of affording protection to American manufactures equal to the difference between home and foreign cost of production; a graduated inheritance tax; a strong navy as the best guarantee of peace; postal savings banks; free trade with the Philippine Islands; and mail subsidies for American ships. He also announced his hope to bring about a better understanding between the North and the South, and to aid in the solution of the negro problem. In accordance with his pre-election pledge, Congress was called to meet in extra session on the 15th of March to revise the tariff. Hearings had been previously held by the Ways and Means Committee of the House of Representatives, and a measure was promptly reported. After passing the House it was sent to the Senate, where it was much changed. The final Payne-Aldrich Act was approved by the President on the 5th of August 1909, though in many respects it was not the measure he desired. The wish to meet people of the different sections of the country and to explain his position upon the questions of the day led the President to begin (14th September 1909), a tour which included the Pacific coast, the South-west, the Mississippi Valley and the South Atlantic states, and during which he travelled 13,000 miles and made 266 speeches.

Mr Taft delivered the Dodge lectures at Yale University in 1906 on the Responsibilities of Citizenship, published as *Four Aspects of Civic Duty* (1906). Some of his political speeches have been published under the titles *Present Day Problems* (1908), and *Politicial Issues and Outlooks* (1909).

TAGANROG, a seaport of southern Russia, on the N. shore of the Sea of Azov, in the Don Cossacks territory, some 170 m. S.E. of the town of Ekaterinoslav. It is built principally of wood, stands on a low cape, and has the aspect of an important commercial city. The imperial palace, where Alexander I. died in 1825, and the Greek monastery (under the patriarch of Jerusalem) are worthy of notice. Statues of Alexander I. (1830) and Peter the Great (1903) adorn the town. In the 13th century Pisan merchants founded there a colony, *Portus Pisanus*, which, however, soon disappeared during the migrations of the Mongols and Turks. An attempt to obtain possession of the promontory was made by Peter the Great, but it was not definitely annexed by the Russians until seventy years afterwards (1769). The commercial importance of the town dates from the second half of the 19th century; in 1870 its population had risen to 38,000, and after it was brought into railway connexion with Kharkov and Voronezh, and thus with the fertile provinces of south and south-east Russia, the increase was still more rapid, the number reaching 56,047 in 1885, and 58,928 in 1900—Greeks, Jews, Armenians and West-Europeans being important elements. The town was bombarded and in part destroyed by an Anglo-French fleet in May 1855. Taganrog is an episcopal see of the Orthodox Greek Church, and has tanneries, tallow works and tobacco manufactures. The roadstead is very shallow, and exposed to winds which cause great variations in the height of the water; it is, moreover, rapidly silting up. At the quay the depth of water is only 8 to 9 feet, and large ships have to lie 5 to 13 miles from the town. Moreover, the port is closed by ice three to four months in the year. Notwithstanding the disadvantages of its open roadstead, the foreign trade has rapidly expanded, the annual value of the exports having increased from 6½ millions sterling in 1899 to over 10 millions sterling in 1904. The chief article of export being corn, the trade of the city is subject to great fluctuations. Linseed and other oil-bearing grains are also important articles of commerce, as well as wool and butter. The imports, which consist chiefly of machinery, fruits (dried and fresh), wine, oil and textiles, do not much exceed half a million sterling annually.

TAGES (*Tăgēs*), a minor Etruscan deity, grandson of Jupiter, and founder of the art of divination in Etruria. According to the story, during the ploughing of a field near Tarquinii a being of boyish appearance sprang out of the furrow. The shouts of the ploughman (Tarchon) brought to the spot all the people of Etruria, whom the boy proceeded to instruct in the art of divination. Having done this, he suddenly disappeared. His instructions were for some time handed down orally, but were subsequently committed to writing, and formed the twelve books of Tages, containing a complete system of Etruscan lore.

See Cicero, *De Div.* ii. 23; Ovid, *Metam.* xv. 553; Festus, *s.v.*; Mommsen, *Hist. of Rome* (Eng. tr.), bk. i. ch. 12.

TAGLIACOZZI, GASPARO (1546–1599), Italian surgeon, was born at Bologna in 1546, and studied at that university under Cardan, taking his degree in philosophy and medicine at the age of twenty-four. He was appointed professor of surgery and afterwards of anatomy, and achieved notoriety at least, and the fame of a wonder-worker. He died at Bologna on the 7th of November 1599.

His principal work is entitled *De Curtorum Chirurgia per Insitionem Libri Duo* (Venice, 1597, fol.,; it was reprinted in the following year under the title of *Chirurgia Nova de Narium, Aurium, Labiorumque Defectu per Insitionem Cutis ex Humero, arte hactenus omnibus ignota, sarciendo* (Frankfort, 1598, 8vo).

TAGLIACOZZO, a town of the Abruzzi, Italy, in the province of Aquila, 56 m. by rail E.N.E. of Rome, and 10 m. W. of Avezzano. Pop. (1901) 4517 (town); 9061 (commune). It lies 2428 ft. above sea-level, at the mouth of the deep ravine of the Imele. It contains several old churches, notably S. Francesco, with a fine rose window in the façade, and medieval houses. The palace, built at the end of the 14th century by the Orsini, is fine. The place was given to the Colonna family in 1526. At the end of 1268 a battle took place here between Conradin of Hohenstaufen and Charles of Anjou, which resulted in the defeat of Conradin and his execution.

TAGLIONI, MARIA (1804–1884), Italian ballet dancer, daughter of Filippo Taglioni (1777–1871), master of the ballet at Stockholm, Cassel, Vienna and Warsaw, was born at Stockholm on the 23rd of April 1804. She was trained by her father, who is said to have been pitilessly severe. It was to his care and her own special talent for dancing that she owed her success, for she possessed no remarkable personal attraction. Her first appearance was at Vienna on the 10th of June 1822, in a ballet of which her father was the author, *La Réception d'une jeune nymphe à la cour de Terpsichore*. Her success was immediate, and was repeated in the chief towns of Germany. On the 23rd of July 1827 she made her Paris début at the Opéra, in the *Ballet de Sicilien*, and aroused a furore of enthusiasm. Among her more remarkable performances were the dancing of the Tyrolienne in *Guillaume Tell*, of the *pas de fascination* in Meyerbeer's *Robert le Diable*, and in *La Fille du Danube*. At this period the ballet was an important feature in opera, but with her retirement in 1847 the era of grand ballets may be said to have closed. In 1832 she married Comte Gilbert de Voisins, by whom she had two children. Losing her savings in speculation, she afterwards supported herself in London as a teacher of deportment, especially in connexion with the ceremony of presentation at court. During the last two years of her life she lived with her son at Marseilles, where she died on the 23rd of April 1884. Taglioni is frequently mentioned in the novels of Balzac; and Thackeray, in *The Newcomes*, says that the young men of that epoch "will never see anything so graceful as Taglioni in *La Sylphide*."

TAGUS (Span. *Tajo*, Portug. *Tejo*), the longest river of the Iberian Peninsula. Its length is 565 m., of which 192 are on or within the frontier of Portugal, and the area of its basin is about 31,850 sq. m. The basin is comparatively narrow, and the Tagus, like the other rivers of the Iberian tableland, generally flows in a rather confined valley, often at the bottom of a rocky gorge below the general level of the adjacent country. The river rises on the western slope of the Muela de San Juan (5225 ft.), a mountain which forms part of the Sierra de Albarracin, 88 m. E. of Madrid. Thence the Tagus flows at first north-westwards, but, after receiving the Gallo on the right, it flows west, and then south-west or west-south-west, which is its general direction for the rest of its course. Regular river navigation begins only at Abrantes, a few miles below which the Tagus is greatly widened by receiving on its right bank the impetuous Zezere from the Serra da Estrella. Passing Santarem, the highest point to which the tide ascends, and the limit of navigation for large sailing vessels and steamers, the river divides below Salvaterra into two arms, called the Tejo Novo (the only one practicable for ships) and the Mar de Pedro. These branches enclose a deltaic formation, a low tract of marshy alluvium known as the Lezirias, traversed by several minor channels. Both branches terminate in a broad tidal lake immediately above Lisbon (*q.v.*). The Tagus estuary, though partly blocked by a bar of sand, is one of the chief harbours of south-western Europe.

The narrower part of the Tagus basin lies to the south, and the left-hand tributaries which drain it are almost all mere brooks, dry in summer. The principal exception is the Zatas or Sorraia, which, rising in the Serra d'Ossa, flows westwards across the plateau of Alemtejo, and joins the Mar de Pedro. The principal right-hand tributaries, besides the Gallo and Zezere, are the Jarama, descending from the tableland of New Castile a little below Aranjuez, the Alberche and the Tietar, which collect their head waters from opposite sides of the Sierra de Gredos, and the Alagon, from the rough and broken country between the Sierras de Gredos and Gata.

TAHITI, the largest and most important of the French Society Islands (*q.v.*) in the Pacific Ocean, in 17° 38′ S., 149° 30′ W. Pop. about 10,300. The island, in shape not unlike the figure 8, has a length of 33 m., a coast-line of 120, and an area of 402 sq. m. It is divided into two portions by a short isthmus (Isthmus of Taravao) about a mile in width, and nowhere more than 50 ft. above sea-level. The southern, the peninsula of Taiarapu, or Tahiti-iti (Little Tahiti) measures 11 m. in length by 6 m. in breadth; while the northern, the circular main island of Porionuu, or Tahiti-uni (Great Tahiti), has a length of 22 m. and a breadth of 20. The whole island is mountainous. A little to the north-west of the centre of Great Tahiti the double-peaked Orohena rises to 7349 ft., and the neighbouring Aorai is only a little lower. Little Tahiti has no such elevation, but its tower-like peaks are very striking. The flat land of the Tahitian coast, extending to a width of several miles—with its chain of villages, its fertile gardens, and its belt of palms, sometimes intersected by stream-fed valleys which open on the seashore—forms a most pleasing foreground to the grand mountain ranges. A good road surrounds the island, the extreme north of which is formed by Point Venus, W. of which lie the Bay of Matavai and Papeete, the European town and seat of government, on its beautiful harbour.

Climate.—The seasons are not well defined. Damp is excessive; there is little variation in the weather, which, though hot, is nevertheless not depressing, and the climate for the tropics must be considered remarkably healthy. The rainfall is largest between December and April, but there is so much at other times of the year also that these months hardly deserve the name of the rainy season. During this period north-west winds are frequent, continuing at times for weeks, and there are thunderstorms and hurricanes. These, while not generally destructive, are sometimes so, as notably the storm of the 13th of January 1903. During the eight drier and cooler months south-east trade winds prevail, but there are southerly winds which bring rain, and even westerly breezes are not infrequent. The mean temperature for the year on the coasts is 77° F. (maximum 84°, minimum 69°); and the average rainfall from December to March (4 months) is 29 inches; from April to November (8 months), 19 inches.

Fauna.—Mammals, as in other Polynesian islands, are restricted to a few species of bats (mostly of the genus *Pteropus*), rats and mice, none of them peculiar. Of domestic animals, the pig and the dog—the former a small breed which quickly disappeared before the stronger European strains—were plentiful even in Wallis's days. The ornithology is very poor as compared with that of the Western Pacific; the Society Islands possess no peculiar genera and but few peculiar species. They claim, however, a thrush, several small parrots of great beauty, doves, pigeons, rails and a sandpiper (*Tringa leucoptera*). A jungle-fowl (var. of *Gallus bankiva*) is found in the mountains, but as domesticated fowls were abundant, even when Tahiti was first discovered by Europeans, these wild birds are doubtless the offspring of tame birds. The lagoons swarm with fish of many species. Insects are poor in species, though some of them are indigenous. Crustaceans and molluscs, on the other hand, are well represented; worms, echinoderms, and corals comparatively poorly. A noteworthy feature of Tahitian conchology is the number of peculiar species belonging to the genus *Partula*, almost every valley being the habitat of a distinct form.[1]

Flora.—The flora, though luxuriant and greatly enhancing the beauty of the islands, is not very rich. It is, however, less poor in trees, shrubs and hardwood plants, than in the smaller undergrowth. Orchids, including some beautiful species, and ferns are abundant; but, here as in Polynesia generally, *Rubiaceae* is the order best represented. Remarkable are the banana thickets, which grow at an altitude of from 3000 to 5000 ft. Along the shore—in some places almost to the extinction of all native growth—many exotics have established themselves; and a great variety of fruit-bearing and other useful trees have been introduced.[2]

Inhabitants.—The Tahitians are a typical Polynesian race, closely connected physically with the Marquesans and Rarotongans, but widely divided from them in many of their customs. The dialects, also, of the three groups are different, the Tahitian being perhaps the softest in all Oceania. The women rank with the most beautiful of the Pacific, though the accounts given of them by early voyagers are much exaggerated; and for general symmetry of form the people are unsurpassed by any race in the world. Even now in its decadence, after generations of drunkenness and European disease and vice, grafted on inborn indolence and licentiousness, many tall and robust people (6 ft. and even upwards in height) are to be found. Men and women of good birth can generally be distinguished by their height and fairness, and often, even in early age, by their enormous corpulence. The skin varies from a very light olive to a full dark brown. The wavy or curly hair and the expressive eyes are black, or nearly so; the mouth is large, but well-shaped and set with beautiful teeth; the nose broad (formerly flattened in infancy by artificial means); and the chin well developed.

The native costume was an oblong piece of bark-cloth with a hole in its centre for the head, and a plain piece of cloth round the loins was worn alike by men and women of the higher classes. Men of all ranks wore, with or without these, the T bandage. The women concealed their breasts except in the company of their superiors, when etiquette demanded that inferiors of both sexes should uncover the upper part of the body. The chiefs wore short feather cloaks, not unlike those of the Hawaiians, and beautiful semicircular breastplates, dexterously interwoven with the black plumage of the frigate bird, with crimson feathers and with sharks' teeth; also most elaborate special dresses as a sign of mourning. The priests had strange cylindrical hats, made of wicker-work and over a yard in height. Circumcision, and in both sexes tattooing, were generally practised, and much significance was attached to some of the marks. The houses were long, low, and open at the sides. Household utensils were few—plain round wooden dishes, sometimes on legs, coco-nut shells, baskets, &c. Low stools and head-rests were used. Pottery being unknown, all food was baked in a hole dug in the ground or roasted over the fire. Their chief musical instruments were the nose-flute—often used as the accompaniment of song—and the drum. Conch-shells were also used. Tahitian stone adzes, which are greatly inferior in finish to those of the Hervey Islands, are, like the adzes of Polynesia in general, distinguished from those of Melanesia by their triangular section and adaptation to a socket. Slings were favourite weapons of the Tahitians; they had also plain spears expanding into a wide blade, and clubs. The bow and arrow seem only to have been used in certain ceremonial games. Their canoes, from 20 to 70 ft. in length, were double or single, and provided with sail and outriggers. They were not well finished, but the high curved sterns, rising sometimes to a height of 20 ft., of those destined to carry the images of their gods, were carved with strange figures and hung with feathers. Cannibalism is unknown, though some ceremonies which were performed in connexion with human sacrifices may possibly be survivals of this practice. The staple food of the islanders consisted of the bread-fruit, the taro-root, the yam, the sweet potato, and in some districts the wild plantain; but they also ate much fish (the turtle was considered sacred food), as well as pigs and dogs, though of the latter, as pets, the women were so fond as to suckle the puppies sometimes even to the exclusion of their own children.

Tahitians were good fishermen and bold seamen. They steered by the stars, of which they distinguished many constellations. The land was carefully tended and the fields well irrigated. Three great classes were recognized:—(1) The sovereign, who bore a semi-sacred as well as a political character, and the reigning chiefs of districts; (2) the proprietors and cultivators of inherited land, who also built canoes, made arms, &c.; to these two classes also belonged the priests, who were medicine-men as well; (3) the fishers, artisans, &c., and slaves. As wars and infanticide depopulated the island this class gradually acquired land and with it certain privileges. Rank is hereditary and determined by primogeniture, not necessarily in the male line. The firstborn of a sovereign succeeded at once to titular sovereignty; the father, who was the first to pay homage to his child, then abdicated, and became regent. It is easy to see that, while this custom tended to keep honours within a family, it may have encouraged the practice of infanticide, which was common in all grades of society when Tahiti was first visited by Europeans. The age at which the child's authority became real varied according to his own abilities and the will of his subjects. Though arbitrary, the power of the king was limited by the power of his vassals, the district chiefs, who ruled absolutely over their respective districts, and who might be of as good blood as himself. The king had a councillor, but was alone responsible for any act. The bi-insular form of Tahiti promoted the independence of the chiefs, and war was rarely declared without their being first summoned to council. Their power over their own people was absolute. The form of government was thus strictly feudal in character, but it gradually centralized into a monarchy, which, in the person of Pomare II., the English missionaries greatly helped to regulate and strengthen. The sovereign sent his commands by a messenger, whose credentials were a tuft of coco-nut film. This tuft was returned intact as a sign of assent or torn in token of refusal.

The temples were square tree-surrounded enclosures, with a single entrance and several small courts, within which were houses for the images and attendant priests. A pyramidal stone structure, on which were the actual altars, stood at the further end of the square. In the temples were buried the chiefs, whose embalmed bodies, after being exposed for a time, were interred in a crouching position. Their skulls, however, were kept in the houses of their nearest relations. In the great temple at Atahura the stone structure was 270 ft. long, 94 ft. wide, and 50 ft. high, and its summit was reached by a flight of steps built of hewn coral and basalt. Sacrificial offerings, including human sacrifices, formed a prominent part of Tahitian worship. An eye of the victim was offered to the king, and placed within his mouth by the officiating priest. Every household possessed its own guardian spirits, but there were several superior divinities, of which, at the beginning of the 19th century, Oro was the most venerated. The images, which are less remarkable than those of Hawaii, were rough representations of the human form carved in wood. The *Areoi*, a licentious religious association, was a special feature of Tahitian society.

The Tahitians are light-hearted, frivolous, courteous and generous, but deceitful and cruel. They were always notorious for their immorality, one of their customs being a systematized exchange of wives. Besides dancing, the singing of songs, and the recitation of historical and mythical ballads, the natives had also a variety of sports and games. Wrestling, boxing, and spear-throwing matches, with foot and canoe races, were held; also sham fights and naval reviews. They had several ball games—one (played chiefly by women), a kind of football; but surf-swimming was perhaps the favourite sport, and cock-fighting was much practised.

Products, Trade, Administration.—Papeete, as the emporium for a widely scattered archipelago (including Paumotu, &c.), has an export trade in mother-of-pearl, pearls (mainly from the Paumotu islands), oranges, trepang (for China), copra and vanilla. Many whalers formerly visited Papeete harbour. During the American Civil War, in the middle of the 19th century, Tahitian cotton was put upon the European market, but its cultivation had ceased by 1884, and it has been little grown since. This is also true of coffee and tobacco, among other crops which have been tried. Sugar and rum are also produced.

The importation of "labour," chiefly for the plantations, from other Polynesian islands was placed under government control in 1862. The Tahitians themselves prefer handicrafts to agricultural work, and many are employed as artisans by European masters.

The total value of exports was £140,325 and of imports £127,600 in 1904. Papeete is the seat of government. The French establishments in the Eastern Pacific are administered by a governor, a privy council, and a council including the *maire* of Papeete and the presidents of the chambers of commerce and agriculture.

History.—The discovery and early exploration of the Society Islands is treated under that heading. In 1788, when Lieutenant Bligh in the "Bounty" visited Tahiti, the leading chief was Pomare, whose family had been pre-eminent in the island for

[1] Finsch and Hartlaub, *Fauna Central-Polynesiens*, Halle, 1867.

[2] De Castillo, *Illustrationes Florae Insularum Maris Pacifici*, Paris, 1886.

more than a century. Aided by sixteen of the "Bounty" mutineers, and armed with guns procured from Bligh and a Swedish vessel, Pomare greatly strengthened his power and brought to a successful close a long struggle with Eimeo.

The attempt at colonization by the Spaniards in 1774 was followed by the settlement of thirty persons brought in 1797 by the missionary ship "Duff." Though befriended by Pomare I. (who lived till 1805), they had many difficulties, especially from the constant wars, and at length they fled with Pomare II. to Eimeo and ultimately to New South Wales, returning in 1812, when Pomare renounced heathenism. In 1815 he regained his power in Tahiti. For a time the missionaries made good progress—a printing press was established (1817), and coffee, cotton and sugar were planted (1819); but soon there came a serious relapse into heathen practices and immorality. Pomare II. died of drink in 1824. His successor, Pomare III., died in 1827, and was succeeded by his half-sister Aimata, the unfortunate "Queen Pomare (IV.)." In 1828 a new fanatical sect, the "Mamaia," arose, which gave much trouble to the missions. The leader proclaimed that he was Jesus Christ, and promised to his followers a sensual paradise. In 1836 the French Catholic missionaries in Mangareva attempted to open a mission in Tahiti. Queen Pomare, advised by the English missionary and consul Pritchard, refused her consent, and removed by force two priests who had landed surreptitiously and to whom many of the opposition party in the state had rallied. In 1838 a French frigate appeared, under the command of Abel Dupetit-Thouars, and extorted from Pomare the right of settlement for Frenchmen of every profession. Pritchard opposed this, and caused Pomare to apply for British protection; but this was a failure, and the native chiefs compelled the queen, against her will, to turn to France. A convention was signed in 1843, placing the islands under French protection, the authority of the queen and chiefs being expressly reserved. Dupetit-Thouars now reappeared, and, alleging that the treaty had not been duly carried out, deposed the queen and took possession of the islands. His high-handed action was not countenanced by the French government; but while, on formal protest being made from England, it professed not to sanction the annexation, it did not retrace the steps taken. Two years were spent in reducing the party in the islands opposed to French rule; an attempt to conquer the western islands failed; and at length, by agreement with England, France promised to return to the plan of a protectorate and leave the western islands to their rightful owners. Pomare died in 1877, and her son Ariane (Pomare V.) abdicated in 1880, handing over the administration to France, and in the same year Tahiti, including Eimeo, was proclaimed a French colony. In 1903 the whole of the French establishments in the Eastern Pacific were declared one colony, and the then existing elective general council was superseded by the present administration.

Besides the narratives of early voyages, and general works covering the Society Islands (for which see PACIFIC), see Vincendon-Dumoulin, *Les Iles Tahiti, esquisses historiques et géographiques*, Paris, 1844; A. Gonfil, "Tahiti," in *La France coloniale*, Paris, 1886; H. Le Chartier, *Tahiti*, Paris, 1887; Monchoisy, *La Nouvelle Cythère*, Paris, 1888; G. Collingridge, "Who discovered Tahiti?" in *Journ. Polynesian Soc.*, xii., 1903. Among the narrative works of visitors to Tahiti may be mentioned Pierre Loti, *Le Mariage de Loti*, Paris, 1881; Dora Hort, *Tahiti: the Garden of the Pacific*, London, 1891.

TAHR, the native name of a shaggy-haired brown Himalayan wild goat characterized by its short, triangular and sharply keeled horns. Under the name of *Hemitragus jemlaicus*, it typifies a genus in which are included the wariatu, or Nilgiri ibex (*H. hylocrius*), from the Nilgiri and Anamalai hills of Southern India, and a small species, *H. jayakeri*, from South Arabia. Tahr frequent the worst ground of almost all ruminants.

TAILLANDIER, SAINT-RENÉ (1817–1879), French critic, whose original name was René Gaspard Ernest Taillandier, was born in Paris on the 16th of December 1817. He completed his studies at Heidelberg, and then became professor of literature successively at Strassburg, Montpellier and the Sorbonne, where he was nominated to the chair of French eloquence in 1868. Most of the articles included in his published volumes first appeared in the *Revue des deux mondes*. In January 1870 he became general secretary of the ministry of education, and continued in this office after the fall of the Empire. He became officer of the Legion of Honour in 1870, and was elected to the Academy in 1873. He died in Paris on the 22nd of February 1879.

His works include:—*Allemagne et Russie, études historiques et littéraires* (1856), *Le Poète du Caucase . . . Michel Lermontoff* (1856), *Maurice de Saxe* (2 vols. 1865), *Tchèques et Magyars* (1869), *Le Général Philippe de Ségur* (1875).

TAILLE (from Fr. *tailler*, to cut or divide; late Lat. *taliare*, said to come from *talia*, *talea*), the equivalent of the English *tallage* (*q.v.*), was in France the typical direct tax of the middle ages, just as the word *tonlieu* was the generic term for an indirect tax. Other words used in certain districts in the same sense as *taille* were *queste* (*questa, quista*), *fouage* (*foragium*), *cote*. The essence of the tax denoted by these names was that the amount was fixed *en bloc* for a whole group of persons, and afterwards divided among them in various ways. In ancient French law we find three forms of *taille:* the *taille servile*, *taille seigneuriale*, and *taille royale*.

The *taille servile* can scarcely be termed a tax; it was rather a tax which had degenerated into a source of profit for certain individuals. Every lord who possessed serfs could levy the *taille* on them, and originally this was done arbitrarily (*a volonté*) both as to frequency and amount. It always remained a characteristic feature of serfdom, but was limited and fixed, either by contracts or concessions from the lord (*taille abonnée*), or by the customs.

The *taille seigneuriale* was a true tax, levied by a lord on all his subjects who were neither nobles nor ecclesiastics. But, in our opinion, when feudalism was established, the right of levying it did not belong to every lord, but only to the lord having the *haute justice*. But he levied it by right, without the necessity for any contract between him and those who paid it. He fixed the sum to be paid by each group of inhabitants, who then had to see that it was assessed, collected, and paid to the lord, electing commissaries (*preud hommes*) from among themselves for this purpose. This was reducing the administration of taxation to its simplest form. Custom, however, or an order of the lord generally fixed the principle upon which the division was made. It was often a "hearth tax" (*fouage*), when each fire, *i.e.* each head of a family, paid the same sum, arrived at by dividing the local contingent of the *taille* by the number of fires. But this equality, which took no account of wealth or poverty, was felt to be unjust, and the assessment began to be made according to the resources of each family, "the strong bearing the weak, and the weak relieving the strong." The seigniorial *taille*, like the servile, had the character of a personal tax (*taille personelle*), a rudimentary tax on income, every man being taxed according to his wages or other income. The king originally had only the right of levying the *taille* in places where he had retained the exercise of the *haute justice*. At that time there was no royal *taille*, strictly speaking; it was only the seigniorial *taille* transferred to the crown, but it was one of the first taxes his right to levy which upon all the inhabitants of the domain of the crown, whether serfs or *roturiers*, was recognized. In the course of the 13th century the idea began to prevail that it was fair for the king, in time of war, to levy a *taille* upon the subjects of the lords having the *haute justice* in various parts of the royal domain. Moreover, *tailles* were often granted him by the provincial estates or the states-general. Thus the general *taille*, raised for the benefit of the king, became more and more frequent, and naturally tended to become permanent. This transformation was confirmed, rather than effected, by the *ordonnance* of 1439. Its immediate object was, not the regulation of the *taille*, but the organization of the *compagnies d'ordonnance*, *i.e.* the heavy cavalry which the king from that time on maintained on a permanent footing. Military expenses thus becoming permanent, it was natural that the *taille*, the tax which had long been devoted to meeting the expenses of the royal wars, should also become permanent. This was contained implicitly in the *ordonnance* of 1439, which at the same time suppressed the seigniorial *taille*, as competing too closely with the royal *taille* by imposing a double burden on the taxpayer. A kind of seigniorial *taille* continued to exist besides the servile *taille*, but this kind presupposed a title, a contract between the taxable *roturier* and the lord, or else immemorial possession, which amounted to a title.

The royal *taille* naturally retained the distinctive characteristics of the seigniorial, as can be seen from an examination of the way in which it was assessed and collected; the chief characteristic being that ecclesiastics and nobles, who were exempt from the seigniorial *taille*, were also exempt from the royal. The royal *taille*, though levied by the king by right, did not fall upon the whole kingdom. The *pays d'élections* were subject to it, the *pays d'états* were not (see FRANCE: *Law and Institutions*).

Throughout the *pays d'élections* the *taille* was almost universally personal (*taille personnelle*), *i.e.* a tax on the whole income of the taxpayer, whatever its source. It was also a distributory tax (*impôt de repartition*); every year the king in his council fixed the total sum which the *taille* was to produce in the following year; he drew up and signed the *brevet de la taille* (warrant), and the contribution of the individual taxpayer was arrived at in the last analysis by a series of subdivisions.

The *conseil du roi* first divided the total sum among the various *généralités* (the higher financial divisions), again dividing the amount due from each *généralité* among the *élections* of which it was composed. Then the *élus* in each *élection* divided the contribution due from it among the parishes. The final division took place in the parish or community, among the inhabitants subject to the tax. So far the system remained the same as that of the old seigniorial *taille*. The assessment and collection of it were the business of the community; the crown, in principle, had nothing to do with them and did not bear the cost of a local administration for the purpose. The community had to produce its contingent of the *taille*. In principle it was even held to be the debtor for the amount; hence the inhabitants were jointly responsible, a state of affairs which was not suppressed till the time of Turgot, and even then not completely.

The inhabitants subject to the *taille*, summoned to a general assembly by the syndic, elected commissaries for the assessment (*asséeurs*) and collection (*collecteurs*) of the tax from among themselves. Originally two series were elected, both assessors and collectors. But from 1600 onwards the same persons fulfilled both functions, the object being, by giving the assessors the duty of collecting the tax, to lead to a juster and more conscientious assessment. The system appeared to be admirable, forming in this respect a kind of self-government, but in practice it was frequently oppressive for the taxpayers. The assessors estimated the individual incomes arbitrarily, village quarrels and rivalries leading them to over-charge some and under-charge others, and complaints were numberless on this point. Control should no doubt have been exercised by the *élus*, but they do not seem to have taken this part of their duties very seriously. Payment was rigorously enforced, and thus for a variety of reasons the *taille* was a burdensome and hated tax. It had still further vices: not only were nobles and ecclesiastics exempt from it, but many other privileges had been introduced by law, total or partial exemption extending to a large number of civil and military officials and *employés* of the crown on the *ferme générale*. The towns in general were not subject to it, at least directly; some had been exempt from time immemorial, others (*rédimées*) had purchased exemption for a sum of money, yet others (*abonnées*) had compounded for the tax, *i.e.* instead of paying the *taille* they paid into the royal treasury a sum fixed by contract, which they generally raised by *octrois*, or entrance dues.

Such was the administration of the *taille* until about the middle of the 17th century, after which time, although the broad lines remained the same, important reforms were introduced. They came principally from the provincial *intendants*, or from the *cours des aides*, which were animated by a liberal spirit. The *intendants*, by an exercise of their general or special powers, took the place of the *élus*, and delegated *commissaires aux tailles* (commissaries of the *taille*) for the assessment of the parishes, who guided and supervised the elected collectors—for the most part ignorant and partial peasants. They also endeavoured to distinguish between different kinds of income, in order to arrive at a more just estimate of the total income, and fixed by tariff the proportion in which each kind of income was to contribute. They sometimes settled officially and of their own authority the share of certain taxpayers, and, though this was sometimes done as a favour, it was often a measure of justice. They also tried to limit the scope of privileges. These efforts were inspired by a series of scientific studies and criticisms, chief among which were Vauban's *Dîme royale*, and the *Taille tarifée* of the Abbé de St. Pierre.

In certain districts the *taille* was real (*taille reelle*) *i.e.* a tax on real property. It was not an equal tax falling on all landowners, but the question as to whether a certain estate was to be taxed or not was decided according to the quality of the property, and not that of the owner. The *biens nobles* (*fiefs*) and the *biens ecclesiastiques* were exempt; *tenures roturières*, however, by whomsoever held, were taxed. A small part of the *pays d'élections* was also *pays de taille réele*. But it was the chief form of tax in the *pays d'états*, and even there an attempt had generally been made to check the exemption of nobles' property. It has been shown that in these districts the *taille* had originally been personal, having become real by a curious evolution. In these districts there were *cadastres*, or *compoix-terriers* (land registers), which allowed of a non-arbitrary assessment; and at the end of the *ancien régime* merely needed revision.

In certain provinces where the royal *taille* was levied there were neither *élections* nor *généralités*, and the whole administration of the tax was in the hands of the *intendants*. These were the provinces of the east and north, which were united to the crown at a period when the power of the *intendants* was already fully developed; they were sometimes known as *pays d'imposition*.

See FRANCE: *Law and Institutions*; Henri Sée, *Les Classes rurales et le régime domanial en France au Moyen Âge* (Paris, 1901); and Auger, *Code des tailles* (Paris, 1788). (J. P. E.)

TAILLEFER, the surname of a bard and warrior of the 11th century, whose exact name and place of birth are unknown. He accompanied the Norman army to England in 1066, and obtained permission from William to strike the first blow at the battle of Hastings. He fought with spirit and determination, and was killed in the battle. Mention of Taillefer is made by Guido, bishop of Amiens, in his *Carmen de bello Hastingensi*, v. 931–44 (in *Mon. Hist. Brit.*, 1848) and by Henry of Huntingdon in his *Historia Anglorum* (in *Rer. Brit. med. aevi script.*, p. 763, ed. Arnold, London, 1879); and his prowess is depicted on the Bayeux tapestry. The statement of Wace in the *Roman de Rou*, 3rd part, v. 8035–62, ed. Andresen (Heilbronn, 1879), that Taillefer went before the Norman army singing of Charlemagne and of Roland and the vassals who died at Roncevaux, has been considered important in demonstrating the existence of a comparatively early tradition and song of Roland.

See W. Spatz, *Die Schlacht von Hastings* (Berlin, 1896); Freeman, *History of the Norman Conquest*.

TAILOR (Fr. *tailleur*, from *tailler*, to cut, Lat. *talea*, a thin rod, a cutting for planting), one who cuts out and makes clothes. Formerly the tailor, or *cissor*, made apparel for both men and women, and not merely outer garments, but also articles of linen and the padding and lining of armour—whence the style "Taylors and Linen Armourers" applied to the Merchant Taylors Company of the City of London in their earliest charters. But the word is now generally limited to those who make the outer (cloth) garments for men, and less frequently for women, though a phrase such as "shirt-tailor" is occasionally met with. In modern usage, too, it commonly has the implication that the garments are made to the order, and to the measure, of the individual purchaser, as opposed to ready-made clothing, which means articles of apparel manufactured in large quantities in a series of stock or standard sizes, such that any purchaser may expect to find among them one that will fit him with more or less accuracy. The clothing trade was originally confined to goods of the poorest grades, but it has come, especially in America, to include articles of good, though not of the first, quality. It probably first came into existence at seaport towns, where, to meet the convenience of sailors returning from long voyages and requiring their wardrobes to be replenished at short notice, the "outfitters" kept stocks of ready-made garments on sale; but it made no considerable progress until after the middle of the 19th century, when the introduction of the sewing-machine brought about the possibility of manufacturing in large quantities. Its development was attended with gradually increasing subdivision of labour and, to a large extent, with the disappearance of the tailor as a skilled craftsman. The first step was for a garment, such as a coat, to be completed by the joint efforts of a family. Then followed the "task system," which in America was the result of the influx of Russian Jews that began about 1875. Under it a team of three men, with a "presser" and a girl to sew on the buttons, divided the work between them. Payment was made by the "task," *i.e.* a specified number of garments, the money being divided between the members of the team in certain proportions. Often several teams would be run by a contractor, who naturally selected the cheapest workshops he could find and packed them as full of workers as possible; and when through stress of competition he had to accept lower prices the plan he adopted was to increase the number of garments to a task, leaving the pay unaltered. The result was the introduction of many of the worst features of the "sweating system," the workers having to work excessively long hours in order to finish the task, which in some cases meant as many as twenty coats a day. In the "factory" or "Boston" system the subdivision is still more minute, and as many as one hundred persons may be concerned in the production of one coat. The amount of tailoring skill required in a worker is even further reduced, but the premises come under the regulation of the factory laws. The factory system has also cheapened production in a legitimate way, because it has enabled mechanical power for driving sewing-machines, and also expensive labour-saving machinery, to be introduced to an extent not economically possible in small shops.

TAIN, a royal and police burgh of the county of Ross and Cromarty, Scotland. Pop. (1901) 2076. It is situated on rising ground within a mile of the southern shore of Dornoch Firth, 25½ m. N.E. of Dingwall by the Highland Railway. The name, of which the Tene, Tayne and Thane are older forms, is derived from the Icelandic *thing*, "assembly" or "court." Among the principal buildings are the town hall, court house, public hall, Easter Ross combination poorhouse, and the academy (opened in 1812). The industries include distilling, the making of aerated waters, and woollen manufactures, and the town is important as a market and distributing centre. The rainfall is one of the lowest in the kingdom. Duthac (locally called Duthus), a saint of the 11th century, is believed to have been a native, and the old ruined chapel near the station is supposed to have been his shrine. To the collegiate church of St Duthus, a Decorated building, founded by James III. in 1471, James IV. made several pilgrimages in penance for his father's death. The building was used as the parish church till 1815, when it fell into disrepair, but it was restored between 1871 and 1876. It has monuments to Patrick Hamilton, the martyr, and Thomas Hog (1628–1692), the Scottish divine, for some time a prisoner on the Bass. Three and a half miles S.E. are the remains of the Early English abbey of Fearn, founded at Edderton in 1230 by Farquhar, 1st earl of Ross, and transferred hither in 1338. The chancel, nave and two side chapels exist, and it still serves as the parish church. Patrick Hamilton became titular abbot in 1517, and after his martyrdom the abbey was added to the bishopric of Ross.

TAINE, HIPPOLYTE ADOLPHE (1828–1893), French critic and historian, the son of Jean Baptiste Taine, an attorney, was born at Vouziers on the 21st of April 1828. He remained with his father until his eleventh year, receiving instruction from him, and attending at the same time a small school which was under the direction of M. Pierson. In 1839, owing to the serious illness of his father, he was sent to an ecclesiastical pension at Rethel, where he remained eighteen months. J. B. Taine died on the 8th of September 1840, leaving a moderate competence to his widow, his two daughters, and his son. In the spring of 1841 Taine was sent to Paris, and entered as a boarder at the Institution Mathé, where the pupils attended the classes of the Collège Bourbon. Madame Taine followed her son to Paris. Taine was not slow to distinguish himself at school. When he was but fourteen years old he had already drawn up a systematic scheme of study, from which he never deviated. He allowed himself twenty minutes' playtime in the afternoon and an hour's music after dinner; the rest of the day was spent in work. In 1847, as *vétéran de rhétorique*, he carried off six first prizes in the general competition, the prize of honour, and three accessits; he won all the first school prizes, the three science prizes, as well as two prizes for dissertation. It was at the Collège Bourbon that he formed lifelong friendships with several of his schoolfellows who afterwards were to exercise a lasting influence upon him: among these were Prévost-Paradol, for many years his most intimate friend; Planat, the future "Marcelin" of the *Vie Parisienne*; and Cornélis de Witt, who introduced him to Guizot when the latter returned from England in 1846.

Public education was the career which seemed to lie open to Taine after his remarkable school successes. In 1848 he accordingly took both his *baccalauréat* degrees, in science and letters, and passed first into the École Normale; among his rivals, who passed in at the same time, were About, Sarcey, Libert, and Suckau. Among those of Taine's fellow-students who afterwards made a name in teaching, letters, journalism, the theatre and politics, &c., were Challemel-Lacour, Chassang, Aubé, Perraud, Ferry, Weiss, Yung, Gaucher, Gréard, Prévost-Paradol and Levasseur. Taine made his influence felt among them at once; he amazed everybody not only by his erudition, but by his indefatigable energy; and not only by his prodigious industry, but by his facility both in French and Latin, in verse as well as in prose. He devoured Plato, Aristotle, the Fathers of the Church, and he analysed and classified all that he read. He already knew English, and set himself to master German in order to read Hegel in the original. His brief leisure was devoted to music. The teachers of his second and third years, Deschanel, Géruzez, Berger, Havet, Filon, Saisset and Simon, were unanimous in praising the nobility of his character, the vigour and the fertility of his intellect, the distinction of style with which his work was always stamped; they were equally unanimous in finding fault with his unmeasured taste for classification, abstraction and formula. The director of studies, M. Vacherot, gauged his capacity at the end of his second year with prophetic insight. He prophesied that Taine would be a great savant, adding that he was not of this world, and that Spinoza's motto, "Vivre pour penser," would also be his. In the month of August 1851 he came forward as a candidate for the fellowship in philosophy (*agrégation de philosophie*) in company with his friends Suckau and Cambier. Taine was declared to be admissible, together with five other candidates; but in the end only two candidates were admitted, his friend Suckau and Aubé. This decision created almost a scandal. Taine's reputation had already spread beyond the college. Everybody had taken for granted that he would be admitted first. The fact was that his examiners sincerely considered his ideas to be absurd, his style and method of handling a subject dry and tiresome.

The Minister of Public Instruction, however, judged Taine less severely, and appointed him provisionally to the chair of philosophy at the college of Toulon on 6th October 1851; but he never entered upon his duties, as he did not wish to be so far from his mother, and on 13th October he was transferred to Nevers as a substitute. Two months later, on the 27th December, occurred the *coup d'état*, after which every university professor was regarded with suspicion; many were suspended, others resigned. In Taine's opinion it was the duty of every man, after the plébiscite of the 10th December, to accept the new state of affairs in silence; but the universities were not only asked for their submission, but also for their approbation. At Nevers they were requested to sign a declaration expressing their gratitude towards the President of the Republic for the measures he had taken. Taine was the only one to refuse his endorsement. He was at once marked down as a revolutionary, and in spite of his success as a teacher and of his popularity among his pupils, he was transferred on 29th March 1852 to the lycée of Poitiers as professor of rhetoric, with a sharp warning to be careful for the future. Here, in spite of an abject compliance with the stringent rules imposed upon him, he remained in disfavour, and on 25th September 1852 he was appointed assistant professor of the sixth class at the lycée of Besançon. This time he could bear it no longer, and he applied for leave, which was readily granted him on 9th October 1852, and renewed every year till his decennial appointment came to an end. It was in this painful year, during which Taine worked harder than ever, that the fellowship of philosophy was abolished. As soon as Taine heard of this he at once began to prepare himself for the fellowship in letters, and to work hard at Latin and Greek themes. On 10th April 1852 a decree was published by which three years of preliminary study were necessary before a candidate could compete for the fellowship, but by which a doctor's degree in letters counted as two years. Taine immediately set to work at his dissertations for the doctor's degree; on the 8th June (1852) they were finished, and 150 pages of French prose on the Sensations and a Latin essay were sent to Paris. On the 15th July he was informed that the tendency of his Essay on the Sensations made it impossible for the Sorbonne to accept it, so for the moment he laid this work aside, and on 1st August he began an essay on La Fontaine. He then started for Paris, where an appointment which was equivalent to a suspension awaited him. His university career was over, and he was obliged to devote himself to letters as a profession. In a few months his two dissertations, *De personis Platonicis* and the essay on La Fontaine's fables were finished, and on 30th May 1853 he took his doctor's degree. This was the last act of his university career; his life as a man of letters was now to begin.

No sooner had he deposited his dissertations at the Sorbonne than he began to write an essay on Livy for one of the competitions set by the Academy. Here again the moral tendency of his work excited lively opposition, and after much discussion the competition was postponed till 1855; Taine toned down some of the censured passages, and the work was crowned by the Academy in 1855. The essay on Livy was published in 1856 with the addition of a preface setting forth determinist doctrines, much to the disgust of the Academy. In the beginning of 1854 Taine, after six years of uninterrupted efforts, broke down and was obliged to rest: but he found a way of utilizing his enforced leisure; he let himself be read to, and for the first time his attention was attracted to the French Revolution; he acquired also a knowledge of physiology in following a course of medicine. In 1854 he was ordered for his health to the Pyrenees, and Hachette, the publisher, asked him to write a guide-book of the Pyrenees. Taine's book was a collection of vivid descriptions of nature, historical anecdotes, graphic sketches, satirical notes on the society which frequents watering-places, and underlying the whole book was a vein of stern philosophy; it was published in 1855.

The year 1854 was an important one in the life of Taine. His enforced leisure, the necessity of mixing with his fellow-men, and of travelling, tore him from his cloistered existence and brought him into more direct contact with reality. His method of expounding philosophy underwent a change. Instead of employing the method of deduction, of starting with the most abstract idea and following it step by step to its concrete realization, henceforward he starts from the concrete reality and proceeds through a succession of facts until he arrives at the central idea. His style also became vivid and full of colour; he shows that he is acutely sensible to the outward manifestations of things and depicts them in all their relief. Simultaneously with this change in his works his life became less self-centred and solitary. He lived with his mother in the Isle Saint-Louis, and now he once more associated with his old friends, Planat, Prévost-Paradol and About. He made the acquaintance of Renan, and through Renan that of Sainte-Beuve, and he renewed friendly relations with M. Havet, who for three months had been his teacher at the École Normale. These years (1855–56) were Taine's periods of greatest activity and happiness in production. On 1st February 1855 he published an article on La Bruyère in the *Revue de l'Instruction Publique*. In the same year he published seventeen articles in this review and twenty in 1856 on the most diverse subjects, ranging from Menander to Macaulay. On 1st August 1855 he published a short article in the *Revue des Deux Mondes* on Jean Reynaud. On 3rd July 1856 appeared his first article in the *Débats* on Saint-Simon, and from 1857 onwards he was a constant contributor to that journal. But he was seeking a larger field. On 17th January 1856 his history of English literature was announced, and from 14th January 1855 to 9th October 1856 he published in the *Revue de l'Instruction Publique* a series of articles on the French philosophers of the 19th century, which appeared in a volume at the beginning of 1857. In this volume he energetically attacked the principles which underlie the philosophy of Victor Cousin and his school with an irony which amounts at times to irreverence. The book closes with the sketch of a system in which the methods of the exact sciences are applied to psychological and metaphysical research. The work itself met with instantaneous success, and Taine became famous. Up till that moment the only important articles on his work were an article by About on the *Voyage aux Pyrénees*,[1] and two articles by Guizot on his *Livy*.[2] After the publication of *Les Philosophes Français*, the articles of Sainte-Beuve in the *Moniteur* (9th and 16th March 1856), of Sherer[3] in the *Bibliothèque Universelle* (1858), and of Planche in the *Revue des Deux Mondes* (1st April 1857) show that from this moment he had taken a place in the front rank of the new generation of men of letters. Caro published an attack on Taine and Renan, called "L'Idée de Dieu dans une Jeune École," in the *Revue Contemporaine* of 15th June 1857. Taine answered all attacks by publishing new books. In 1858 appeared a volume of *Essais de Critique et d'Histoire*; in 1860 *La Fontaine et ses Fables*, and a second edition of his *Philosophes Français*. During all this time he was persevering at his history of English literature up to the time of Byron. It was from that moment that Taine's influence began to be felt; he was in constant intercourse with Renan, Sainte-Beuve, Sherer, Gautier, Flaubert, Saint-Victor and the Goncourts, and gave up a little of his time to his friends and to the calls of society. In 1862 Taine came forward as a candidate for the chair of literature at the Polytechnic School, but M. de Loménie was elected in his place.

The following year, however, in March, Marshal Randon, Minister of War, appointed him examiner in history and German to the military academy of Saint Cyr, and on 26th October 1864 he succeeded Viollet-le-Duc as professor of the history of art and æsthetics at the École des Beaux Arts. Renan's appointment at the Collège de France and Taine's candidature for the Polytechnic School had alarmed Mgr. Dupanloup, who in 1863 issued an *Avertissement à la Jeunesse et aux Pères de Famille*, which consisted of a violent attack upon Taine, Renan and Littré: Renan was suspended, and Taine's appointment to Saint Cyr would have been cancelled but for the intervention of the Princess Mathilde. In December 1863 his *Histoire de la Littérature Anglaise* was published, prefaced by an introduction in which Taine's determinist views were developed in the most uncompromising fashion. In 1864 Taine sent this work to the Academy to compete for the Prix Bordin. M. de Falloux and Mgr. Dupanloup attacked Taine with violence; he was warmly defended by Guizot: finally, after three days of discussion, it was decided that as the prize could not be awarded to Taine, it should not be awarded at all. This was the last time Taine sought the suffrages of the Academy save as a candidate, in which quality he appeared once in 1874 and failed to be elected, Mézières, Caro and Dumas being the rival candidates; and twice in 1878, when, after having failed in May, H. Martin being chosen, he was at last elected in November in place of M. Loménie. In 1866 he received the Legion of Honour, and on the conclusion of his lectures in Oxford on Corneille and Racine, the University conferred upon him (1871) its degree of D.C.L.

The period from 1864 to 1870 was perhaps the happiest of Taine's life. He derived pleasure from his employment at the Beaux Arts and Saint Cyr, which left ample leisure for travel and research. In 1864 he spent February to May in Italy, which furnished him with several articles for the *Revue des Deux Mondes* from December 1864 to May 1866. In 1865 appeared *La Philosophie de l'Art*, in 1867 *L'Idéal dans l'Art*, followed by essays on the philosophy of art in the Netherlands (1868), in Greece (1869), all of which short works were republished later (in 1880) as a work on the philosophy of art. In 1865 he published his *Nouveaux Essais de Critique et d'Histoire*; from 1863 to 1865 appeared in *La Vie Parisienne* the notes he had taken for the past two years on Paris and on French society under the sub-title of "Vie et Opinions de Thomas Frédéric Graindorge," published in a volume in 1867, the most personal of his books, and an epitome of his ideas. In 1867 appeared a supplementary volume to his history of English literature, and in January 1870 his *Théorie de l'Intelligence*. In 1868 he married Mademoiselle Denuelle, the daughter of a distinguished architect.

He had made a long stay in England in 1858, and had brought back copious notes, which, after a second journey in 1871, he published in 1872 under the title of *Notes sur l'Angleterre*. On 28th June 1870 he started to visit Germany, but his journey was abruptly interrupted by the outbreak of the war; his project had to be abandoned, and Taine, deeply shaken by the events of 1870, felt that it was the duty of every Frenchman to work solely in the interests of France. On 9th October 1870 he

[1] *Revue de l'Instruction Publique*, 29th May 1856.
[2] *Débats*, 26th and 27th January 1857.
[3] Reprinted in *Mélanges de Critique Religieuse*.

published an article on "L'Opinion en Allemagne et les Conditions de la Paix," and in 1871 a pamphlet on *Le Suffrage Universel;* and it was about this time also that the more or less vague ideas which he had entertained of writing on the French Revolution returned in a new and definite shape. He determined to trace in the Revolution of 1789 the reason of the political instability from which modern France was suffering. From the autumn of 1871 to the end of his life his great work, *Les Origines de la France Contemporaine*, occupied all his time, and in 1884 he gave up his professorship in order to devote himself wholly to his task; but he succumbed before it was finished, dying in Paris on 5th March 1893. In the portion of the work which remained to be finished Taine had intended to draw a picture of French society and of the French family, and to trace the development of science in the 19th century. He had also planned a complementary volume to his *Théorie de l'Intelligence*, to be entitled *Un Traité de la Volonté.*

The *Origines de la France Contemporaine*, Taine's monumental achievement, stands apart from the rest of his work. His object was to explain the existing constitution of France by studying the more immediate causes of the present state of affairs—the last years of what is called the *Ancien Régime*, the Revolution and the beginning of the 19th century, to each of which several volumes were assigned. He also had another object, although he was perhaps hardly conscious of it, which was to study man in one of his pathological crises; for Taine makes an investigation into human nature, and the historian checks and endorses the pessimism and misanthropy of Graindorge. The problem which Taine set himself was to inquire why the centralization of modern France is so great that all individual initiative is practically non-existent, and why the central power, whether it be in the hands of a man or of an assembly, is the sole and only power; also to expose the error underlying two prevalent ideas:—(1) That the Revolution destroyed absolutism and set up liberty; the Revolution, he points out, merely caused absolutism to change hands. (2) That the Revolution destroyed liberty instead of establishing it; that France was less centralized before 1789 than after 1800. This also he shows to be untrue. France was already a centralized country before 1789, and grew rapidly more and more so from the time of Louis XIV. onwards. The Revolution merely gave it a new form.

The *Origines* differ from the rest of Taine's work in that, although he applies to a period of history the method which he had already applied to literature and the arts, he is unable to approach his subject in the same spirit; he loses his philosophic calm; he cannot help writing as a man and a Frenchman, and he lets his feelings have play; but what the work loses thus in impartiality it gains in life.

Taine was the philosopher of the epoch which succeeded the era of romanticism in France. The romantic era had lasted from 1820 to 1850. It had been the result of a reaction against the classical school, or rather against the conventionality and lifeless rules of this school in its decadence. The romantic school introduced the principle of individual liberty both as regards matter and style; it was a brilliant epoch, rich in men of genius and fruitful of beautiful work, but towards 1850 it had reached its decline, and a young generation, tired in turn of its conventions, its hollow rhetoric, its pose of melancholy, arose, armed with new principles and fresh ideals. Their ideal was truth; their watchword liberty; to get as near as possible to scientific truth became their object. Taine was the mouthpiece of this period, or rather one of its most authoritative spokesmen.

Many attempts have been made to apply one of Taine's favourite theories to himself, and to define his predominant and preponderant faculty. Some critics have held that it was the power of logic, a power which was at the same time the source of his weakness and of his strength. He had a passion for abstraction. "Every man and every book," he said, "can be summed up in three pages, and those three pages can be summed up in three lines." He considers everything as a mathematical problem, whether it be the universe or a work of art: "C'est beau comme un syllogisme," he said of a sonata of Beethoven. Taine's theory of the universe, his doctrine, his method of writing criticism and history, his philosophical system, are all the result of this logical gift, this passion for reasoning, classification and abstraction. But Taine's imaginative quality was as remarkable as his power of logic; hence the most satisfactory definition of Taine's predominating faculty would be one which comprehended the two gifts. M. Lemaître gave us this definition when he called Taine a *poète-logicien;* M. Bourget likewise when he spoke of Taine's *imagination philosophique*, and M. Barrès when he said that Taine had the power of dramatizing abstractions. For Taine was a poet as well as a logician; and it is possible that the portion of his work which is due to his poetic and imaginative gift may prove the most lasting.

Taine's doctrine consisted in an inexorable determinism, a negation of metaphysics; as a philosopher he was a positivist. Enamoured as he was of the precise and the definite, the spiritualist philosophy in vogue in 1845 positively maddened him. He returned to the philosophy of the 18th century, especially to Condillac and to the theory of transformed sensation. Taine presented this philosophy in a vivid, vigorous and polemical form, and in concrete and coloured language which made his works more accessible, and consequently more influential, than those of Auguste Comte. Hence to the men of 1860 Taine was the true representative of positivism.

Taine's critical work is considerable; but all his works of criticism are works of history. Hitherto history had been to criticism as the frame is to the picture; Taine reversed the process, and studied literary personages merely as specimens and productions of a certain epoch. He started with the axiom that the complete expression of a society is to be found in its literature, and that the way to obtain an idea of a society is to study its literature. The great writer is not an isolated being; he is the result of a thousand causes; firstly, of his race; secondly, of his environment; thirdly, of the circumstances in which he was placed while his talents were developing. Hence Race, Environment, Time—these are the three things to be studied before the man is taken into consideration. Taine completed this theory by another, that of the *predominating faculty*, the *faculté maîtresse.* This consists in believing that every man, and especially every great man, is dominated by one faculty so strong as to subordinate all others to it, which is the centre of the man's activity and leads him into one particular channel. It is this theory, obviously the result of his love of abstraction, which is the secret of Taine's power and of his deficiencies. He always looked for this salient quality, this particular channel, and when he had once made up his mind what it was, he massed up all the evidence which went to corroborate and to illustrate this one quality, and necessarily omitted all conflicting evidences. The result was an inclination to lay stress on one side of a character or a question to the exclusion of all others.

Taine served science unfalteringly, without looking forward to any possible fruits or result. In his work we find neither enthusiasm nor bitterness, neither hope nor yet despair; merely a hopeless resignation. The study of mankind was Taine's incessant preoccupation, and he followed the method already described. He made a searching investigation into humanity, and his verdict was one of unqualified condemnation. In "Thomas Graindorge" we see him aghast at the spectacle of man's brutality and woman's folly. In man he sees the primeval savage, the gorilla, the carnivorous and lascivious animal, or else the maniac with diseased body and disordered mind, to whom health, either of mind or body, is but an accident. Taine is appalled by the *bête humaine;* and in all his works we are conscious, as in the case of Voltaire, of the terror with which the possibilities of human folly inspire him. It may be doubted whether Taine's system, to which he attached so much importance, is really the most lasting part of his work, just as it may be doubted whether a sonata of Beethoven bears any resemblance to a syllogism. For Taine was an artist as well as a logician, an artist who saw and depicted what he saw in vital and glowing language. From the artist we get his essay on La Fontaine, his articles on Balzac and Racine, and the passages on Voltaire and Rousseau in the *Ancien Régime*. Moreover, not only was Taine an artist who had not escaped from the influence of the romantic tradition, but he was by his very method and style a romanticist. His emotions were deep if not violent, his vision at times almost lurid. He sees everything in startling relief and sometimes in exaggerated outline, as did Balzac and Victor Hugo. Hence his predilection for exuberance, strength and splendour; his love of Shakespeare, Titian and Rubens; his delight in bold, highly-coloured themes.

Taine's influence was great, and twofold. On his own generation it was considerable; during the epoch in which he lived, while a wave of pessimism was sweeping over French literature, he was the high priest of the cult of misanthropy, in which even science was held to be but an idol, worthy of respect and devotional service, but not of faith. In its turn came the reaction against positivism and pessimism, and an attempt at spiritual renascence. Around a man so remarkable as Taine a school is certain to form itself; Taine's school, which was one of positivist doctrines, rigid systems and resigned hopelessness, was equally certain to produce at some time or another a school of determined opponents to its doctrines and system. If, therefore, the tone which pervades the works of Zola, Bourget and Maupassant can be immediately attributed to the influence we call Taine's, it is also the influence of Taine which is one of the ultimate causes of the protest embodied in the subsequent reaction.

(M. Ba.)

Bibliography.—The official life, *H. Taine, sa vie et sa correspondance*, was published in 3 vols. in 1902–5 (Eng. trans. by Mrs. R. L. Devonshire, 1902–8). His friend, M. E. Boutmy, published an appreciative study of Taine's philosophy in his *Taine, Scherer, Laboulaye* (Paris, 1901). See also A. Sorel, *Nouveaux essais d'histoire et de critique* (1898); Gabriel Monod, *Les Maîtres de l'histoire* (Paris, 1894); Émile Faguet, *Politiques moralistes au XIXe siècle* (Paris, 1900); P. Lacombe, *La psychologie des individus et des sociétés chez Taine* (1906); P. Nève, *La philosophie de Taine* (1908); and especially Victor Giraud, *Essai sur Taine, son œuvre et son influence, d'après des documents inédits* (2nd ed., 1902); V. Giraud, *Bibliographie de Taine* (Paris, 1902). A comprehensive list of books and articles on Taine is given in H. P. Thieme's *Guide bibliographique de la littérature française de* 1800 *à* 1906 (Paris, 1907). More recently, Taine's historical work has been adversely criticized, especially by A. Aulard in lectures delivered at the Sorbonne in 1905–6 and 1906–7 (*Taine, historien de la révolution française*, 1907), devoted to destructive criticism of Taine's work on the French Revolution.

TAIREN, or Dairen (Russian *Dalny*), a free port created by the Russian government and opened to foreign trade in 1901, situated on the Central Manchurian railway, and thus one of the Pacific termini of the Trans-Siberian railway. It stands at the head of Talien-wan Bay, on the east side of Liao-tung peninsula, in Manchuria, about 20 m. N.E. of Port Arthur. The harbour is roomy, easy of entrance, and free from ice all the year round. The town is situated along the front of the harbour and occupies the slope leading up to the hills at the rear. It is designed to accommodate 30,000 inhabitants and is separated from the Chinese quarter by a large natural park. The climate is temperate and healthy. Tairen is provided with wharves to accommodate the largest ocean steamers, the wharves having a vertical face with 28 ft. depth at low water. The area of the port is 132 acres, and the inner harbour is protected by a stone and concrete breakwater 5950 ft. long. At an early period in the Russo-Japanese war (28th of May 1904), Dalny was occupied by the Japanese after slight resistance.

TAIT, ARCHIBALD CAMPBELL (1811–1882), Anglican divine, archbishop of Canterbury, was born at Edinburgh on the 21st of December 1811. His parents were Presbyterians, but he early turned towards the Scottish Episcopal Church, and was confirmed in his first year at Oxford, having entered Balliol College in October 1830 as a Snell exhibitioner from the University of Glasgow. He won an open scholarship, took his degree with a first-class *in literis humanioribus* (1833), and became fellow and tutor of Balliol; he was also ordained deacon (1836) and priest (1838), and served the curacy of Baldon. Rapid changes among the fellows found him at the age of twenty-six "the senior and most responsible of the four Balliol tutors." The experience gained during this period stood him in good stead afterwards as a member of the first Oxford University Commission (1850–52). He never sympathized with the principles of the Tractarian movement, and on the appearance of Tract XC. in 1841 he drafted the famous protest of the "Four Tutors" against it; but this was his only important contribution to the controversy. On the other hand, although his sympathies were on the whole with the liberal movement in the university, he never took a lead in the matter. In 1842 he became an undistinguished but useful successor to Arnold as headmaster of Rugby; and a serious illness in 1848, the first of many, led him to welcome the comparative leisure which followed upon his appointment to the deanery of Carlisle in 1849. His life there, however, was one of no little activity; he served on the University Commission, he restored his cathedral, and did much excellent pastoral work. There too he suffered the great sorrow of his life. He had married Catharine Spooner at Rugby in 1843; in the spring of 1856, within five weeks, five of their children were carried off by virulent scarlet fever. Not long afterwards he was consecrated bishop of London on the 22nd of November 1856, as successor to C. J. Blomfield. His translation to Canterbury in 1868 (he had refused the archbishopric of York in 1862) constituted a recognition of his work, but made no break in it. His last years were interrupted by illness and saddened by the death in 1878 of his only son Craufurd, and of his wife.

If Blomfield had almost remodelled the idea of a bishop's work, his successor surpassed him. Tait had all Blomfield's earnestness and his powers of work, with far wider interests. Blomfield had given himself zealously to the work of church-building; Tait followed in his steps by inaugurating (1863) the Bishop of London's Fund. He devoted a very large part of his time at London in actual evangelistic work; and to the end his interest in the pastoral side of the work of the clergy was greater than anything else. With his wife, he was instrumental in organizing women's work upon a sound basis, and he did not a little for the healthful regulation of Anglican sisterhoods during the formative period in which this was particularly necessary. Nor was he less successful in the larger matters of administration and organization, which brought into play his sound practical judgment and strong common-sense. He was constant in his attendance in parliament, and spared no pains in pressing on measures of practical utility. The modification of the terms of clerical subscription (1865), the new lectionary (1871), the Burials Act (1880) were largely owing to him; for all of them, and especially the last, he incurred much obloquy at the time. The Royal Commissions on Ritual (1867) and on the Ecclesiastical Courts (1881) were due to him, and he took a large part in the deliberations of both. Probably his successor (see Benson, E. W.) was brought into closer relations with the colonial churches than Tait was; but the healthy development of the Lambeth Conferences on the lines of mutual counsel rather than of a hasty quasi-synodic action was largely due to him.

On the other hand, Tait was not successful in dealing with matters which called for the higher gifts of a ruler, and especially in his relations with (*a*) the liberal trend in modern thought, and (*b*) the Catholic revival. (*a*) As regards the former, he was himself not a little in sympathy with it. But although well-read, he was no scholar in the true sense, and had neither the knowledge to feel sure of his ground nor the theological insight to perceive the real point at issue. His object in dealing with questions of faith, as in dealing with the ritual question, was primarily a practical one: he wished to secure peace, and obedience to the law as he saw it. Consequently, after his sympathies had led him to express himself favourably towards some movement, he frequently found himself compelled to draw back. He expressed a qualified sympathy with some of the writers of *Essays and Reviews*, and then joined in the censure of it by the bishops (1861). The same kind of apparent vacillation was found in his action in other cases; *e.g.*, in the Colenso case

(1863), and in the controversy as to the use or disuse of the Athanasian symbol (1872). It was naturally and widely misunderstood. Some who did not know him thought, or pretended to think, that he was a Socinian or a free-thinker. The world at large knew better; but even Temple warned him, in the case of *Essays and Reviews*, "You will not keep friends if you compel them to feel that in every crisis of life they must be on their guard against trusting you." (*b*) As regards the second point, Tait was concerned with it during the whole of his episcopate, and above all on the side of ritual, on which it naturally came into most direct conflict with the recognized ecclesiastical practice of the day. He had to deal with the St George's-in-the-East riots in 1859, and the troubles at St Alban's, Holborn, in their earlier stages (1867); he took part as assessor in the Privy Council judgment in the Ridsdale case (1877); he was more closely concerned than any other bishop with the agitation against confession in 1858, and again in 1877. His method throughout was the same: he endeavoured to obtain a compliance to the law as declared by the courts; failing this, he made the most earnest efforts to secure obedience to the ruling of the Ordinary for the sake of the peace of the Church; after this, he could do nothing. He did not perceive how much of reason the "ritualists" had on their side: that they were fighting for practices which, they contended, were covered by the letter of the rubric; and that, where rubrics were notoriously disregarded on all hands, it was not fair to proceed against one class of delinquent only. In fact, if others were inclined to ignore it altogether, Tait could hardly realize anything but the connexion between the English Church and the State. From such a position there seemed to be no escape but in legislation for the deprivation of the recalcitrant clergy; and the Public Worship Regulation Act (1874) was the result. For this Tait was by no means responsible as a whole: some of the provisions which proved most irksome were the result of amendments by Lord Shaftesbury which the bishops were unable to resist; and it must be borne in mind that the most disastrous results of the measure were not contemplated by those who were instrumental in passing it. The results followed inevitably: clergy were cited before a new tribunal, and not only deprived but imprisoned. A widespread feeling of indignation spread not only among High Churchmen, but among many who cared little or nothing for the ritual practices involved; and it seemed impossible to foretell what the outcome would be. But the aged archbishop was moved as much as anybody, and tried hard to mitigate such a state of things. At length, when the Rev. A. H. Mackonochie was on the point of being deprived of his benefice of St. Alban's, Holborn, for contumacy, the archbishop, then on his deathbed at Addington, took steps which resulted in the carrying out of an exchange of benefices (which had already been projected), which removed him from the jurisdiction of the court. This proved to be the turning-point; and although the ritual difficulty by no means ceased, it was afterwards dealt with from a different point of view, and the Public Worship Regulation Act became practically obsolete. The archbishop died on the 3rd of December (Advent Sunday), 1882, leaving a legacy of peace to the Church.

Tait was a Churchman by conviction; but although the work of his life was all done in England, he remained a Scotsman to the end. It was the opinion of some that he never really understood the historical position of the English Church and took no pains to learn. John Tillotson, one of his predecessors in the archbishopric, was a favourite hero of his, and in some ways the two men resembled one another. But Tait had none of Tillotson's gentleness, and he rode roughshod over the obstacles in his way. He cannot be called a great ecclesiastical statesman, but he administered his office well and was undoubtedly one of the foremost public men of his day.

See R. T. Davidson and D. Benham, *Life of Archbishop Tait*, 2 vols. (1891); A. C. Tait, *Catharine and Craufurd Tait* (1880). (W. E. Co.)

TAIT, ARTHUR FITZWILLIAM (1819–1905), American artist, was born near Liverpool, England, on the 5th of August 1819. He emigrated to the United States in 1850, and was identified with the art life of New York until his death. In 1858 he was elected to full membership in the National Academy of Design, New York. He died at Yonkers, New York, on the 28th of April 1905. He painted barnyard fowls and wild birds as well as sheep and deer, with great dexterity, and reproductions of his minute panels of chickens had an enormous vogue.

TAIT, PETER GUTHRIE (1831–1901), Scottish physicist, was born at Dalkeith on the 28th of April 1831. After attending the Academy at Edinburgh and spending a session at the University, he went up to Cambridge as a member of Peterhouse, and graduated as senior wrangler and first Smith's prizeman in 1852. As a fellow and lecturer of his college he remained in Cambridge for two years longer, and then left to take up the professorship of mathematics at Queen's College, Belfast. There he made the acquaintance of Thomas Andrews, whom he joined in researches on the density of ozone and the action of the electric discharge on oxygen and other gases, and by whom he was introduced to Sir W. R. Hamilton and quaternions. In 1860 he was chosen to succeed his old master, J. D. Forbes, as professor of natural philosophy at Edinburgh, and this chair he occupied till within a few months of his death, which occurred on the 4th of July 1901, at Edinburgh. The first scientific paper that appears under Tait's name only was published in 1860. His earliest work dealt mainly with mathematical subjects, and especially with quaternions (*q.v.*), of which he may be regarded as the leading exponent after their originator, Hamilton. He was the author of two text-books on them—one an *Elementary Treatise on Quaternions* (1867), written with the advice of Hamilton, though not published till after his death, and the other an *Introduction to Quaternions* (1873), in which he was aided by Professor Philip Kelland (1808–1879), who had been one of his teachers at Edinburgh. In addition, quaternions was one of the themes of his address as president of the mathematical section of the British Association in 1871. But he also produced original work in mathematical and experimental physics. In 1864 he published a short paper on thermodynamics, and from that time his contributions to that and kindred departments of science became frequent and important. In 1871 he emphasized the significance and promise of the principle of the dissipation of energy. In 1873 he took thermoelectricity for the subject of his discourse as Rede lecturer at Cambridge, and in the same year he presented the first sketch of his well-known thermoelectric diagram before the Royal Society of Edinburgh. Two years later researches on "Charcoal Vacua" with J. Dewar led him to see the true dynamical explanation of the Crookes radiometer in the largeness of the free path of the molecule of the highly rarefied air. From 1879 to 1888 he was engaged on difficult experimental investigations, which began with an inquiry into the corrections required, owing to the great pressures to which the instruments had been subjected, in the readings of the thermometers employed by the "Challenger" expedition for observing deep-sea temperatures, and which were extended to include the compressibility of water, glass and mercury. Between 1886 and 1892 he published a series of papers on the foundations of the kinetic theory of gases, the fourth of which contained what was, according to Lord Kelvin, the first proof ever given of the Waterston-Maxwell theorem of the average equal partition of energy in a mixture of two different gases; and about the same time he carried out investigations into impact and its duration. Many other inquiries conducted by him might be mentioned, and some idea may be gained of his scientific activity from the fact that a selection only from his papers, published by the Cambridge University Press, fills three large volumes. This mass of work was done in the time he could spare from his professorial teaching in the university. In addition, he was the author of a number of books and articles. Of the former, the first, published in 1896, was on the dynamics of a particle; and afterwards there followed a number of concise treatises on thermodynamics, heat, light, properties of matter and dynamics, together with an admirably lucid volume of popular lectures on *Recent Advances in Physical Science*. With Lord Kelvin he collaborated in writing the well-known *Treatise on Natural Philosophy*. "Thomson and Tait," as it is familiarly called ("T and T′" was the authors' own formula), was planned soon after Lord Kelvin became acquainted with Tait, on the latter's appointment to his professorship in Edinburgh, and it was intended to be an all-comprehensive treatise on physical science, the foundations being laid in kinematics and dynamics, and the structure completed with the properties of matter, heat, light, electricity and magnetism. But the literary partnership ceased in about eighteen years, when only the first portion of the plan had been completed, because each of the members felt he could work to better advantage separately than jointly. The friendship, however, endured for the twenty-three years which yet remained of Tait's life.

Tait collaborated with Balfour Stewart in the *Unseen Universe*, which was followed by *Paradoxical Philosophy*. Among his articles may be mentioned those which he wrote for the ninth edition of this Encyclopaedia on Light, Mechanics, Quaternions, Radiation and Thermodynamics, besides the biographical notices of Hamilton and Clerk Maxwell.

TAJIK, or PARSIWAN, a subject race of Afghanistan. Underlying the predominant Pathan elements in the country, the Tajik (Tajak, or Tausik) represents the original Persian possessor of the soil, who still speaks his mother tongue and therefore calls himself Parsiwan. There are pure Persians in Afghanistan, such as the Kizilbashes of Kabul and the Naoshirwanis of Kharan; but the name Tajik (= "stranger") appears to be applied only to an admixture of original Arab and Persian stock, who are the slaves of the community—hewers of wood and drawers of water. Everywhere the Tajiks are the cultivators in rural districts, and the shopkeepers and clerks in the towns. They are a fine, athletic people, generally fair in complexion, and assimilate in aspect, in dress, and much in manners to the Afghans, but they are never nomadic. The Tajik is as much the slave of the Pathan in Afghanistan as is the Hindki (whose origin is similar) in the plains of the Indus. Yet the Tajik population of the richly-cultivated districts north of Kabul proved themselves to be of good fighting material in the Afghan war of 1879–80, and the few Kizilbashes that are to be found in the Indian army are brave soldiers. The number of the Tajiks in Afghanistan is estimated at 900,000.

The name itself originally occurs in the Pahlavi writings, and is explained to mean, first, the Arabs in general, then their descendants born in Persia and elsewhere out of Arabia, and, lastly, the Persians in general and their descendants born in Turkestan and elsewhere out of Persia. Tajik thus came to be the collective name of all communities of Iranian stock and Persian speech wherever found in Central Asia. These are co-extensive with the former eastward and northward limits of the Persian empire; but, after the ascendancy of the Turki races, they became the subject element in Turkestan, Afghanistan, Bokhara, Khiva, Kashgaria, while still politically dominant in Badakshan, Wakhan, Darwaz, Kost and Karateghin. In most of these places the Tajiks, with the kindred Galchas, seem to form the bulk of the population, the distinction being that "Tajik" is applied rather to the settled and more civilized lowlanders of modern Persian speech, "Galcha" to the highlanders of Ferghana, Kohistan, Wakhan, &c., who speak either archaic forms of Persian or dialects intermediate between the Iranian and Sanskritic branches of the Indo-European linguistic family.

But, although mainly of Iranian stock, with light complexion and regular features, the Tajiks claim Arab descent, regarding the district about Bagdad as their primeval home, and considering themselves the descendants of the Arabs who overran Central Asia in the first century of the Hejira. At the same time, "it is evident that the inhabitants of the greater part of this region (Central Asia) must from an early period have come in contact with the successive waves of Turkish (Tûrki) and even Mongol population which broke over them; accordingly we find that, although the type is essentially Iranian, it has undergone a certain modification" (Capt. J. M. Trotter, *Bokhâra*, p. 169). The term Tajik must be distinguished from *Sarte*, the latter simply meaning "trader" or "shopkeeper," and being applied indiscriminately to the settled as opposed to the nomad element, and especially to the urban populations, of whatever race, in Central Asia. The Tajiks are known as Tâts on the west side of the Caspian (Baku, Lenkoran, &c.).

TAKHTSINGJI (1858–1896), Maharaja of Bhaunagar, a Rajput chief of the Gohel clan, and the ruler of a state in Kathiawar, was born on the 6th of January 1858, and succeeded to the throne of Bhaunagar on the death of his father, Jaswantsingji, in 1870. During his minority, which ended in 1878, he was educated at the Rajkot college and afterwards under an English officer, while the administration of the state was conducted jointly by Mr. E. H. Percival, a member of the Indian Civil Service, and Azam Gowrishankar Yodeyshankar, C.S.I., one of the foremost native statesmen of India, who had served the state in various capacities since 1822. At the age of twenty Takhtsingji found himself the ruler of a territory nearly 3000 square miles in extent. His first public act was to sanction a railway connecting his territory with one of the main trunk lines, which was the first enterprise of its kind on the part of a raja in western, if not in all, India. The commerce and trade, and the economic and even social development of the state, which came in the wake of this railway, confirmed Takhtsingji in a policy of progressive administration, under which educational establishments, hospitals and dispensaries, trunk roads, bridges, handsome edifices and other public works grew apace. In 1886 he inaugurated a system of constitutional rule, by placing several departments in the hands of four members of a council of state under his own presidency. This innovation, which had the warm support of the governor of Bombay, Lord Reay, provoked a virulent attack upon the chief, who brought his defamers to trial in the High Court of Bombay. The punishment of the ringleaders broke up a system of blackmailing to which rajas used to be regularly exposed, and the public spirit of Takhtsingji in freeing his brother chiefs from this evil was widely acknowledged throughout India, as well as by the British authorities. In 1886 he was created G.C.S.I.; and five years later his hereditary title of thakore was raised to that of maharaja. In 1893 he took the occasion of the opening of the Imperial Institute by Queen Victoria to visit England in order to pay personal homage to the sovereign of the British Empire, on which occasion the University of Cambridge conferred on him the degree of LL.D. He died in 1896. (M.M.BH.)

TAKIN, the Mishmi name of a remarkable hollow-horned ruminant (*Budorcas taxicolor*), the typical representative of which inhabits the Mishmi Hills, in the south-east corner of Tibet, immediately north of the Assam Valley, while a second form is found further east, in the Moupin district. The takin, which may be compared in size to a Kerry cow, is a clumsily built brute with yellowish-brown hair and curiously curved horns, which recall those of the South African white-tailed gnu. Its nearest relatives appear to be the serows of the outer Himalaya and the Malay countries, which are in many respects intermediate between goats and antelopes, but it is not improbably also related to the musk-ox (*q.v.*). As it lacks the thick woolly coat of the two Tibetan antelopes known as the chiru and the goa, there can be little doubt that it inhabits a country with a less severe climate than that of the Central Tibetan plateau, and it is probably a native of the more or less wooded districts of comparatively low elevation forming the outskirts of Tibet. It is remarkable for the shortness of the cannon-bones of the legs, in which it resembles the Rocky Mountain goat.

TAKLA MAKAN, the Central Asian desert which lies between the N. foot of the Kuen-lun ranges and the wide curve of the Tarim river on the W., N., and E. It appears to be naturally divisible into two parts by the river Khotan-darya, and the name applied to the western part between that river and the Yarkand-darya (Tarim) is the desert of Takla Makan proper, while the part between the Khotan-darya and the line of the lower Tarim and the Cherchen-darya is known as the desert of Cherchen. The former is occupied almost entirely by sand-dunes. Sand mountains range in altitude from 60 ft. up to as much as 300 ft. The only breaks in this "sea of sand-waves" are a few small patches of alluvial clay. Often two distinct systems of dunes can be distinguished; one system, consisting of the larger concatenations, stretches from E. to W., while the secondary or transverse dunes run from N. to S. or from N.E. to S.W. The steeper faces of the dunes and of the dune-accumulations are for the most part turned towards the S., the S.W. and the W., that is, invariably away from the direction of the prevailing winds; but in some parts the steep faces are those fronting the E. and the S. In the desert of Cherchen, however, where the general height of the dunes in the N.E. is uniformly greater than in the desert of Takla Makan proper, reaching up to 350 ft., the configuration is complicated by the appearance of elongated expanses of level clay called *bayirs*, varying in size from half a mile to a dozen miles in length, barren and tinged with saline deposits in the middle, with scanty vegetation around, and lofty sand-dunes overhanging them on both sides. These elliptical, cauldron-shaped basins all stretch from N.E. or E.N.E. to S.W. or W.S.W., and are arranged in long curving chains, the successive depressions being parted by transverse ridges of sand. They owe their configuration in great part, perhaps entirely, to the prevailing wind.

On perfectly level ground the dunes are crescentic in shape, have a steep face towards the W., are highest in the centre, and slope away in each direction towards the two horns or cusps of the crescent. On the windward side they have a convex, spoon-shaped slope, regularly formed, but crumpled by tiny sand-waves or ripple-marks. "With regard to the large accumulations of sand (in the desert of Cherchen) we have ascertained the following laws—(1) In the N. of the desert they turn their steep faces towards the N.W., in the middle towards the W.N.W., and in the S. towards the W. and W.S.W.; (2) their eastern slopes ascend rather slowly towards their crests; (3) on the other side their steep leeward faces go down sheer at an angle of 33°, or else in two or three steps; (4) their mass diminishes towards the S.; (5) they are each built up of an innumerable number of individual dunes; (6) although their relief is influenced by winds from other quarters than the predominant, their mass is unaffected by them; (7) it is their varying breadths which give rise originally to the thresholds, and consequently to the formation of the bayirs" (Sven Hedin, *op. cit.* i. 362).

The bayirs become progressively rarer, less distinct, and smaller in size as one advances from E. to W. At the same time the arrangement of the sand-dunes grows more and more irregular, and the dunes themselves plunge steeply down towards the W., the S., and the S.W., and are drawn out towards the N.N.E. and S.S.W., the N. and S. and the N.W. and S.E. In that part of the desert two systems of dunes are distinguishable, intersecting or rather crossing over one another diagonally or at right angles. In the extreme west, at Ordan-Padshah, between Kashgar and Yarkand, the dunes travel annually some 13 ft. towards the S.E., not towards the S.W. The principal cause of the difference between the arrangement of the sand-dunes in the desert of Cherchen and the arrangement of the sand-dunes in the desert of Takla Makan proper in the W. is the wind. In the latter, winds from several quarters co-operate to mould the relief of the desert into capricious and changing outlines; but in the E. the wind blows not only with greater regularity from one settled direction, the N.E. or E.N.E., but also with much greater violence. Indeed, it is in the open Lop country, where the mountains, the Kuruk-tagh on the N., and the Astin-tagh on the S., are the nearest to each other, that the wind develops its greatest and most concentrated energy.[1] In the E., where the sand waves are most exposed to the fiercest wind, they form elongated waves, distinctly outlined, corresponding to the breakers of the ocean. They disseminate themselves westwards over the desert in ever-widening concentric circles. The curving courses of the Tarim and the Koncheh-darya are the only check upon the invasion of the Takla Makan by the sand which is generated in the desert of Lop or further E. and N. in the mountains which girdle the desert of Gobi. But the former river is itself encroaching upon the N.E. margin of the desert, and pressing more and more towards the S.W.

With regard to the origin of the stupendous masses of sand that fill the basin of the Tarim, K. Bogdanovich considers them to consist for the most part of the disintegrated products of the fine-grained alluvial clays of the desert itself. On the other hand, G. N. Potanin and V. A. Obruchev both seek for its origin in the hard rocks of the mountains which encircle the deserts; and in this view, subject to certain modifications, Sven Hedin is disposed to agree. But he adds[2] that the masses of sand themselves "are derived from three separate sources, in part directly, in part indirectly—(1) the direct transportation by the wind of the products of disintegration from the adjacent mountains, whether sandstones or crystalline rocks; (2) through the activity of the wind operative amongst the arenaceous alluvia of the rivers and temporary lakes; (3) through the sand that was already present in the soil, and which became exposed in rings more or less concentric in proportion as the former (Central Asian Mediterranean) sea dried up." Of these agencies the river Tarim makes by comparison much the smallest contribution of disintegrated material to the volume of sand. The area covered by sands in the desert of Takla Makan proper is estimated at nearly 116,000 sq. m., and the area covered by them in the desert of Cherchen at nearly 143,000 sq. m.

[1] Sven Hedin, *op. cit.* i. 364.
[2] *Op. cit.* ii. 448.

Vegetation and animal life are extremely scarce. The former is practically confined to various steppe plants, *kamish* (reeds), tamarisks (almost invariably growing on root-mounds), and poplars. The animals are hares, rats and one or two other rodents, foxes, and in a few places the wild camel.

The climate is one of extremes. At Merket on the W. verge of the desert of Takla Makan proper the winters are cold, though the snowfall is small, while the summers are hot. In the desert of Cherchen a temperature of −22° F. has been observed in the depth of winter, and there snow sometimes falls heavily. During the sand-storms which sweep over the region in spring, the thermometer drops as much as 10° or 12° F. below zero. On the other hand, a temperature as high as 86° has been recorded in the end of April (cf. GOBI). It is only in winter that this appalling desert can be crossed with any degree of safety. It is destitute of water, but in winter it is possible to transport ice on the backs of camels. Sometimes for days together the desert is enveloped in an impenetrable dust-haze, which chokes and smothers every living creature. In the second half of the 13th century Marco Polo left a vivid description of this desert and related legends associated with it (see the edition of his travels in English by Sir H. Yule, ed. 1903). The fullest account by a modern writer is that given by Sven Hedin in his *Scientific Results of a Journey in Central Asia*, 1899–1902 (Stockholm, vols. i. and ii. 1905–6); see also his *Through Asia* (London, 1898), vol. i. For archaeology, see TURKESTAN. (J. T. BE.)

TALAING, more accurately called Môn, the name given to the remnant of the Peguan race, which for long strove with the Burmans for the ascendancy in what is now Burma. In the middle of the 18th century the Peguans were masters of the country from the Gulf of Martaban to far to the north of Mandalay. Now, however, the Talaing population is practically confined to the Tenasserim and Pegu divisions of Lower Burma, and even there it seems to be dying out. According to the census of 1901 they numbered only 321,898 persons, of whom 154,480 spoke the Talaing language. The Talaings are, historically, the most important representatives in Burma of the Môn-Annam linguistic family, who have left tokens of their presence from the Khasia Hills in Assam to the Gulf of Siam. The origin of the name Talaing is disputed, but it is most commonly believed to be a term of reproach, meaning "downtrodden," given by the conquering Burmans. The people call themselves Mons. They are lighter in complexion and more sturdily built than the Burmans and the face is rounder.

TALAR, the architectural term given to the throne of the Persian monarchs which is carved on the rock-cut tomb of Darius at Nakst in Rustan, near Persepolis, and above the portico which was copied from his palace.

TALAVERA DE LA REINA, a town of central Spain, in the province of Toledo; on the right bank of the river Tagus, and on the Madrid-Cáceres railway. Pop. (1900) 10,580. Talavera is of great antiquity, the Caesobriga of the Romans. Portions of the triple wall which surrounded it remain standing, and the Arco de San Pedro is one of its Roman gates restored. Among the ancient buildings are the Torres Albarranas, built by the Moors in the 10th century, the Gothic collegiate church, and three secularized convents, one of which dates from the 14th century, but has twice been partially restored, and is now a factory. The bridge of thirty-five arches across the Tagus dates from the 15th century. Talavera "of the queen" was so named because, from the reign of Alphonso XI. (1312–50), it was the property of the queens of Castile.

For the operations which culminated in the famous battle of Talavera, between the English and the French, and those which followed that engagement, see PENINSULAR WAR. Sir Arthur Wellesley (afterwards Duke of Wellington), the British commander, acting in co-operation with Lieutenant-General Cuesta's Spanish army, took position on the 27th of July 1809 on the Upper Tagus, protected by his advanced guard. His line, facing due east, ran north from the right bank of the river to a ridge running parallel to the Tagus, beyond which ridge, also parallel to the river, lay the Sierra de Montalban. Cuesta's men with their right flank resting on the river held Talavera itself and the close country to the northward of it; Wellesley's right connected with Cuesta's left, and his line stretched away northwards to the ridge mentioned above. The Sierra was not, on the first day, occupied, and even on the inner ridge itself the division of General (afterwards Lord) Hill was from some misunderstanding very late in taking up its position. The whole front was covered by a rivulet running from the ridge to the Tagus. The battle was begun by the attack of two French divisions on the British advanced guard, which retired into the main position with severe loss and in some disorder. Marshal Victor's forces followed them up sharply, and soon came upon Wellesley's line of battle. For some time the possession of the ridge (owing to the delay of Hill's Division) was doubtful, and Rufane Donkin's brigade had a severe struggle, but in the end the arrival of Hill's troops secured this all-important point for the Allied left. Meanwhile the Spaniards (though there was at first a temporary panic amongst them) and the right divisions of the British repulsed an attack in the plain, and the day closed with the armies facing each other along the rivulet and on the ridge. The losses had been heavy on both sides. Early on the 28th the battle was renewed by a furious attack on Hill's troops, whose left was now prolonged to the Sierra by the Allied cavalry and a division borrowed from Cuesta. King Joseph Bonaparte and Jourdan his chief of staff, who were present, were averse from fighting on this present ground, wishing to wait for Soult, whom they expected to come in on Wellesley's rear, and it was only after long discussion that the king gave a reluctant assent to Victor's plan of attack. That Marshal's divisions once more tried to oust Hill from the ridge, and once more failed before the steady volleys of the British line and the charge of the cavalry posted in this quarter (though, owing perhaps to defective ground-scouting, this nearly ended in disaster). At the same time General Sebastiani's 4th corps, after a heavy bombardment, assaulted the Allied centre in the plain. Here the British and Spanish battalions held their own firmly, and a counter attack by General Mackenzie's division hurled back the French in disorder. Yet another attack followed these failures, and came very near to achieving a great success. This time Lapisse's division of Victor's corps attacked the Allies' left centre, composed of the British Guards. The French columns were again checked by the British line, but here the counter-stroke, unlike Mackenzie's, was carried too far, and the troops in the ardour of incautious pursuit were very severely handled and pushed back to the position by the French reserves; when Wellesley decided the day by a counter attack with the 48th regiment, made with great intrepidity and steadiness. The Guards, with splendid discipline, resumed their positions, and eventually the French, with their leader Lapisse mortally wounded, fell back. Failure all along the line and heavy losses left King Joseph no alternative but to retire towards Madrid. The French lost 7268 men out of 46,138 present, the British 5363 out of 20,641; the Spanish losses were officially returned at 1201 out of some 36,000 present.

TALBOT (Family). Apart from its achievements, this is one of the few families in the English aristocracy which traces alike its descent and its surname from the Norman conquerors of England; and it may be said that there has hardly been a time during more than seven centuries in which the Talbots have not been of considerable account in public life. Yet in some periods they appear rather as a potential influence, while at certain marked epochs they stand out among the most prominent actors in English history. The name of Richard Talbot occurs in Domesday Book as the holder of nine hides of land in Bedfordshire under Walter Giffard. There is no evidence that he came over to England with the Conqueror himself; and, as he did not hold of the king *in capite*, it is clear that he was not a leader. Talbot being a personal nickname and not derived from a place, those who bore it were not of necessity connected, and the early pedigree is obscure. But a Geoffrey Talbot took part with the empress Maud against King Stephen; and a Hugh Talbot held the castle of Plessis against Henry I. for Hugh de Gournay, and afterwards became a monk at Beaubec in Normandy. Richard Talbot, with whom the proved pedigree begins, obtained from Henry II. on his accession the lordship of Linton in Herefordshire, and from Richard I. the custody of Ludlow Castle; and his descendants for some generations appear to have been wardens of various castles on the borders of Wales, and intermarried with the great families of this region. Under Edward II. a Gilbert Talbot was head of the house, and invaded Scotland in the king's company, but afterwards took part with Thomas of Lancaster against the king. He, however, was pardoned, and obtained from Edward III. a confirmation of the grant of the manor of Linton and other lands, being also summoned to parliament as a baron (1331).

His son Richard, who had married a daughter and co-heiress of John Comyn of Badenoch, laid claim to certain lands in Scotland in her right, and, when restrained from entering that country by land (Edward III. having then made an alliance with King David), he joined in a successful expedition which invaded it by sea in the interests of Edward Baliol. Three years later he was taken prisoner in Scotland, and redeemed for 2000 marks, after which the king made him governor of Berwick. He took part also in Edward's wars against France, as did likewise his son Gilbert, who succeeded him. His wife had brought him the noble seat of Goodrich Castle on the Wye, and at this time the family possessed lands in the counties of Oxford, Gloucester, Hereford and Kent. Gilbert's son Richard added to this inheritance by marrying the heiress of Lord Strange of Blackmere, and himself became under Richard II. one of the heirs of the earl of Pembroke, thus adding to his estates, lands in Berkshire, Wilts, Salop and Essex. Another Gilbert Talbot, grandson of the last, claimed to carry the great spurs at the coronation of Henry V., and had a commission to receive the submission of Owen Glendower and his adherents. He also distinguished himself in the invasion of Normandy. He was twice married, his second wife being a Portuguese lady, but he left no male issue, and was succeeded by his brother John.

Hitherto the head of the house had borne the name of Lord Talbot; but this John, after obtaining by marriage the title of Lord Furnival, was for his distinguished actions created earl of Shrewsbury (see Shrewsbury, John Talbot, 1st earl of).

Besides his martial exploits, this John claims some attention for his family alliances. His first wife Maud, a granddaughter of Thomas, Lord Furnival, brought him the castle of Sheffield as part of her inheritance, and he was accordingly summoned to parliament in the days of Henry IV. as John Talbot of Hallamshire, otherwise Lord Furnival, more than thirty years before he was made earl of Shrewsbury. The property became a favourite residence of the family during the Tudor era; and, but for the death in 1616 of Gilbert, 7th earl of Shrewsbury, without male issue, Sheffield might have remained much longer a centre of feudal magnificence rather than of commerce and manufactures. The second wife of John, earl of Shrewsbury, was Margaret, the eldest of three daughters of Richard Beauchamp, earl of Warwick, by that earl's second wife, a daughter of Thomas, Lord Berkeley. By her he obtained a third part of the Berkeley property; and, though she did not become the mother of a line of earls, her eldest son, John Talbot, was created Viscount Lisle, and it was he who fell along with his father at the disastrous battle of Chatillon in Gascony. His son Thomas, who inherited the title of Viscount Lisle, was slain at the early age of twenty-two in a feudal contest with Lord Berkeley, arising out of a dispute as to the possession of Berkeley castle, on the 20th of March 1470; and the title was afterwards conferred on Edward Grey, the husband of one of his two sisters.

John, the second earl of Shrewsbury, was the 1st earl's son by his first wife. He had been knighted at Leicester in 1426 along with the infant king Henry VI., had served in the wars of France, and been made chancellor of Ireland during his father's lifetime, when he was only Lord Talbot. Afterwards he was made lord high treasurer of England, and in 1459 was rewarded for his services to the house of Lancaster with a grant of 100 marks a year out of the lordship of Wakefield, forfeited by Richard, duke of York. But next year he and his brother Christopher were slain at the battle of Northampton, fighting in the cause of Henry VI. His son John succeeded him, and then his grandson George, who fought for Henry VII. at Stoke, and whom King Henry VIII. sent as his lieutenant against the rebels in the Pilgrimage of Grace. But perhaps the thing which most redounds to his credit is the humanity with which he received the fallen Cardinal Wolsey into his house at Sheffield when he was on his way up to London as a state prisoner.

Francis, the 5th earl, took a leading part in the invasions of

Scotland under Henry VIII. and Edward VI., and was one of the two peers who alone opposed the bill for abolishing the pope's jurisdiction under Elizabeth. His son George, who succeeded, was the earl to whom the custody of Mary Stuart was committed, his task being rendered all the more difficult for him by the intrigues of his second wife, Bess of Hardwick, the builder of Chatsworth, who had married three husbands before her union with him. Two sons of this last earl succeeded one another, and the title then devolved, for want of male issue, on the lineal descendants of Sir Gilbert Talbot of Grafton in Worcestershire, third son of John, the 2nd earl. But the old baronies of Talbot, Strange of Blackmere, and Furnival had passed away in 1616 to the daughters of the 7th earl, of whom the youngest married Thomas (Howard) earl of Arundel, whose descendant, the duke of Norfolk, has the valuable Furnival estates. The above Sir Gilbert had fought for Henry VII. at Bosworth, where he was severely wounded, was knighted on the field, and was throughout one of the first Tudor's most trusted councillors. He fought also at Stoke against the insurgents with Lambert Simnel, was made a knight banneret, governor of Calais, and lord chamberlain.

The 9th earl, George, descended from this Gilbert, died unmarried, and his nephew, who followed, was succeeded by his grandson Francis, chiefly memorable for his unhappy fate. His second wife, the "wanton Shrewsbury" of Pope, a daughter of the earl of Cardigan, was seduced by the duke of Buckingham, whom the outraged husband challenged to a duel. The countess, it is said, was present at the scene, and held Buckingham's horse in the disguise of a page, saw her husband killed, and then clasped her lover in her arms, receiving blood-stains upon her dress from the embrace. Charles, the 12th earl, son of this unfortunate nobleman, was raised by William III. to the dignity of a duke, but as he left no son this title died along with him in 1718, and the earldom of Shrewsbury devolved on his cousin Gilbert, a Roman Catholic priest.

From this time the direct line of Sir Gilbert Talbot of Grafton began to fail. A nephew three times succeeded to an uncle, and then the title devolved upon a cousin, who died unmarried in 1856. On the death of this cousin the descent of the title was for a short time in dispute, and the lands were claimed for Lord Edmund Howard (now Talbot), an infant son of the duke of Norfolk, under the will of the last earl; but the courts decided that, under a private act obtained by the duke of Shrewsbury shortly before his death, the title and bulk of the estates must go together, and the true successor to the earldom was found in Earl Talbot, the head of another line of the descendants of Sir Gilbert Talbot of Grafton, sprung from a second marriage of Sir Gilbert's son, Sir John Talbot of Albrighton. The head of this family in the beginning of the 18th century was a divine of some mark, William Talbot, who died bishop of Durham in 1730. His son Charles, who filled the office of lord chancellor, was created Baron Talbot of Hensol in Glamorganshire in 1733; and his son William was advanced to the dignity of Earl Talbot in 1761, to which was added Ingestre, the barony of Dynevor, with special remainder to his daughter, Lady Cecil Rice, in 1780. Then succeeded a nephew, who was created Viscount and Earl Talbot, and assumed by royal licence the surname of Chetwynd before Talbot, from his mother.

All the titles just mentioned have been united in the line of the Earl Talbot who successfully claimed the Shrewsbury title as the 18th earl, the earldom of Shrewsbury (1442) being now the oldest existing that is not merged in a higher title. The family seats (Alton Towers and Ingestre Hall) and the chief estates are in Staffordshire. The old badge of the family was a "talbot" or running hound. (J. Ga.; J. H. R.)

TALBOT, MARY ANNE (1778–1808), the "British Amazon," was born in London on the 2nd of February 1778. She believed herself to be the illegitimate child of the 1st Earl Talbot. Early in her career she eloped, in the disguise of a boy, with a captain. In 1792 she was a drummer in Flanders. In the capture of Valenciennes her lover was killed; and Mary Anne deserted and became cabin boy on a French lugger, which she asserted was captured by the British, who transferred her to the "Brunswick," where she served as a powder monkey, being wounded in Lord Howe's victory of the 1st of June 1794. For this she later received a small pension. When the wound healed she again went to sea, was captured by the French, and imprisoned for a year and a half. Her sex was not discovered until shortly afterwards she was seized by a pressgang. She finally became a household servant to Robert Kirby, a London publisher, who included an account of her adventures in his *Wonderful Museum* (1804) and in *Life and Surprising Adventures of Mary Anne Talbot* (1809). She died on the 4th of February 1808.

TALBOT, WILLIAM HENRY FOX (1800–1877), English discoverer in photography, was the only child of William Davenport Talbot, of Lacock Abbey, Wilts, and of Lady Elizabeth Fox Strangways, daughter of the 2nd earl of Ilchester. He was born on the 11th of February 1800, and was educated at Harrow and at Trinity College, Cambridge, where he gained the Porson prize in 1820, and graduated as twelfth wrangler in 1821. From 1822 to 1872 he frequently communicated papers to the Royal Society, many of them on mathematical subjects. At an early period he had begun his optical researches, which were to have such important results in connexion with photography. To the *Edinburgh Journal of Science* in 1826 he contributed a paper on "Some Experiments on Coloured Flame"; to the *Quarterly Journal of Science* in 1827 a paper on "Monochromatic Light"; and to the *Philosophical Magazine* a number of papers on chemical subjects, including one on "Chemical Changes of Colour." Before L. J. M. Daguerre exhibited in 1839 pictures taken by the sun, Talbot had obtained similar success, and as soon as Daguerre's discoveries became known communicated the results of his experiments to the Royal Society. In 1841 he made known his discovery of the calotype or talbotype process, and after the discovery of the collodion process by Frederick Scott Archer in 1851 he devised a method of instantaneous photography. For his discoveries, which are detailed in his *Pencil of Nature* (1844), he received in 1842 the Rumford medal of the Royal Society. While engaged in his scientific researches he devoted much time to archaeology. He published *Hermes, or Classical and Antiquarian Researches* (1838–39), and *Illustrations of the Antiquity of the Book of Genesis* (1839). With Sir Henry Rawlinson and Dr Edward Hincks he shares the honour of having been one of the first decipherers of the cuneiform inscriptions of Nineveh. He was also the author of *English Etymologies* (1846). He died at Lacock Abbey on the 17th of September 1877.

TALBOT OF HENSOL, CHARLES TALBOT, 1st Baron (1685–1737), lord chancellor of England, was the eldest son of William Talbot, bishop of Durham, a descendant of the 1st earl of Shrewsbury. He was educated at Eton and Oriel College, Oxford, and became a fellow of All Souls College in 1704. He was called to the bar in 1711, and in 1717 was appointed solicitor-general to the prince of Wales. Having been elected a member of the House of Commons in 1720, he became solicitor-general in 1726, and in 1733 he was made lord chancellor and raised to the peerage with the title of Baron Talbot of Hensol. Talbot proved himself an equity judge of exceptional capacity and of the highest character during the three years of his occupancy of the Woolsack. He died on the 14th of February 1737. Among his contemporaries Talbot enjoyed the reputation of a wit; he was a patron of the poet Thomson, who in *The Seasons* commemorated a son of his to whom he acted as tutor; and Butler dedicated his famous *Analogy* to the lord chancellor. The title assumed by Talbot was derived from Hensol in Glamorganshire, which came to him through his wife.

See Lord Campbell, *Lives of the Lord Chancellors and Keepers of the Great Seal* (8 vols. London, 1845–69); Edward Foss, *The Judges of England* (9 vols. London, 1848–64); Lord Hervey, *Memoirs of the Reign of George II.* (2 vols. London, 1848); G. E. C., *Complete Peerage*, vol. vii. (London, 1896).

TALC, a mineral which in its compact forms is known as *steatite*, or *soapstone*. It was probably the μαγνῆτις λίθος of Theophrastus, described as a stone of silvery lustre, easily cut. The word talc, sometimes written talk, is said to come from the Arabic *talq*, and not to be connected, as has been fancifully suggested, with the Swedish *tälja*, "to cut." Talc and mica were confused by the older writers, and even at the present day mica is sometimes known in trade as talc; whilst the term was formerly applied also to foliated gypsum.

Talc is found occasionally in small hexagonal and rhombic plates, with perfect basal cleavage, and they are supposed to be monoclinic. Talc often occurs in foliated masses, sometimes with a curved surface, readily separating into thin very flexible, non-elastic laminae. The plates give a six-rayed percussion-figure. Talc has a hardness of only about 1, and a specific gravity of from 2·6 to 2·8. Its extreme softness and its greasy feel are characteristic. The lustre on the cleavage face is pearly, or sometimes silvery, and one of the old names of the mineral was *stella terrae*, while German writers sometimes called it *Katzensilber*. The colour is white, grey, yellow or frequently green. The mineral has strong birefringence and a small optic axial angle.

Talc is a magnesium silicate $H_2Mg_3Si_4O_{12}$. It is generally regarded as a hydrous silicate, but the water is expelled only at a very strong heat, and may therefore be regarded as basic. By the action of heat the hardness of the mineral is greatly increased. Pseudomorphs are known after actinolite, pyroxene, &c., and the mineral has probably been generally formed by the alteration of ferro-magnesian silicates. Talc occurs chiefly in crystalline schists, usually associated with chlorite, serpentine and dolomite. Fine examples of apple-green colour are found at Mount Greiner, in the Zillerthal, Tirol. Talc-schist is a foliated rock composed chiefly of talc, generally associated with quartz and felspar; but all soapy schists are not necessarily talcose. The pearly micaceous constituent of the Alpine protogine is a muscovite.

The "steatites" of Pliny was a stone resembling fat, but otherwise undescribed. Being easily cut, steatite has always been a favourite material with the carver: it was used for Egyptian scarabs and other amulets, which were usually coated with a blue vitreous glaze; and it was employed for Assyrian cylinder-seals and for other ancient signets. By the Chinese steatite is largely used for ornamental carvings, but many of their "soapstone" figures are wrought in a compact pyrophyllite (*q.v.*), which is essentially different from talc. The name agalmatolite is often applied to the material of these figures, and was suggested by M. H. Klaproth from the Greek ἄγαλμα, "an image." Pagodite is an old name for Chinese figure-stone. Ancient steatite carvings are found among the ruins of Rhodesia.

Steatite is usually a white, grey, greenish or brown substance, occurring in veins or nodular masses or in lenticular bedded deposits. Pseudomorphs after quartz and dolomite occur near Wunsiedel in Bavaria. In some cases it is a product of the alteration of pyroxenic rocks, and the commercial mineral may be very impure. The ease with which steatite may be worked, coupled with its power of resisting heat, has led to its employment for vessels for household use, whence it is called "potstone"—the *lapis ollaris* of old writers. Among the uses of steatite may be mentioned its employment, especially in America, for sinks, stoves, firebricks, foot-warmers, tips for gas-burners and electric switchboards: when ground it is used as a filler for paper, for leather-dressing, for covering steam-pipes, as an ingredient in soap, for toilet-powder, for certain paints and as a lubricant. A fine granular steatite is used by tailors for marking cloth under the name of "French chalk" or "Spanish chalk." Slate pencils are made of steatite and pyrophyllite; and in Burma steatite pencils are used for writing on black paper. In the oxyhydrogen flame, steatite has been fused and drawn out into threads, like quartz-fibres.

Steatite and talc-schists are widely distributed, and have occasionally been used as building stones. When first raised the stone is soft, but hardens on exposure. Soapstone from Gudbrandsdal is used in the cathedral of Trondhjem in Norway. Veins of steatite occur in the serpentine of the Lizard district in Cornwall, and the mineral was used under the name of soap rock in the manufacture of the old Worcester porcelain. Among localities of steatite in the British Isles mention may be made of Crohy Head and Gartan near Letterkenny in co. Donegal, Ireland; the Shetland isles, the Hebrides (Harris) and Shiness in Sutherland. In North America the distribution of the mineral is very extensive; localities of economic importance are near Gouverneur and elsewhere in St Lawrence co., New York; at Francestown in New Hampshire; Stockbridge, Windsor co., Vermont; Lynnfield, Massachusetts; near Lafayette, Pennsylvania; Albemarle, Amelia, Buckingham, Fairfax and Fluvanna cos., Virginia; Cherokee, Moore and Swain cos., North Carolina; and in Murray co., Georgia.

A fibrous steatite from New York state, used in the manufacture of paper, is known as agalite. Rensselaerite is a wax-like talcose substance, passing into serpentine, from St Lawrence co., New York, named by E. Emmons in 1837 after S. Van Rensselaer, of Albany, N.Y. Beaconite is an asbestiform talc from Michigan, named by L. W. Hubbard. The term pyrallolite was given by Nils G. Nordenskiöld to a mineral from Finland, which appears to be talc pseudomorphous after pyroxene. Talcoid was K. F. Naumann's name for a white lamellar mineral from near Pressnitz in Bohemia. A blue earthy mineral from near Silver City, New Mexico, known locally as "native ultramarine," is a magnesium silicate.

See "Talc and Soapstone" in vol. ii. of *Mineral Resources of the U.S.* (Washington, 1909), and J. H. Pratt, "Economic Papers," No. 3 of Geol. Surv. of N. Carolina (1900); also E. W. Parker in 19th *Report* of U.S. Geol. Surv. (1898); C. H. Smyth, junior, *The Fibrous Talc Industry of St Lawrence Co.*, N.Y., in "Mineral Industry," vol. ix., for 1900; and G. P. Merrill's *Non-metallic Minerals* (New York, 1904). (F. W. R.*)

TALCA, a province of Chile, bounded N. by Curico, E. by Argentina, S. by Linares and Maule, and W. by the Pacific. Area 3840 sq. m. Pop. (1895) 128,961. In the E. the Andean slopes cover a considerable part of its territory, and in the W. another large area is covered by the coast range. Between these is the central valley of Chile in which the population and industries of the province are chiefly concentrated. The mountainous parts are well wooded. The intermediate plain, which is rolling and slopes gently to the S., is fertile and devoted to wheat and stock. The capital of the province is Talca (pop. 1895, 33,232; 1902 estimated 42,766), on the Rio Claro, a tributary of the Maule, 156 m. by rail S. of Santiago. It is one of the most important provincial towns and commercial centres of central Chile. There are woollen factories, especially for the universally worn "poncho." Talca has railway connexion with Santiago on the N., with Concepción on the S., and with Constitución at the mouth of the Maule.

TALCAHUANO, or TALCAGUANO, a seaport of the province of Concepción, Chile, on the bay of Concepción, 8 m. N.W. of the city and port of that name. Pop. (1895) 10,431; (1902, estimated) 13,499. It is sheltered by the island of Quiriquina. It has the best harbour on the Pacific coast of South America, and is one of the most important ports of southern Chile, being connected by rail with Concepción, Santiago and southern Chile. Its foreign trade is large and steadily increasing. The Chilean government has established its chief naval depot here.

TALE (O.Eng. *talu*, number, account, story; the word is common to many Teutonic languages; cf. Ger. *Zahl*, number, *Erzählung*, narrative, Du. *taal*, speech, language), a general term, in the usual acceptance of the word, for fictitious narratives, long or short, ancient or modern (see NOVEL). In this article "tale" is used in a stricter sense, as equivalent to the German "Volks-märchen" or the French "conte populaire." Thus understood, popular tales mean the stories handed down by oral tradition from an unknown antiquity, among savage and civilized peoples. So understood, popular tales are a subject in mythology, and indeed in the general study of the development of man, of which the full interest and importance was long unrecognized. Popular tales won their way into literature, it is true, at a very distant period. The Homeric epics, especially the *Odyssey*, contain adventures (those, for example, of the Cyclops and the husband who returns in disguise) which are manifestly parts of the general human stock of popular narrative. Other examples are found in the *Rigveda*, and in the myths which were handled by the Greek dramatists. Collections of popular tales, more or less subjected to conscious literary treatment, are found in Sanskrit, as in the work of Somadeva, whose *Kathā Sarit Sāgara*, or "Ocean of the Streams of Story," has been translated by Mr Tawney (Calcutta, 1880). The THOUSAND

AND ONE NIGHTS (*q.v.*) are full of popular tales, and popular tales are the staple of the medieval *Gesta Romanorum*, and of the collections of Straparola and other Italian conteurs. In all these and similar gatherings the story, long circulated from mouth to mouth among the people, is handled with conscious art, and little but the general outline of plot and character of incident can be regarded as original. In the *Histories ou Contes du Temps Passé* of Perrault (Elzevir, Amsterdam, 1697; the Parisian edition is of the same date) we have one of the earliest gatherings of tales which were taken down in their nursery shape as they were told by nurses to children. This at least seems probable, though M. Alfred Maury thinks Perrault drew from literary sources. Perrault attributed the composition to his son, P. Darmancour, at that time a child, and this pretext enabled him to give his stories in a simple and almost popular guise. It seems that popular tales in many cases probably owe their origin to the desire of enforcing a moral or practical lesson. It appears that their irrational and "infantile" character—"dépourvues de raison"—is derived from their origin, if not actually among children, at least among childlike peoples, who have not arrived at "raison," that is, at the scientific and modern conception of the world and of the nature of man.

The success of Perrault's popular tales brought the genre into literary fashion, and the Comtesse d'Aulnoy invented, or in some cases adapted, "contes," which still retain a great popularity. But the precise and scientific collection of tales from the lips of the people is not much earlier than our century. The chief impulse to the study was given by the brothers Grimm. The first edition of their *Kinder- und Haus-Märchen* was published in 1812. The English reader will find a very considerable bibliography of popular tales, as known to the Grimms, in Mrs Alfred Hunt's translation, *Grimm's Household Tales, with Notes* (London, 1884). "How unique was our collection when it first appeared," they exclaim, and now merely to enumerate the books of such traditions would occupy much space. In addition to the märchen of Indo-European peoples, the Grimms became acquainted with some Malay stories, some narratives of Bechuanas, Negroes, American Indians, and Finnish, Esthonian, and Magyar stories. Thus the Grimms' knowledge of non-European märchen was extremely slight. It enabled them, however, to observe the increase of refinement "in proportion as gentler and more humane manners develop themselves," the monstrosities of Finnish and Red-Indian fancy gradually fading in the narratives of Germans and Italians. The Grimms notice that the evolution of popular narrative resembles the evolution of the art of sculpture, from the South-Sea idol to the frieze of the Parthenon, "from the strongly marked, thin, even ugly, but highly expressive forms of its earliest stages to those which possess external beauty of mould." Since the Grimms' time our knowledge of the popular tales of non-European races has been greatly enriched. We possess numbers of North-American, Brazilian, Zulu, Swahili, Eskimo, Samoan, Maori, Kaffir, Malagasy, Bushman, North African, Fiort, New Caledonian, and even Australian märchen, and can study them in comparison with the stories of Hesse, of the West Highlands of Scotland, of Scandinavia.

While the popular romances of races of all colours must be examined together, another element in this subject is not less important. It had probably been often observed before, as by Lord Fountainhall (1670), but the fact was brought out most vividly by J. G. von Hahn (*Griechische und albanesische Märchen*, Leipzig, 1864), that the popular tales of European races turn on the same incidents, and display the same succession of situations, the same characters, and the same plots, as are familiar in the ancient epic literature of Greece, India, Germany and Scandinavia. The epics are either fully-developed märchen evolved by the literary genius of poets and saga-men, or the märchen are degenerate and broken-down memories of the epics and sagas, or perhaps there may be examples of both processes. The second view,—namely, that the popular tales are, so to speak, the scattered grains of gold of which the epic is the original "pocket" or "placer,"—the belief that the märchen are the detritus of the saga,—was for a long time prevalent. But a variety of arguments enforce the opposite conclusion, namely, that the märchen are essentially earlier in character than the epic, the final form to which they have been wrought by the genius of Homer or of some other remote yet cultivated poet. If this view be accepted, the evolution of märchen and of certain myths has passed through the following stages:—

(1) The popular tale, as current among the uncultivated peoples, such as Iroquois, Zulus, Bushmen, Samoans, Eskimo, and Samoyedes. This tale will reflect the mental condition of rude peoples, and will be full of monstrous and miraculous events, with an absence of reason proper, as Perrault says, "à ceux qui n'en ont pas encore." At the same time the tale will very probably enforce some moral or practical lesson, often the sanction of a taboo, and may even appear to have been invented with this very purpose, for man is everywhere impressed with the importance of *conduct*.

(2) The same tale—or rather a series of incidents and a plot essentially the same—as it is discovered surviving in the oral traditions of the illiterate peasantry of European races. Among them the monstrous element, the ferocity of manners observed in the first stage, will be somewhat modified, but will be found most notable among the Slavonic tribes. Nowhere, even in German and Scottish märchen, is it extinct, cannibalism and cruel torture being favourite incidents.

(3) The same plots and incidents as they exist in the heroic epics and poetry of the cultivated races, such as the Homeric epics, the Greek tragedies, the Cyclic poets, the *Kalewala* of the Finns, certain hymns of the *Rigveda*, certain legends of the Brahmanas, the story of the Volsungs,—in these a local and almost historical character is given by the introduction of names of known places, and the adventures are attributed to national heroes,—Odysseus, Oedipus, Sigurd, Wainamoïnen, Jason, Pururavas, and others. The whole tone and manners are nobler and more refined in proportion as the literary workmanship is more elaborate.

This theory of the origin of popular tales in the fancy of peoples in the savage condition (see MYTHOLOGY), of their survival as märchen among the peasantry of Indo-European and other civilized races, and of their transfiguration into epics, could only be worked out after the discovery that savage and civilized popular tales are full of close resemblances. These resemblances, when only known to exist among Indo-European peoples, were explained as part of a common Aryan inheritance, and as the result of a malady of language. This system, when applied to myths in general, has already been examined (see MYTHOLOGY). According to another view, märchen everywhere resemble each other because they all arose in India, and have thence been borrowed and transmitted. For this theory consult Benfey's *Panchatantra* and M. Cosquin's *Contes de Lorraine* (Paris, 1886). In opposition to the Aryan theory, and the theory of borrowing from India, the sytem which is here advocated regards popular tales as kaleidoscopic arrangements of comparatively few situations and incidents, which again are naturally devised by the early fancy. Among these incidents may be mentioned, first, kinship and intermarriage between man and the lower animals and even inorganic phenomena. Thus a girl is wooed by a frog, pumpkin, goat, bear, or elephant, in Zulu, Scotch, Walachian, Eskimo, Ojibway, and German märchen. This incident is based on the lack of a sense of difference between man and the things in the world which is prevalent among savages (see MYTHOLOGY). Other incidents familiar in our nursery tales (such as "Cinderella" and "Puss in Boots") turn on the early belief in metamorphosis, in magic, in friendly or protecting animals (totems or beast manitous). Others depend on the early prevalence of cannibalism (compare Grimm, 47, "The Juniper Tree"). This recurs in the mad song of Gretchen in *Faust*, concerning which a distinguished student writes, "This ghost of a ballad or rhyme is my earliest remembrance, as crooned by an old East-Lothian nurse." (Compare Chambers's *Popular Rhymes of Scotland*, 1870, p. 49.) The same legend occurs among the Bechuanas, and is published by Casalis. Yet another incident springs from the taboo on certain actions between husband and wife, producing the story of Cupid and Psyche (see Lang's *Custom and Myth*, 1884, p. 64). Once more, the custom which makes the youngest child the heir is illustrated in the märchen of the success, despite the jealousy of the elders, of Cinderella, of the Zulu prince (Callaway's *Tales from the Amazulu*, pp. 64, 65), and in countless other märchen. In other cases, as in the world-wide märchen corresponding to the Jason epic, we seem in presence of an early romantic invention,—how diffused it is difficult to imagine. Moral lessons, again, are inculcated by the numerous tales which turn on the duty of kindness, or on the impossibility of evading fate as announced in prophecy. In opposition to the philological explanation of the story of Oedipus as a nature-myth, this theory of a collection of incidents illustrative of moral lessons is admirably set forth in Prof. Comparetti's *Edipo e la Mitologia Comparata* (Pisa, 1867).

On a general view, then, the stuff of popular tales is a certain number of incidents and a certain set of combinations of these incidents. Their strange and irrational character is due to their remote origin in the fancy of men in the savage condition; and their wide distribution is caused, partly perhaps by oral transmission from people to people, but more by the tendency of the early imagination to run everywhere in the same grooves. The narratives, in the ages of heroic poetry, are elevated into epic song, and in the middle ages they were even embodied in legends of the saints. This view is maintained at greater length, and with numerous illustrations, in the introduction to Mrs Hunt's translation of Grimm's *Kinder- und Haus-Märchen*, and in *Custom and Myth*, already referred to.

For savage popular tales see Theal's *Kaffir Folk Lore* (2nd ed., London, 1886); Callaway's *Nursery Tales of the Amazulu* (London, 1868); Schoolcraft's *Algic Researches;* Gill's *Myths and Tales of the South Pacific;* Petitot's *Traditions Indiennes* (1886); Shortland's *Maori Religion and Mythology* (London, 1882); the *South African Folk Lore Record;* the *Folk Lore Record* (London, 1879–85, Malagasy stories); Rink's *Tales and Traditions of the Eskimo*; Bleek's *Hottentot Tales and Fables* (London, 1864); Castrén's *Samoyedische Märchen;* Maspero's *Contes Egyptiens* (from ancient Egyptian MSS.); and Leland's *Algonquin Legends* (London, 1884). For European tales, the bibliography in the translation of Grimm already referred to may be used, and the Maisonneuve collection, *Les Littératures populaires*, may be recommended. The names of Liebrecht, Köhler, Dasent, Ralston, Nigra, Pitré, Cosquin, Afanasief, Gaidoz, Sébillot, may serve as clues through the enchanted forest of the nursery tales of Europe. Miss Coxe's *Cinderella* (Folk-Lore Society) is an excellent work on the subject, as is Sidney Hartland's *Legend of Perseus*, mainly concerned with myths of miraculous births. For Australia see Mrs Langloh Parker's *Australian Legendary Tales* (2 vols.) and Howitt's *Native Tribes of South-East Australia*. M. Sébillot has edited French tales, and Mr Dennett has given *Folk-Lore of the Fiort*. There are abundant materials and discussions in Frazer's *The Golden Bough*. (A. L.)

TALENT (Lat. *talentum*, adaptation of Gr. *τάλαντον*, balance, weight, from root *ταλ-*, to lift, as in *τλῆναι*, to bear, *τάλας*, enduring, cf. Lat. *tollere*, to lift, Skt. *tulā*, balance), the name of an ancient Greek unit of weight, the heaviest in use both for monetary purposes and for commodities (see WEIGHTS AND MEASURES). The weight itself was originally Babylonian, and derivatives were in use in Palestine, Syria and Egypt. In medieval Latin and also in many Romanic languages the word was used figuratively, of will, inclination or desire, derived from the sense of balance, but the general figurative use for natural endowments or gifts, faculty, capacity or ability, is due to the parable of the talents in Matt. xxv.

TALFOURD, SIR THOMAS NOON (1795–1854), English judge and author, the son of a brewer in good circumstances, was born on the 26th of May 1795 at Reading (not, as is sometimes stated, at Doxey, near Stafford). He received his early education at Hendon, and at the Reading grammar-school. At the age of eighteen he was sent to London to study law under Joseph Chitty, the special pleader. Early in 1821 he joined the Oxford circuit, having been called to the bar at the middle Temple in the same year. When, fourteen years later, he was created a serjeant-at-law, and when again he in 1849 succeeded Mr. Justice Coltman as judge of the court of common pleas, he attained these distinctions more perhaps for his laborious care in the conduct of cases than on account of any forensic brilliance. At the general election in 1835 he was returned for Reading. This seat he retained for close upon six years, and he was again returned in 1847. In the House of Commons he introduced an International Copyright Bill; his speech on this subject was considered the most telling made in the House during that session. The bill met with strong opposition, but Talfourd had the satisfaction of seeing it pass into law in 1842, albeit in a greatly modified form. Dickens dedicated the *Pickwick Papers* to him.

In his early years in London Talfourd was dependent—in great measure, at least—upon his literary exertions. He was at this period on the staff of the *London Magazine*, and was an occasional contributor to the *Edinburgh* and *Quarterly* reviews, the *New Monthly Magazine*, and other periodicals; while, on joining the Oxford circuit, he acted as law reporter to *The Times*. His legal writings on matters germane to literature are excellent expositions, animated by a lucid and telling, if not highly polished, style. Among the best of these are his article "On the Principle of Advocacy in the Practice of the Bar" (in the *Law Magazine*, January 1846); his *Proposed New Law of Copyright of the Highest Importance to Authors* (1838); *Three Speeches delivered in the House of Commons in Favour of an Extension of Copyright* (1840); and his famous *Speech for the Defendant in the Prosecution, the Queen* v. *Moxon, for the Publication of Shelley's Poetical Works* (1841).

But Talfourd cannot be said to have gained any position among men of letters until the production of his tragedy *Ion*, which was privately printed in 1835, and produced in the following year at Covent Garden theatre. The tragedy was also well received in America, and was reproduced at Sadler's Wells in December 1861. This dramatic poem, its author's masterpiece, turns upon the voluntary sacrifice of Ion, king of Argos, in response to the Delphic oracle, which had declared that only with the extinction of the reigning family could the prevailing pestilence incurred by the deeds of that family be removed.

Two years later, at the Haymarket theatre, *The Athenian Captive* was acted with moderate success. In 1839 *Glencoe, or the Fate of the Macdonalds*, was privately printed, and in 1840 it was produced at the Haymarket; but this home drama is inferior to his two classic plays. *The Castilian* (1853) did not excite a tenth part of the interest called forth by *Ion*. Before this he had produced various other prose writings, among them his "History of Greek Literature," in the *Encyclopaedia Metropolitana*. Talfourd died in court during the performance of his judicial duties, at Stafford, on the 13th of March 1854.

In addition to the writings above-mentioned, Talfourd was the author of *The Letters of Charles Lamb, with a Sketch of his Life* (1837); *Recollections of a First Visit to the Alps* (1841); *Vacation Rambles and Thoughts*, comprising recollections of three Continental tours in the vacations of 1841, 1842, and 1843 (2 vols., 1844); and *Final Memorials of Charles Lamb* (1849–50).

TALGARTH, a decayed market town in Breconshire, South Wales, situated on the Ennig near its junction with the Llynfi (a tributary of the Wye), with a station on the joint line of the Cambrian and Midland companies from Brecon to Three Cocks Junction (2½ m. N.N.E., but in Talgarth parish). The population of the whole parish (which measures 12,294 acres) was 1466 in 1901. The church of St Gwendoline, restored in 1873, is in Perpendicular style, with an embattled tower restored in 1898. The Baptists, Congregationalists and Calvinistic Methodists have each a chapel in the town, and there is also a Congregational church at Tredwestan, founded in 1662. About 1 m. S.W. is Trevecca, where Howel Harris, one of the founders of Welsh Methodism, was born in 1713, and where in 1752 he established a communistic religious "family" of about a hundred persons; their representatives in 1842 handed over the property to the Welsh Calvinistic Methodist connexion, who in that year opened there a theological college, and in 1874 added to it a Harris memorial chapel. In 1906 the college was removed to Aberystwyth, and the buildings are now used by the Connexion as a preparatory school for ministerial students.

The fortified station of Dinas occupies the summit of a hill about $2\frac{1}{2}$ m. S.E. of Talgarth, and commands the mountain pass to Crickhowell and the eastern part of the vale of Usk. Its castle, built on the site of an earlier British fortress, was destroyed (according to Leland) by the inhabitants to prevent its falling into the hands of Glendower. The town was in the manor of English Talgarth, there being also a manor of Welsh Talgarth, in which Welsh laws prevailed.

TALIENWAN, an open bay or roadstead on the east side of the Liaotung peninsula, Manchuria. It was leased to Russia by China in 1898 with the naval fortress of Port Arthur, from which it is distant 40 m., the lease being transferred to Japan in 1905. The Russian town of Dalny (now Tairen) was built upon the west side of the bay, known as Port Victoria. Being ice-free all the year round, it has an advantage over Niuchwang, which is frozen up for four months in the year. Niuchwang, however, lies much nearer to the great producing and consuming districts of Manchuria. Talienwan is in railway connexion with Niuchwang and Peking and via the Siberian railway with Europe. It was the rendezvous of the British fleet during the Anglo-China war of 1860, whence the names Port Arthur and Port Victoria.

TALIESSIN, the name of a late 6th century British bard, of whom practically nothing is known except the attribution to him of the collection of poems known as the *Book of Taliessin.* See the article CELT, § *Literature*, IV.

TALISMAN, a magical charm. The word is often used as a term synonymous with amulet (*q.v.*), but strictly should be applied to an inanimate object which is supposed to possess a supernatural capacity of conferring benefits or powers, an amulet being that which protects or wards off evil (see MAGIC). The most common form which the talisman took in medieval or later times was that of a disk of metal or stone engraved with astrological figures, or with magical formulae, of which *Abraxas* (*q.v.*) and *Abracadabra* (*q.v.*) are the most familiar. The word is derived through the Spanish from Arab. *ṭilsamān*, plural of *ṭilsam*, an adaptation of Gr. τέλεσμα, payment, outlay (from τελεῖν, to accomplish), used in Late Gr. of an initiation or mystery and in Med. Gr. of a charm.

TALLADEGA, a city and the couty-seat of Talladega county, Alabama, U.S.A., 35 m. E. of Birmingham. Pop. (1900) 5056 (2687 negroes); (1910) 5854. It is served by the Southern, the Louisville & Nashville and other railways. Talladega is situated in the foothills of the Blue Ridge, about 560 ft. above sea level. It is the seat of the Alabama Synodical College for Women (Presbyterian, 1903), of Talladega College (Congregational, opened 1867; chartered 1869 and 1889) for the higher education of negroes—the first college for negroes in the state, and of several institutions devoted to the care of the deaf, dumb and blind. Limestone and coal are found in the vicinity. Among the manufactures are cotton goods, cotton-seed oil, iron, hosiery, chemicals and fertilizers. There are several mineral springs near the city, and the municipal water supply is derived from a spring in the city. The electric lighting and power plant is operated by water power on Jackson Shoals. Talladega was originally an Indian village. On the 9th of November 1813, it was the scene of a decisive victory of the whites and their Indian allies, 2000 strong, led by Gen. Andrew Jackson, over 1000 " Red Sticks," or Creek Indians, who were hostile to the extension of white settlements in Indian territory.

TALLAGE (med. Lat. *tallagium*, Fr. *tailage*, from late Lat. *talare*, *taleare*, Fr. *tailler*, to cut, classical Lat. *talea*, a cutting, slip; cf. " tally " and the French *taille*, *q.v.*), a special tax in England paid by cities, boroughs and royal demesnes. The word, variously interpreted as a part " cut off " from the property taxed, or as derived from the tally (*q.v.*), first appears in the reign of Henry II. as a synonym for the *auxilium burgi*, which was an occasional payment exacted by king and barons over and above the annual *firma burgi* from burgage tenants, since all boroughs after the Norman Conquest came to be regarded as in some lord's demesne. The tax displaced the Danegeld so far as the towns and demesne lands of the Crown were concerned in the second half of the 12th century, and gradually the barons were deprived of the right of tallaging their respective demesnes without royal authorization. The imposition of tallage continued under the immediate successors of Henry II.; the barons failed to secure its prohibition or even limitation at Runnymede, and Henry III. levied it frequently. The amount to be paid was determined during this time by officials of the exchequer in special fiscal circuits through separate negotiations with the various tax-paying communities, the towns usually raising their quota by means of a capitation or poll tax. Its imposition practically ceased by 1283 in favour of a general grant made in parliament, and the king's retention of tallage seemed particularly unnecessary and illogical after burgesses were summoned to parliament. The opinion used to be held that tallage was forbidden by the *Confirmatio cartarum*, but the Latin version of that document which bears the title *De tallagio non concedendo*, although cited as a statute in the preamble to the Petition of Right in 1627 and in a judicial decision of 1637, was merely a chronicler's summary of the purposes of the official French document, which did not mention tallage by name. After 1297, however, there were only three levies of the tax: one by Edward I. in 1304; again in 1312 by Edward II. despite the protests of London and Bristol; and finally in 1332, when Edward III. encountered such opposition from parliament that he withdrew the commissions and accepted in its place a grant of a tenth-and-fifteenth. The last time that the king granted leave to the barons to tallage their demesnes was in 1305. The second statute of 1340 formally enacted that the nation should thenceforth not " make any common aid or sustain charge," including tallage, without consent of parliament.

See William Stubbs, *Constitutional History of England*, vol. i. sect. 161, vol. ii. sect. 275; D. J. Medley, *English Constitutional History*, 3rd ed. (London, 1902); Pollock and Maitland, *History of English Law*, vol. i., 2nd ed.; S. J. Low and F. S. Pulling, *Dictionary of English History.*

TALLAHASSEE, the capital of Florida, U.S.A., and the county seat of Leon county, in the W. part of the state, about 40 m. E. of the Apalachicola river and 20 m. from the Gulf of Mexico, about midway by railway between Jacksonville and Pensacola. Pop. (1900) 2981 (1755 negroes); (1910) 5018; in 1900 the population of the county was 19,887, of whom 16,000 were negroes. Tallahassee is served by the Seaboard Air Line and the Georgia, Florida & Alabama railways. The city is finely situated on a hill, about 300 ft. above sea-level, and the streets are wide and well-shaded. The principal buildings are the State Capitol, Grecian in architecture, the Federal Building, and the County Court House. In the Episcopal cemetery two monuments mark the graves of Charles Louis Napoléon Achille Murat (1801–1847), the eldest son of Joachim Murat, and of his wife Catherine (1803–1867), the daughter of Col. Bird C. Willis of Virginia and a grand-niece of George Washington.[1] Tallahassee is the seat of the Florida Female College, co-ordinate with the State University for men, and the State Normal and Industrial School (for negroes), an agricultural and mechanical college. About 17 m. S. of Tallahassee, in Wakulla county, is the Wakulla Spring, about 106 ft. deep, one of the largest of the remarkable springs of Florida.

Tallahassee's name is of Seminole origin, and means, it is said, " tribal land." During a war with the Apalachee Indians in 1638 the Spaniards, according to tradition, fortified a hill W. of the city, where the Fort St Luis Place, a plantation

[1] Murat settled here about 1821, became a naturalized American citizen, relinquishing his claim to the crown of Naples, and lived here for much of the time until his death, holding successively the office of alderman, mayor and postmaster of the city, and devoting some of his leisure to the preparation of three books, describing political and social conditions in America, the last of which, *Exposition des principes du gouvernement républicain tel qu'il a été perfectionné en Amérique* (1838), was translated into many languages and was very popular in Europe. After his death his wife lived in what is still known as the Murat Homestead, about 2 m. W. of Tallahassee, and after the American Civil War she received an annuity of 30,000 francs from Napoleon III.

mansion, now stands. About 1818 most of the Indians were expelled from the vicinity, and a settlement was made by the whites. In 1824 Tallahassee, then virtually uninhabited, was formally chosen by the United States Government as the capital of the Territory of Florida, and it continued as the capital after the admission of Florida into the Union as a state in 1845. It was a residential centre for well-to-do planters before the Civil War, and Bellair, 6 m. S., now in ruins, was a fashionable pleasure resort. On the 10th of January 1861 a state convention adopted at Tallahassee an Ordinance of Secession.

TALLBOY (partly a translation and partly a corruption of the French *hautbois*), a double chest of drawers. Whereas the chest of drawers in its familiar form (sometimes in the 18th century called a "lowboy") contains three long and two short drawers, the tallboy has five, six, or seven long drawers, and two short ones. It is a very late 17th-century development of the smaller chest. The early examples are of walnut, but by far the largest proportion of the many that have survived are of mahogany, that being the wood most frequently employed in the 18th century for the construction of furniture, especially the more massive pieces. Occasionally the walnut at the beginning of the vogue of the tallboy was inlaid, just as satin-wood varieties were inlaid, depending for relief upon carved cornice-mouldings or gadrooning, and upon handsome brass handles and escutcheons. The tallboy was the wardrobe of the 18th century, but it eventually gave place to the modern type of wardrobe, which, with its sliding drawers, was speedily found to be not only as capacious as its predecessor but more convenient of access. The topmost drawers of the tallboy could only be reached by the use of bed steps, and the disappearance of high beds and the consequent disuse of steps exercised a certain influence in displacing a characteristic piece of furniture which was popular for at least a century.

TALLEMANT, GÉDÉON, SIEUR DES RÉAUX (1619–1692), French author, was born at La Rochelle on the 7th of November 1619. He belonged to a wealthy middle-class family of Huguenot persuasion; the name des Réaux he derived from a small property purchased by him in 1650. When he was about eighteen years of age he was sent to Italy with his brother François, abbé Tallemant. On his return to Paris, Tallemant took his degrees in civil and canonical law, and his father secured for him the position of *conseiller au parlement*. The profession was distasteful to him, and he decided to ensure himself a competence by marriage with his cousin Élisabeth de Rambouillet. His half-brother had married a d'Angennes, and this connexion secured for Tallemant an introduction to the Hôtel de Rambouillet. Madame de Rambouillet was no admirer of Louis XIII., and she gratified Tallemant's curiosity with stories of the reigns of Henry IV. and Louis XIII. of real historical value. But the society of the Hôtel de Rambouillet itself opened a field for his acute and somewhat malicious observation. In the *Historiettes* he gives finished portraits of Voiture, Balzac, Malherbe, Chapelain, Valentin Conrart and many others; Blaise Pascal and Jean de la Fontaine appear in his pages; and he chronicles the scandals of which Ninon de l'Enclos and Angélique Paulet were centres. They are invaluable for the literary history of the time. It has been said that the malicious intention of his work may be partly attributed to his bourgeois extraction and that the consequent slights he received are avenged in his pages, but independent testimony has established the substantial correctness of his statements. In 1685 he was converted to Catholicism. It seems that the change was not entirely disinterested, for Tallemant, who had suffered considerable pecuniary losses, soon after received a pension of 2000 livres. He died in Paris on the 6th of November 1692.

Des Réaux was a poet of some merit and contributed to the *Guirlande de Julie*, but it is by his *Historiettes* that he is remembered. The work remained in manuscript until it was edited in 1834–6 by MM. de Châteaugiron, Jules Taschereau and L. J. N. de Monmerqué, with a notice on Tallemant by Monmerqué. A third edition (6 vols. 1872) contains a notice by Paulin Paris. Tallemant had begun *Mémoires pour la régence d'Anne d'Autriche*, but the manuscript has not been found.

TALLEYRAND-PÉRIGORD, CHARLES MAURICE DE (1754–1838), French diplomatist and statesman, was born at Paris on the 13th of February 1754, though some accounts give the date as the 2nd of February. His father was Lieutenant-General Charles Daniel de Talleyrand-Périgord, and his mother was Alexandrine (*née*) de Damas Antigny. His parents, descended from ancient and powerful families, were in constant attendance at the court of Louis XV., and (as was generally the case then in their class) neglected the child. In his third or fourth year, while under the care of a nurse in Paris, he fell from a chest of drawers and injured his foot for life. This accident darkened his prospects; for though by the death of his elder brother he should have represented the family and entered the army, yet he forfeited the rights of primogeniture, and the profession of arms was thenceforth closed to him. Entrusted to the care of his grandmother at Chalais in Périgord, he there received the only kind treatment which he experienced in his early life, and was ever grateful for it. He was removed at the age of eight to the Collège d'Harcourt at Paris (now the Lycée St Louis), where his rich intellectual gifts enabled him to make good by private study the defects of the training there imparted. At the age of twelve he fell ill of smallpox, but his parents showed little or no interest in his recovery. Destined for the church by the family council which deprived him of his birthright, he was sent when about thirteen years of age to St Sulpice, where he conceived a dislike of the doctrines and discipline thrust upon him. After a visit to his uncle, the archbishop of Reims, he returned to St Sulpice to finish his preliminary training for the church, but in his spare time he read the works of Montesquieu, Voltaire, and other writers who were beginning to undermine the authority of the *ancien régime*, both in church and state. As subdeacon he witnessed the coronation of Louis XVI. at Reims, but he did not take priest's orders until four years later. Recent researches into his early life discredit most of the stories that have been told respecting his profligacy and his contempt for the claims of the church; and it is admitted that, while rejecting her authority in the sphere of dogma and intellect, he observed the proprieties of life (gambling being then scarcely looked on as a vice) and respected the outward observances of religion.

During his life at Paris he had opportunities of mixing in the circles of the philosophers and of others who frequented the salon of Madame de Genlis, and he there formed those ideas in favour of political and social reform which he retained through life. After taking his licentiate in theology in March 1778, he gave little more attention to theological studies. Nevertheless the acuteness of his powers, added no doubt to his social position, gained for him in the year 1780 the position of agent-general of the clergy of France, in which capacity he had to perform important administrative duties respecting the relations of the clergy to the civil power. The growing claims of the state on the exchequer of the clergy made his duties responsible, his colleague as agent-general being of little use. At the extraordinary assembly of the clergy in 1782 he made various proposals, by one of which he sought, though in vain, to redress the most glaring grievances of the underpaid *curés*. Though the excellence of his work as agent-general in the years 1780–86 was fully acknowledged, and earned him a special gift of 31,000 livres, yet he did not gain a bishopric until the beginning of the year 1789, probably because the king disliked him as a freethinker. He now became bishop of Autun, with a stipend of 22,000 livres, and was installed on the 15th of March.

The first rumblings of the revolutionary storm were making themselves heard. The elections for the States General were soon to take place; and the first important act of the new bishop was to draw up a manifesto or programme of the reforms which he desired to see carried out by the States General of France. It comprised the following items: the formation of a constitution which would strengthen the monarchy by calling to it the support of the whole nation, the drafting of a scheme of local self-government on democratic lines, the reform of the administration of justice and of the criminal law, and the abolition of the most burdensome of feudal and class privileges. This programme was adopted by the clergy of his diocese as their *cahier*, or book of instructions to their representative at the States General, namely Talleyrand himself.

His influence in the estate of the clergy, however, was cast against the union of the three estates in a single assembly, and he voted in the minority of his order which in the middle of June opposed the merging of the clergy in the National Assembly. The folly of the court, and the weakness of Louis XVI. at that crisis, probably convinced him that the cause of moderate reform and the framing of a bicameral constitution on the model of that of England were hopeless. Thereafter he inclined more and more to the democratic side, though for the present he concerned himself mainly with financial questions. In the middle of July he was chosen as one of the committee to prepare a draft of a constitution; and in the session of the Assembly which Mirabeau termed the *orgie* of the abolition of privileges (4th of August) he intervened in favour of discrimination and justice. On the 10th of October, that is, four days after the insurrection of women and the transference of the king and court to Paris, he proposed to the Assembly the confiscation of the lands of the church to the service of the nation, but on terms rather less rigorous than those in which Mirabeau (*q.v.*) carried the proposal into effect on the 2nd of November. He identified himself in general with the Left of the Assembly, and supported the proposed departmental system which replaced the old provincial system early in 1790. At the federation festival of the 14th of July 1790 (the "Feast of Pikes") he officiated at the altar reared in the middle of the Champ de Mars. This was his last public celebration of mass. For a brilliantly satirical but not wholly fair reference to the part then played by Talleyrand, the reader should consult Carlyle's *French Revolution*, vol. ii., bk. i., ch. 12. The course of events harmonized with the anticlerical views of Talleyrand, and he gradually loosened the ties that bound him to the church. He took little part in, though he probably sympathized with, the debates on the measure known as the Civil Constitution of the Clergy, whereby the state enforced its authority over the church to the detriment of its allegiance to the pope. When the Assembly sought to impose on its members an oath of obedience to the new decree, Talleyrand and three other bishops complied out of the thirty who had seats in the Assembly. The others, followed by the greater number of the clergy throughout France, refused, and thenceforth looked on Talleyrand as a schismatic. He did not long continue to officiate, as many of the so-called "constitutional" clergy did; for, on the 21st of January 1791, he resigned the see of Autun, and in the month of March was placed under the ban of the church by the pope.

Just before his resignation he had been elected, with Mirabeau and Sieyès, a member of the department of Paris; and in that capacity did useful work for some eighteen months in seeking to support the cause of order in the turbulent capital. Though he was often on strained terms with Mirabeau, yet his views generally coincided with those of that statesman, who is said on his death-bed (2nd of April 1791) to have communicated to him his opinions on domestic and international affairs, especially advising a close understanding with England. Talleyrand's reputation for immorality, however, was as marked as that of Mirabeau. While excelling him in suppleness and dexterity, he lacked the force of character possessed by the great "tribune of the people"; and his influence was gradually eclipsed by that of the more ardent and determined champions of democracy, the Girondins and the Jacobins. In the closing days of the first or Constituent Assembly, Talleyrand set forth (10th of September 1791) his ideas on national education. Education was to be free, and to lead up to the university. In place of dogma, the elements of religion were alone to be taught.

Debarred from election to the second National Assembly (known as the Legislative) by the self-denying ordinance passed by the "constituents," Talleyrand, at the close of 1791, sought to enter the sphere of diplomacy for which his mental qualities and his clerical training furnished him with an admirable equipment. The condition of affairs on the continent seemed to French enthusiasts to presage an attack by the other Powers on France. In reality those Powers were far more occupied with the Polish and Eastern questions than with the affairs of France; and the declaration of Pilnitz, drawn up by the sovereigns of Austria and Prussia, which appeared to threaten France with intervention, was recognized by all well-informed persons to be "a loud-sounding nothing." The French foreign minister, Delessart, believed that he would checkmate all the efforts of the *émigrés* at the continental courts provided that he could confirm Pitt in his intention of keeping England neutral. For that purpose Delessart sent Talleyrand, well known for his Anglophil tendencies, to London, but in the unofficial or semi-official capacity which was rendered necessary by the decree of the Constituent Assembly referred to above. Talleyrand arrived in London on the 24th of January 1792, and found public opinion so far friendly that he wrote off to Paris, "Believe me, a *rapprochement* with England is no chimera." Pitt received him cordially; and to Grenville the envoy stated his hope that the two free nations would enter into close and friendly relations, each guaranteeing the other in the possession of its existing territories, India and Ireland being included on the side of Britain. After some delay the British government decided to return no definite answer to this proposal, a result due, as Talleyrand thought, to the Gallophobe views of King George and of the ministers Camden and Thurlow. Talleyrand, however, was convinced that Great Britain would not intervene against France unless the latter attacked the Dutch Netherlands.

He returned to Paris on the 10th of March to persuade the foreign minister (Dumouriez now held that post) of the need of having a fully accredited ambassador at London. The ex-Marquis Chauvelin was appointed, with Talleyrand as adviser. The situation became more complex after the 19th of April, when France declared war against Austria and prepared to invade the Austrian or Belgic Netherlends. Owing to certain indiscretions of Chauvelin and the growing unpopularity of the French in England (especially after the disgraceful day of the 20th of June at the Tuileries), the mission was a failure; but Talleyrand had had some share in confirming Pitt in his policy of neutrality, even despite Prussia's overtures for an alliance against France. After Talleyrand's return to Paris early in July (probably in order to sound the situation there) matters went from bad to worse. The overthrow of the monarchy on the 10th of August and the September massacres rendered hopeless all attempts at an *entente cordiale* between the two peoples; and the provocative actions of Chauvelin, undertaken in order to curry favour with the extremists now in power at Paris, undid all the good accomplished by the tact and moderation of Talleyrand. The latter now sought to escape from France, where events were becoming intolerable; and after some unsuccessful attempts to obtain a passport to leave Paris, he succeeded on the 14th of September and landed in England on the 23rd, avowedly on private business, but still animated by the hope of averting a rupture between the two governments. In this he failed. The provocative actions of the French Convention, especially their setting aside of the rights of the Dutch over the estuary of the Scheldt, had brought the two nations to the brink of war, when the execution of Louis XVI. (21st of Jan. 1793) made it inevitable. Talleyrand was expelled from British soil and made his way to the United States. There he spent thirty months in a state of growing uneasiness and discontent with his surroundings.

The course of events after the Thermidorian reaction of July 1794 favoured his return to France. Thanks to the efforts of Daunou and others his name was removed from the list of *émigrés*, and he set sail for Europe in November 1795. Landing at Hamburg in the January following, he spent some time there in the company of his friends Madame de Genlis and Reinhard; and when party rancour continued to abate at Paris, he returned thither in September. After a time marked by some pecuniary embarrassment, he was recommended by Madame de Staël to the Director Barras for the post of minister of foreign affairs.

His claims on the attention of the Directors had been strengthened by his reading two papers before the French Institute, the first on the commercial relations between England and the United States (in the sense referred to above), and the second on the advantages to be derived from new colonies. In the latter there occurred the suggestive remarks that, whereas revolutions made men prematurely old and weary, the work of colonization tended to renew the youth of nations. France, he observed, needed the spur to practical energy which the Americans had at hand in the effort to subdue the difficulties placed in their way by nature. Similar efforts would tend to make Frenchmen forget the past, and would at the same time supply an outlet for the poor and discontented. The practical statesmanship contained in these papers raised Talleyrand in public estimation; and, thanks to the efforts above named, he gained the post of foreign minister, entering on his duties in July 1797.

Bonaparte by his victories over the Austrians in Italy and Styria had raised the French republic to heights of power never dreamed of, and now desired to impose on the emperor terms of peace, to which the Directors demurred. Talleyrand, despite the weakness of his own position (he was as yet little more than the chief clerk of his department), soon came to a good understanding with the general, and secretly expressed to him his satisfaction at the terms which the latter dictated at Campo Formio (17th of October 1797). The *coup d'état* of Fructidor (September 1797) had perpetuated the Directory and led to the exclusion of the two "moderate" members, Carnot and Barthélémy; but Talleyrand saw that power belonged really to the general who had brought about the *coup d'état* in favour of the Jacobinical Directors headed by Barras.

After the rupture of the peace negotiations with England, which resulted from the *coup d'état* of Fructidor, the policy of France became more warlike and aggressive. The occupation of Rome and of Switzerland by the French troops and the events of Bonaparte's Egyptian expedition (see NAPOLEON I.) brought about a renewal of war on the continent, but with these new developments Talleyrand had little or no connexion. His powers as minister were limited, and he regretted the extension of the area of war. Moreover, in the autumn of 1797 his reputation for political morality (never very bright) was overclouded by questionable dealings with the envoys of the United States sent to arrange a peaceful settlement of certain disputes with France. The investigations of the most recent of Talleyrand's biographers tend to show that the charges made against him of trafficking with the envoys have been overdrawn; but all his apologists admit that irregularities occurred. Talleyrand refused to clear himself of the charges made against him as his friends (especially Madame de Staël) urged him to do; and the incident probably told against his chances of admission into the Directory, which were discussed in the summer of 1798. A year later he resigned the portfolio for foreign affairs (20th of July 1799), probably because he foresaw the imminent collapse of the Directory. If so, his premonitions were correct. Their realization was assured by the return to France of the "Conqueror of the East" in October. The general and the diplomatist soon came to an understanding, and Talleyrand tactfully brought about the alliance between Bonaparte and Sieyès (*q.v.*) (then the most influential of the five Directors) which paved the way for the *coup d'état* of Brumaire (see FRENCH REVOLUTION and NAPOLEON I.).

Talleyrand's share in the actual events of the 18th, 19th Brumaire (9th, 10th of November) 1799 was limited to certain dealings with Barras on the former of those days. About midday he took to Barras a letter, penned by Roederer, requesting him to resign his post as Director. By what means Talleyrand brought him to do so, whether by persuasion, threats or bribes, is not known; but on that afternoon Barras left Paris under an escort of soldiers. With the more critical and exciting events of the 19th of Brumaire at St Cloud Talleyrand had no direct connexion; but he had made all his preparations for flight in case the blow failed. His reward for helping on the winning cause was the ministry for foreign affairs, which he held from the close of December 1799 on to the summer of 1807. In the great work of reconstruction of France now begun by the First Consul, Talleyrand played no unimportant part. His great aim was to bring about peace, both international and internal. He had a hand in the pacific overtures which Bonaparte, early in the year 1800, sent to the court of London; and, whatever may have been the motives of the First Consul in sending them, it is certain that Talleyrand regretted their failure. After the battle of Marengo an Austrian envoy had come to Paris in response to a proposal of Bonaparte, and Talleyrand persuaded him to sign terms of peace. These were indignantly repudiated at Vienna, but peace was made between the two Powers at Lunéville on the 9th of February 1801.

As regards French affairs, Talleyrand used his influence to help on the repeal of the vexatious laws against *émigrés*, non-juring priests, and the royalists of the west. He was also in full sympathy with the policy which led up to the signature of the Concordat of 1801–2 with the pope (see CONCORDAT); but it is probable that he had a hand in the questionable intrigues which accompanied the closing parts of that complex and difficult negotiation. At the end of June 1802 the pope removed Talleyrand from the ban of excommunication and allowed him to revert to the secular state. On the 10th of September 1803, owing to pressure put on him by Bonaparte, he married Madame Grand, a *divorcée* with whom he had long been living.

During the meeting of Italian notables at Lyons early in 1802 Talleyrand was serviceable in manipulating affairs in the way desired by Bonaparte, and it is known that the foreign minister suggested to them the desirability of appointing Bonaparte president of the Cisalpine Republic, which was thenceforth to be called the Italian Republic. In the negotiations for peace with England which went on at Amiens during the winter of 1801–2 Talleyrand had no direct share, these (like those at Lunéville) being transacted by Napoleon's eldest brother, Joseph Bonaparte (*q.v.*). On the other hand he helped the First Consul in assuring French supremacy in Switzerland, Italy and Germany. In Germany the indemnification of the princes who lost all their lands west of the Rhine was found by secularizing and absorbing the ecclesiastical states of the empire. This unscrupulous proceeding, known as the Secularizations (February 1803), was carried out largely on lines laid down by Bonaparte and Talleyrand; and the latter is known to have made large sums of money by trafficking with the claimants of church lands.

While helping to establish French supremacy in neighbouring states and assisting Bonaparte in securing the title of First Consul for life, Talleyrand sought all means of securing the permanent welfare of France. He worked hard to prevent the rupture of the peace of Amiens which occurred in May 1803, and he did what he could to prevent the sale of Louisiana to the United States earlier in the year. These events, as he saw, told against the best interests of France and endangered the gains which she had secured by war and diplomacy. Thereafter he strove to moderate Napoleon's ambition and to preserve the European system as far as possible. The charges of duplicity or treachery made against the foreign minister by Napoleon's apologists are in nearly all cases unfounded. This is especially so in the case of the execution of the duc d'Enghien (March 1804), which Talleyrand disapproved. The evidence against him rests on a document which is now known to have been forged. On the assumption of the imperial title by Napoleon in May 1804, Talleyrand became grand chamberlain of the empire, and received close on 500,000 francs a year.

Talleyrand had rarely succeeded in bending the will of the First Consul. He altogether failed to do so with the Emperor Napoleon. His efforts to induce his master to accord lenient terms to Austria in November 1805 were futile; and he looked on helplessly while that Power was crushed, the Holy Roman Empire swept away, and the Confederation of the Rhine set up in central Europe. In the bargainings which accompanied this last event Talleyrand is believed to have reaped a rich harvest from the German princes most nearly concerned. On the 6th of July 1806 Napoleon conferred on his minister the title of prince of Benevento, a papal fief in the Neapolitan territory.

In the negotiations with England which went on in the summer of 1806 Talleyrand had not a free hand; they came to nought, as did those with Russia which had led up to the signature of a Franco-Russian treaty at Paris by d'Oubril which was at once disavowed by the tsar. The war with Prussia and Russia was ended by the treaties of Tilsit (7th and 9th of July 1807). Talleyrand had a hand only in the later developments of these negotiations; and it has been shown that he cannot have been the means of revealing to the British government the secret arrangements made at Tilsit between France and Russia, though his private enemies, among them Fouché, have charged him with acting as traitor in this affair.

Talleyrand had long been weary of serving a master whose policy he more and more disapproved, and after the return from Tilsit to Paris he resigned office. Nevertheless Napoleon retained him in the council and took him with him to the interview with the Emperor Alexander I. at Erfurt (September 1808). There Talleyrand secretly advised that potentate not to join Napoleon in putting pressure on Austria in the way desired by the French emperor; but it is well known that Alexander was of that opinion before Talleyrand tendered the advice. Talleyrand disapproved of the Spanish policy of Napoleon which culminated at Bayonne in May 1808; and the stories to the contrary may in all probability be dismissed as idle rumours. It is also hard to believe the statement in the Talleyrand *Memoirs* that the ex-foreign minister urged Napoleon to occupy Catalonia until a maritime peace could be arranged with England. On Talleyrand now fell the disagreeable task of entertaining at his new mansion at Valençay, in Touraine, the Spanish princes virtually kidnapped at Bayonne by the emperor. They remained there until March 1814. At the close of 1808, while Napoleon was in Spain, Talleyrand entered into certain relations with his former rival Fouché (*q.v.*), which aroused the solicitude of the emperor and hastened his return to Paris. He subjected Talleyrand to violent reproaches, which the ex-minister bore with his usual ironical calm.

After the Danubian campaign of 1809 and the divorce of Josephine, Talleyrand used the influence which he still possessed in the imperial council on behalf of the choice of an Austrian consort for his master, for, like Metternich (who is said first to have mooted the proposal), he saw that this would safeguard the interests of the Habsburgs, whose influence he felt to be essential to the welfare of Europe. He continued quietly to observe the course of events during the disastrous years 1812–13; and even at the beginning of the Moscow campaign he summed up the situation in the words, "It is the beginning of the end." Early in 1814 he saw Napoleon for the last time; the emperor upbraided him with the words: "You are a coward, a traitor, a thief. You do not even believe in God. You have betrayed and deceived everybody. You would sell even your own father." Talleyrand listened unmoved, but afterwards sent in his resignation of his seat on the council. It was not accepted. He had no share in the negotiations of the congress of Châtillon in February-March 1814. On the surrender of Paris to the allies (30th of March 1814), the Emperor Alexander I. took up his abode at the hôtel Talleyrand, and there occurred the conference wherein the statesman persuaded the victorious potentate that the return of the Bourbons was the only possible solution of the French problem, and that the principle of legitimacy alone would guarantee Europe against the aggrandizement of any one state or house. As he phrased it in the Talleyrand *Memoirs:* "The house of Bourbon alone could cause France nobly to conform once more to the happy limits indicated by policy and by nature. With the house of Bourbon France ceased to be gigantic in order to be great." These arguments, reinforced by those of the royalist agent de Vitrolles, convinced the tsar; and Talleyrand, on the 1st of April, convened the French senate (only 64 members out of 140 attended), and that body pronounced that Napoleon had forfeited the crown. Ten days later the fallen emperor recognized the inevitable and signed the Act of Abdication at Fontainebleau. The next effort of Talleyrand was to screen France under the principle of legitimacy and to prevent the scheme of partition on which several of the German statesmen were bent. Thanks mainly to the support of the tsar and of England these schemes were foiled; and France emerged from her disasters with frontiers which were practically those of 1792.

At the congress of Vienna (1814–15) for the settlement of European affairs, Talleyrand, as the representative of the restored house of Bourbon in France, managed adroitly to break up the league of the Powers (framed at Chaumont in February 1814) and assisted in forming a secret alliance between England, Austria and France in order to prevent the complete absorption of Poland by Russia and of Saxony by Prussia. The new triple alliance had the effect of lessening the demands of those Powers, and of leading to the well-known territorial compromise of 1815. Everything was brought into a state of uncertainty once more by the escape of Napoleon from Elba; but the events of the Hundred Days, in which Talleyrand had no share—he remained at Vienna until the 10th of June—brought in the Bourbons once more; and Talleyrand's plea for a magnanimous treatment of France under Louis XVIII. once more prevailed in all important matters. On the 9th of July 1815 he became foreign minister and president of the council under Louis XVIII., but diplomatic and other difficulties led him to resign his appointment on the 23rd of September 1815, Louis, however, naming him high chamberlain and according him an annuity of 100,000 francs. The rest of his life calls for little notice except that at the time of the July Revolution of 1830, which unseated the elder branch of the Bourbons, he urged Louis Philippe, duke of Orleans (*q.v.*), to take the throne offered to him by popular acclaim. The new sovereign offered him the portfolio for foreign affairs; but Talleyrand signified his preference for the embassy in London. In that capacity he took an important part in the negotiations respecting the founding of the new kingdom of Belgium. In April 1834 he crowned his diplomatic career by signing the treaty which brought together as allies France, Great Britain, Spain and Portugal; and in the autumn of that year he resigned his embassy. During his last days he signed a paper signifying his reconciliation with the Roman Catholic Church and his regret for many of his early actions. The king visited his death-bed. His death, on the 17th of May 1838, called forth widespread expressions of esteem for the statesman who had rendered such great and varied services to his country. He was buried at Valençay. He had been separated from the former Madame Grand in 1815 and left no heir.

Under all the inconsistencies of Talleyrand's career there lies an aim as steadily consistent as that which inspired his contemporary, Lafayette. They both loved France and the cause of constitutional liberty. Talleyrand believed that he served those causes best by remaining in office whenever possible, and by guiding or moderating the actions of his chiefs. He lived to see the triumph of his principles; and no Frenchman of that age did so much to repair the mischief wrought by fanatics and autocrats. In the opinion of enlightened men this will mitigate the censures that must be passed on him for his laxity in matters financial. If he enriched himself, he also helped to save France from ruin at more crises than one. In private life his ease of bearing, friendliness, and, above all, his inexhaustible fund of humour and irony, won him a large circle of friends; and judges so exacting as Mmes de Staël and de Rémusat and Lord Brougham avowed their delight in his society.

By a codicil added to his will on the 17th of March 1838 Talleyrand left his memoirs and papers to the duchess of Dino and to M. de Bacourt. The latter revised them with care, and added to them other pieces emanating from Talleyrand. They were not to be published until after the lapse of thirty years from the time of Talleyrand's death. For various reasons they did not see the light until 1891. This is not the place in which to discuss so large a question as that of the genuineness of the *Mémoires*, which, indeed, is now generally admitted. There are, however, several suspicious circumstances which tell against them as documents of the first importance, notably these: first that Talleyrand is known to have destroyed many of his most important papers, and secondly that

M. de Bacourt almost certainly drew up the connected narrative which we now possess from notes which were in more or less of confusion. For this question see articles by M. Chuquet in *Rev. critique d'histoire et de littérature*, 25th of May 1891 (Paris); also articles by others in the *Rev. historique*, vols. xlviii. and xlix. (Paris); also in the *Quarterly Review*, No. 345 (London, 1891), and *Edinburgh Review*, vol. 174 (London, 1891); by P. Bailleu in the *Historische Zeitschrift*, vol. lxviii. (Munich, 1892), and by Albert Sorel in his *Lectures historiques* (pp. 70–112).

The Talleyrand *Mémoires* were edited by the duc de Broglie in 5 vols. (Paris, 1891–2). They have been translated into English by A. Hall, 5 vols. (London, 1891–2). Of his letters and despatches the following are the chief collections:—G. Pallain, *La mission de Talleyrand à Londres en* 1792 (Paris, 1889), and *Le ministère de Talleyrand sous le Directoire* (Paris, 1891); P. Bertrand, *Lettres inédites de Talleyrand à Napoléon*, 1800–9 (Paris, 1889); G. Pallain, *Talleyrand et Louis XVIII.* (Paris, 1881), and *Ambassade de Talleyrand à Londres* (1830–4), 2 vols. (Paris, 1891).

Among the biographies, or biographical notices, of Talleyrand the following are, on the whole, hostile to him: G. Touchard Lafosse, *Talleyrand, histoire politique et vie intime* (Paris, 1848); G. Michaud, *Hist. politique et privée de Talleyrand* (Paris, 1853); A. Pichot, *Souvenirs intimes sur Talleyrand* (Paris, 1870); Sainte-Beuve, "Talleyrand," in *Nouveaux lundis*, No. xii.; and Villemarest, *Talleyrand.* The estimate of him of Sir H. L. E. Bulwer Lytton in his *Historical Characters*, 2 vols. (London, 1867) and that of Lord Brougham in *Historical Sketches of Statesmen*, 3 vols. (London, 1845, new edition), are better balanced, but brief. Of recent biographies of Talleyrand the best are Lady Blennerhasset's *Talleyrand* (Berlin, 1894, Eng. translation by F. Clarke, 2 vols. London, 1894); *Talleyrand, a Biographical Study*, by Joseph McCabe (London, 1906); and Bernard de Lacombe, *La vie privée de Talleyrand* (1910). (J. Hl. R.)

TALLIEN, JEAN LAMBERT (1767–1820), French Revolutionist, was the son of the *maître d'hôtel* of the marquis de Bercy, and was born in Paris. The marquis, perceiving the boy's ability, had him well educated, and got him a place as a lawyer's clerk. Being much excited by the first events of the Revolution, he gave up his desk to enter a printer's office, and by 1791 he was overseer of the printing department of the *Moniteur*. While thus employed he conceived the idea of the *journal-affiche*, and after the arrest of the king at Varennes in June 1791 he placarded a large printed sheet on all the walls of Paris twice a week, under the title of the *Ami des Citoyens, journal fraternel*.

This enterprise, of which the expenses were defrayed by the Jacobin Club, made him well known to the revolutionary leaders; and he made himself still more conspicuous in organizing the great "Fête de la Liberté" on the 15th of April 1792, in honour of the released soldiers of Château-Vieux, with Collot d'Herbois. On the 8th of July 1792, he was the spokesman of a deputation of the section of the Place Royale which demanded from the legislative assembly the reinstatement of the mayor, Jérome Pétion, and the *procureur*, P. L. Manuel, and he was one of the most active popular leaders in the attack upon the Tuileries on the 10th of August, on which day he was appointed secretary or clerk to the revolutionary commune of Paris. In this capacity he exhibited an almost feverish activity; he perpetually appeared at the bar of the assembly on behalf of the commune; he announced the massacres of September in the prisons in terms of apology and praise; and he sent off the famous circular of the 3rd of September to the provinces, recommending them to do likewise. He had several persons imprisoned in order to save them from the fury of the mob, and protected several suspects himself. At the close of the month he resigned his post on being elected, in spite of his youth, a deputy to the Convention by the department of Seine-et-Oise, and he began his legislative career by defending the conduct of the Commune during the massacres. He took his seat upon the Mountain, and showed himself one of the most vigorous Jacobins, particularly in his defence of Marat, on the 26th of February 1793; he voted for the execution of the king, and was elected a member of the Committee of General Security on the 21st of January 1793. After a short mission in the western provinces he returned to Paris, and took an active part in the *coups d'état* of the 31st of May and the 2nd of June, which resulted in the overthrow of the Girondists. For the next few months he remained comparatively quiet, but on the 23rd of September 1793, he was sent with Claude Alexandre Ysabeau (1754–1831) on his mission to Bordeaux. This was the month in which the Terror was organized under the superintendence of the Committees of Public Safety and General Security.

Tallien showed himself one of the most vigorous of the proconsuls sent over France to establish the Terror in the provinces; though with but few adherents, he soon awed the great city into quiet. It was at this moment that the romance of Tallien's life commenced. Among his prisoners was Therèse, the divorced wife of the comte de Fontenay, and daughter of the Spanish banker, François Cabarrus, one of the most fascinating women of her time, and Tallien not only spared her life but fell in love with her. Suspected of "Moderatism" on account of this incident, especially when he was recalled to Paris, Tallien increased, in appearance, his revolutionary zeal, but Therèse abated his revolutionary ardour, and from the lives she saved by her entreaties she received the name of "Our Lady of Thermidor," after the 9th of Thermidor. Tallien was even elected president of the Convention on the 24th of March 1794. But the Terror could not be maintained at the same pitch: Robespierre began to see that he must strike at many of his own colleagues in the committees if he was to carry out his theories, and Tallien was one of the men condemned with them. They determined to strike first, and on the great day of Thermidor it was Tallien who, urged on by the danger in which his beloved lay, opened the attack upon Robespierre. The movement was successful; Robespierre and his friends were guillotined; and Tallien, as the leading Thermidorian, was elected to the Committee of Public Safety. He showed himself a vigorous Thermidorian; he was instrumental in suppressing the Revolutionary Tribunal and the Jacobin Club; he attacked J. B. Carrier and Joseph Lebon, the *représentants en mission* of Nantes and Arras; and he fought bravely against the insurgents of Prairial. In all these months he was supported by Therèse, whom he married on the 26th of December 1794, and who became the leader of the social life of Paris. His last political achievement was in July 1795, when he was present with Hoche at the destruction of the army of the *émigrés* at Quiberon, and ordered the executions which followed. After the close of the Convention Tallien's political importance came to an end, for, though he sat in the Council of Five Hundred, the moderates attacked him as terrorist, and the extreme party as a renegade. Madame Tallien also tired of him, and became the mistress of the rich banker Ouvrard. Bonaparte, however, who is said to have been introduced by him to Barras, took him to Egypt in his great expedition of June 1798, and after the capture of Cairo he edited the official journal there, the *Décade Egyptienne.* But General J. F. Menou sent him away from Egypt, and on his passage he was captured by an English cruiser and taken to London, where he had a good reception among the Whigs and was well received by Fox. On returning to France in 1802 he obtained a divorce from his wife (who in 1805 married the comte de Caraman, later prince de Chimay), and was left for some time without employment. At last, through Fouché and Talleyrand, he got the appointment of consul at Alicante, and remained there until he lost the sight of one eye from yellow fever. On returning to Paris he lived on his half-pay until 1815, when he received the favour of not being exiled like the other regicides. His latter days were spent in poverty; he had to sell his books to get bread. He died in Paris on the 16th of November 1820.

Tallien left an interesting *Discours sur les causes qui ont produit la Révolution française* (Paris, 1791, in 8vo) and a *Mémoire sur l'administration de l'Égypte à l'arrivée des Français.* See *Tallien et l'Expédition d'Égypte*, in *La Révolution Française: Revue d'histoire moderne et contemporaine*, t. iii. p. 269. On Madame Tallien see Arsène Houssaye, *Notre Dame de Thermidor* (Paris, 1866); J. Turquan, *Souveraines et grandes Dames: La citoyenne Tallien, témoignages des contemporains et documents inédits* (Paris, 1898); and Louis Gastine, *La belle Tallien* (1909).

TALLIS (Tallys, Talys, or Tallisius), **THOMAS** (*c.* 1515–1585), justly styled "the father of English cathedral music," was born about 1515. It has been conjectured that, after singing as a chorister at old Saint Paul's under Thomas Mulliner, he obtained a place among the children of the chapel royal. He is known to have become organist at Waltham abbey, where, on the dissolution of the monastery in 1540, he received, in compensation for the loss of his preferment, 20s. for wages and 20s. for reward. In the library of the British Museum there is preserved a volume of MS. treatises on music, once belonging to the abbey, on the last page of which appears his autograph, "Thomas Tallys"—the only specimen known.

Not long after his dismissal from Waltham, Tallis was appointed a gentleman of the chapel royal; and thenceforward he laboured so zealously for the advancement of his art that the English school owes more to him than to any other composer of the 16th century.

One of the earliest compositions by Tallis to which an approximate date can be assigned is the well-known *Service in the Dorian Mode*, consisting of the *Venite*, *Te Deum*, *Benedictus*, *Kyrie*, *Nicene Creed*, *Sanctus*, *Gloria in Excelsis*, *Magnificat* and *Nunc Dimittis*, for four voices, together with the *Preces*, *Responses*, *Paternoster* and *Litany*, for five, all published for the first time, in the Rev. John Barnard's *First Book of Selected Church Music*, in 1641, and reprinted, with the exception of the *Venite* and *Paternoster*, in Boyce's *Cathedral Music* in 1760.[1] That this work was composed for the purpose of supplying a pressing need, after the publication of the second prayer-book of King Edward VI. in 1552, there can be no doubt. Written in the style known among Italian composers as *lo stile famigliare*, *i.e.* in simple counterpoint of the first species, *nota contra notam*, with no attempt at learned complications of any kind—it adapts itself with equal dignity and clearness to the expression of the verbal text it is intended to illustrate, bringing out the sense of the words so plainly that the listener cannot fail to interpret them aright, while its pure rich harmonies tend far more surely to the excitement of devotional feeling than the marvellous combinations by means of which too many of Tallis's contemporaries sought to astonish their hearers, while forgetting all the loftier attributes of their art. In self-restraint the *Litany* and *Responses* bear a close analogy to the *Improperia* and other similar works of Palestrina, wherein, addressing himself to the heart rather than to the ear, the *princeps musicae* produces the most thrilling effects by means which, to the superficial critic, appear almost puerile in their simplicity, while those who are able to look beneath the surface discern in them a subtlety of style such as none but a highly cultivated musician can appreciate. Of this profound learning Tallis possessed an inexhaustible store; and it enabled him to raise the English school to a height which it had never previously attained, and which it continued to maintain until the death of its last representative, Orlando Gibbons, in 1625. Though this school is generally said to have been founded by Dr Tye, there can be no doubt that Tallis was its greatest master, and that it was indebted to him alone for the infusion of new life and vigour which prevented it from degenerating, as some of the earlier Flemish schools had done, into a mere vehicle for the display of fruitless erudition. Tallis's ingenuity far surpassed that of his most erudite contemporaries; and like every other great musician of the period, he produced occasionally works confessedly intended for no more exalted purpose than the exhibition of his stupendous skill. In his canon *Miserere nostri* (given in Hawkins's *History of Music*) the intricacy of the contrapuntal devices seems little short of miraculous; [yet the resulting harmony is smooth and normal, and only the irregular complexity of the rhythm betrays the artificiality of its structure. The famous forty-part motet, *Spem in alium*, written for eight five-part choirs, stands on a far higher plane, and the *tour de force* of handling freely and smoothly so many independent parts is the least remarkable of its qualities. An excellent modern edition of it was produced by Dr A. H. Mann in 1888 (London, Weekes & Co.); and, when the reader has overcome the difficulty of reading a score that runs across two pages, he finds himself in the presence of a living classic. The art with which the climaxes are built up shows that Tallis's object in writing for forty voices is indeed to produce an effect that could not be produced by thirty-nine.] These *tours de force*, however, though approachable only by the greatest contrapuntists living in an age in which counterpoint was cultivated with a success that has never since been equalled, serve to illustrate one phase only of Tallis's many-sided genius, which shines with equal brightness in the eight psalm-tunes (one in each of the first eight modes) and unpretending little *Veni Creator*, printed in 1567 at the end of Archbishop Parker's *First Quinquagene of Metrical Psalms*, and many other compositions of like simplicity.

[1] Boyce's unaccountable omission of the very beautiful *Venite* is a misfortune which cannot be too deeply deplored, since it has led to its consignment to almost hopeless oblivion.

In 1575 Tallis and his pupil William Byrd—as great a contrapuntist as himself—obtained from Queen Elizabeth royal letters patent granting them the exclusive right of printing music and ruling music-paper for twenty-one years; and, in virtue of this privilege, they issued, in the same year, a joint work, entitled *Cantiones quae ab argumento Sacrae vocantur, quinque et sex partium*, containing sixteen motets by Tallis and eighteen by Byrd, all of the highest degree of excellence. Some of these motets, adapted to English words, are now sung as anthems in the Anglican cathedral service. But no such translations appear to have been made during Tallis's lifetime; and there is strong reason for believing that, though both he and Byrd outwardly conformed to the new religion, and composed music expressly for its use, they remained Catholics at heart.

Tallis's contributions to the *Cantiones Sacrae* were the last of his compositions published during his lifetime. He did not live to witness the expiration of the patent, though Byrd survived it and published two more books of *Cantiones* on his own account in 1589 and 1591, besides numerous other works. Tallis died November 23, 1585, and was buried in the parish church at Greenwich, where a quaint rhymed epitaph, preserved by Strype, and reprinted by Burney and Hawkins, recorded the fact that he served in the chapel royal during the reigns of Henry VIII., Edward VI., Mary, and Elizabeth. This was destroyed with the old church about 1710; but a copy has since been substituted. Portraits, professedly authentic, of Tallis and Byrd, were engraved by Vandergucht in 1730, for Nicolas Haym's projected *History of Music*, but never published. One copy only is known to exist.

Not many works besides those already mentioned were printed during Tallis's lifetime; but a great number are preserved in MS. It is to be feared that many more were destroyed, in the 17th century during the spoliation of the cathedral libraries by the Puritans. (W. S. R.)

TALLOW (M.E. *talugh*, *talg*, cf. Du. *talk*, L. Ger. *talg*; the connexion with O.E. *taelg*, dye, or Goth, *tulgus*, firm, is doubtful), the solid oil or fat of ruminant animals, but commercially obtained almost exclusively from oxen and sheep. The various methods by which tallow and other animal fats are separated and purified are dealt with in the article OILS. Ox tallow occurs at ordinary temperatures as a solid hard fat having a yellowish white colour. The fat is insoluble in cold alcohol, but it dissolves in boiling alcohol, in chloroform, ether and the essential oils. The hardness of tallow and its melting-point are to some extent affected by the food, age, state of health, &c., of the animal yielding it, the firmest ox tallow being obtained in certain provinces of Russia, where for a great part of the year the oxen are fed on hay. New tallow melts at from 42·5° to 43° C., old tallow at 43·5°, and the melted fat remains liquid till its temperature falls to 33° or 34° C. Tallow consists of a mixture of two-thirds of the solid fats palmitin and stearin, with one-third of the liquid fat olein.

Mutton tallow differs in several respects from that obtained from oxen. It is whiter in colour and harder, and contains only about 30 per cent. of olein. Newly rendered it has little taste or smell, but on exposure it quickly becomes rancid. Sweet mutton tallow melts at 46° and solidifies at 36° C.; when old it does not melt under 49°, and becomes solid on reaching 44° or 45° C. It is sparingly soluble in cold ether and in boiling alcohol.

TALLOW TREE, in botany, the popular name of a small tree, *Stillingia sebifera*, belonging to the family Euphorbiaceae, a native of China, but cultivated in India and other warm countries. The seeds are thickly coated with a white greasy substance—so-called vegetable tallow—from which candles are made, and which is also used in soap-making and dressing cloth. The butter tree or tallow tree of Sierra Leone is *Pentadesma butyracea*, a member of the family Guttiferae. The fruit, which is 4 to 5 in. long and about 3 in. in diameter, has a thick fleshy rind abounding in a yellow greasy juice.

TALLY, an old device, now obsolete, formerly used in the English exchequer for the purpose of keeping accounts. The tally was a willow or hazel stick about one inch in depth and thickness, and roughly shaped like a thick knife-blade (see Fig. 1). Notches (see Fig. 2) were cut on it showing the amount paid, a gauged width of $1\frac{1}{2}$ inches representing £1000, 1 inch £100, $\frac{3}{8}$ inch £10, half a notch of this size representing £1; $\frac{3}{16}$ inch 1s., and the smallest notch 1d.; half-pennies were represented by small holes. The account of the transaction was written on the two opposite sides, the piece of wood being then split down the middle through the notches; one half, called the tally, being given as a form of receipt to the person making the payment, while the other half, called the counter-tally, was kept in the exchequer. Payments made into the exchequer were entered into an account-book, from which they were transferred to a strip of parchment, or *teller's bill*; this was then thrown down a pipe into the *tally-court*, a large room directly under the teller's office. In the tally-court were officers of the clerk of the "pells"[1] and of the auditor as representing the chamberlain of the exchequer. The teller's bill was then entered in the introitus or receipt-book by the officer of the clerk of the pells, and in another book, called the *bill of the day*, by the auditor's clerk. A tally was then made of the teller's bill, and it was given on application, generally on the following day, to the person paying in the money. At the end of the day, the bill of the day was passed on to the clerk of the cash-book, by whom all the day's receipts were entered (see the "Great Account" of *Public Income and Expenditure*, part ii. app. 13, July 1869, by H. W. Chisholm).

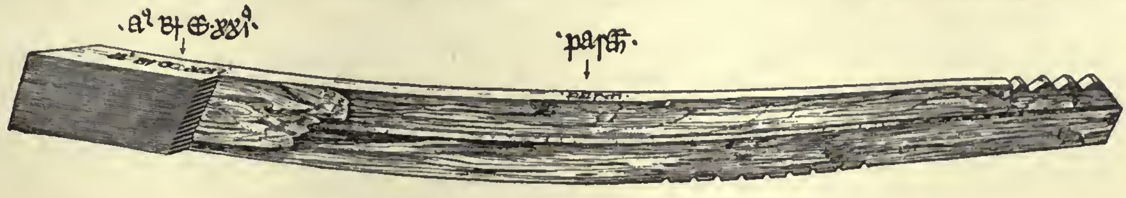

FIG. 1.—A tally ($\frac{3}{4}$ scale) (not the same as that shown in Fig. 2).

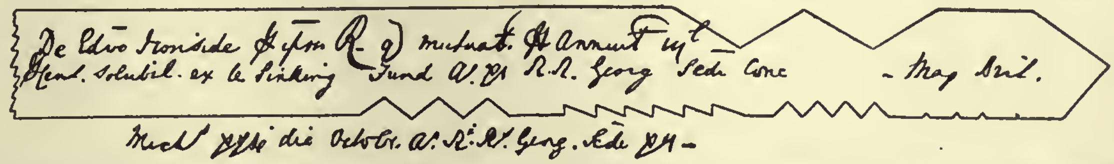

FIG. 2.—Diagrammatic view, showing notches with facsimile of writing, of an Exchequer tally ($\frac{3}{4}$ scale), acknowledging the receipt of £236, 4s. $3\frac{1}{2}$d. on the 25th of October 1739, from Edward Ironside, Esq., as a loan to the king on £3 per cent. annuities payable out of the Sinking Fund, on account of £500,000 granted by Act 11 Geo. II., c. 27. The date is written upon the upper side of the tally, where the two notches denoting £200 are cut. The lower side, on which the smaller notches are cut, has only the word *Sol* written upon it.

The practice of issuing wooden tallies was ordered to be discontinued by an act of 1782; this act came into force on the death of the last of the chamberlains in 1826. The returned tallies were stored in the room which had formerly been the Star-chamber. This room was completely filled by them, so that in 1834, when it was desired to use the room, the tallies were ordered to be destroyed. They were used as fuel for the stoves which warmed the houses of parliament. On the 16th of October 1834 the houses of parliament were burnt down by the overheating of the stoves through using too many of the tallies.

The so-called *tally-trade* was an old system of dealing carried on in London and in the manufacturing districts of England, by which shopkeepers furnished certain articles on credit to their customers, the latter paying the stipulated price for them by weekly or monthly instalments (see M'Culloch, *Dictionary of Commerce*)—the precursor, in fact, of the modern instalment system.

See S. R. Scargill-Bird, *Guide to the Public Records* (*Calendar of State Papers*); H. Hall, *Curiosities and Antiquities of the Exchequer*.

[1] So called from the pells or sheepskins (Lat. *pellis*, skin) on which the records were written. The clerk of the pells was originally the private clerk of the treasurer. His duty was to keep separate records of all monies entering and leaving the exchequer. These records were kept on two rolls, the *pellis introitus*, or pells receipt roll, and the *pellis exitus*, or pells issue roll. The office gradually became a sinecure, its duties being discharged by deputy. Previously to 1783 the salary of the office was derived from fees and percentages, but in that year parliament settled the salary at £1500 a year. The office was abolished in 1834.

TALMA, FRANÇOIS JOSEPH (1763–1826), French actor, was born in Paris on the 15th of January 1763. His father, a dentist there, and afterwards in London, gave him a good English education, and he returned to Paris, where for a year and a half he practised dentistry. His predilection for the stage was cultivated in private theatricals, and on the 21st of November 1787 he made his *début* at the Comédie Française as Seide in Voltaire's *Mahomet*. His efforts from the first won approval, but for a considerable time he only obtained secondary parts. It was as the *jeune premier* that he first came prominently into notice, and he attained only gradually to his unrivalled position as the exponent of strong and concentrated passion. Talma was among the earliest advocates of realism in scenery and costume, being aided by his friend the painter David. His first essay in this direction took the form of appearing in the small rôle of Proculus in Voltaire's *Brutus*, with a toga and Roman head-dress, much to the surprise of an audience accustomed to 18th century costume on the stage, and heedless whether or not it suited the part played. Talma possessed in perfection the physical gifts fitting him to excel in the highest tragedy, an admirably proportioned figure, a striking countenance, and a voice of great beauty and power, which, after he had conquered a certain thickness of utterance, enabled him to acquire a matchless elocution. At first somewhat stilted and monotonous in his manner, he became by perfection of art a model of simplicity. Talma married Julie Carreau, a rich and talented lady in whose salon were to be met the principal Girondists. The actor was an intimate friend of Napoleon, who delighted in his society, and even, on his return from Elba, forgave him for performing before Louis XVIII. In 1808 the emperor bad taken him to Erfurt and made him play the *Mort de César* to a company of crowned heads. Five years later he took him also to Dresden. Talma was also a friend of Joseph Chénier, Danton, Camille Desmoulins and other revolutionists. It was in Chénier's anti-monarchical *Charles IX.*, produced on the 4th of November 1789, that a prophetic couplet on the destruction of the Bastille made the house burst into a salvo of applause, led by Mirabeau. This play was responsible for the political dissensions in the Comédie Française which resulted in the establishment, under Talma, of a new theatre known for a time as the Théâtre de la République, on the site of the present Théâtre Français. Here he won his greatest triumphs. Further development in costume and make-up was shown in his stage portrait of Jean Jacques Rousseau (1790), pronounced a wonderful likeness in *Le journaliste des ombres*. In 1801 he divorced his wife, and in 1802 married Charlotte Vanhove, an actress of the Comédie Française. He made his last appearance on the 11th of June 1826 as Charles VI. in Delaville's tragedy, and he died in Paris on the 19th of October of that year.

Talma was the author of *Mémoires de Lekain, précédés de réflexions sur cet acteur et sur l'art théâtral*, contributed to the *Collection des mémoires sur l'art dramatique*, and published separately (1856) as *Réflexions de Talma sur Lekain et l'art théâtral*.

See *Mémoires de F. J. Talma, écrits par lui-même, et recueillis et mis en ordre sur les papiers de sa famille*, by Alex. Dumas (1850).

TALMAGE, THOMAS DE WITT (1832–1902), American Presbyterian preacher, born at Bound Brook, New Jersey, on the 7th of January 1832. He was educated at the University of the City of New York (now New York University) and at the Reformed Dutch Theological Seminary at New Brunswick, N.J., from which he was graduated in 1856. Immediately afterwards he became pastor of a Reformed church at Belleville, N.J. In 1859 he removed to Syracuse, N.Y.; in 1862 to Philadelphia, where he was pastor of the Second Reformed Dutch Church; and in 1869 to the Central Presbyterian Church in Brooklyn, where a large building known as the Tabernacle was erected for him in 1870. In 1872 this building was burned down. A larger one, holding 5000 persons, was built for him in 1873, but even this could not contain the crowds attracted by his eloquence and sensationalism. In 1889 this church also was burned to the ground, only to be succeeded by another and larger one, which in its turn was burned in 1894. Shortly afterwards he removed to Washington, where from 1895 to 1899 he was the associate pastor, with Dr Byron Sunderland (d. 1901), of the First Presbyterian Church. During the last years of his life Dr Talmage ceased to preach, and devoted himself to editing, writing and lecturing. At different periods he was editor of the *Christian at Work* (1873–76), New York; the *Advance* (1877–79), Chicago; *Frank Leslie's Sunday Magazine* (1879–89), New York; and the *Christian Herald* (1890–1902), New York. For years his sermons were published regularly in more than 3000 journals, reaching, it is said, 25,000,000 readers. His books also have had large circulations; among them are *The Almond Tree in Blossom* (1870); *Every Day Religion* (1875); *The Brooklyn Tabernacle* (1884); *From Manger to Throne* (1895); and *The Pathway of Life* (1895). His eloquence, while sensational, was real and striking, and his fluency and the picturesqueness of his language and imagery were remarkable. He died at Washington on the 12th of April 1902.

TALMUD, the great Rabbinical thesaurus which grew up during the first four or six centuries of the Christian Era, and, with the Old Testament, became the "Bible" of the Jews, and the chief subject of their subsequent literary activity.

1. *Contents*.—The Talmūd (Hebrew "teaching, learning") consists of the *Mishnāh* (Heb. "[oral] repetition, teaching"), a systematic collection of religious-legal decisions developing the laws of the Old Testament, and the *Gĕmārā* (Aramaic "completion, decision," or perhaps also "teaching"), supplementary material, legal and otherwise.[1] The whole was in two great recensions, Palestinian and Babylonian. Other material related to the Mishnāh is preserved in the *Tōsephtā* (Aram. "addition") and the *Midrāshīm*, and since all these, together with the *Targūmīm*, represent the orthodox Rabbinical literature connecting the Old Testament with medieval and modern Judaism, the reader should also consult the articles JEWS (parts ii. and iii.), MIDRASH, TARGUM, and for more detailed and critical treatment the references given to the *Jewish Encyclopedia*.

[1] Mishnah stands in contrast to *Miqrā* ("reading, scripture"); its Aram. equivalent is *Mathnīthā*, from *tĕnā*, "to repeat," whence the appellation *Tannā*, "teacher" (§ 3 below). These and the terms Gemara, Talmud, &c., are more fully explained in H. L. Strack's invaluable *Einleitung in den Talmud* (Leipzig, 1908), pp. 2 sqq.

The Mishnah is a more or less careful arrangement of the extant Oral Law (see § 2). It forms the foundation of the Gemara, and is divided into six *Sĕdārīm* or Orders, each containing a number of *Massektōth* ("weavings," cf. the etymology of "text") or Tractates. These are subdivided into *Pĕrāqīm* ("sections") or chapters, and these again into paragraphs or sentences.

I. *Zĕra'īm* ("seeds"), the first Order, on agriculture, is introduced by (1) *Bĕrākōth* ("blessings"), on daily and other prayers and blessings. (2) *Pē'āh* ("corner"), deals with Lev. xix. 9 seq., xxiii. 22; Deut. xxiv. 19–22, and the rights of the poor. (3) *Dĕmai*, or rather *Dammai* ("doubtful"), on doubtful cases relating to the tithing of fruit offerings. (4) *Kil'ayim* ("of two sorts"), on forbidden mixtures (Lev. xix. 19; Deut. xxii. 9–11). (5) *Shĕbī'īth* ("seventh"), on the sabbatical year (Ex. xxiii. 11; Lev. xxv. 1–8; Deut. xv. 1 sqq.). (6) *Tĕrūmōth* ("heave offerings"), on the laws in Num. xviii. 8 sqq., 25 seq.; Deut. xviii. 4. (7) *Ma'asrōth* ("tithes") or *Ma'asēr Rī'shōn* ("first tithe"), with reference to the Levites, Num. xviii. 21–24. (8) *Ma'asēr Shēnī* ("second tithe"), with reference to the tithe eaten at Jerusalem, Deut. xiv. 22–26. (9) *Ḥallāh* ("cake"), on Num. xv. 18–21. (10) *'Orlāh* ("foreskin" [of trees]), on Lev. xix. 23–25. (11) *Bikkūrīm* ("first-fruits"), on Ex. xxiii. 19; Deut. xxvi. 1 sqq. The fourth chapter of this treatise, printed in most editions, is properly a Baraitha.

II. *Mō'ēd* ("festival"). (1) *Shabbāth*, on the Sabbath as a day of rest, Ex. xx. 10, xxiii. 12; Deut. v. 14, &c. (useful edition by Strack, 1890). (2) *'Ērūbīn* ("mixtures" or amalgamations), on legitimate methods of avoiding inconvenient restrictions on the Sabbath. (3) *Pĕsāḥīm* ("passovers"—sacrifices and meals), on Ex. xii., xiii. 6–8, xxiii. 15; Lev. xxiii. 5 sqq.; Num. xxviii. 16 sqq.; Deut. xvi. 1 sqq., &c. (4) *Shĕqālīm* ("shekels"), on the poll tax (Ex. xxx. 12 sqq.; Neh. x. 33). (5) *Yōmā* (Aram. "the day"), or *Kippūrīm* ("atonement"), or *Y. ha-k.* ("the day of atonement"), on Lev. xvi., xxiii. 26–32 (useful edition by H. L. Strack, Leipzig, 1904). (6) *Sukkāh* or *Sukkōth* ("booth[s]"), on Lev. xxiii. 34 sqq.; Num. xxix. 12 sqq.; Deut. xvi. 13–16. (7) *Bēṣāh* ("egg," the opening word) or *Yōm tōb* ("good [*i.e.* feast] day"), general rules for feast-days. (8) *Rōsh ha-Shānāh* ("New Year festival"), on the services, the calendar, and more particularly on the first of the Seventh Month (cf. Num. x. 10, xxviii. 11 sqq., &c.). (9) *Ta'anīth* or *Ta'aniyyōth*, *i.e.* "fast[s]," special observances relating thereunto; in particular to public fasts appointed in time of drought. (10) *Mĕgillāh*, "roll" (of Esther), the reading of it at Purim, &c. (11) *Mō'ēd qāṭōn* ("the small M," to distinguish it from the name of this order), or *Mashkīn* (the first word), regulations for the intermediate festivals at Passover and Tabernacles. (12) *Ḥăgīgāh* ("festival"), on the three principal festivals, Deut. xvi. 16, the duty of pilgrims and the defilements to be avoided (transl. from Bab. Talm. by A. W. Streane, Camb., 1891).

III. *Nāshīm* ("women"). (1) *Yĕbāmōth* ("sisters-in-law"), on the levirate, &c. (2) *Kĕthūbōth* ("marriage contracts"), rights and duties of husband and wife. (3) *Nĕdārīm* ("vows"), on Num. xxx. (4) *Nāzīr* ("Nazirite"), on Num. vi. (5) *Giṭṭīn* ("documents"), on divorce and separation. (6) *Sōṭāh* ("the faithless woman"), on Num. v. 11–31. (7) *Qiddūshīn* ("sanctifications" of marriage), on the contraction of legal marriage.

IV. *Nĕzīqīn* ("damages"), also known as *Yĕshū'ōth* ("deeds of help"). (1) *Bābā qammā* (Aram. "the first gate"), on injuries and compensation; civil law. (2) *B. Mĕṣī ā* (Aram. "the middle gate"), on sales, leases, lost property. (3) *B. Bathrā* (Aram. "the last gate"), on real estate, succession, &c. (4) *Sanhedrīn* (συνέδριον), on procedure and criminal law. (5) *Makkōth*, "blows," on the number to be inflicted (Deut. xxv. 1–3) and for what offence, &c. (6) *Shĕbū'ōth* ("oaths"), on Lev. v. 4 sqq. (7) *'Ēduyyōth*, "testimonies," viz. of later teachers regarding their predecessors, on the schools of Hillel and Shammai, 'Aqiba, &c., important for the problem of the literary growth of the Mishnah. (8) *'Ăbōdāh Zārāh* ("idolatrous worship"), regulations in reference to heathen idolatry (useful edition with Germ. transl. by Strack, 1909; and including that of the Gemara by F. C. Ewald, Nuremberg, 1856). (9) *'Abōth* or *Pirqē* A. ("sayings of the fathers"), a famous collection of maxims; the sixth chapter on "the possession of the law" does not properly belong to the Mishnah (ed. with transl. by C. Taylor, Camb. 1897, and in German by H. L. Strack, 1901). (10) *Hōrāyōth* ("decisions"), on judicial and other errors (Lev. iv. 1 sqq.).

V. *Qŏdāshīm* ("holy things"). (1) *Zĕbāḥīm* ("sacrifices"), or *shĕḥīṭath qŏdāshīm* ("the slaughter of holy things"), on the sacrificial laws, &c. (2) *Mĕnāḥōth* ("meat-offerings"), on Lev. ii. 5, 11–13, vi. 7–16, xiv. 10–20, &c. (3) *Ḥullīn* or *Shĕḥīṭath H.* ("[the slaughter of] common things"), on non-sacrificial meat. (4) *Bĕkōrōth* ("first-born"), on firstlings (Ex. xiii. 12 seq.; Lev. xxvii. 26 seq.; Num. viii. 16–18, xviii. 15–17; Deut. xv. 19 sqq.). (5) *'Arākīn* ("valuations" for ransom, &c.), on Lev. xxv. 15–28, 29 sqq., xxvii. 2 sqq., 28 seq. (6) *Tĕmūrāh* ("exchange" of dedicated animals), cf. Lev. xxvii. 10, 33. (7) *Kĕrīthōth* ("cutting off"), on excommunication, &c. (8) *Mĕ'īlāh* ("trespass"), on Lev. v. 15 sqq.; Num. v. 6–8. (9) *Tāmīd*, on the "continual or perpetual (daily burnt offering)," Ex. xxix. 38–42; Num. xxviii. 2–8. (10) *Middōth* (" measures "), an important tractate on the temple (measurements, gates, halls, &c.). (11) *Qinnīm* (" nests "), on sacrifices of doves by the poor (cf. Lev. i. 14–17, v. 1 sqq., xii. 8).

VI. *Ṭohŏrōth* or *Ṭĕh.*, " purifications," a euphemism for things which are ritually or ceremonially " unclean." (1) *Kēlīm* (" vessels "), their uncleanness (cf. Lev. xi. 32 sqq.; Num. xix. 14 sqq., xxxi. 20 sqq.). (2) *Ohālōth* (" tents "), on defilement through a corpse (Num. xix. 14–20), &c. (3) *Nĕgā'īm* (" plagues," *i.e.* leprosy), on Lev. xiii. seq. (4) *Pārāh* (the [red] " heifer "), on Num. xix. (5) *Ṭĕhārōth* (euphemism for impurities), on minor defilements. (6) *Miqwā'ōth* (ritual baths), bathing for the defiled (cf. Lev. xiv. 8, xv. 5 sqq.; Num. xxxi. 23; also Mark vii. 4). (7) *Niddāh* (female " impurity "), on Lev. xv. 19–33. (8) *Makshīrīn* (" predisposing "), or *Mashqīn* (" liquids "), on defilement caused by wet unclean things (cf. Lev. xi. 34, 37 seq.). (9) *Zābīm* (" those with a discharge "), on Lev. xv. (10) *Tĕbūl Yōm* (" immersed for [or on] the day "), on those who have taken a ritual bath and must wait until sunset before becoming ritually pure (see Lev. xv. 5, xxii. 6 seq.; Num. xix. 19). (11) *Yādāyīm*, " hands," their purification (cf. Matt. xv. 2, 20; Mark vii. 2–4, &c.). (12) *Ūqṣīn* (" stems "), on the relation between fruit and the stems and stalks as regards defilement, &c.

To Order IV. the Babylonian recension of the Talmud adds seven treatises, which are of later origin and are regarded as more or less extra-canonical. (1) *Ābōth dĕ Rabbi Nathan*, an expansion of IV. 9, attributed to a second-century Rabbi, but post-Talmudic (ed. S. Schechter, 1887). (2) *Sōphĕrīm* (" scribes "), on the writing of the scrolls of the Pentateuch, grammatical (Massoretic) rules, and (a later addition) on the liturgy (ed. J. Müller, Leipzig, 1878). (3) *Ēbel Rabbāthi* (" great weeping "), or, euphemistically, *Sĕmāḥōth* (" joys "), on mourning customs and rules. (4) *Kallāh* (" betrothed, bride "), on chastity in marriage, &c. *Dĕrek Ēreṣ* (5) *Rabbah*, and (6) *Zūṭā*, a " large " and a " small " treatise on various rules of " conduct " and social life. (7) *Pĕreq ha-Shālōm*, a " chapter on peace " (peacefulness). In addition to these seven, other small Talmudic treatises are also reckoned (edited by R. Kirchheim, Frankfort-on-Main, 1850). These deal with (1) the writing of the rolls of the Law; (2) *Mĕzūzāh* (Deut. vi. 9, xi. 20); (3) *Tĕphillīn* (prayers, phylacteries); (4) the fringes (Num. xv. 38); (5) slaves; (6) the Samaritans (see J. A. Montgomery, *The Samaritans*, pp. 196 sqq.); and (7) proselytes.

The Mishnah itself contains 63 tractates, or, since IV. 1–3 originally formed one (called *Nĕzīqīn*) and IV. 4, 5 were united, 60. The number is also given as 70 (cf. 2 Esd. xiv. 44–46), perhaps by including the seven smaller treatises appended to IV. There are 523 chapters (or 525, see I. 11, IV. 9).

2. *The Origin of the Mishnah.*—A careful distinction was drawn between the Written Law, the Mosaic Tōrāh, and the rest of the Scriptures (תּוֹרָה שֶׁבִּכְתָב), and the Oral Law, or Tōrāh by Mouth (תּוֹרה שֶׁבְּעַל פֶּה). The origin of the latter, which has become codified in the Mishnah, has often been discussed. It was supposed that it had been handed down by Ezra; that it was indebted to Joshua, David or Solomon; that it was as old as Moses, to whom it had been communicated orally or in writing, complete or in its essence. The traditional view is well illustrated in the words ascribed to R. Simeon Lakish, 3rd century A.D.:[1] " What is that which is written, ' I will give thee the tables of stone, and the Law and the Commandment, which I have written, that thou mayest teach them (Ex. xxiv. 12) '? ' Tables,' these are the Ten Words (the Decalogue); the ' Law ' is the Scripture; ' and the commandment,' that is the Mishnah: ' which I have written,' these are the Prophets and Writings (*i.e.* The Hagiographa), ' to teach them,' that is the Gemara—thus instructing us that all these were given to Moses from Sinai." Literary and historical criticism places the discussion on another basis when it treats the Mosaic Tōrāh *in its present form* as a post-exilic compilation (about 5th century B.C.) from sources differing in date, origin and history. There is no *a priori* reason why other legal enactments should not have been current when the compilation was first made; the Pentateuchal legislation is incomplete, and covers only a small part of the affairs of life in which legal decisions might be needed. There must have been a large body of usage to which Jewish society subscribed; customary usage is one of the most binding of laws even among modern Oriental communities where laws in writing are unknown, and one of the most interesting features is the persistence in the East of closely-related forms and principles of custom from the oldest times to the present day. Laws must be adjusted from time to time to meet changing needs, and new necessities naturally arose in the Greek and Roman period for which the older codes and usages made no provision. Much in the same way as Roman law was derived from the Twelve Tables, the Jewish written laws were used as the authority for subsequent modifications, and the continuity of the religious-legal system was secured by a skilful treatment of old precedents.[2] In the article MIDRASH it will be seen that new teaching could justify itself by a re-interpretation of the old writings, and that the traditions of former authoritative figures could become the framework of a teaching considerably later than their age. It is probable that this process was largely an unconscious one; and even if conscious, the analogy of the conventional " legal fiction " and the usual anxiety to avoid the appearance of novelty is enough to show that it is not to be condemned. By the help of a tradition —a " haggadic " or " halakic " Midrash (*q.v.* § 1)—contemporary custom or ideals could appear to have ancient precedents, or by means of an exegetical process they could be directly connected with old models. In the Old Testament many laws in the Mosaic legislation are certainly post-Mosaic and the value of not a few narratives lies, not in their historical or biographical information, but in their treatment of law, ritual, custom, belief, &c. Later developments are exemplified in the pseudepigraphical literature, notably in the Book of Jubilees, and when we reach the Mishnah and Talmud, we have only the first of a new series of stages which, it may be said, culminate in the 16th-century *Shulḥan 'Ārūk*, the great compendium of the then existing written and oral law. Thus, the problem of the origin or antiquity of the unwritten Oral Law, a living and fluid thing, lies outside the scope of criticism; of greater utility is the study of the particular forms the laws have taken in the written sources which from time to time embody the ever-changing legacy of the past.

The course of development between the recognition of the supremacy of the Pentateuch and the actual writing down of the Mishnah and Gemara can be traced only in broad lines. It is known that a great mass of oral tradition was current, and there are a number of early references to written collections, especially of haggadah. On the other hand, certain references indicate that there was a strong opposition to writing down the Oral Law. It is possible, therefore, that written works were in circulation among the learned, and that these contained varying interpretations which were likely to injure efforts to maintain a uniform Judaism. Philo speaks of μυρία ἄγραφα ἔθη καὶ νόμιμα (ed. Mangey, ii. 629), and the oral esoteric traditions of the Pharisees are attested by Josephus (xiii. 10, 6, cf. 16, 2); cf. in the New Testament, Matt. xv. 1–9, Mark vii. 8, &c.; and the δευτερώσεις " repetitions " (cf. the term Mishnah) of the Christian Fathers. For the *written* collections, see Strack, *op. cit.*, pp. 10 sqq.; J. Theodor, *Jew. Ency.*, viii. 552; J. Z. Lauterbach, *ib.*, p. 614; W. Bacher, *ib.*, xii. 19; S. Schechter, *Hastings' Dict. Bible*, v. 62; and art. MIDRASH, § 5, in this work. The theory of an esoteric tradition is distinctly represented in 2 Esdras xiv., where Moses receives words which were not to be published, and Ezra re-writes seventy books which were to be delivered to the wise men of his people. Also the Book of Jubilees knows of secret written traditions containing regulations regarding sacrifices, &c., and Jacob hands over " all his books and the books of his fathers to Levi his son that he might preserve them and renew them for his children (*i.e.* the priestly caste) unto this day " (xlv. 16).

3. *Growth of the Mishnah and Gemara.*—According to the traditional view the canon of the Old Testament closed with the work of Ezra. He was followed by the *Sōphĕrīm*, " scribes " (or the Men of the great Synagogue), to the Maccabaean age, and these again by the " Pairs " (*zūgōth*, Gr. ζυγόν), the reputed heads of the Sanhedrin, down to the Herodian age (150–30 B.C.). The last culminate in Hillel (*q.v.*) and Shammai, the founders of two great rival schools, and to this famous pair the work

[1] For the sake of convenience Ben (" son ") and Rabbi are, as usual, abbreviated to b. and R. For the quotation which follows, see Oesterley and Box, *The Religion and Worship of the Synagogue* (London, 1907) p. 51; and, on the subject, S. Schechter, *Studies in Judaism* (London, 1896), ch. vii.—" the history of Jewish tradition "; E. Weber, *Jüdische Theologie* (Leipzig, 1897), pp. 91 seq. and 130 sqq.; Strack, *op. cit.*, p. 8 seq.; W. Bousset, *Relig. d. Judentums* (Berlin, 1906), pp. 176 sqq., and *Jew. Ency.*, iv. 423 sqq.; see also G. B. Gray's art. " Law Literature " in the *Ency. Bib.*

[2] See W. R. Smith, *Old Test. in the Jewish Church*, p. 51 seq., 160.

of collecting *hălākōth* ("legal decisions") has been ascribed. The ensuing period of the *Tannā'īm*, "teachers" (about A.D. 10–220), is that of the growth of the Mishnah.[1] Among the best known representatives of the schools are Rabban (a title given to Hillel's descendants) Gamaliel, the Phil-Hellene and teacher of the apostle Paul (Acts xxii. 3) and his son Simeon (Josephus, *Life*, § 38 seq., *Wars*, iv. 3, 9), and Rabban Joḥanan b. Zakkai, founder of the seat of learning at Jamnia (Jabneh). A little later (about 90–130 A.D.) are the famous Gamaliel II., Eliezer b. Hyrqanos (at Lydda), and Ishmael b. Elisha, the last of whom founded the school at Usha and is renowned for his development of the rules of exegesis framed by Hillel. With Rabbi Aqība (*q.v.*) and the synods of Jamnia (about 90 and 118 A.D.) a definite epoch in Judaism begins. At Jamnia, under the presidency of Gamaliel II. and Eleazar b. Azariah, a collection of traditional *halakoth* was formed in the tractate *'Eduyyōth* (larger than and not to be identified with IV., 7 above). Here, too, was discussed the canonicity of the Song of Songs and of Ecclesiastes, and it is probable that here Aqība and his colleagues fixed the official text of the canonical books. Aqība had an important share in the early development of the Mishnah (Strack, pp. 19, 89); and, in the collecting of material, he was followed notably by the school of Ishmael (about 130–160 A.D.), which has left its mark upon the early halakic Midrashim (see MIDRASH, § 5, 1–3). The more interesting names include R. Meir, a well-known haggadist, R. Simeon b. Yoḥai, R. Jose b. Ḥalaphta and R. Jehudah b. 'El'ai. But, as collections of decisions were made by prominent teachers from time to time, confusion was caused by their differences as regards both contents and teaching (*Sotah*, 22*a*; *Shabb.* 138*b*). Consequently, towards the close of the second century a thoroughly comprehensive effort was made to reduce the *halakoth* to order. Judah, grandson of Gamaliel II., known as the Prince or Patriarch (*nāsī'*), as *Rabbēnū* ("our teacher"), or simply as "Rabbi" *par excellence*, was the editor. He gathered together the material, using Meir's collection as a basis, and although he did not write the Mishnah as it now is, he brought it into essentially its present shape. His methods were not free from arbitrariness; he would attribute to "the wise" the opinion of a single authority which he regarded as correct; he would ignore conflicting opinions or those of scholars which they themselves had afterwards retracted, and he did not scruple to cite his own decisions.[2]

The period of the *'Ămōrā'īm*, "speakers, interpreters," (about 220–500 A.D.), witnessed the growth of the Gemara, when the now "canonical" Mishnah formed the basis for further amplification and for the collecting of old and new material which bore upon it. In Palestine learning flourished at Caesarea, Sepphoris, Tiberias and Usha; Babylonia had famous schools at Nehardea (from the 2nd century A.D.), Sura, Pumbeditha and elsewhere.[3] Of their teachers (who were called Rabbi and Rab respectively) several hundreds are known. R. Ḥiyya was redactor of the *Siphrā* on Leviticus (MIDRASH, § 5, 2); to him and to R. Hoshaiah the compilation of the *Tōsephtā* is also ascribed. Abbā Arīka or Rab, the nephew of the first mentioned, founded the school of Sura (219 A.D.). Rab and Shemuel (Samuel) "the astronomer" (died 254 A.D.) were pupils of "Rabbi" (*i.e.* Judah, above), and were famed for their knowledge of law; so numerous were their points of difference that the Talmud will emphasize certain decisions by the statement that the two were agreed. The Gemara is much indebted to this pair and to Joḥanan b. Nappāḥā (199–279). The latter, founder of the great school of Tiberias, has indeed been venerated, on the authority of Maimonides, as the editor of the Palestinian Talmud; but the presence of later material and of later names, *e.g.* Manī b. Jona and Jose b. Abin (Abun), refute this view. The Babylonian Rabbah b. Naḥmani (d. *c.* 330) had a dialectical ability which won him the title "uprooter of mountains." His controversies with R. Joseph b. Ḥiyya (known for his learning as "Sinai"), and those between their disciples Abayi and Rābā are responsible for many of the minute discussions in the Babylonian Gemara. Meanwhile the persecutions of Constantine and Constantius brought about the decay of the Palestinian schools, and, probably in the 5th century, their recension of the Talmud was essentially complete. In Babylonia, however, learning still flourished, and with Rab Ashi (352–427) the arranging of the present framework of the Gemara may have been taken in hand. Under Rabba Tosĕpha'a (died 470) and Rabina, *i.e.* Rab Abina (died 499), heads of the academy of Sura, the Babylonian recension became practically complete.

Finally, the *Sabōrā'ē*, "explainers, opiners" (about 500–540), made some additions of their own in the way of explanations and new decisions. They may be looked upon as the last editors of the now unwieldy thesaurus; less probable is the view, often maintained since Rashi (11th century), that it was first written down in their age.[4]

4. *The Two Talmuds.*—The Palestinian recension of the Mishnah and Gemara is called "the Talmud of the Land of Israel," or "T. of the West"; a popular but misleading name is "the Jerusalem Talmud." It is an extremely uneven compilation. "What was reduced to writing does not give us a work carried out after a preconcerted plan, but rather represents a series of jottings answering to the needs of the various individual writers, and largely intended to strengthen the memory" (Schechter). Political troubles and the unhappy condition of the Jews probably furnish the explanation; hence also the abundance of Palestinian haggadic literature in the Midrashim, whose "words of blessing and consolation" appealed more to their feelings than did the legal writings. The Pal. Talmud did not attain the eminence of the sister recension, and survives in a very incomplete form, although it was perhaps once fuller. It now extends only to Orders I.–IV., with the omission of IV. 7 and 9, and with the addition of part of VI. 7.[5] The Babylonian Talmud (or Tal. Babli) contains the Gemara to $36\frac{1}{2}$ tractates, but the material is relatively very full, and it is about three times as large as the Pal., although the Gemara there extends to 39 tractates. In the latter the Gemara follows each paragraph of the Mishnah; in the former, references are usually made to the leaves (the two pages of which are called *a* and *b*), the enumeration of the *editio princeps* being retained in subsequent editions. The Mishnah is written in a late literary form of Hebrew; but the Gemara is in Aramaic (except the *Baraithas*), that of the Bab. T. being an Eastern Aram. dialect (akin to Mandaitic), that of the Pal. T. being Western Aram. (akin to Biblical Aram. and the Targums). Greek was well understood in cultured Palestine; hence the latter recension uses many Greek terms which it does not explain; whereas in the Bab. T. they are much less common, and are sometimes punningly interpreted.[6] The Pal. Tal. is the more concise, but it is remarkable for the numerous repetitions of the same passages; these are useful for the criticism of the text, and for the light they throw upon the incompleteness of the work of compilation. The Bab. Tal., on the other hand, is diffuse and freer in its composition, and it is characterized by the exuberance of Halakah, which is usually rather subtle and far-fetched. Both Talmuds offer a good field for research (see below). Especially interesting are the *Baraithas* which are preserved in the Gemara in *Hebrew*; they are "external" decisions not included in the more authoritative

[1] On the various teachers, especially the Haggadists, see W. Bacher, *Agada der Babylon. Amoräer* (Strassburg, 1879), *A. d. Tannaiten* (1884, new edition begun in 1903), *A. d. Pal. Amoräer* (1892).

[2] See the criticisms in *Jew. Ency.*, viii. 612, and J. Bassfreund, *Monatsschrift f. d. Gesch. u. Wissens. d. Judentums*, 1907, pp. 427 sqq. On the earlier stages, see *Jew. Ency.*, viii. 610, and Hastings' *Dict. Bible*, v. 61, col. 2, with the references.

[3] On these schools, see art. JEWS, § 42 seq.; and *Jew. Ency.*, i. 145–148.

[4] See Strack, p. 16 seq. The view has little in its favour, although memory played a more important part then than now. For early mnemonic aids to the Mishnah, see Strack, p. 68, *Jew. Ency.*, xii. 19.

[5] The Mishnah was first critically edited by W. H. Lowe (Cambridge, 1883).

[6] The Greek words are treated by S. Krauss and I. Löw, *Griech. u. Lat. Lehnwörter* (Berlin, 1898–9). For the Persian elements in the Bab. T., see *Jew. Ency.*, vii. 313.

Mishnah, but they differ from and are sometimes older than the Mishnic material, with which they sometimes conflict (so in particular as regards the rejected decisions of the school of Shammai). They usually begin: "our Masters taught," "it is taught," or "he taught," the verb *tĕnā* (cf. *Tannā'īm*, "teachers") being employed (see further *Jew. Ency.*, ii. 513 seq.). Parallel to the Mishnah is the *Tōsephtā*, an independent compilation associated with R. Nehemiah (a contemporary of Meir and Simeon b. Yoḥai), Ḥiyya b. Abba and others; it is arranged according to the Mishnic orders and tractates, but lacks IV. 9 and V. 9–11. The halakoth are fuller and sometimes older than the corresponding decisions in the Mishnah, and the treatment is generally more haggadic.[1] The method of making the discussions part of an interpretation of the Old Testament (halakic Midrash), as exemplified in the *Tōsephtā*, is apparently older than the abstract and independent decisions of the Mishnah—which presuppose an acquaintance with the Pentateuchal basis—and, like the employment of narrative or historical Midrash (*e.g.* in the Pentateuch, Chronicles and Jubilees), was more suitable for popular exposition than for the academies. For other halakic literature which goes back to the period of the Tannā'īm, see the *Mekiltā*, *Siphrā* and *Siphrē*, art. MIDRASH, § 5, 1–3.

The Palestinian Talmud, although used by the Qaraites in their controversies, fell into neglect, and the Babylonian recension became, what it has since been, the authoritative guide. With the *Gĕōnīm*, the heads of Sura and Pumbeditha (about 589–1038), we enter upon another stage. The "canonical" Mishnah and Gemara were now the objects of study, and the scattered Jews appealed to the central bodies of Judaism in Babylonia for infofmation and guidance. The Geonim in their "Responses" or "Questions and Answers" supplied authoritative interpretations of the Old Testament or of the Talmud, and regulated the application of the teaching of the past to the changed conditions under which their brethren now lived. The legal, religious and other decisions formulated in the pontifical communications of one generation usually became the venerated teaching of the next, and a new class of literature thus sprang into existence. (See GAON.) Meanwhile, as the Babylonian schools decayed, Talmudic learning was assiduously pursued outside its oriental home, and some Babylonian Talmudists apparently reached the West. However, the fortunes of the Talmud in a hostile world now become part of the history of the Jews, and the many interesting vicissitudes cannot be recapitulated here. (See JEWS, §§ 44 sqq.) To the use of the Pal. Talmud by the Qaraites in their controversies with the Rabbis we owe the preservation of this recension, incomplete though it is. To the intolerance of Christians are no doubt due the rarity of old MSS., and the impure state of the text of both Talmuds. At the same time, the polemics had useful results since the literary controversy in the 16th century (when Johann Reuchlin took the part of the Jews) led to the *editio princeps* of the Babylonian Talmud (Vienna, 1520–23). A change shows itself in the second edition (Basel, 1578–81), when the *'Abōdāh Zārāh* (above, § 1. IV. 8) was omitted, and passages which offended the Christians were cancelled or modified.[2]

Owing to the nature of its contents the Talmud stood sorely in need of aids and guides, and a vast amount of labour (of varying value) has been devoted to it by Jewish scholars. Of the many commentaries the first place must be given to that of R. Solomon Izhaki of Troyes (see RASHI); his knowledge of contemporary tradition and his valuable notes make it a new starting point in the interpretation of the Talmud. To Rashi's disciples are due the *Tōsāphōth* "additions," which, with the commentary of "*the* Commentator," as he was styled, are often reproduced in printed editions of the Talmud. This school (France and Germany, 12th to 13th century) developed a casuistical and over-ingenious interpretation—in contrast to the Spanish Talmudists who aimed at simplification and codification—and it drew upon it the saying of Naḥmanides (13th cent.): "They try to force an elephant through the eye of a needle." Important also are the introduction to and commentary upon the Mishnah by Maimonides (*q.v.*), and the commentary of Rabbenu Obadiah di Bertinoro (died 1510). Both have often been printed; they were translated by Surenhusius (Amsterdam, 1698–1703). See *Jew. Ency.*, xii. 27–30.

Systematic abstracts of the legal parts of the Talmud were made by Isaac Alfazi (or "Riph," 1013–1103), and by Maimonides (*Mishneh Torah*, otherwise called *Sepher ha-Yād* or *Yād ha-Ḥăzākāh*). The latter prepared a great summary of all Jewish religious and civil law, the standard work upon which Christian theologians from the 16th century onwards based their studies—and also their criticisms—of *early* Rabbinism. Jacob b. Asher b. Yeḥiel in his *Ṭūrīm* ("rows") presented a well-arranged collection of those laws which had not become obsolete together with the addition of new ones. Most important of all, however, is Joseph Caro's *Shulḥān 'Ārūk* ("prepared table"), which came in the age of printing (1565), leapt into popularity, and has been, in its turn, the subject of many commentaries and hand-books. This great work systematized Talmudic law in all its developments, ancient and modern, written and oral (I. Abrahams, *Jew. Lit.*, London, 1906, p. 147 seq.; see also *Jew. Ency.*, iii., 584 sqq.). The lengthy history of the written and oral law thus reached its last stage in a work which grew out of the Talmud but had its roots in a more distant past. It was at the dawn of a period when the ancient codes which had been continuously reinterpreted or readjusted were to be re-examined under the influence of newer ideas and methods of study.[3]

The haggadic portions of the Talmud were collected: (*a*) from the Bab. recension, in the *Haggadoth ha-Talmud* (Constantinople, 1511) and in Jacob ibn Ḥabib's *'En* (eye, well of) Jacob (Salonika, 1516); and (*b*) from the Pal., by Samuel Yapheh (Venice, 1589), and in the Yalkūt Shimeoni (see MIDRASH, § 5, 9). These are superseded by the recent translations made by A. Wünsche (Jer. T., Zürich, 1880; Bab. T., Leipzig, 1886–9).

The standard lexicon was the *'Ārūk(h)* of Nathan b. Yeḥiel of Rome (*c.* 1100) which underlies all subsequent works, notably the great *Aruch Completum* of A. Kohut (Vienna, 1878–1892; supplement, New York, 1892); see further *Jew. Ency.*, iv. 580 seq. Modern dictionaries of the older Rabbinical writings have been made by J. Levy (Leipzig, 1876), M. Jastrow (London and New York, 1886), G. Dalman (Frankfort-on-Main, 1901). More technical is W. Bacher's *Exeget. Terminologie d. jüd. Traditions-lit.* (Leipzig, 1905).

The grammatical aids are modern. For Mishnic Hebrew, see A. Geiger (Breslau, 1845), Strack and Siegfried (Leipzig, 1884), and M. H. Segal's essay on the relation between Mishnic and Biblical Hebrew (*Jew. Quart. Rev.*, xx. 647–737); for Western Aramaic, especially G. Dalman, *Jüd. Pal. Aram.* (Leipzig, 1905); for Eastern Aram., S. D. Luzzatto (Eng. trans. by Goldammer, 1877), C. Levias (Cincinnati, 1900), M. L. Margolis (Munich, 1910), and also T. Nöldeke's *Mandäische Gramm.* (Halle, 1875).

The text of the Talmud has been badly preserved; much useful critical work has been done by R. Rabbinovicz, *Variae Lectiones* (Munich, 1876–86) for the Bab. T., and by B. Ratner, *Ahavath Zion* (in Heb., Wilna, 1901–2) for the Jer. T. As regards translations (a subject critically handled by E. Bischoff, Frankfort-on-Main, 1899) and texts, few are satisfactory; some have already been mentioned in § 1; for a full list see Strack's *Einleitung*, pp. 144–155. One may, however, mention the translations in English by D. A. de Sola and M. J. Raphall (18 Mishnic tractates; London 1843); J. Barclay (also a selection of 18; London, 1878), and the (abbreviated) edition of the Bab. Talm. with text and translation by M. L. Rodkinson (New York, 1869 sqq.). The Bab. text with a German translation has been edited by L. Goldschmidt (Berlin, 1897 sqq.). The Palest. Talm. has been translated into French by M. Schwab (Paris, 1871 sqq.).

5. *Features of Interest and Value.*—Although the Midrashim do not hold the authoritative position which the Talmud enjoys, the two groups cannot be kept apart in any consideration of the interesting or valuable features of the old Rabbinical writings. Viewed as a whole they have the characteristics of other Palestinian literature, the merits and defects of other oriental works. As regards the Talmud, neither the Mishnah nor the subsequent Gemara aimed at presenting a digested corpus of law. It is really a large collection of opinions and views, a remarkably heterogeneous mixture of contents, for which the history of its growth is no doubt largely responsible. It appals the reader with its irregularity of treatment, its variations of style, and its abrupt transitions from the spiritual to the crude and trivial, and from superstition to the purest insight. Like the Koran it is often concise to obscurity and cannot be translated literally;

[1] Lat. transl. of Orders I.–III., V., by Ugolinus, *Thes.*, xvii.–xx., recent ed. by M. S. Zuckermandel (Pasewalk, 1880); see *Jew. Ency.*, xii. 207 sqq.

[2] On the censorship and burning of the Talmud, see *Jew. Ency.*, iii. 642 sqq., xii. 22; Strack, 71 seq., 78 sqq.

[3] It is interesting to compare the development of Jewish law with that of the Mahommedan, Roman and English systems, the points of resemblance and difference being extremely suggestive for other studies. On the Jewish codifiers generally, see S. Daiches in L. Simon's *Aspects of Heb. Genius* (London, 1910), pp. 87 sqq.

it presupposes a knowledge which made commentaries a necessity even, as we have seen, to the Jews themselves. The opening of Order II. 6, for example, would be unintelligible without a knowledge of the law in Levit. xxiii. 42: "A booth (the interior of which is) about 20 cubits high is disallowed. R. Judah allows it. One which is not ten hands high, one which has not three walls, or which has more sun than shade is disallowed. 'An old booth?' (marks of quotation and interrogation must be supplied). The school of Shammai disallows it; but the school of Hillel allows it," &c. In the Gemara, the decisions of the Mishnah are not only discussed, explained or developed, but all kinds of additional matter are suggested by them. Thus, in the Bab. Gem. to III. 5, the reference in the Mishnah to the Zealots (Σικάριοι) is the occasion for a long romantic account of the wars preceding the destruction of the Second Temple. In IV. 3 the incidental prohibition of the cutting up of a roll of Scripture leads to a most valuable discussion of the arrangement of the Canon of the Old Testament, and other details including some account of the character and date of Job. There are numerous haggadic interpolations, some of considerable interest. Prose mingles with poetry, wit with wisdom, the good with the bad, and as one thing goes on to suggest another, it makes the Talmud a somewhat rambling compilation. It is scarcely a law-book or a work of divinity; it is almost an encyclopaedia in its scope, a store-house reproducing the knowledge and the thought, both unconscious and speculative, of the first few centuries of the Christian era.

A good idea of its heterogeneity is afforded by the English translations of Talmudic and other commentaries by P. I. Hershon (London, 1880–5). For miscellaneous collections of excerpts, see H. Polano (in the Chandos Classics); Chenery, *Legends from the Midrash*; I. Myers, *Gems from the Talmud*; S. Rapoport, *Tales and Maxims from the Midrash*; E. R. Montague, *Tales from the Talmud*. A valuable general introduction to the Rabbinical literature (with numerous excerpts) is given by J. Winter and A. Wünsche, *Gesch. d. Jüd.-Hellen. u. Talm. Litteratur* (Trier, 1894). The literature has not been fully explored for its contribution to the various branches of antiquarian research. On the animal fables, most of them found also in Indian and in classical collections, see J. Jacobs, *Fables of Aesop* (London, 1889); for myth, superstition and folk-lore, see D. Joel, *Aberglaube* (Breslau, 1881), and M. Grünbaum, *Semit. Sagenkunde* (Leiden, 1893), *Ges. Aufsätze* (Berlin, 1901); for mathematics, see B. Zuckermann (Breslau, 1878); for medicine, J. Bergel (Leipzig, 1885), &c. For these subjects, and for law, zoology, geography, &c. &c., see the full and classified bibliographies in M. L. Rodkinson, *Hist. of Talmud* (New York, 1903), vol. ii. ch. viii., and Strack's *Einleitung*, pp. 164–175.

Ordinary estimates of the Talmud are often influenced by the attitude of Christianity to Judaism and Jewish legalism, and by the preponderating interest which has been taken in the religious-legal side of the Rabbinical writings. The canonization of oral tradition in the Mishnah brought the advantages and the disadvantages of a legal religion, and controversialists have usually seen only one side. The excessive legalism which pervades the Talmud was the scholarship of the age, and the Talmud suffers to a certain extent because accepted opinions and isolated views are commingled. To those who have no patience with the minutiae of legislation, the prolix discussions are as irksome as the arguments appear arbitrary.[1] But the Talmudical discussions were often merely specialist and technical —they were academical and ecclesiastical debates which did not always touch every-day life; sometimes they were for the purpose of reconciling earlier conflicting views, or they even seem to be mere exhibitions of dialectic skill (cf., perhaps, Mk. xii. 18–23). It may be supposed that this predilection for casuistry stimulated that spirit which impelled Jewish scholars of the middle ages to study or translate the learning of the Greeks.[2] Once again it was—from a modern point of view—old-fashioned scholarship; yet one may now recognize that in the development of European science and philosophy it played a necessary part, and one can now realize that again the benefit was for common humanity rather than for the Jews alone. It may strike one as characteristically Jewish that extravagant and truly oriental encomiums were passed upon such legalists and Talmudists as Isaac Alfazi, Rashi or Maimonides; none the less the medieval Jews were able to produce and appreciate excellent literature of the most varied description. In any case, the Talmud must be judged, like other authoritative religious literature, by its place in history and by its survival. From age to age groups of laws were codified and expanded—the Priestly law of the Old Testament, the Mishnah, the complete Talmud, the subsequent codifications of Alfazi, Maimonides, and finally Joseph Caro. Thus, the Talmud occupies an intermediate place between the older sources and its later developments. At each step disintegration was arrested, but not Jewish genius; and the domination of the Law in Judaism did not as a matter of fact have the petrifying results which might have been anticipated. The explanation may be found partly in the intense feeling of solidarity uniting the Deity with his worshippers and his worshippers among themselves. No distinction was drawn between secular and religious duties, between ceremonial, ethical or spiritual requirements. Modern distinctions of moral and ceremonial being unknown, ancient systems must be judged in the light of those modes of thought which could not view religion apart from life. The Talmud discusses and formulates rules upon points which other religions leave to the individual; it inculcates both ceremonial and spiritual ideas, and often sets up most lofty ethical standards. The bonds, rigorous and strange as they often appear to others, were a sacrament enshrined in the imagination of the lowliest follower of the Talmud. Some of the keenest legalists (*e.g.* the Babylonian Rab) are famous for their ethical teaching, and for their share in popular exposition; one of the best ethical systems of medieval Judaism (by Baḥya ibn Pekuda) is founded upon the Talmud; the last exponent of Rabbinical legalism, Joseph Caro, was at the same time a mystic and a pietist; and the combination of the poetical with the legal temperament is frequent. The Talmud outlived the reactionary tendencies of the Qaraites (*q.v.*) and of the Kabbalah (*q.v.*), and fortunately, since these movements, important though they undoubtedly were for the evolution of thought, had not within them the power to be of lasting benefit to the rank and file of the community. Finally, no religion has been without exhibitions of fanaticism and excess on the part of its followers, and if the Old Testament itself was the authority for witch-burning among Christians, it is no longer profitable to ask whether the Talmud was responsible for offences committed by or alleged against those whose lives were regulated by it. On the other hand, Judaism has never been without its heroes, martyrs or saints, and the fact that it still lives is sufficient to prove that the mechanical legalism of the Talmud has not hindered the growth of Jewish religion.

Apart from the general interest of the literature for history and of its contents for various departments of research, the exegetical methods of the Talmud are especially instructive. There were rules of interpretation, and they give expression to one dominant idea: there is an infinite potentiality in the words of the Old Testament, none is fortuitous or meaningless or capable of only a single interpretation, they were said for all time, "for our sake also" and "for our learning" (cf. Paul, in Romans iv. 24, xv. 4). This was not conducive to *critical* inquiry; questions of the historical background of the biblical passage or of the trustworthiness of the text scarcely found a place. The interpretation itself is markedly subjective; by the side of much that is legitimate exegesis, there is much that appears arbitrary in the extreme. The endeavour was made to interpret, not necessarily according to the letter, but according to individual conceptions of the spirit and underlying motive. Thus, the same evidence could give rise to widely differing conflicting interpretations, which may not be directly deducible from or justified by the Scripture. Hence the value

[1] The whole subject of Jewish legalism should be compared with Islam, where again law and religion are one; as regards the legal aspect, see the extremely suggestive and instructive study, "The Relations of Law and Religion, the Mosque el-Azhar," by J. Bryce, *Studies in History and Jurisprudence* (1901), ii. No. xiii.

[2] Some of the most influential of the Greek works in the middle ages had passed through Syriac, Arabic and Hebrew translations before they appeared in their more familiar Latin dress!

of the teaching, whether halakic or haggadic, rests upon its intrinsic worth, and not upon the exegetical principles which were the tools common to the age. Moreover, it was also considered necessary that teaching should be authenticated, as it were, by its association with older authority whose standing guaranteed its genuineness. For this reason anonymous writings were attributed to famous names, and traditions were judged (as in Islam), not so much upon their merits, as by the chain of authorities which traced them back to their sources.

To supplement what has already been pointed out in the article MIDRASH, it may be noticed that the familiar penalty of the "forty stripes save one" (2 Cor. xi. 24; Josephus, *Ant.*, iv. 8, 23) is discussed in the Mishnah (*Makkoth*, iv. 5), and is subsequently explained by an extremely artificial interpretation of Deut. xxv. 2–3 (as though "to the number 40"). But the penalty is obviously older than, and entirely independent of, the arbitrary explanation by which it is supported. Again, the rending of clothes on the occasion of a charge of blasphemy (Matt. xxvi. 65) is actually connected with Joseph b. Qorha of the 2nd century A.D. (*Sanhed.*, vii. 5), although elsewhere this halakah is anonymous. Here the effort was made to substantiate a practice, but the tradition was not unanimous; and it often happens that the Talmud preserves different traditions regarding the same teaching, different versions of it, or it is ascribed to different authorities (see *Jew. Ency.*, xii. p. 15, col. 2). The fact that certain teaching is associated with a name may have no real significance for its antiquity, even as a law ascribed to the age of Moses—the recognized law-giver—may prove to be of much earlier or of much later inception. This feature naturally complicates all questions affecting origin and originality, and cannot be ignored in any study of the Talmud in its bearing upon the New Testament.[1] Similar or related forms of interpretation and teaching are found in the Talmud, in Hellenistic Judaism, in the New Testament, in early Church Fathers and in Syriac writers. As regards the New Testament itself, the points of similarity are many and often important. It has been asserted that "the writings of recent Jewish critics have tended on the whole to confirm the Gospel picture of external Jewish life, and where there is discrepancy these critics tend to prove that the blame lies not with the New Testament originals, but with their interpreters." The Talmud also makes "credible details which many Christian expositors have been rather inclined to dispute. Most remarkable of all has been the cumulative strength of the arguments adduced by Jewish writers favourable to the authenticity of the discourses in the Fourth Gospel . . ."[2] The points of contact between the phraseology in the Gospel of John and the early Midrashim are especially interesting.[3] The popularity of the parable as a form of didactic teaching finds many examples in the Rabbinical writings, and some have noteworthy parallels in the New testament.[4] It is known that there were theological controversies between Jews and Christians, and in the Midrash *Bereshith Rabbah* (MIDRASH, § 5, 5) is a passage (translated in *Jew. Ency.*, viii. 558) directed against the Christian view which found support for the doctrine of the Trinity in Gen. i. 26. But it is uncertain how far the doctrines of Judaism were influenced by Christianity, and it is even disputed whether the Talmud and Midrashim may be used to estimate Jewish thought of the 1st or 2nd century A.D. Much valuable work has been done by modern Jewish scholars on the "higher criticism" of these writings, which, it must be remembered, range over several centuries, but it still remains difficult to date their contents. Moreover, in endeavouring to sketch the theology of early Judaism it has been easy to find in the heterogeneous and conflicting ideas a system which agreed with preconceived views, and to reject as late or exceptional whatever told against them. In considering the evidence it is a delicate task to avoid confusing its meaning for its age with that which has appeared the only natural or appropriate one to subsequent interpreters (whether Jewish or Christian) who have been necessarily influenced by their environment and by contemporary thought. At all events, if these writings have many old elements and may be used to illustrate the background of the New Testament, they illustrate not only the excessive legalism and ritualism against which early Christianity contended, but also the more spiritual and ethical side of Judaism. Upon this latter phase the pseudepigraphical and apocalyptical writings have shed much unexpected light in linking the Old Testament with both Christian and Rabbinical theology. The various problems which arise are still under discussion, and are of great importance for the study of Palestinian thought at the age of the parting of the ways. They touch, on the one hand, the absolute originality of Christianity and its attitude to Jewish legalism, and, on the other, the true place of the *pseudepigrapha* in Jewish thought and the antiquity of the Judaism which dominates the Talmud. They do not, however, exclude the possibility that by the side of the scholasticism of the early Jewish academical circles was the more popular thought which, forming a link between Jews and Christians, ultimately fell into neglect as Judaism and Christianity formulated their theologies.

On the close relation between the thought of the age, see B. Ritter, *Philo u. d. Halacha* (Leipzig, 1879); M. Grünwald in Königsberger's *Monatsblätter* (Berlin, 1890); N. I. Weinstein, *Zur Genesis d. Agada* (Frankfort-on-Main, 1901); W. Bousset, *Relig. d. Judentums*, pp. 50 sqq.; R. Graffin's ed. of Aphraates (*q.v.*) (Paris, 1894), p. xlix. seq.; S. Funk on the haggadic elements in Aphraates (Vienna, 1891); and art. MIDRASH, § 4. In this respect the pseudepigraphic lit. is frequently of the greatest interest; thus Mark. iv. 24 finds a close parallel in "the Testament of Zebulun," viii. 3 (R. H. Charles, *Test. of xii. Patriarchs*, p. 117), and does not differ essentially from the saying ascribed to Gamaliel II. (*Shabb.* 51*b*) and others. A close parallel to Matt. vii. 3 is ascribed to R. Tarpon, latter half of 1st century A.D. (*Arak.* 16*b*: "If one says, take the mote from thy eye, he answers, take the beam from thy eye"); it seems to have been a popular saying (see *Baba Bathra*, 15*b*). See further, for the Talmud and Midrashim in relation to the New Testament generally, the literature in Strack, pp. 165 sqq.; also A. Wünsche, *Neue Beiträge z. Erläut. d. Evangelien* (Göttingen, 1878); C. H. Toy, *Judaism and Christianity* (London, 1890; with Schechter's essay in his *Studies* [1896], pp. 283–305); H. Laible, *Jesus Christus im Talmud* (Berlin, 1891); R. T. Herford, *Christianity in Talmud and Midrash* (London, 1903; with W. Bacher's review in *Jew. Quart. Rev.*, xvii. 171–183); Bousset, *op. cit.*; Oesterley and Box, *op. cit.* (with C. G. Montefiore's review in *Jew. Quart. Rev.*, 1908, pp. 347–357); I. Abrahams in Swete's *Camb. Bibl. Essays* (1909), pp. 163–192; C. G. Montefiore, *Synoptic Gospels* (1909); H. L. Strack, *Jesus, die Häretiker u. die Christen* (1910).

Results of criticism.

The Talmud itself is still the authoritative and practical guide of the great mass of the Jews, and is too closely connected with contemporary and earlier Palestinian history to be neglected by Christians. With the progress of modern research the value of this and of the other old Rabbinical writings is being re-estimated, and criticism has forced a modification of many old views.[5] Thus, an early reference to the *title* of a work does not prove that it is that which is now current; this applies, for example, to the tractate ʿ*Ēduyyōth* (see *Jew. Ency.*, viii. 611), and to the Midrash *Siphrē*, which frequently differs from that as known to the Talmud (*ib.*, xi. 331). It has been found that a tradition, however

[1] There are many details in the Talmud which cannot be dated; if some are obviously contemporary, others find parallels in Ancient Babylonia, for example in the code of Hammurabi. See L. N. Dembitz, *Jew. Quart. Rev.*, xix. 109–126, and the literature on the code (see BABYLONIAN LAW). Numerous miscellaneous examples of the intimate relationship between the Rabbinical and older oriental material will be found in H. Pick, *Assyrisches u. Talmudisches* (Berlin, 1903); A. Jeremias, *Bab. im N. Test.* (Leipzig, 1905), *Alte Test. im Lichte d. Alten Orients* (*ib.*, 1906); E. Bischoff, *Bab. astrales im Weltbilde d. Thalmud u. Midrasch* (*ib.*, 1907).

[2] I. Abrahams, on "Rabbinic Aids to Exegesis," in Swete's *Camb. Bibl. Essays* (1909), p. 181.

[3] See the essay of Schlatter, *Sprache u. Heimat d. vierten Evangelisten* (1902).

[4] See P. Fiebig, *Alt-jüd. Gleichnisse u. d. Gleichnisse Jesu* (Leipzig, 1904); Lauterbach, *Jew. Ency.*, ix. 512 sqq.; Oesterley and Box, p. 96 seq.

[5] The "higher criticism" of these writings affords many useful hints and suggestions for that of other composite works, *e.g.* the Old Testament. It may be noticed also that the references to the Old Testament sometimes represent a slightly divergent text; see V. A. Aptowitzer, *Schriftwort in d. Rabb. Lit.* (1906); I. Abrahams, *Camb. Bibl. Essays*, pp. 172 sqq.

tenacious or circumstantial, is not necessarily genuine, and that too in spite of the chain of authorities by which its antiquity or genuineness appeared to be confirmed. Implicit reliance can no longer be necessarily placed upon the reputed authorship or editorship of a work; yet, although many of the views of medieval Jews in this respect prove to be erroneous (*e.g.* on the authorship of the Zōhar; see KABBALAH), they may sometimes preserve the recollection of a fact which only needs restatement (*e.g.* R. Johanan as the editor of the Pal. Talmud).

Finally, the Talmud comes at the end of a very lengthy development of Palestinian thought (see PALESTINE: *History*). It is in the direct line of descent from the Old Testament—intervening literature having been lost—the essence of which it makes its own. Forced by the events of history, this legacy of the past was subjected to successive processes and adapted to the needs of successive generations and of widely different historical and social conditions. Legal compendiums and systems of philosophy served their age and gave place to later developments; and the elasticity of interpretation which characterizes it enabled it to outlive Karaites and Kabbalists. It also escaped the classicism of the Renaissance with its insistence upon the test—*either* fact *or* fiction. As an oriental work among an oriental people the moral and spiritual influence of the Talmud has rested upon its connexion with a history which appealed to the imagination and the feelings, upon its heterogeneity of contents suitable for all moods and minds, and upon the unifying and regulative effects of its legalism. The relationship of Talmudism to the Old Testament has been likened to that of Christian theology to the Gospels; the comparison, whether fitting or not, may at least enable one to understand the varying attitudes of Jewish thinkers to their ancient sources. With closer contact to the un-oriental West and with the inevitable tendencies of modern western scholarship the Talmud has entered upon a new period, one which, though it may be said to date from the time of Moses Mendelssohn (see JEWS, § 48), has reached a more distinctive stage at the present day. In the weakening of that authority which had been ascribed almost unanimously to the Talmud, and invariably to the Old Testament, a new and greater strain has been laid upon Judaism to reinterpret its spirit once more to answer the diverse wants of its adherents. This is part of that larger and pressing psychological problem of adjusting the "authority" ascribed to past writings to that of the collective human experience; it does not confront Judaism alone, and it must suffice to refer to the writings of "Reformed Judaism"; see, *e.g.* C. G. Montefiore, *Liberal Judaism* (London, 1903); *Truth in Religion* (1906); I. Abrahams, *Judaism* (1907), and the essays of S. Schechter.

Reformed Judaism.

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TALUKDAR (Hind. from *talūk*, district, and *dār*, holding), the name of (1) an official in the state of Hyderabad, India, equivalent to magistrate and collector, and (2) a landholder with peculiar tenures in various parts of India, particularly in Oude (see UNITED PROVINCES).

TALUS (Lat. for the "ankle-bone"), in architecture, the slope of an embankment wall, which is thicker at the bottom than at the top, to resist the pressure of the earth behind it.

TAM, JACOB BEN MEÏR (1100–1171), a grandson of Rashi (*q.v.*), was the most famous French glossator (*tosafist*) on the text of the Talmud. In 1147 he was attacked and injured by a disorderly band who had attached themselves to the Crusaders. He escaped to the neighbouring Troyes, where about 1160 was held the first of the Jewish Synods, for which the Rhinelands became celebrated. At this meeting it was laid down that disputes between Jew and Jew were not to be carried to a Christian court, but were to be settled by fraternal arbitration. New conditions of life had arisen owing to the closer terms on which Jews and Christians lived, and Jacob Tam was foremost in settling the terms which were to govern the relations, from the Jewish side. Many others of his practical ordinances (*Takkanoth*), connected with marriage and divorce, trade and proselytism, as well as with synagogue ritual, had abiding influence, and bear invariably the stamp of enlightened independence within the limits of recognized authoritative tradition and law. Of his legal work the most important was collected in his *Sefer ha-yashar*. He was also a poet and grammarian.

See Gross, *Gallia Judaica* (index); M. Schloessinger in *Jewish Encyclopedia*, vii. 36–39. (I. A.)

TAMAQUA, a borough of Schuylkill county, Pennsylvania, U.S.A., on the Tamaqua (Little Schuylkill) river, about 20 m. above its junction with the Schuylkill, about 17 m. E.N.E. of Pottsville, and about 98 m. N. of Philadelphia. Pop. (1890) 6054; (1900) 7267, (625 foreign-born); (1910) 9462. Tamaqua is served by the Central railroad of New Jersey, by the Philadelphia and Reading railway and by an electric line connecting with Mauch Chunk, Pottsville, and other places. Tamaqua is in a rich anthracite coal district, and coal-mining is its chief industry. Among manufactures are foundry and machine-shop products, powder, stoves, furniture, hosiery, &c. The borough owns the water-works. The first settlement here was made in 1799 and anthracite coal was discovered in 1817. In 1829 Tamaqua was laid out and received its present name, an Indian word meaning "running water." It was incorporated as a borough in 1833. Between 1869 and 1875 the Molly Maguires were active here.

TAMARIND. This name is popularly applied to the pods of a leguminous tree, which are hard externally, but within filled with an acid juicy pulp containing sugar and various acids, such as citric and tartaric, in combination with potash. The acid pulp is used as a laxative and a refrigerant, the pods being largely imported both from the East and the West Indies. The tree is now widely distributed in tropical countries, but it is generally considered that its native country is in eastern tropical Africa, from Abyssinia southward to the Zambezi. The name (meaning in Arabic "Indian date") shows that it entered medieval commerce from India, where it is used, not only for its pulp, but for its seeds, which are astringent, its leaves, which furnish a yellow or a red dye, and its timber. The tree (*Tamarindus indica*) attains a height of 70 to 80 ft., and bears elegant pinnate foliage and purplish or orange veined flowers arranged in terminal racemes. The flower-tube bears at its summit four sepals, but only three petals and three perfect stamens, with indications of six others. The stamens, with the stalked ovary, are curved away from the petals at their base, but are directed towards them at their apices. The anthers and the stigmas are thus brought into such a position as to obstruct the passage of an insect attracted by the brilliantly-coloured petal, the inference of course being that insect visits are necessary for transference of pollen and the fertilization of the flower.

TAMARISK. The genus *Tamarix* gives its name to a small group of shrubs or low trees constituting the tamarisk family Tamaricaceae. The species of tamarisk and of the very closely allied genus *Myricaria* grow in salt-deserts, by the sea-shore, or in other more or less sterile localities in warm, temperate, subtropical, and tropical regions of the eastern hemisphere. Their long slender branches bear very numerous small appressed leaves, in which the evaporating surface is reduced to a minimum. The flowers are minute and numerous, in long clusters at the ends of the branches or from the trunk. Each has 4–5 free sepals, and as many petals springing with the 4–10 stamens from a fleshy disk. In *Tamarix* the stamens are free, while in *Myricaria* they are united into one parcel. The free ovary is one-celled, with basal placentas, and surmounted by 3–5 styles. The fruit is capsular, and contains numerous seeds, each usually with a long tuft of hairs at one end. The great value of these shrubs or trees lies in their ability to withstand the effects of drought and a saline soil, in consequence of which they grow where little else can flourish. On this account the common tamarisk, *T. gallica*, is planted on sea-coasts, and affords shelter where none other could be provided. Some species produce galls, valued for their tannin, while the astringent bark of others has occasionally been used for medicinal purposes. The ashes of the plant, when grown near the sea, are said to contain soda. For tamarisk manna, see MANNA.

TAMATAVE (called by the natives *Tòamàsina*), the chief seaport of Madagascar, situated nearly on the centre of the eastern coast in 18° 10′ S., 49° 32′ E. It owes its importance to the existence of a coral reef, which forms a spacious and fairly commodious harbour, entered by two openings. The town is built on a sandy peninsula which projects at right angles from the general coast-line. On this are crowded together a considerable number of houses, with good shops and merchants' offices in the main thoroughfares. Tamatave is the seat of several foreign consuls, as well as of numerous French officials, and is the chief port for the capital and the interior. Imports consist principally of piece-goods, farinaceous foods, and iron and steel goods, and exports of gold dust, raffia, hides, caoutchouc and live animals. Communication with Europe is maintained by steamers of the Messageries Maritimes and the Havraise companies, and also with Mauritius, and from thence to Ceylon, by the British Union-Castle line. Of the whole foreign trade of Madagascar, 46 per cent. is through Tamatave. Owing to the character of the soil and the formerly crowded native population, the town has often been attacked by epidemics: the plague broke out in 1898, and again in 1900; but since the draining of the neighbouring marshes, there has been improvement. Since 1895 the native population has been removed from the town and settled in a new village to the north-west. A telegraph, 180 miles in length, connects Tamatave with the capital. There is also a service, partly by railway and partly by steamer, along the coast lagoons, connecting the port with Antanànarìvo. Pop. about 4600.

TAMAULIPAS, a northern Gulf-coast state of Mexico, bounded N. by Texas, U.S.A., E. by the Gulf of Mexico, S.E. by Vera Cruz, S. by San Luis Potosi, W. by Nuevo Leon, and N.W. by Coahuila. Area 32,128 sq. m. Pop. (1900) 218,948. The central and southern parts of the state are mountainous, but there are extensive fertile plains in the N. sloping gently N.E. toward the Rio Grande, and the coastal zone is sandy, much broken by lagoons and uninhabited. Except in the N. this coastal zone is only 5 to 7 m. wide, but the foothills region back of this is usually well wooded and fertile, and the low alluvial river valleys penetrate deeply into the sierras. There are four navigable rivers in the state—the Rio Grande del Norte, or Rio Bravo, which forms the boundary line with the United States, the Conchas or Presas, the Soto da Marina, and the Tamesi. The Panuco forms the southern boundary for a short distance. A peculiar feature of the hydrography of Tamaulipas is the series of coastal lagoons formed by the building of new beaches across the indentations of the coast. The largest of these is the Laguna de la Madre, 125 m. long, which receives the waters of the Rio Conchas, and is separated in places from the Gulf by only a narrow ridge of sand dunes. The climate is hot, humid and malarial on the coast, but is pleasant on the more elevated lands of the interior. On the plains bordering the Rio Grande frosts are frequent. The rainfall is abundant, especially on the mountain slopes of the south. The principal industry is agriculture. Sugar, cereals, tobacco, cotton and coffee are produced, and probably fruit may be raised successfully. Stock-raising receives some attention and hides and cattle are exported. The preparation of ixtle fibre for export is becoming an important industry. Copper is mined and extensive deposits of petroleum and asphalt are being exploited. Railway communication is provided by the Mexican National which crosses the northern end of the state, the Belgian line from Monterrey to Tampico, and a branch of the Mexican Central from San Luis Potosi to Tampico.

The capital of Tamaulipas is Ciudad Victoria (pop. in 1900, 10,086), a small sierra town on the Monterrey and Tampico railway about 120 m. from Tampico. Its public buildings are good and it has the improvements of a modern town. It has a fine climate, a good trade, and is a summer resort for residents of the coast. The city is near the Rio Santander, and was once called Nuevo Santander. Among other towns in the state may be mentioned: Matamoros (*q.v.*), on the Rio Grande; Tampico (*q.v.*), on the Panuco, the principal port of the state; Tula (6935 in 1900); Jaumave (about 10,000 in 1900, chiefly Indians), 38 m. S.W. of Ciudad Victoria, in the heart of a prominent ixtle-producing region; Mier (7114 in 1895), on the Rio Grande, 95 m. E.N.E. of Monterrey; San Carlos (6871 in 1895), 57 m. N.E. of the capital; Camargo (6815 in 1895), on the San Juan near the Rio Grande, once the old Spanish mission of San Augustin Laredo; and Reynosa (6137 in 1895), 54 m. W.N.W. of Matamoros.

TAMAYO Y BAUS, MANUEL (1829–1898), Spanish dramatist, was born at Madrid on the 15th of September 1829. He came of a family connected with the theatre, his mother being the eminent actress Joaquina Baus. It is interesting to note that she appeared as Geneviève de Brabant in an arrangement from the French made by Tamayo when he was in his twelfth year. Through the influence of his uncle, Antonio Gil y Zárate, minister of education, Tamayo's independence was secured by his nomination to a post in a government office. The earliest of his printed pieces, *Juana de Arco* (1847), is an arrangement from Schiller, and *Una Aventura de Richelieu*, which the author has not cared to preserve, is said to be an imitation of Alexandre Duval. The general idea of his *Angela* (1852) was derived from Schiller's *Kabale und Liebe*, but the atmosphere is Spanish, the situations are original, and the phrasing is Tamayo's own. His first great success was *Virginia* (1853), a dramatic essay in Alfieri's manner, remarkable for its ingenuity and noble diction. In 1854 Tamayo was expelled from his post by the new Liberal government, but was restored before long by Cándido Nocedal, a minister who had been struck by the young man's talent. He collaborated with Aureliano Fernández-Guerra y Orbe in writing *La Ricahembra* (1854), a historical drama which recalls the vigour of Lope de Vega. *La Locura de Amor* (1855), in which Juana *la loca*, the passionate, love-sick daughter of Isabel the Catholic, figures as the chief personage, established Tamayo's reputation as Spain's leading playwright. *Hija y Madre* (1855) is a failure, and *La Bola de Nieve* (1856) is notable solely for its excellent workmanship. It is unfortunate that Tamayo's straitened means forced him to put original work aside and to adapt pieces from the French. Examples of this sort are fairly numerous. *Lo Positivo* (1862), imitated from Adrien-Augustin-Léon Laya's *Duc Job*, is well-nigh forgotten, though the Spanish version is a dexterous piece of stagecraft and contains some elements of original value. *Del dicho al hecho* (1864) is from *La Pierre de touche* of Jules Sandeau and Émile Augier, and a pleasing proverb, *Más vale Maña que Fuerza* (1866) is a great improvement upon Mme Caroline Berton's *Diplomatie du Ménage*. The revolution of 1868, which cost Tamayo his post at the San Isidro Library, is indirectly responsible for *No hay mal que por bien no venga* (1868), a clever arrangement of *Le Feu au Couvent*, by Henri Murger's friend, Théodore Barrière. During these seven years Tamayo produced only one original piece, *Lances de Honor* (1863), which turned upon the immorality of duelling, and led to a warm discussion among the public. Written in prose, the piece is inspired by a breath of medieval piety which had not been felt in the Spanish theatre since the 17th century. This renascence of an old-world motive has induced many critics to consider *Lances de Honor* as Tamayo's best work, but that distinction should be accorded rather to *Un Drama nuevo* (1867), a play in which the author has ventured to place Shakespeare and Yorick upon the scene. *Los Hombres de bien* (1870) was

Tamayo's final contribution to the Spanish stage. His last years were spent in recasting his *Virginia*, and the result of his efforts may be read in the posthumous edition of his *Obras* (Madrid, 1898–99). In 1858 Tamayo was elected a member of the Spanish Academy, to which he afterwards became permanent secretary; and in 1884 the Conservative minister, Alejandro Pidal y Mon, appointed him director of the National Library. He died on the 20th of June 1898. (J. F.-K.)

TAMBOUR (Fr. for "drum"), the term in architecture given to the inverted bell of a Corinthian capital round which were carved the acanthus leaves decorating it: applied also to the wall of a circular structure, whether on the ground or raised aloft on pendentives and carrying a dome; and to the drum of a column which is built in several courses.

TAMBOURINE (Fr. *tambour de Basque*; Ger. *baskische Trommel*, *Tambourin*, or *Schellen-trommel*), a popular instrument of percussion of indefinite musical pitch, used for marking the rhythm in dance or bacchanalian music. The tambourine consists of a flat wooden or metal ring, over one end of which is stretched a parchment or vellum head; in the circumference of the ring are fixed nine or ten metal disks or small bells which jingle as the tambourine is struck by the hand, or merely waved through the air. A tremolo effect is obtained by stroking the head with the finger-tips. In a 14th-century MS. (Brit. Mus. Sloane 3983, fol. 13) a tambourine of modern appearance with a snare bears the inscription "Tympanum." The tambourine is of the highest antiquity, and was known at different times under the names of *timbrel* or *tabret*, *tympanon* or *tympanum*, and *symphonia*. (K. S.)

TAMBOV, one of the largest and most fertile governments of central Russia, extending from N. to S. between the basins of the Oka and the Don, and having the governments of Vladimir and Nizhniy-Novgorod on the N., Penza and Saratov on the E., Voronezh on the S., and Orel, Tula and Ryazan on the W. It has an area of 25,703 sq. m., and consists of an undulating plain intersected by deep ravines and broad valleys, ranging 450 to 800 ft. above sea-level. Cretaceous and Jurassic deposits, thickly covered with boulder-clay and loess, are widely spread over its surface, concealing the underlying Devonian and Carboniferous strata. These last crop out in the deeper ravines, and seams of coal have been noticed at several places. Iron ore (in the north-west), limestone, clay and gypsum are obtained, and traces of petroleum have been discovered. The mineral waters of Lipetsk, similar to those of Franzensbad in their alkaline elements, and chalybeate like those of Pyrmont and Spa, are well known in Russia. The Oka touches the north-west corner of the government, but its tributaries, the Moksha and the Tsna, are important channels of traffic. The Don also merely touches Tambov, and of its affluents none except the Voronezh and the Khoper and the Vorona, a tributary of the Khoper, are at all navigable. As a whole, it is only in the north that Tambov is well drained; in the south, which is exposed to the dry south-east winds, the want of moisture is much felt, especially in the district of Borisoglyebsk. The climate is continental, and, although the average temperature at Tambov is 42° F., the winter is comparatively cold (January, 13°; July, 68°). The rivers remain frozen for four months and a half. Forests occupy about 7½ per cent. of the total area, and occur chiefly in the west; in the south-east wood is scarce, and straw is used for fuel. The soil is fertile throughout; in the north it is clayey and sometimes sandy, but the rest of the government is covered with a sheet, 2 to 3 feet thick, of black earth, of such richness that in Borisoglyebsk cornfields which have not been manured for eighty years still yield good crops.

The estimated population in 1906 was 3,205,200. The government is divided into twelve districts, the chief towns of which are Tambov, Borisoglyebsk, Yelatma, Kirsanov, Kozlov, Lebedyan, Lipetsk, Morshansk, Shatsk, Spask, Temnikov and Usman. The inhabitants are Great Russians in the centre, but there is a notable admixture of Mordvinians and Meshcheryaks in the west and north-west, as also of Tatars. The Mordvinians are rapidly becoming Russified. Nonconformity has a relatively strong hold in the government. Notwithstanding a high birth-rate (45 in the thousand), the annual increase of population is but slow (0·5 per cent. annually). The prevailing occupation is agriculture, modern machinery being used on the steppe farms. More than two-thirds of the area is arable, and of this proportion 53 per cent. belongs to the peasant communities, 36 per cent. to private individuals, and 11 per cent. to the crown. The principal crops are rye, wheat, oats, barley and potatoes. Grain is exported to a considerable extent from the south, although the yield is deficient in the north. Hemp and linseed are also cultivated, and the production of tobacco is yearly increasing. Beetroot is extensively grown for sugar. Live-stock breeding, though less extensively carried on than formerly, is still important. Excellent breeds of horses are met with, not only on the larger estates, but also in the hands of the wealthier peasants, those of the Bityug river being most esteemed. Manufacturers are represented chiefly by distilleries, tallow-melting works, sugar factories, flour-mills and woollen-cloth mills. Commerce is brisk, owing to the large grain export—Kozlov, Morshansk, Tambov and Borisoglyebsk being the chief centres for this traffic, and Lebedyan for the trade in horses and cattle. This government is backward educationally. A distinctive feature is its large villages of crown peasants.

The region now included in the north of the government was settled by Russians during the earliest centuries of the principality of Moscow, but until the end of the 17th century the fertile tracts in the south remained too insecure for settlers. In the following century a few immigrants began to come in from the steppe, and landowners who had received large grants of land from the tsars began to bring their serfs from central Russia. (P. A. K.; J. T. Be.)

TAMBOV, a town of Russia, capital of the government of the same name, 300 m. by rail S.E. from Moscow, on the Tsna river, and on the railway to Saratov. Pop. (1884) 34,000; (1900) 49,208. The town is almost entirely built of wood, with broad unpaved streets, lined with low houses surrounded by gardens; but it is an archiepiscopal see of the Orthodox Greek Church. Woollens, tobacco, oil and various other commodities are manufactured. The trade in grain, and in cattle purchased in the south and sent to Moscow, is far less important than that of Morshansk and Kozlov.

TAMBURELLO (called in Piedmont *Tabasso*), a court game popular in Italy, particularly in the northern provinces. It is a modification of the ancient game of *Pallone* (*q.v.*), bearing the same general relation to it as Squash does to Racquets. A full-sized Tamburello Court, which need not be as true and even as that for Pallone, is 90 to 100 yards long and half as wide, divided laterally through the middle by a line (*cordino*) into two equal spaces, the *battuta* and the *rimessa*. Three players regularly form a side, each carrying in one hand an implement called *tamburello*, resembling a tambourine (whence the name), which is a round frame of wood upon which is tightly stretched a cover of horse-hide. A rubber ball about the size of a lawn-tennis ball is used. One of the players opens the service (*battuta*), which is made from a small square called the *trampolino*, situated at one corner of the *battuta* but outside the court. The service must be over the middle line. The ball must then be hit from side to side over the line, the side failing to return it or sending it out of court losing a point. The game is scored like lawn-tennis, four points constituting a game, counting 15+15+10+10. Tamburello, a less expensive game than Pallone, is popular with the lower classes, who use it as a medium for betting.

TAMILS. The word *Tamil* (properly *Tamiḻ*) has been identified with Draviḍa, the Sanskrit generic appellation for the south Indian peoples and their languages; and the various stages through which the word has passed—Dramiḍa, Dramila, Damila—have been finally discussed by Bishop Caldwell in his *Comparative Grammar of the Dravidian Languages* (2d ed., 1875, p. 10 seq.). The identification was first suggested by Dr Graul (*Reise nach Ostindien*, vol. iii., 1854, p. 349), and then adverted to by Dr G. U. Pope (*Tamil Handbook*, 1859, Introduction) and Dr Gundert (*Malayâḻma Dictionary*, 1872, *s.v.*). Dr Pope, however, believed Tamiḷ to be a corruption of *tenmoli*, southern speech, in contradistinction to *vaḍugu*, the northern, *i.e.*, Telugu language. As in the case of the Kafir, Turkish, Tagala and other typical languages, the term Tamulic or Tamulian has occasionally been employed as the designation of the whole class of Dravidian peoples and languages, of which it is only the most prominent member. The present article deals with Tamil in its restricted sense only. The Tamils proper are smaller and of weaker build than Europeans, though graceful in shape. Their physical appearance is described as follows:—a pointed and frequently hooked pyramidal nose, with conspicuous nares, more long than round; a marked sinking in of the orbital line, producing a strongly defined orbital ridge; hair and eyes black; the latter, varying from small to middle-sized, have a peculiar sparkle and a look of calculation; mouth large, lips thick, lower jaw not heavy; forehead well-formed, but receding, inclining to flattish, and seldom high; beard considerable, and often strong; colour of skin very dark, frequently approaching to black (*Manual of the Administration of the Madras Presidency*, Madras, 1885, vol. i., Introd., p. 36; see also Caldwell, *Comparative Grammar of the Dravidian Languages*, 1875, pp. 558–79). The Tamils have many good qualities—frugality, patience, endurance, politeness—and they are credited with astounding memories; their worst vices are said to be lying and lasciviousness. Of all the South-Indian tribes they are the least sedentary and the most enterprising. Wherever money is to be earned, there will Tamils be found, either as merchants or in the lower capacity of domestic servants and labourers. The tea and coffee districts of Ceylon are peopled by about 950,000; Tamils serve as coolies in the Mauritius and the West Indies; in Burma, the Straits, and Siam the so-called Klings are all Tamils (Graul, *Reise nach Ostindien*, Leipzig, 1855, vol. iv. pp. 113–212).

Language.—The area over which Tamil is spoken extends from a few miles north of the city of Madras to the extreme south of the eastern side of the peninsula, throughout the country below the Eastern Ghats, from Pulicat to Cape Comorin, and from the Ghats to the Bay of Bengal, including also the southern portion of Travancore on the western side of the Ghats and the northern part of Ceylon. According to the census of 1901, the total number of Tamil-speaking people in all India was 16,525,500. To these should be added about 160,000 in the French possessions. But as of all the Dravidian languages the Tamil shows the greatest tendency to spread, its area becomes ever larger, encroaching on that of the contiguous languages. Tamil is a sister of Malayâḷam, Telugu, Kanarese, Tulu; and, as it is the oldest, richest, and most highly organized of the Dravidian languages, it may be looked upon as typical of the family to which it belongs. The one nearest akin to it is Malayâḷam, which originally appears to have been simply a dialect of Tamil, but differs from it now both in pronunciation and in idiom, in the retention of old Tamil forms obsolete in the modern language, and in having discarded all personal terminations in the verb, the person being always indicated by the pronoun (F. W. Ellis, *Dissertation on the Malayâḷam Language*, p. 2; Gundert, *Malayâḷma Dictionary*, Introd.; Caldwell, *Comparative Gr.*, Introd., p. 23; Burnell, *Specimens of South Indian Dialects*, No. 2, p. 13). Also, the proportion of Sanskrit words in Malayâḷam is greater, while in Tamil it is less, than in any other Dravidian tongue. This divergence between the two languages cannot be traced farther back than about the 10th century; for, as it appears from the Cochin and Travancore inscriptions, previous to that period both languages were still substantially identical; whereas in the *Râmacharitam*, the oldest poem in Malayâḷam, composed probably in the 13th century, at any rate long before the arrival of the Portuguese and the introduction of the modern character, we see that language already formed. The modern Tamil characters originated "in a Brahmanical adaptation of the old Grantha letters corresponding to the so-called Vaṭṭeḷuttu," or round-hand, an alphabet once in vogue throughout the whole of the Pâṇḍyan kingdom, as well as in the South Malabar and Coimbatore districts, and still sparsely used for drawing up conveyances and other legal instruments (F. W. Ellis, *Dissertation*, p. 3). It is also used by the Moplahs in Tellicherry. The origin of the Vaṭṭeḷuttu itself is still a controverted question. Dr Burnell, the greatest authority on the subject, stated his reasons for tracing that character through the Pahlavi to a Semitic source (*Elements of South Indian Palaeography*, 2nd ed., 1878, pp. 47–52, and plates xvii. and xxxii.). In the 8th century the Vaṭṭeḷuttu existed side by side and together with the Grantha, an ancient alphabet still used throughout the Tamil country in writing Sanskrit. During the four or five centuries after the conquest of Madura by the Cholas in the 11th it was gradually superseded in the Tamil country by the modern Tamil, while in Malabar it continued in general use down to the end of the 17th century. But the earliest works of Tamil literature, such as the *Tolkâppiyam* and the *Kuṛaḷ*, were still written in it. The modern Tamil characters, which have but little changed for the last 500 years, differ from all the other modern Dravidian alphabets both in shape and in their phonetic value. Their angular form is said to be due to the widespread practice of writing with the style resting on the *end* of the left thumb-nail, while the other alphabets are written with the style resting on the left side of the thumb.

The Tamil alphabet is sufficiently well adapted for the expression of the twelve vowels of the language (*a, â, i, î, u, û, e, ê, o, ô, ei, au*), —the occasional sounds of *ö* and *ü*, both short and long, being covered by the signs for *e, ê, i, î*; but it is utterly inadequate for the proper expression of the consonants, inasmuch as the one character *k* has to do duty also for *kh, g, gh*, and similarly each of the other surd consonants *ch, ṭ, t, p* represents also the remaining three letters of its respective class. The letter *k* has, besides, occasionally the sound of *h*, and *ch* that of *s*. Each of the five consonants *k, ch, ṭ, t, p* has its own nasal. In addition to the four semivowels, the Tamil possesses a cerebral *ṛ* and *ḷ*, and has, in common with the Malayâḷam, retained a liquid *ḻ*, once peculiar to all the Dravidian languages, the sound of which is so difficult to fix graphically, and varies so much in different districts, that it has been rendered in a dozen different ways (*Manual of the Administration of the Madras Presidency*, vol. ii. pp. 20 seq.). Fr. Müller is probably correct in approximating it to that of the Bohemian *ř*. There is, lastly, a peculiar *n*, differing in function but not in pronunciation from the dental *n*. The three sibilants and *ḥ* of Sanskrit have no place in the Tamil alphabet; but *ch* often does duty as a sibilant in writing foreign words, and the four corresponding letters as well as *j* and *ksh* of the Grantha alphabet are now frequently called to aid. It is obvious that many of the Sanskrit words imported into Tamil at various periods (Caldwell, *loc. cit.*, Introd., pp. 86 seq.) have, in consequence of the incongruity of the Sanskrit and Tamil notation of their respective phonetic systems, assumed disguises under which the original is scarcely recognizable: examples are *ulagu* (loka), *uruvam* (rûpa), *arukken* (arka), *aṛputam* (adbhutam), *naṭchattiram* (nakshatram), *iruḍi* (rishi), *tîrkam* (dîrgha), *arasen* (râjan). Besides the Sanskrit ingredients, which appear but sparsely in the old poetry, Tamil has borrowed from Hindustani, Arabic, and Persian a large number of revenue, political, and judicial terms, and more recently a good many English words have crept in, such as *tiraṭṭi*, treaty, *paṭlar*, butler, *âkṭ*, act, *kulôb*, club, *kavarnar*, governor, *pinalkôdu*, penal code, *sîkku*, sick, *mejastiraṭṭu*, magistrate. But, as compared with its literary sister languages, it has preserved its Dravidian character singularly free from foreign influence. Of Tamil words which have found a permanent home in English may be mentioned curry, (*kaṛi*), mulligatawny (*milagu*, pepper, and *taṇṇîr*, cool water), cheroot (*suruṭṭu*), pariah (*paṛeiyan*).

The laws of euphony (avoiding of hiatus, softening of initial consonants, contact of final with initial consonants) are far more complicated in Tamil than in Sanskrit. But, while they were rigidly adhered to in the old poetical language (Sen-Tamil, or "Perfect" Tamil), there is a growing tendency to neglect them in the language of the present day (Koḍun-Tamil). It is true the Tamil rules totally differ from the prevailing Sanskrit; still the probability is in favour of a Sanskrit influence, inasmuch as they appear to follow Sanskrit models. Thus, *iruḷ nîkkinân* becomes *iruṇîkkinân*; *pon pâttiram, poṛpâttiram*; *vîṭṭil kaṇḍên, vuṭṭiṛ kaṇḍên*; *vâlsirumei, vâṭsirumei*; *palan tandân, palanṛândan*. Nouns are divided into high-caste or personal and low-caste or impersonal,—the former comprising words for rational beings, the latter all the rest. Only in high-caste nouns a distinction between masculine and feminine is observed in the singular; both have a common plural, which is indicated by change of a final *n* (feminine *ḷ*) into *r*; but the neuter plural termination *kaḷ* (*gaḷ*) may be super-added in every case. Certain nouns change their base termination before receiving the case affixes, the latter being the same both for singular and plural. They are for the acc. *ei*, instr. *âl*, social *ôḍu* (*oḍu, uḍan*), dat. *ku*, loc. *il* (*iḍattil, in*), abl. *ilirundu* (*ininṛu*), gen. *uḍeiya* (*adu*). There is, besides, a general oblique affix *in*, which is not only frequently used for the genitive, but may be inserted before any of the above affixes, to some of which the emphatic particle *ê* may also be superadded. In the old poetry there is a still greater variety of affixes, while there is an option of dispensing with all. Adjectives, when attributive, precede the noun and are unchangeable; when predicative they follow it and receive verbal affixes. The pronouns of the 1st person are sing. *nân* (*yân*), inflexional base *en*, plural *nâm* (*yâm*), infl. *nam*, including, *nângaḷ*, infl. *engaḷ*, excluding the person addressed; of the 2nd person *nî*, infl. *un* (*nin*, *nun*), plural *nîr* (*nîyir*, *nîvir*), *nîngaḷ*, infl. *um*, *ungaḷ* (*num*). To each of those forms, inclusive also of the reflexive pronouns *tân*, *tâm*, *tângal*, a place is assigned in the scale of honorific pronouns. As in the demonstrative pronouns the forms beginning with *i* indicate nearness, those with *a* distance, and (in the old poetry) those with *u* what is between the two, so the same forms beginning with *e* (or *yâ*, as in *yâr*, *âr*, who?) express the interrogative. The verb consists of three elements—the root (generally reducible to one syllable), the tense characteristic, and the personal affix. There are three original moods, the indicative, imperative, and infinitive (the 2nd singular imperative is generally identical with the root), as well as three original tenses, the present, past, and future. The personal affixes are—sing. (1) *-ên*; (2) *-ây*, honorific *-îr*; (3) masc. *-ân*, fem. *-âḷ*, honor. *-âr*, neuter *-adu*; plural (1) *-ôm* (*-âm*, *-êm*); (2) *-îrkaḷ*; (3) masc. fem. *-ârkaḷ*, neut. *-ana*. These affixes serve for all verbs and for each of the three tenses, except that, in the future, *-adu* and *-ana* are replaced by *-um* (*kkum*). It is only in the formation of the tenses that verbs differ, intransitive verbs generally indicating the present by *-kiṟ-* (*-kinṟ-*), the past by *-d-*, *-nd-*, or *-in-*, and the future by *-v-* (*-b-*), and transitive verbs by the corresponding infixes, *-kkiṟ-* (*-kkinṟ-*), *-tt-* (*-nd-*), and *-pp-*; but there are numerous exceptions and seemingly anomalous formations. Other tenses and moods are expressed with the aid of special affixes or auxiliary verbs. Causal verbs are formed by various infixes (*-ppi-*, *-vi-*, *-ttu-*), and the passive by the auxiliary *paḍu*, to fall, or by *uṇ*, to eat, with a noun. The following four peculiarities are characteristic of Tamil:—first, the tenseless negative form of the verb, expressed by the infix *a*, which is elided before dissimilar vowels; second, the predicative employment of two negative particles *illei* and *alla*, the one denying the existence or presence, the other denying the quality or essence; third, the use of two sets of participles,—one, called adjective or relative participle, which supplies the place of a relative clause, the language possessing no relative pronouns, and an ordinary adverbial participle or gerund; and, fourth, the practice of giving adjectives a verbal form by means of personal affixes, which form may again be treated as a noun by attaching to it the declensional terminations, thus: *periya*, great; *periyôm*, we are great; *periyômukku*, to us who are great. The old poetry abounds in verbal forms now obsolete. Adjectives, adverbs and abstract nouns are derived from verbs by certain affixes. All post-positions were originally either nouns or verbal forms. *Oratio indirecta* is unknown in Tamil, as it is in all the other Indian languages, the gerund *enṟu* being used, like *iti* in Sanskrit, to indicate quotation. The structure of sentences is an exact counterpart of the structure of words, inasmuch as that which qualifies always precedes that which is qualified. Thus the attributive precedes the substantive, the substantive precedes the preposition, the adverb precedes the verb, the secondary clause the primary one, and the verb closes the sentence. The sentence, "Having called the woman who had killed the child, he asked why she had committed such infanticide," runs in Tamil as follows:—

Kuḷandeiyei kkonṟupottavaḷei aḷeippittu nî ên ippaḍi
The child her who had killed having caused to be called, "Thou why thus
ppaṭṭa sisu-v-atti seydây ênṟu kettân.
made child-murder didst?" having said he asked.

Much as the similarity of the structure of the Tamil and its sister languages to that of the Ugro-Tartar class may have proved suggestive of the assumption of a family affinity between the two classes, such an affinity, if it exist, must be held to be at least very distant, inasmuch as the assumption receives but the faintest shade of support from an intercomparison of the radical and least variable portion of the respective languages.

Literature.—The early existence, in southern India, of peoples, localities, animals and products the names of which, as mentioned in the Old Testament and in Greek and Roman writers, have been identified with corresponding Dravidian terms, goes far to prove the high antiquity, if not of the Tamil language, at least of some form of Dravidian speech (Caldwell, *loc. cit.*, Introd., pp. 81–106; *Madras District Manual*, i., Introd., pp. 134 seq.). But practically the earliest extant records of the Tamil language do not ascend higher than the middle of the 8th century of the Christian era, the grant in possession of the Israelites at Cochin being assigned by the late Dr Burnell to about 750 A.D., a period when Malayâḷam did not exist yet as a separate language. There is every probability that about the same time a number of Tamil works sprung up, which are mentioned by a writer in the 11th century as representing the old literature (Burnell, *loc. cit.*, p. 127, note). The earlier of these may have been Saiva books; the more prominent of the others were decidedly Jain. Though traces of a north Indian influence are palpable in all of them that have come down to us (see, *e.g.*, F. W. Ellis's notes to the *Kuṟaḷ*), we can at the same time perceive, as we must certainly appreciate, the desire of the authors to oppose the influence of Brahmanical writings, and create a literature that should rival Sanskrit books and appeal to the sentiments of the people at large. But the refinement of the poetical language, as adapted to the genius of Tamil, has been carried to greater excess than in Sanskrit; and this artificial character of the so-called Sen-Tamil is evident from a comparison with the old inscriptions, which are a reflex of the language of the people, and clearly show that Tamil has not undergone any essential change (Burnell, *loc*, *cit.*, p. 142).

The rules of Sen-Tamil appear to have been fixed at a very early date. The *Tolkâppiyam*, the oldest extant Tamil grammar, is assigned by Dr Burnell (*On the Aindra School of Sanskrit Grammarians*, pp. 8, 55) to the 8th century (best edition by C. Y. Tâmodaram Pillei, Madras, 1885). The *Vîrasôḷiyam*, another grammar, is of the 11th century. Both have been superseded by the *Nannûl*, of the 15th century, which has exercised the skill of numerous commentators, and continues to be the leading native authority (English editions in Pope's *Third Tamil Grammar*, and an abridgment by Lazarus, 1884). The period of the prevalence of the Jains in the Pâṇḍya kingdom, from the 9th or 10th to the 13th century, is justly termed the Augustan age of Tamil literature. To its earlier days is assigned the *Nâlaḍiyâr*, an ethical poem on the three objects of existence, which is supposed to have preceded the *Kuṟaḷ* of Tiruvaḷḷuvan, the finest poetical production in the whole range of Tamil composition. Tradition, in keeping with the spirit of antagonism to Brahmanical influence, says that its author was a pariah. It consists of 1330 stanzas on virtue, wealth and pleasure. It has often been edited, translated and commented upon; see the introduction to the excellent edition published by the Rev. Dr Pope, in which also a comprehensive account of the peculiarities of Sen-Tamil will be found. To the Avvei, or Matron, a reputed sister of Tiruvaḷḷuvan, but probably of a later date, two shorter moral poems, called *Attisûḍi* and *Konṟeivêyndan*, are ascribed, which are still read in all Tamil schools. *Chintâmaṇi*, an epic of upwards of 3000 stanzas, which celebrates the exploits of a king Jîvakan, also belongs to that early Jain period, and so does the *Divâkaram*, the oldest dictionary of classical Tamil. The former is one of the finest poems in the language; but no more than the first and part of the third of its thirteen books have been edited and translated. Kamban's *Râmâyaṇam* (about 1100 A.D.) is the only other Tamil epic which comes up to the *Chintâmaṇi* in poetical beauty. The most brilliant of the poetical productions which appeared in the period of the Saiva revival (13th and 14th centuries) are two collections of hymns addressed to Siva, the one called *Tiruvâsakam*, by Mâṇikka-Vâsakan, and a later and larger one called *Têvâram*, by Sambandhan and two other devotees, Sundaran and Appan. Both these collections have been printed, the former in one, the latter in five volumes. They are rivalled both in religious fervour and in poetical merit by a contemporaneous collection of Vaishṇava hymns, the *Nâlâyira-prabandham* (also printed at Madras). The third section of it, called *Tiruvâymoḷi*, or "Words of the Sacred Mouth," has been published in Telugu characters, with ample commentaries, in ten quartos (Madras, 1875–76). After a period of literary torpor, which lasted nearly two centuries, King Vallabha Deva, better known by his assumed name Ativîrarâma Pâṇḍyan (second half of the 16th century), endeavoured to revive the love of poetry by compositions of his own, the most celebrated of which are the *Neiḍadam*, a somewhat extravagant imitation of Srî Harsha's Sanskrit *Naishadham*, and the *Veṟṟivêrkei*, a collection of sententious maxims. Though he had numerous followers, who made this revival the most prolific in the whole history of Tamil literature, none of the compositions of any kind, mainly translations and bombastic imitations of Sanskrit models, have attained to any fame. An exceptional place, however, is occupied by certain Tamil sectarians called *śittar* (*i.e. siddhas* or sages), whose mystical poems, especially those contained in the *Sivavâkyam*, are said to be of singular beauty. Two poems of high merit, composed at the end of the 17th century, also deserve favourable notice—the *Nîtineriviḷakkam*, an ethical treatise by Kumâragurupara Desikan, and the *Prabhulingalîlei*, a translation from the Kanarese of a famous text-book of the Vîra-Saiva sect. See the analysis in W. Taylor's *Catalogue*, vol. ii. pp. 837–47.

The modern period, which may be said to date from the beginning of the last century, is ushered in by two great poets, one native and the other foreign. Tâyumânavan, a philosopher of the pantheistic school, composed 1453 stanzas (*pâdal*) which have a high reputation for sublimity both of sentiment and style; and the Italian Jesuit Joseph Beschi (d. 1742), under the name Vîramâmuni, elaborated, on the model of the *Chintâmaṇi*, a religious epic *Têmbâvaṇi*, which.

though marred by blemishes of taste, is classed by native critics among the best productions of their literature. It treats of the history of St Joseph, and has been printed at Pondicherry in three volumes, with a full analysis. English influence has here, as in Bengal and elsewhere in India, greatly tended to create a healthier tone in literature both as to style and sentiment. As one of the best Tamil translations of English books in respect of diction and idiom may be mentioned the *Bâlavyâpârikal*, or "Little Merchants," published by the Vernacular Text Society, Madras. P. Percival's collection of *Tamil Proverbs* (3rd ed., 1875) should also be mentioned. The copper-plate grants, commonly called *ŝâsanams*, and stone inscriptions in Tamil, many of which have been copied and translated (*Archaeological Survey of Southern India*, vol. iv.; R. Sewell, *Lists of the Antiquarian Remains in the Presidency of Madras*, vols. i., ii.), are the only authentic historical records. (See also Sir Walter Elliot's contribution to the *International Numismata Orientalia*, vol. iii. pt. 2.) As early as the time of the Chinese traveller Hsüan Tsang, books were written in southern India on talipot leaves, and Albiruni mentions this custom as quite prevalent in his time (1031). It has not died out even at the present day, though paper imported from Portugal has, during the last three centuries, occasionally been used. Madras is now the largest depository of Tamil palm-leaf MSS., which have been described in Wilson's *Catalogue of the Mackenzie Collection* (Calcutta, 1828, 2 vols.), W. Taylor's *Catalogue* (Madras, 1857, 3 vols.), and Condaswamy Iyer's *Catalogue* (vol. i., Madras, 1861). The art of printing, however, which was introduced in southern India at an early date, while it has tended to the preservation of many valuable productions of the ancient literature, has also been the means of perpetuating and circulating a deal of literary rubbish and lasciviousness which would much better have remained in the obscurity of manuscript. Dr Burnell has a note in his *Elements of South Indian Paleography* (2nd ed., p. 44), from which it appears that in 1578 Tamil types were cut by Father João de Faria, and that a hundred years later a Tamil and Portuguese dictionary was published at Ambalakkâḍu. At present the number of Tamil books (inclusive of newspapers) printed annually far exceeds that of all the other Dravidian vernaculars put together. The earliest Tamil version of the New Testament was commenced by the Dutch in Ceylon in 1688; Fabricius's translation appeared at Tranquebar in 1715. Since then many new translations of the whole Bible have been printed, and some of them have passed through several editions. The German missionary B. Ziegenbalg was the first to make the study of Tamil possible in Europe by the publication of his *Grammatica Damulica*, which appeared at Halle in 1716. Some time later the Jesuit father Beschi devoted much time and labour to the composition of grammars both of the vulgar and the poetical dialect. The former is treated in his *Grammatica Latino-Tamulica*, which was written in 1728, but was not printed till eleven years later (Tranquebar, 1739). It was twice reprinted, and two English translations have been published (1831, 1848). His *Sen-Tamil Grammar*, accessible since 1822 in an English translation by Dr Babington, was printed from his own MS. (*Clavis humaniorum literarum sublimioris Tamulici idiomatis*) at Tranquebar in 1876. This work is especially valuable, as the greater portion of it consists of a learned and exhaustive treatise on Tamil prosody and rhetoric. (See, on his other works, Graul's *Reise*, vol. iv. p. 327.) There are also grammars by Anderson, Rhenius, Graul (in vol. ii. of his *Bibliotheca Tamulica*, Leipzig, 1855), Lazarus (Madras, 1878), Pope (4th edition in three parts, London, 1883–85), and *Grammaire Française-Tamoule*, by the Abbé Dupuis (Pondicherry, 1863). The last two are by far the best. The India Office library possesses a MS. dictionary and grammar "par le Rév. Père Dominique" (Pondicherry, 1843), and a copy of a MS. Tamil-Latin dictionary by the celebrated missionary Schwarz, in which 9000 words are explained. About the like number of words are given in the dictionary of Fabricius and Breithaupt (Madras, 1779 and 1809). Rottler's dictionary, the publication of which was commenced in 1834, is a far more ambitious work. But neither it nor Winslow's (1862) come up to the standard of Tamil scholarship; the *Dictionnaire Tamoul-Français*, which appeared at Pondicherry in 2 vols. (1855–62), is superior to both, just as the *Dictionarium Latino-Gallico-Tamulicum* (*ibid.*, 1846) excels the various English-Tamil dictionaries which have been published at Madras.

See A. T. Mondière and J. Vinson in *Dictionnaire des Sciences Anthropologiques, s.v.* "Dravidiens"; S. C. Chitty, *The Tamil Plutarch*, Jaffna, 1859; J. Murdoch, *Classified Catalogue of Tamil Printed Books*, Madras, 1865; C. E. Gover, *Folk-Songs of Southern India*, Madras, 1871; Bishop Caldwell's *Comparative Grammar of the Dravidian Languages*, 2nd ed., London, 1875; Graul's *Reise nach Ostindien*, vols. iv. and v.; the quarterly *Lists of Books* registered in the Madras Presidency; [Dr. Maclean's] *Manual of the Administration of the Madras Presidency*, vols. i. and ii., Madras, 1885, folio; F. Müller, *Grundriss der Sprachwissenschaft*, Vienna, 1884, iii. i. 162–246; G. U. Pope, *First Lessons in Tamil*, 7th ed., Oxford, 1904, and *The Nāladiyār*, Oxford, 1893; and J. Vinson, *Manuel de la Langue Tamoule*, Paris, 1903. (R. R.)

TAMLUK, an ancient town of British India, in the Midnapore district of Bengal, on the river Rupnarayan. Pop. (1901) 8805. Under the name of Tamralipta was the capital of the Peacock dynasty, and a seaport at which the Chinese Buddhist pilgrims embarked. It is now 60 m. from the sea, and the ruins of the old city lie deep beneath river silt. It contains the palace of a local raja, and some temples of peculiar construction.

TAMMANY HALL, a political organization in New York City, U.S.A., claiming to be the regular representative of the Democratic party in that city. It takes its name from a sachem or chief of the Delaware Indians, Tamanend or Tammany, the name itself meaning "the Affable." Before the War of Independence there were Whig societies called "Sons of St Tammany" and "Sons of Liberty," with rituals in which Indian words were used to suggest the American character of the lodges. On the 12th of May 1789 William Mooney (d. 1832), an upholsterer, of Irish birth, who had probably been a member of an earlier Tammany society, founded in New York City the "Society of St Tammany" or "Columbian Order" as a patriotic, benevolent and non-political organization, with the intent to counteract the influence of what was believed to be the aristocratic Order of the Cincinnati. A few short-lived societies of a similar kind were founded in other states. In 1805 the New York Society was incorporated as a benevolent society, in 1811 it built its first wigwam, or hall, in Frankfort Street near the City Hall, and in 1867 it moved to its present hall in Fourteenth Street. The society was a secret organization, divided into tribes, with sachems (the most important being the Grand Sachem) as the chief officials, a sagamore, or master of ceremonies, and a winskinskie, or door-keeper, and with a ritual of supposedly Indian character. This "Tammany Society" is not itself the well-known political organization, but rents its hall to the Tammany Hall General Committee, the "Tammany Hall" of political notoriety; the leading members, however, of the "Society" and of the "Hall" are identical, and the "Society" controls the meeting-place of the "Hall," so that the difference between the two is little more than nominal. Almost from the beginning Tammany has been actively engaged in politics, being part of, and during the greater period of its existence actually representing in New York City, the Democratic party, though always subordinating the interests of the party as a whole to its own selfish interests. It has had local rivals at different times, but these, though successful for a while, have not lived long; on the other hand, the Hall has not generally been regarded with favour by the Democratic party throughout the country at large.

Soon after its founding, Tammany came under the influence of Aaron Burr. In 1800 it worked for the election of Jefferson as President. It bitterly opposed De Witt Clinton for many years and was hostile to his large Irish constituency; but, after it secured in 1822 the constitutional amendments providing for manhood suffrage and for the abolition of imprisonment of debtors, and especially after 1827 when Tammany first tried to reduce the five-year period of residence necessary for naturalization, the foreign-born element gradually came into control of the "Society" and of the "Hall." About 1842 Irish "gangs," which used physical violence at election time, became a source of Tammany strength. It reached its height of power about 1870, under the leadership of William Marcy Tweed (1823–78), who used his popularity as a volunteer fireman to advance himself in Tammany and who was the first "boss" of the organization, which had formerly been controlled by committees. In the mayoralty and the other administrative offices and in the common council of the city, in the chief executive office of the state, in the state legislature, and even in some of the judges' seats, Tweed had placed (or had secured the election of) accomplices or tools, or else controlled votes by purchase. In April 1870 Tweed secured the passage of a city charter which put the control of the city into the hands of the mayor, the comptroller, and the commissioners of parks and public works. A system of official plunder then began that has had few parrallels in modern times. How much was actually stolen can never be known; but the bonded debt of the city, which was $36,000,000 at the beginning of 1869, was $97,000,000 in September 1871, an increase of $61,000,000 in two years and eight months; and within the same period a floating debt of $20,000,000 was incurred, making a total of $81,000,000. For this vast sum the city had little to show. The method of plunder was the presentation of excessive bills for work done, especially in connexion with the new court-house then being erected. The bills were ostensibly paid in full, but in reality only in part, the rest being retained by Tweed, and divided amongst his followers in proportion to their importance. The total cost of the court-house to the city was about $13,000,000—many times the actual cost of construction. The amount paid in these two years for the city printing and stationery was nearly $3,000,000. The end came through a petty quarrel over the division of the spoils. One of the plunderers, dissatisfied with the office he had received, gave to the *New York Times* a copy of certain swollen accounts which showed conclusively the stealing that had been going on. When Tweed was interviewed about the frauds his only reply was, "What are you going to do about it?" The better classes, however, were now thoroughly aroused, and with Samuel J. Tilden, afterwards governor of the state, at their head, and with the assistance of the *Times* and of *Harper's Weekly*, in the latter of which the powerful cartoons of Thomas Nast appeared, completely overthrew the ring and rescued the city. Tweed was tried and convicted, but was afterwards released on a technicality of law; he was re-arrested, but managed to escape and fled to Spain; he was identified and was brought back to gaol, where he died. The rest of the gang fared little better. Within a few years and under a new leader, John Kelly, Tammany was again in control of the city. Kelly was succeeded by Richard Croker, whose reign as "boss" continued until 1901. Since 1881 Tammany has been in virtual control of the city government about one-half the time, a Tammany and a reform mayor often alternating. There were elaborate investigations of Tammany's control of the city by committees of the legislature in 1890, 1894, and 1899. The most conspicuous overthrows of Tammany since the days of Tweed were in 1894, in 1901, when practically the whole reform ticket from mayor to alderman was elected, and in 1909, when the mayor (not a member of Tammany) was the only Tammany nominee on the general ticket elected. The grosser forms of corruption that prevailed under Tweed did not as a rule prevail in later years. Instead, the money raised by and for the Hall and its leaders has come from the blackmailing of corporations, which find it easier to buy peace than to fight for their rights; from corporations which desire concessions from the city, or which do not wish to be interfered with in encroachments on public rights; from liquor-dealers, whose licences are more or less at the mercy of an unscrupulous party in power; from other dealers, especially in the poorer parts of the city, whose business can be hampered by the police; from office-holders and candidates for office; and, lastly, indirectly through corrupt police officials, from the criminal classes and gambling establishments in return for non-intervention on the part of the police. The power of Tammany Hall is the natural result of the well-regulated machine which it has built up throughout the city, directed by an omnipotent "boss." Each of the "assembly districts" into which the city is divided sends a certain number of representatives to the General Committee of Tammany Hall. Each district also has a "boss" or leader and a committee, and these leaders form the Executive Committee of the Hall. There is also a "captain" for each of the voting precincts, over 1000 in number, into which the city is divided. The patronage of the city filters down from the real "boss" of the Hall to the local precinct leader, the latter often having one or more small municipal offices at his disposal; he also handles the election money spent in his precinct. The party headquarters in the different assembly districts are largely in the nature of social clubs, and it is in considerable degree through social means that the control of the Hall over the poorer classes is maintained. The headquarters are generally over or near a saloon, and the saloon-keepers throughout Manhattan belong as a rule to the Hall—in fact, are its most effective allies or members. It should be remembered too that the Hall is not subject to divided counsels, but is ruled by one man, a "boss" who has risen to his position by sheer force of ability, and in whose hands rest the finances of the Hall, for which he is accountable to no one. When the "Greater New York" was incorporated the power of Tammany seemed likely to grow less because it was confined to the old city (Boroughs of Manhattan and the Bronx), and the Democratic organizations in the other boroughs were hostile to it. The power of the organization in the state and in the nation is due to its frequent combination with the Republican organization, which controls the state almost as completely as Tammany does the city.

See Gustavus Myers, *The History of Tammany Hall* (New York, 1901). (F. H. H.)

TAMMERFORS (Finnish *Tampere*), the chief industrial city of Finland, capital of the province of Tavastehus, on the rapids connecting Lakes Näsi-järvi and Pyhä-järvi, 125 m. by rail N.W. of Helsingfors. Pop. (1904) 40,261. Tammerfors is an important centre for the manufacture of cotton, linen, and woollen goods, leather and paper. The town owes its existence as a manufacturing centre to the tsar Alexander I.

TAMPA, a city and the county seat of Hillsboro county, Florida, U.S.A., in the western part of the state, at the head of Hillsborough Bay (the E. branch of Tampa Bay), at the mouth of the Hillsborough river. Pop. (1880) 720; (1890) 5532; (1900) 15,839, of whom 5085 were foreign-born and 4382 were negroes; (1910, U.S. census) 37,782. It is served by the Tampa Northern, the Atlantic Coast Line and the Seaboard Air Line railways, and by lines of steamers to the West Indies and to the Gulf and Atlantic ports of the United States. The larger vessels enter at Port Tampa (pop. in 1905, 1049), 9 m. from the city, on the W. side of the peninsula separating Hillsborough Bay from Old Tampa Bay, the W. branch of Tampa Bay. In order to reach water sufficiently deep for the steamers, the railway tracks have been carried by earth filling about seven-eighths of a mile into the bay. The United States government has greatly improved the harbour, and in 1899 adopted a project (modified in 1905) for constructing a channel 26 ft. deep and 300 ft. wide (500 ft. across the bar) from Port Tampa to the Gulf of Mexico; in July 1909 80 per cent. of this work had been completed. In 1905–1908 the channel of Hillsborough Bay was made 20 ft. deep at mean low water and 150 ft. wide from the lower bay to the mouth of Hillsborough river, with a turning basin at the inner end 450 ft. wide and 1050 ft. long. Tampa Bay has permanent sea-coast defences. Tampa is the principal gateway for trade and travel between the United States and the West Indies. Owing to its delightful climate and its attractive situation it has become a favourite health resort. Many visitors are attracted by the fishing (especially for tarpon) and shooting in the vicinity, water-fowl being plentiful in the Bay, and deer, quail and wild turkeys being found in the vicinity inland. There are large prehistoric shell-mounds at Indian Hill, about 20 m. S.E. Tampa is an important shipping point for naval stores and phosphate rock, for vegetables, citrus fruit and pineapples, raised in the vicinity, and for lumber, cattle and fuller's earth. The Florida Citrus Exchange has its headquarters here. After the Spanish-American War (1898) a large trade with the West Indies developed. Cattle and pine lumber are sent to Cuba, and Havana tobacco and fine grades of Cuban timber are imported. There is a large trade with Honduras also. The imports increased from $755,316 in 1897 and $490,093 in 1898 (an extremely unfavourable year owing to the Spanish-American War) to $4,179,464 in 1909; the exports from $820,792 in 1897 and $521,792 in 1898 to $1,344,786 in 1899 and $4,492,498 in 1909; a part of the custom-house clearings of Key West are actually shipped from Tampa. In 1905 the value of the factory product was $11,264,123, an increase of 59 per cent. since 1900. The principal product is cigars; most of the tobacco used is imported from Cuba, and the manufacturing is done chiefly by Cubans who live in a district known as Ybor City. It is said that more clear Havana cigars are manufactured in Tampa than in Havana. Other manufactures are boilers, foundry products, lumber and fertilizers; and there are two shipyards.

Tampa Bay was the landing-place of the expeditions of the Spanish explorers, Pamfilo de Narvaez and Hernando de Soto. (See FLORIDA.) In January 1824 the United States government established here a fort, Fort Brooke, which was an important base of supplies during the second Seminole War, and around it a settlement gradually developed. The fort was abandoned in 1860, and its site is now a public park. During the early part of the Civil War a small Confederate force was in possession, but in November 1862 it was driven out by United States gunboats. Tampa grew rapidly after the completion of the first railway thither in 1884, and in 1886 it was chartered as a city and became a port of entry. During the Spanish-American War United States troops were encamped in De Soto Park in Tampa, and Port Tampa was the point of embarkation for the United States army that invaded Cuba.

TAMPICO, a city and port of Mexico, in the state of Tamaulipas, on the N. bank of the Panuco river, about 6 m. from the Gulf of Mexico. Pop. (1906) 17,569, including the neighbouring settlements connected with the port works. The climate is hot, humid and unhealthy, and the city has suffered frequently from epidemics of yellow fever. A modern sewer system and waterworks, constructed in 1903–1906, have improved its sanitary condition and will in time reduce its heavy death-rate—about 78 per 1000 in 1903, when an epidemic of yellow fever caused 327 deaths, and the births numbered 512 against 1335 deaths. The eastern and poorer part of the town stands on low ground only 2 or 3 ft. above the river, and is subject to inundations. The western part rises about 150 ft., consists largely of private residences, and is provided with water and good drainage. The business section is well built, largely of stone and brick, and its streets are well paved and provided with gas and electric light. The neighbourhood is swampy and malarial. Tampico has two important railway connexions: the Monterrey and Gulf line running N.N.W. to Ciudad, Victoria and Monterrey, and a branch of the Mexican Central running westward to San Luis Potosi. There is also a line of river boats on the Panuco running up to the mouth of the Tamazunchale about 135 m., and another running to Tamiahua on the lagoon of that name by way of the Tuxpam canal, about 77 m. Industries include an electric light and power plant, factories for making ice, clothing, and fruit conserves, saw-mill, oil refinery, and a shipyard for small river boats. The modern port works, which have made Tampico accessible to a larger class of steamers, include two stone jetties at the mouth of the Panuco, which have increased the depth of water on the bar to 23 ft. at low water and 26 ft. at high water; seven wharves on the N. bank of the river to accommodate fourteen steamers at a time; steel sheds with railway tracks, and railway connexions at the wharves. The depth of water at the wharves varies from 18 to 25 ft. The exports include silver bullion (from San Luis Potosi, Aguascalientes, Torreon and Monterrey), ixtle fibre, sugar, hides, live cattle, cotton-seed cake, deer skins, honey, fustic, sarsaparilla, coffee, rubber, broom-root, copper ores and asphalt.

TAMWORTH, a municipality of Inglis county, New South Wales, Australia, on the Peel and Cockburn rivers, 285 m. by rail N. of Sydney. Pop. (1901) 5799. It is an attractive town in a pleasant situation, with fine broad streets lined with shady trees, and was the first town in Australia to be lighted by electricity. Tamworth is the centre of several goldfields, at one of which, Bingera, diamonds are found. It is also the market of a pastoral and agricultural district. Brewing, malting, steam, saw and flour milling, coach building and the manufacture of boots and galvanized iron are its principal industries.

TAMWORTH, a market town and municipal borough of England, in the Lichfield parliamentary division of Staffordshire and the Tamworth division of Warwickshire, on the river Tame, a southern tributary of the Trent. Pop. (1901) 7271. It is 110 m. N.E. from London by the London and North-Western railway, and is also served by the west and north line of the Midland railway (Bristol-Birmingham-Derby). The castle, situated on a height above the Anker near its junction with the Tame, is chiefly of the Jacobean period, but is enclosed by massive ancient walls. Here was a residence of the Mercian kings, and, after being bestowed on the Marmions by William the Conqueror, the castle remained for many years an important fortress. Formerly the town was surrounded by a ditch called the King's Dyke, of which some trace remains. The church of St Editha, originally founded in the 8th century, was rebuilt, after being burned by the Danes, by Edgar, who made it collegiate, but the existing Decorated building, was erected after a fire in 1345. The free grammar school, refounded by Edward IV., was rebuilt in 1677, and again in 1867. The charities include Guy's almshouses, endowed in 1678 by Thomas Guy, founder of Guy's Hospital, London. On the commons or moors burgesses have rights of pasture. Coal, fireclay and blue and red brick clay are dug in the neighbourhood; and there are also market gardens. In the town are a clothing factory, paper-mills, and manufactures of small wares. The town is governed by a mayor, 4 aldermen, and 12 councillors. Area, 285 acres.

Tamworth (*Tamwurda*, *Thamworth*, *Tomworth*) is situated near the Roman Watling Street. It was burned by the Danes and restored in 913 by Aethelflead, lady of the Mercians, who built the fort which was the origin of the later castle. The town was again destroyed by the Danes in 943. There is no description of Tamworth in Domesday, but its burgesses are incidentally mentioned several times. In Anglo-Saxon and Norman times it possessed a mint, and it is called a borough in the Pipe Rolls of Henry II., but it was not then in a flourishing condition. Tamworth was incorporated by Elizabeth in 1560 by letters patent, which state that it is an "ancient mercate town," and suggest that the charters have been lost or burned. The governing charter in 1835 was that of Charles II., incorporating it under the title of the bailiffs and commonalty of the borough of Tamworth in the counties of Stafford and Warwick. Edward III. granted two fairs, still kept up in 1792, to be held respectively on St George's day and the day of the Translation of St Edward; another ancient fair, in honour of St Swithin, or perhaps originally of St Editha, is still held (July 26). Tamworth sent two members to parliament from 1562 to 1885, when its representation was merged in that of the county.

TANA, a river of British East Africa, which gives its name to the Tanaland province of that protectorate. It has a course, following the main windings only, of over 500 m. Its sources are along the watershed close to the eastern wall of the eastern rift-valley, and it enters the Indian Ocean in 2° 40′ S., about 110 m. N. by E. of Mombasa. One series of its numerous headstreams traverses the Kikuyu plateau north of the Athi, while others flow down the southern and eastern slopes of Kenya. The main stream, from about 37° E. 1° S., where it runs close to the upper waters of the Athi, flows in a wide curve N.E., nearly reaching the equator. About 39° E. it turns S., and from this point is not known to receive any tributary of importance. Its course is very tortuous, the current rapid, and the channel much obstructed by snags. Its width varies, as a general rule, between 100 and 200 yds. The banks are usually low, in part forested and inundated at high water, but away from the river the country appears to consist of dry plains covered with mimosa scrub. Adjoining the lower Tana are many backwaters, which seem to show that the course has been subject to great changes. In 2° 20′ S. the river again turns east, but during the last 10 m. it flows south-west, parallel to the coast, entering the sea across a dangerous bar. The Tana has been navigated in a steam-launch for some 300 m. from the mouth. North of the Tana is the Ozi, a small river connected with the Tana by the Belazoni canal.

TANAGER, a word adapted from the quasi-Latin *Tanagra* of Linnaeus, which again is an adaptation, perhaps with a classical allusion, of *Tangara*, used by M. J. Brisson and G. L. L. Buffon, and said by G. de L. Marcgrave (*Hist. Rer. Nat. Brasiliae*, p. 214) to be the Brazilian name of certain birds found in that country. From them it has since been extended to a great many others mostly belonging to the southern portion of the New World, now recognized by ornithologists as forming a distinct family *Tanagridae* of the *Oscines* division of Passerine birds allied to the *Fringillidae* (see FINCH); and distinguished from them chiefly by their feebler conformation and more exposed nostrils. They are confined to the New World, and are specially characteristic of the tropical forests of Central and South America.

The tanagers have been examined systematically by P. L. Sclater, and in the British Museum *Catalogue* (xi. pp. 49–307) he admits the existence of 375 species, which he arranges in 59 genera, forming six subfamilies, *Procniatinae*, *Euphoniinae*, *Tanagrinae*, *Lamprotinae*, *Phoenicophilinae*, and *Pitylinae*. These are of very unequal extent, for, while the first of them consists of but a single species, *Procnias tersa*—the position of which may be for several reasons still open to doubt—the third includes more than 200. Nearly all are birds of small size, the largest barely exceeding a song-thrush. Most of them are remarkable for their gaudy colouring, and this is especially the case in those forming the genus called by Sclater, as by most other authors, *Calliste*, a term inadmissible through preoccupation, to which the name of *Tanagra* of right seems to belong, while that which he names *Tanagra* should probably be known as *Thraupis*. The whole family is almost confined to the Neotropical region, and there are several forms peculiar to the Antilles; but not a tenth of the species reach even southern Mexico, and not a dozen appear in the northern part of that country. Of the genus *Pyranga*, which has the most northern range of all, three if not four species are common summer immigrants to some part or other of the United States, and two of them, *P. rubra* and *P. aestiva*, known as the scarlet tanager and the summer redbird, reach Canada and Bermuda. *P. aestiva* has a western representative, *P. cooperi*, which by some authors is not recognized as a distinct species. The males of all these are clad in glowing red, *P. rubra* having, however, the wings and tail black. The remaining species, *P. ludoviciana*, the males of which are mostly yellow and black, with the head only red, does not appear eastward of the Missouri plains, and has not so northerly a range. Another species, *P. hepatica*, has shown itself within the limits of the United States. In all these the females are plainly attired; but generally among the Tanagers, however bright may be their coloration, both sexes are nearly alike in plumage. Little has been recorded of the habits of the species of Central or South America, but those of the north have been as closely observed as the rather retiring nature of the birds renders possible, and it is known that insects, especially in the larval condition, and berries afford the greater part of their food. They have a pleasing song, and build a shallow nest, in which the eggs, generally three in number and of a greenish-blue marked with brown and purple, are laid. A few species are regularly but sparingly imported into Europe alive, and do well as cage birds.

On the whole the *Tanagridae* may perhaps be considered to hold the same relation to the *Fringillidae* as the *Icteridae* do to the *Sturnidae* and the *Mniotiltidae* to the *Sylviinae* or *Turdinae*, in each case the purely New-World Family being the "feebler" type.

(A. N.)

TANAQUIL, the Etruscan name of the wife of Tarquinius Priscus, or of one of his sons. After her immigration to Rome she is said to have received the name Gaia Caecilia. She was famous for her shrewdness and prophetic gifts, which enabled her to foretell the future greatness of her husband and of Servius Tullius. There was a statue of her as Gaia Caecilia in the temple of Sancus, which possessed magical powers. She was celebrated as a spinner of wool, and was supposed to exercise influence over Roman brides. Tanaquil and Gaia Caecilia are, however, really distinct personalities. The anecdotes told of Gaia Caecilia are aetiological myths intended to explain certain usages at Roman marriages.

See Livy, i. 34, 41; Pliny, *Nat. Hist.*, viii. 74, xxxvi. 70; Schwegler, *Römische Geschichte*, bk. xv. 8.

TANAUAN, a town of the province of Batangas, Luzon, Philippine Islands, about 38 m. S.S.E. of Manila. Pop. (1903) 18,263. Tanauan is situated on a rolling upland plain. It formerly produced much sugar, but its inhabitants are now engaged chiefly in the cultivation of rice, Indian corn and fruit. Oranges and hogs are sent from Tanauan to the Manila market. The language is Tagalog.

TANCRED (d. 1112), nephew of Bohemund and a grandson of Robert Guiscard on the female side, was the son of a certain *Marchisus*, in whom some have seen a marquis, and some an Arab (Makrizi). He took the Cross with Bohemund in 1096, and marched with him to Constantinople. Here he refused to take an oath to Alexius, escaping across the Bosphorus in the disguise of a peasant; but after the capture of Nicaea he consented to follow the example of the other princes, and became the man of Alexius. At Heraclea, in the centre of Asia Minor, he left the main body of the Crusaders, and struck into Cilicia, closely followed by Baldwin of Lorraine. He may have been intending, in this expedition, to prepare a basis for Bohemund's eastern principality; in any case, he made himself master of Tarsus, and when he was evicted from it by the superior forces of Baldwin, he pushed further onwards, and took the towns of Adana and Mamistra. He joined the main army before Antioch, and took a great part in the siege. When, in the spring of 1098, two castles were erected by the crusaders, it was Tancred who undertook the defence of the more exposed castle, which lay by St George's Gate, on the west of the city. In the beginning of 1099 he was serving in the ranks of Raymund's army, whether to observe his movements in the interests of Bohemund, or only (as is more probable) to be in the front of the fighting and the march to Jerusalem. But he soon left the count, like so many of the other pilgrims (see under RAYMUND); and he joined himself to Godfrey of Lorraine in the final march. In June 1099 he helped Baldwin de Burg (his future rival) in the capture of Bethlehem; and he played his part in the siege of Jerusalem, gaining much booty when the city was captured, and falling into a passion because the security he had given to the fugitives on the roof of Solomon's temple was not observed by the crusaders. After the capture of Jerusalem he went to Naplous, and began to found a principality of his own. He took part in the battle of Ascalon in August; and after it he was invested by Godfrey with Tiberias and the principality of Galilee, to the north of Naplous. In 1100 he attempted, without success, to prevent Baldwin of Lorraine (his old enemy in Cilicia) from acquiring the throne of Jerusalem, possibly having ambitions himself, and in any case fearing the foundation of a strong non-Norman power in Palestine. Failing in this attempt, and being urgently summoned from the North to succeed Bohemund (now a prisoner with Danishmend) in the government of Antioch, he surrendered his smaller possessions to Baldwin, on condition that they should be restored if he returned in a year and three months, and finally left the kingdom of Jerusalem. He acted as regent in Antioch from 1100 to 1103, when Bohemund regained his liberty. During these years he succeeded in regaining the Cilician towns for Antioch (1101), and in recapturing Laodicea (1103); he imprisoned Raymund of Toulouse, and only gave him his liberty on stringent conditions; and he caused the restoration of the deposed patriarch of Jerusalem, Dagobert, if only for a brief season, by refusing to aid Baldwin I. on any other terms. When Bohemund was set free, Tancred had to surrender Antioch to him; but he soon found fresh work for his busy hands. In 1104 he joined with Bohemund and Baldwin de Burg (now count of Edessa in succession to Baldwin of Lorraine) in an expedition against Harran, in which they were heavily defeated, and Baldwin was taken prisoner. Tancred, however, profited doubly by the defeat. He took over the government of Edessa in Baldwin's place; and in 1105 Bohemund surrendered to him the government of Antioch, while he himself went to Europe to seek reinforcements. Ruler of the two northern principalities, Tancred carried on vigorous hostilities against his Mahommedan neighbours, especially Ridwan of Aleppo; and in 1106 he succeeded in capturing Apamea. In 1107, while Bohemund was beginning his last expedition against Alexius, he wrested the whole of Cilicia from the Greeks; and he steadfastly refused, after Bohemund's humiliating treaty at Durazzo in 1108, to agree to any of its stipulations with regard to Antioch and Cilicia. To the hostility of the Mahommedans and the Greeks, Tancred also added that of his own fellow Latins. When Baldwin de Burg regained his liberty in 1108, it was only with difficulty that he was induced to restore Edessa to him, and the two continued unfriendly for some time; while in 1109 he also interfered in the civil war in Tripoli between the nephew and the eldest son of Raymund of Toulouse. But it was against the emirs of Northern Syria that his arms were chiefly directed;

and he became the hammer of the Turks, restlessly attacking the emirs on every side, but especially in Aleppo, and exacting tribute from them all. He died in 1112, leaving the government to his brother-in-law, Roger de Principatu, until such time as Bohemund II. should come to his inheritance.

Bibliography.—Tancred's *Gesta* were recorded by Ralph of Caen, who drew his information from Tancred's own conversation and reminiscences. Kugler has written a work on *Bohemund und Tancred* (Tübingen, 1862); and Tancred's career is also described by Rey, in the *Revue de l'Orient Latin*, iv. 334-340. (E. Br.)

TANCRED (d. 1194), King of Sicily, an illegitimate son of Roger, the eldest son of King Roger II., was crowned in January 1190 in succession to William II. (*q.v.*). He was supported by the chancellor Matthew d'Ajello and the official class, while the rival claims of Roger II.'s daughter Constance and her husband, Henry VI., king of the Romans and emperor, were supported by most of the nobles. Tancred was a good soldier, though his tiny stature earns from Peter of Eboli the nickname "Tancredulus." But he was ill-supported in his task of maintaining the Norman kingdom, faced with general apathy, and threatened by a baronial revolt, and, in addition, Richard Coeur-de-Lion, at Messina, 1190, threatened him with war. Henry, skilfully winning over Pisa, Genoa and the Roman Commune, isolated Tancred and intimidated Celestine III., who, on the 14th of April 1191, crowned him emperor at Rome. He, however, failed to capture Naples in August and retired north, leaving garrisons along the frontiers of the Regno. Tancred now sought to win over the towns by extensive grants of privileges, and at Gravina (June 1192) was recognized by the pope, whose ineffectual support he gained by surrendering the royal legateship over Sicily. In 1192 and 1193 he commanded personally and with success against the Apulian barons, but his death at Palermo (20th of February 1194) a few days after that of Roger, his son and joint-king, made Henry's path clear. His wife Sibilla indeed maintained a regency for her second son William III., but on Henry's final descent, Naples surrendered almost without a blow in May 1194, and the rest of the Regno followed. Sibilla and the loyal Margarito prepared to defend Palermo, but the citizens admitted the emperor on the 20th of November 1194. Tancred's family fell into Henry's hands, and William III. seems to have died in Germany in 1198.

TANDY, JAMES NAPPER (1740-1803), Irish rebel, son of a Dublin ironmonger, was born in Dublin in 1740. He started life as a small tradesman; but turning to politics, he became a member of the corporation of Dublin, and made himself popular by his denunciation of municipal corruption and by his proposal of a boycott of English goods in Ireland, in retaliation for the restrictions imposed by the government on Irish commerce. In April 1780 Tandy was expelled from the Dublin volunteers (see Flood, Henry) for proposing the expulsion of the duke of Leinster, whose moderation had offended the extremists. He was one of the most conspicuous of the small revolutionary party, chiefly of the shopkeeper class, who formed a permanent committee in June 1784 to agitate for reform, and called a convention of delegates from all parts of Ireland, which met in October 1784. Tandy persuaded the corporation of Dublin to condemn by resolution Pitt's amended commercial resolutions in 1785. He became a member of the Whig club founded by Grattan; and he actively co-operated with Theobald Wolfe Tone in founding the Society of the United Irishmen in 1791, of which he became the first secretary. The violence of his opinions, strongly influenced by French revolutionary ideas, now brought Tandy prominently under the notice of the government. In February 1792 an allusion in debate by Toler (afterwards earl of Norbury), the attorney-general, to Tandy's personal ugliness, provoked him into sending a challenge; this was treated by the House of Commons as a breach of privilege, and a Speaker's warrant was issued for his arrest, which however he managed to elude till its validity expired on the prorogation of parliament. Tandy then took proceedings against the lord lieutenant for issuing a proclamation for his arrest; and although the action failed, it increased Tandy's popularity, and his expenses were paid by the Society of the United Irishmen. Sympathy with the French Revolution was at this time rapidly spreading in Ireland. A meeting of some 6000 persons in Belfast voted a congratulatory address to the French nation in July 1791. In the following year Napper Tandy took a leading part in organizing a new military association in Ireland modelled after the French National Guards; they professed republican principles, and on their uniform the cap of liberty instead of the crown surmounted the Irish harp. Tandy also, with the purpose of bringing about a fusion between the Defenders and the United Irishmen, took the oath of the Defenders, a Roman Catholic society whose agrarian and political violence had been increasing for several years; but being threatened with prosecution for this step, and also for libel, he fled to America, where he remained till 1798. In February 1798 he went to Paris, where at this time a number of Irish refugees, the most prominent of whom was Wolfe Tone, were assembled, planning rebellion in Ireland to be supported by a French invasion, and quarrelling among themselves. None of these was more quarrelsome than Napper Tandy, who was exceedingly conceited, and habitually drunken; his vanity was wounded to find himself of less account than Tone in the councils of the conspirators.

Wolfe Tone, who a few months before had patronizingly described him to Talleyrand as "a respectable old man whose patriotism has been known for thirty years," was now disgusted by the lying braggadocio with which Tandy persuaded the French authorities that he was a personage of great wealth and influence in Ireland, at whose appearance 30,000 men would rise in arms. Tandy was not, however, lacking in courage. He accepted the charge of a corvette, the "Anacreon," placed at his disposal by the French government, in which, accompanied by a few leading United Irishmen, and supplied with a small force of men and a considerable quantity of arms and ammunition for distribution in Ireland, he sailed from Dunkirk and arrived at the isle of Aran, off the coast of Donegal, on the 16th of September 1798. The populace showed no disposition to welcome the invaders. Napper Tandy, who was drunk during most of the expedition, took possession of the village of Rutland, where he hoisted an Irish flag and issued a bombastic proclamation; but learning the complete failure of Humbert's expedition, and that Connaught instead of being in open rebellion was perfectly quiet, the futility of the enterprise was apparent to the French if not to Tandy himself; and the latter having been carried on board the "Anacreon" in a state of intoxication, the vessel sailed round the north of Scotland to avoid the English fleet, and reached Bergen in safety, whence Tandy made his way to Hamburg with three or four companions. In compliance with a peremptory demand from the English government, and in spite of a counter-threat from the French Directory, the refugees were surrendered. Tandy remained in prison till April 1801, when he was tried, pleaded guilty, and was sentenced to death; he was, however, reprieved and allowed to go to France. This leniency may have been partly due to doubts as to the legality of the demand for his surrender by the Hamburg authorities; but the government was probably more influenced by Cornwallis's opinion that Tandy was "a fellow of so very contemptible a character that no person in this country (Ireland) seems to care the smallest degree about him." Moreover, Bonaparte vigorously intervened on his behalf, and is even said to have made Tandy's release a condition of signing the treaty of Amiens. Notwithstanding his vices and his lack of all solid capacity, there is no reason to suppose that Napper Tandy was dishonest or insincere; and the manner in which his name was introduced in the well-known ballad, "The Wearing of the Green," proves that he succeeded in impressing the popular imagination of the rebel party in Ireland. In France, where his release was regarded as a French diplomatic victory, he was received, in March 1802, as a person of distinction; and when he died on the 24th of August 1803 his funeral was attended by the military and an immense number of the civil population.

See R. R. Madden, *The Lives of the United Irishmen*, 7 vols. (Dublin, 1842-46); W. J. MacNeven, *Pieces of Irish History* (New

York, 1807); T. Wolfe Tone, *Autobiography*, ed. by R. Barry O'Brien, 2 vols. (London, 1893); W. J. Fitzpatrick, *Secret Service under Pitt* (London, 1892); Sir Richard Musgrave, *Memoirs of Rebellions in Ireland*, 2 vols. (Dublin, 1802); J. A. Froude, *The English in Ireland in the Eighteenth Century*, 3 vols. (London, 1872–74); *Castlereagh Correspondence*, i., ii.; *Cornwallis Correspondence*, ii., iii. (R. J. M.)

TANEGA-SHIMA, an island lying to the south of Kiushiu, Japan, in 30° 50′ N. and 131° E., 36½ m. long and 7¼ m. broad at its widest part. It is a long low stretch of land, carefully cultivated, and celebrated as the place where Mendez Pinto landed when he found his way to Japan in 1543. Until modern times firearms were colloquially known in Japan as "Tanega-shima," in allusion to the fact that they were introduced by Pinto.

TANEY, ROGER BROOKE (1777–1864), American jurist, was born in Calvert county, Maryland, on the 17th of March 1777, of Roman Catholic parentage. He graduated from Dickinson College, Carlisle, Pennsylvania, in 1795, began the study of law at Annapolis in 1796, and was admitted to the bar in 1799. In 1806 he married Anne Phebe Key, sister of Francis Scott Key. He entered politics as a Federalist, and was a member of the Maryland House of Delegates in 1799–80. His faith in Federalism was weakened by the party's opposition to the War of 1812, and he gradually became associated with the Jacksonian wing of the Republican party. He served in the state Senate in 1816–21, was attorney-general of Maryland in 1827–31; and in July 1831 entered President Jackson's cabinet as attorney-general of the United States. He was the President's chief adviser in the attack on the United States Bank, and was transferred to the treasury department in September 1833 for the special purpose of removing the government deposits. This conduct brought him into conflict with the Senate, which passed a vote of censure, and (in June 1834) refused to confirm his appointment as secretary of the treasury. He returned to his law practice in Baltimore, but on the 28th of December 1835 was nominated Chief-Justice of the United States Supreme Court to succeed John Marshall. After strong opposition the nomination was confirmed, on the 15th of March 1836, by the Senate. Under the guidance of Judges John Jay, Marshall, and Joseph Story, the judiciary from 1790 to 1835 had followed the Federalist loose construction methods of interpreting the constitution. The personnel of the supreme bench was almost entirely changed during President Jackson's administration (1829–37). Five of the seven judges in 1837 were his appointees, and the majority of them were Southerners who had been educated under Democratic influences at a time when the slavery controversy was forcing the party to return to its original strict construction views. In consequence, although the high judicial character of the men appointed and the lawyers' regard for precedent served to keep the court in the path marked out by Marshall and Story, the state sovereignty influence was occasionally manifest, as, for example, in the opinion (written by Taney) in the *Dred Scott* case (1857, 19 Howard, 393) that Congress had no power to abolish slavery in territory acquired after the formation of the national government. During the Civil War, Judge Taney struggled unsuccessfully to protect individual liberty from the encroachments of the military authorities. In the case of *ex parte John Merryman* (1861, Campbell's Reports, 646), he protested against the assumption of power by the President to suspend the privileges of the writ of *habeas corpus* or to confer that power upon a military officer without the authorization of Congress. The delivering of this opinion, on circuit, in Baltimore, in May 1861, was one of the judge's last public acts. He died on the 12th of October 1864.

An authoritative biography is Samuel Tyler's *Memoir of Roger Brooke Taney* (Baltimore, 1872).

TANGA ("the sail"), a seaport of German East Africa, lying opposite the island of Pemba in 5° 6′ S., 39° 7′ E. The town is regularly laid out on elevated ground on the southern shore of Tanga Bay, and has a population of about 6000. Among the public buildings are the administrator's residence, the hospital, the boma (barracks), Protestant and Catholic churches and the government and mission schools. Tanga is the port of the Usambara district, where are many thriving plantations. The harbour is entered by a broad channel five to eight fathoms deep. It is a port of call for the German mail steamers, and the starting-point of a railway to the Usambara highlands.

TANGANYIKA (a name said by V. L. Cameron to signify a "mixing-place"), a vast lake in East-Central Africa, the longest freshwater lake in the world, measuring just over 400 m., with a general breadth varying from 30 to 45 m., and an area of about 12,700 sq. m. It lies at an altitude of about 2600 ft. above the sea, and occupies the southern end of the great central rift-valley, which terminates suddenly at its southern point, the line of depression being represented farther south by the more easterly trough of Lakes Nyasa and Rukwa, from which Tanganyika is separated by the Fipa plateau, composed of old granitoid rocks; though even here traces of old valley-walls are said by Dr Kohlschütter to exist. North of Tanganyika the valley is suddenly interrupted by a line of ancient eruptive ridges, which dam back the waters of Lake Kivu (*q.v.*), but have been recently cut through by the outlet of that lake, the Rusizi, which enters Tanganyika by several mouths at its northern end. The flat plain traversed by the lower Rusizi was evidently once a portion of the lake floor. Tanganyika has been formed by the subsidence of a long narrow tract of country relatively to the surrounding plateaus, which fall to the lake in abrupt cliffs, some thousands of feet high in places. The geological formations thus exposed show that the plateaus are composed of a base of eruptive material, overlaid by enormous deposits of reddish sandstones, conglomerates and quartzites, exposed in parts to a depth of 2000 feet. Besides the plain to the north, a considerable area to the west, near the Lukuga outlet (see below), shows signs of having been once covered by the lake, and it is the opinion of Mr J. E. S. Moore that the sandstone ridges which here bound the trough have been recently elevated, and have been cut through by the Lukuga during the process.

The past history of the lake has long been a disputed question, and Mr Moore's view that it represents an old Jurassic arm of the sea is contested by other writers. This idea originated in the discovery of a jelly-fish, gasteropods, and other organisms of a more or less marine type, and presenting some affinity with forms of Jurassic age. This fauna, to which the term "halolimnic" has been applied, was known to exist from specimens obtained by Mr E. C. Hore and other early travellers, but has been more systematically studied by Mr Moore (during expeditions of 1896 and 1898–99) and Dr W. A. Cunnington (1904–5). Various considerations throw doubt on Mr Moore's theory, especially the almost entire absence of marine fossiliferous beds in the whole of equatorial Africa at a distance from the sea, of any remains of Jurassic faunas which might link the Tanganyika forms with those of undoubted Jurassic age in neighbouring regions. The formation of the existing rift-valley seems in any case to date from Tertiary times only.

Although drinkable, the water of the lake seems at times at least to be very slightly brackish, and it was supposed by some that no outlet existed until, in 1874, Lieutenant Cameron showed that the surplus water was discharged towards the upper Congo by the Lukuga river, about the middle of the west coast. The outlet was further examined in 1876 by Mr (afterwards Sir Henry) Stanley, who found that a bar had formed across the outlet, and it has since been proved that the outflow is intermittent, ceasing almost entirely after a period of scanty rainfall, and becoming again established when the lake-level has been raised by a series of rainy years. About 1880 it was running strongly, but about this time a gradual fall in the lake-level set in, and was continued, with occasional pauses, for some twenty years, the amount being estimated by Wissmann at 2 feet annually. In 1896 Captain H. Ramsay found that a wide level plain, which had before been covered by water, intervened between Ujiji and the lake, but stated that no further sinking had taken place during the two previous years. Near Tembwe Head Mr L. A. Wallace found recent beaches 16 feet above the existing level. The Lukuga was reported blocked by a bar about 1897, but a certain amount of water was found flowing down by Mr Moore in 1899; while in 1901 Mr Codrington found the level 4 or 5 feet higher than in 1900, the outlet having again silted up. A continued rise was also reported in 1907. In any case, the alterations in level appear to be merely periodic, and due to fluctuations in rainfall, and do not point, as some have supposed, to a secular drying up of the lake.

The lake is fed by a number of rivers and small streams which descend from the surrounding highlands. The Mlagarazi (or Malagarasi), perhaps the largest feeder, derives most of its water from the rainy districts east of the strip of high ground which shuts in the lake on the north-east. The main stream, in fact, has a nearly circular course, rising in 4° 40′ S., only some 10 miles from the lake shore and less than 40 miles from its mouth, though its length is at least 220 miles. The other branches of the Mlagarazi, which traverse the somewhat arid granite plateaus between the lake and 33° E., bring comparatively little water to the main stream. In its lower course the river is a rapid stream flowing between steep jungle-clad hills, with one fall of 50 feet, and is of little use for navigation. The various channels of its delta are also obstructed with sand-banks in the dry season. The Rusizi, the next (or perhaps equal) in importance among the feeders of the lake, has already been spoken of. It receives many tributaries from the sides of the rift-valley, and is navigable for canoes. The remaining feeders are of distinctly less importance, the Lofu, which enters in the south-west, being probably the largest.

Tanganyika has never been sounded systematically, but the whole configuration of its valley points to its being generally deep, and this has been confirmed by a few actual measurements. Dr Livingstone obtained a depth of 326 fathoms opposite Mount Kabogo, south of Ujiji. Mr Hore often failed to find bottom with a line of 168 fathoms. The French explorer, Victor Giraud, reported 647 metres (about 350 fathoms) off Mrumbi on the west coast, and Moore depths of 200 fathoms and upwards near the south end. The shores fall rapidly as a rule, and there is a marked scarcity of islands, none occurring of any size or at a distance from the coast line. The lake is subject to occasional storms, especially from the south-south-east and south-west, which leave a heavy swell and impede navigation. The cloud and thunder and lightning effects are spoken of as very impressive, and the scenery of the lake and its shores has been much extolled by travellers.

Vegetation is generally luxuriant, and forest clothes portions of the mountain slopes. The lake lies on the dividing line between the floral regions of East and West Africa, and the oil-palm characteristic of the latter is found on its shores. The largest timber tree is the mvule, which attains vast dimensions, its trunk supplying the natives with the dug-out canoes with which they navigate the lake. The more level parts of the shores have a fertile soil and produce a variety of crops, including rice, maize, manioc, sweet potatoes, sugar-cane, &c., &c. The waters display an abundance of animal life, crocodiles and hippopotami occurring in the bays and river mouths, which are also the haunts of water-fowl of many kinds. Fish are also plentiful. Various sections of the Bantu division of the Negro race dwell around the lake, those on the west and south-west showing the most pronounced Negro type, while the tribes on the east exhibit some intermixture with representatives of the Hamitic stock, and (towards the south) some traces of Zulu influence. The surrounding region has been overrun by Arabs and Swahili from the East African coast.

Though rumours of the existence of the lake had previously reached the east coast, Tanganyika was not visited by any European until, in 1858, the famous expedition of Burton and Speke reached the Arab settlement of Ujiji and partially explored the northern portion. Ujiji became famous some years later as the spot where Dr Livingstone was found by Stanley in 1871, after being lost to sight for some time in the centre of the continent. The southern half of the lake was first circumnavigated by Lieutenant V. L. Cameron in 1874, and the whole lake by Stanley in 1876. The mapping of Tanganyika, which long rested on the surveys of Mr E. C. Hore, published in 1882, received considerable modification, about 1899–1900, from the work of Fergusson, Lemaire, Kohlschütter and others, who showed that while the general outline of the coasts had been drawn fairly correctly, the whole central portion, and to a lesser degree the northern, must be shifted a considerable distance to the west. At Mtowa, in 5° 43′ S., the amount of shifting of the west coast was about 30 miles. At Ujiji, on the east coast, the longitude was given by Kohlschütter as 29° 40′ 2″ E. as compared with 30° 4′ 30″ E. of Cameron, a difference of some 25 miles.

In the partition of Africa among the European Powers, the shores of Tanganyika have been shared by Belgium, Great Britain and Germany, Great Britain holding the southern extremity, Germany the east, and Belgium the west. Stations have been established on the lake by all three Powers, the principal being—German: Bismarckburg in the south and Ujiji in the north; British: Sumbu and Kasakalawe, on Cameron Bay; Belgian: Mtowa or Albertville in 6° S. Missionaries, especially the Catholic "White Fathers," are also active on its shores. A small steamer, the "Good News," was placed on the lake by the London Missionary Society in 1884, but afterwards became the property of the African Lakes Corporation; a larger steamer, the "Hedwig von Wissmann," carrying a quick-firing Krupp gun, was launched in 1900 by a German expedition under Lieutenant Schloifer; and others are owned by the "Tanganyika Concessions" and Katanga companies. The greater part of the trade with Tanganyika is done by the African Lakes Corporation by the Shiré-Nyasa route, but the Germans have opened up overland routes from Dar-es-Salaam.

Authorities.—The narratives of Burton, Livingstone, Cameron and Stanley; E. C. Hore, *Lake Tanganyika* (London, 1892); J. E. S. Moore, in *Geogr. Journal*, September 1897 and January 1901; *To the Mountains of the Moon* (London, 1901); *The Tanganyika Problem* (London, 1903); L. A. Wallace, *Geogr. Journal*, June 1899; H. Ramsay, in *Verhandl. d. Gesell. für Erdkunde Berlin*, No. 7, 1898; H. Glauning and E. Kohlschütter, in *Mitt. aus den Deutschen Schutzgebieten*, Nos. 1 and 2, 1900; E. Kohlschütter, in *Verhandl.* 13 *Deutsch. Geographentages*, 1901; M. Fergusson, in *Geol. Mag.*, August 1901; E. Stromer, in *Petermanns Mitteil.*, December 1901; R. Codrington, in *Geogr. Journal*, May 1902; W. H. Hudleston, in *Transactions Victoria Inst.*, 1904; also papers on the results of Dr W. A. Cunnington's expedition in *Proceedings of the Zoological Society*, 1906, &c.; *Journal of the Linnean Society*, 1907. (E. He.)

TANGERMÜNDE, a town of Germany, in the Prussian province of Saxony, on the Elbe, 43 m. N.E. from Magdeburg by rail *via* Stendal. Pop. (1905) 12,829. It contains iron foundries, shipbuilding yards, refineries, and other industrial establishments, and enjoys a considerable river trade in grain and coal. It is ornamented by numerous brick buildings of the 14th and 15th centuries, including the turreted walls, the church of St Stephen (1376), and the late Gothic town hall. The castle, built in the 14th century, was the chief residence of the margraves of Brandenburg.

See Götze, *Geschichte der Burg Tangermünde* (Stendal, 1871).

TANGIER (locally Tanjah), a seaport of Morocco, on the Straits of Gibraltar, about 14 m. E. of Cape Spartel, nestles between two eminences at the N.W. extremity of a spacious bay. The town, which has a population of about 40,000, presents a picturesque appearance from the sea, rising gradually in the form of an amphitheatre, with the citadel, the remainder of the English mole and York Castle to the right: in the central valley is the commercial quarter, while to the left along the beach runs the track to Tetuan. Though rivalry between European Powers led to many public works being delayed, through the action of the public Sanitary Association the streets, which are narrow and crooked, have been re-paved as well as cleaned and partially lighted, and several new roads have been made outside the town. In some of the older streets European shops have replaced the picturesque native cupboards; drinking dens have sprung up at many of the corners, while telephones and electric light have been introduced by private companies, and European machinery is used in many of the corn-mills, &c. The main thoroughfare leads from Báb el Marsa (Gate of the Port) to the Báb el Sok (Gate of the Market-place) known to the English as Port Catherine. The sok presents a lively spectacle, especially upon Thursdays and Sundays.

Tangier is almost destitute of manufactures, and while the trade, about £750,000 a year, is considerable for Morocco, it is confined chiefly to imports, about two-fifths of which come from Great Britain and Gibraltar, and one quarter from France. The exports are chiefly oxen, meat, fowls and eggs for Gibraltar and sometimes for Spain, with occasional shipments of slippers and blankets to Egypt. Most of the trade, both wholesale and retail, is in the hands of the Jews (see further Morocco).

The harbour formed by the Bay of Tangier is an extensive one, the best Morocco possesses, and good in all weathers except during a strong east wind, but vessels of any size have to anchor a mile or so out as the shore to the west is shallow and sandy, and to the east, rocky and shingly. Since 1907 a basin with an outer and inner mole has been built. It does not, however, accommodate large vessels. The climate is temperate and healthy, and good for consumptives.

As the seaport nearest to Europe, Tangier is the town in the empire in which the effects of progress are most marked, and since the end of the 18th century it has been the diplomatic headquarters. The nucleus of a cosmopolitan society thus formed has expanded into a powerful community enjoying privileges and immunities unknown to natives not receiving its protection. The steadily increasing number of visitors has induced the opening of first-class hotels, and necessitated extensive building operations, resulting in the immigration of some thousands of artisans, chiefly Spanish. The number of European inhabitants (1905) was about 9000 (7500 Spaniards); of Jews about 10,000.

The Roman Tingis, which stood in the immediate vicinity of the site of Tangier, was of great antiquity; under Augustus it became a free city, and when Otho placed the western half of Mauretania under a procurator, he called it Mauretania Tingitana after its capital Tingis. It was held by Vandals, Byzantines and Arabs, and when Mulai Idris passed from Tlemçen to Fez in 788, Tangier was "the oldest and most beautiful city" of the Maghrib. After many futile attempts the Portuguese obtained possession of it in 1471, but it passed to Spain in 1580, returning again to the Portuguese in 1656. In 1662 as part of the dowry of Catherine of Braganza on her marriage to Charles II., it came into the possession of the English, and they defended it against Mulai Ismail in 1680, but in 1684 it was decided, on account of expense, to abandon the place to the Moors. El Ufrani writes that "it was besieged so closely that the Christians had to flee on their vessels and escape by sea, leaving the place ruined from bottom to top." It was bombarded in 1844 by the French, then at war with Morocco. In the early years of the 20th century the sharīf Raisūli terrorized the district round Tangier and made captive several Europeans. As one result of the Algeçiras conference of 1906 a regular police force was organized, and the control of the customs passed into European hands (see MOROCCO: § *History*).

See A. Cousin, *Tanger* (Paris, 1902); *Archives Marocaines* (Paris, 1904–6).

TANGYE, SIR RICHARD (1833–1906), British manufacturer, was born at Illogan, near Redruth, Cornwall, on the 24th of November 1833, the son of a small farmer. As a young boy he worked in the fields, but when he was eight years old he was incapacitated from further manual labour by a fracture of the right arm. His father then determined to give him the best education he could afford, and young Tangye was sent to the Friends' School at Sidcot, Somersetshire, where he progressed rapidly and became a pupil-teacher. Tangye was not long contented with this position, and through an advertisement in *The Friend* obtained a clerkship in a small engineering firm in Birmingham, where two of his brothers, skilled mechanics, subsequently joined him. Here Richard Tangye remained four years, obtaining a complete mastery of the details of an engineering business, and introducing the system of a Saturday half-holiday which was subsequently adopted in all English industrial works. In 1856 he started business in a small way in Birmingham as a hardware factor and commission agent. His first customers were the Cornish mine-owners in the Redruth district, and, the business prospering, he was able before long to start manufacturing hardware goods on his own account, his two brothers joining him in the enterprise. The speciality of the brothers Tangye was the manufacture of machinery, and their hydraulic lifting jacks were successfully employed in the launching of the steamship "Great Eastern." In 1858 the firm, who now confined themselves to making machinery, built their own works, and shortly afterwards secured the sole right of manufacturing the newly invented differential pulley-block, thereby materially adding to their business, which came to include every kind of power-machine—hydraulic, steam, gas, oil and electricity. The business was subsequently turned into a limited company, and in 1894 Richard Tangye was knighted. He died on the 14th of October 1906.

TANISTRY (from Gaelic *tana*, lordship), a custom among various Celtic tribes, by which the king or chief of the clan was chosen from among the heads of the septs and elected by them in full assembly. He held office for life and was required by custom to be of full age, in possession of all his faculties and without any remarkable blemish of mind or body. At the same time, and subject to the same conditions, a *tanist* or next heir to the chieftaincy was elected, who if the king died or became disqualified, at once became king. Usually the king's son became tanist, but not because the system of primogeniture was in any way recognized; indeed, the only principle adopted was that the dignity of chieftainship should descend to the eldest and most worthy of the same blood. These epithets, as Hallam says, were not necessarily synonymous, but merely indicated that the preference given to seniority was to be controlled by a due regard to desert (*Constit. Hist.*, vol. iii. c. xviii.). This system of succession left the headship open to the ambitious, and was a frequent source of strife both in families and between the clans. Tanistry was abolished by a legal decision in the reign of James I. and the English land system substituted.

TANJÓRE, a city and district of British India in the Madras presidency. The city is situated on the right bank of the river Cauvery, and is an important junction on the South Indian railway, 218 m. S. of Madras. Pop. (1901) 57,870. As the last capital of the ancient Hindu dynasty of the Cholas, and in all ages one of the chief political, literary and religious centres of the south, the city is full of interesting associations. It was the scene of the earliest labours of Protestant missionaries in India. The modern history of Tanjore begins with its conquest by the Mahrattas in 1674 under Venkaji, the brother of Sivaji the Great. The British first came into contact with Tanjore by their expedition in 1749 with a view to the restoration of a deposed raja. In this they failed, and a subsequent expedition was bought off. The Mahrattas practically held Tanjore until 1799. In October of that year the district was ceded to the East India Company in absolute sovereignty by Raja Sharabhoji, pupil of the missionary Schwarz. The raja retained only the capital and a small tract of country round. He died in 1833 and was succeeded by his son Sivaji, on whose death in 1855 without an heir the house became extinct. The mission at Tanjore was founded in 1778 by the Rev. Christian F. Schwarz or Schwartz (1726–1798). The mission establishments were taken over in 1826 by the Society for the Propagation of the Gospel, which subsequently founded new stations in several parts of the district. Roman Catholic missions date from the first half of the 17th century. St Peter's College, founded by Schwarz as a school, is now a first-grade college affiliated to the university of Madras. His church dates from 1779. Among interesting ancient buildings may be mentioned the palace within the fort, containing an armoury and fine library; and the Brihadiswaraswami temple, of the 11th century, enclosed in two courts, surmounted by a lofty tower and including the exquisitely decorated shrine of Subrahmanya. Though the city has specialities of jewelry, carpets, modelling in pith, &c., there are no large industries.

The DISTRICT OF TANJORE has an area of 3710 sq. m. On account of its fertility it has been called the "Garden of Southern India." It is irrigated by an elaborate system of dams, cuts and canals in connexion with the rivers Cauvery and Coleroon, and the soil is exceedingly productive. The delta of the Cauvery occupies the flat northern part, which is highly cultivated, dotted over with groves of coco-nut trees, and is one of the most densely populated tracts in India. The staple crop is rice, which is grown on 77 per cent. of the cultivated area. Tanjore is a land of temples, many of them being of very early date. The district is traversed by the main line and several branches of the South Indian railway, some of which have been constructed by the district board. The chief seaport is Negapatam, and the principal export is rice to Ceylon. The population in 1901 was 2,245,029.

See *Tanjore District Gazetteer* (Madras, 1906).

TANKARD, a type of drinking vessel. The word was formerly used loosely of many sizes, usually large, of vessels for holding liquids; thus it was applied to such as held two or more gallons and were used to carry water from the conduits in London in the 16th and early 17th centuries. The word is now generally applied to a straight, flat-bottomed drinking vessel of silver, pewter or other metal, or of glass or pottery mounted on metal, with a hinged cover and handle, holding from a pint to a quart of liquor (see DRINKING VESSELS). The derivation is obscure. It appears in O. Fr. as *tanquart* and in O. Du. as *tanckaert*. It may have been, as is suggested, metathesized from Gr. *κάνθαρος*, Lat. *cantharus*, a large vessel or pot. It is used to gloss *amphora* in the *Promptorium Parvulorum* (*c.* 1440). It is not connected with "tank," a cistern or reservoir for water, which was formerly "stank," and is from Port. *tanque*, O. Fr. *estang*, mod. *étang*, pool; Lat. *stagnum*, whence Eng. "stagnant."

TANNA (Aramaic, "teacher"). The root *teni* or *tena* corresponds philologically to the Hebrew *shana*, from which comes the word *Mishnah* (see MIDRASH and TALMUD), the great Rabbinic code which (with certain parts of the Midrash and other Rabbinic books) was the main literary product of the activity of the *tannaim* (plural of *tanna*). The term *tanna* is used in the Talmud of those teachers who flourished in the first two centuries of the Christian era. The *tannaim* from the date of the destruction of the Temple may be grouped: (1) 70–100, representative name Johanan ben Zaqqai (*q.v.*); (2) 100–130, representative name Aqība (*q.v.*); (3) 130–160, representative name Judah the Prince, compiler of the *Mishnah*. The successors of the *tannaim* were called *'amoraim* (see 'AMORA).

See W. Bacher, *Die Agada der Tannaiten*. An alphabetical list of tannaim and 'amoraim is given in the *Jewish Encyclopedia*, xii. 49–54. (I. A.)

TANNAHILL, ROBERT (1774–1810), Scottish song-writer, son of a Paisley silk-weaver, was born on the 3rd of June 1774. He was apprenticed to his father's trade at the age of twelve, and, inspired by the poetry of Robert Burns, he wrote verses as he drove the shuttle to and fro, with shelf and ink-bottle rigged up on his loom-post. He was shy and reserved, of small and delicate physique, and took little part in the social life of the town. The steady routine of his trade was broken only by occasional excursions to Glasgow and the land of Burns, and a year's trial of work at Bolton. He began in 1805 to contribute verses to Glasgow and Paisley periodicals, and published an edition of his poems by subscription in 1807. Three years later, on the 17th of May 1810, the life of the quiet, gentle, diffident and despondent poet was brought by his own act to a tragic end. Tannahill's claims to remembrance rest upon half a dozen songs, full of an exquisite feeling for nature, and so happily set to music that they have retained their popularity. "Loudon's Bonnie Woods and Braes," "Jessie, the Flower o' Dunblane," and "Gloomy Winter's Noo Awa" are the best of them. "Jessie, the Flower o' Dunblane" and "The Farewell" tell the story of the poet's own unhappy love for Janet Tennant.

Tannahill's centenary was celebrated at Paisley in 1874. See edition by D. Semple (1876) for details of his life.

TANNER, HENRY OSSAWA (1859–), American artist, of negro descent, was born at Pittsburg, Pennsylvania, on the 21st of June 1859. He was the son of Benjamin Tucker Tanner (b. 1835), who became bishop of the African Methodist Episcopal Church in 1888, edited the *Christian Recorder*, the organ of his church, from 1867 to 1883, founded, and from 1884 to 1888 edited, the *African Methodist Episcopal Church Review*, and published several pamphlets, poems and hymns, and an *Apology for African Methodism* (1867). The son was a pupil of Thomas Eakins, in Philadelphia, and of J. P. Laurens and Benjamin Constant in Paris. He first exhibited at the Salon in 1895. His "Daniel in the Lions' Den" received an honourable mention at the Salon of 1896. "The Raising of Lazarus," which received a third-class medal in 1897, was purchased by the French government for the permanent collection of the Luxembourg. Other pictures are, "The Annunciation" (Salon, 1898), "Nicodemus Coming to Christ" (1899), "The Jews' Wailing Place," and "Christ in the Temple."

TANNER, THOMAS (1674–1735), English antiquary and prelate, was born at Market Lavington in Wiltshire on the 25th of January 1674, and was educated at Queen's College, Oxford, taking holy orders in 1694. Next year he became chaplain and then fellow of All Souls College, and a few years later private chaplain to John Moore (1646–1714), bishop of Norwich and afterwards of Ely, who appointed him chancellor of the diocese of Norwich. In 1706 he became rector of Thorpe, near Norwich, in 1713 a canon of Ely, in 1724 a canon of Christ Church, Oxford, and in 1732 bishop of St Asaph. He died in Oxford, where he had passed most of his life, on the 14th of December 1735.

Tanner's chief work is his *Notitia Monastica*, a short account of all the religious houses in England and Wales. This was published at Oxford in 1695; it was reprinted with additions by the author's brother, John Tanner, in 1744; and was reprinted again with further additions by James Nasmith (1740–1808) in 1787. He also wrote *Bibliotheca Britannico-Hibernica*, a dictionary of all the authors who flourished in England, Scotland and Ireland before the opening of the 17th century, at which he laboured for forty years. This was not published until 1748, thirteen years after the author's death. The bishop collected materials for a history of Wiltshire and worked for some time on a new edition of the works of John Leland. His valuable collection of books and manuscripts is in the Bodleian library at Oxford.

Another writer of this name was THOMAS TANNER (1630–1682), the author of *The Entrance of Mazzarini* (Oxford, 1657–58). Educated at St Paul's School, London, and at Pembroke Hall, Cambridge, he became a barrister and later a clergyman, being vicar of Colyton, Devon, and afterwards of Winchfield, Hants.

TANNHÄUSER, or TANHUSER, German Minnesinger of the 13th century, who lived for a time at the court of Frederick II., duke of Austria. After Duke Frederick's death he was received at the court of Otto II., duke of Bavaria; but, being of a restless disposition, and having wasted his fortune, he spent much time in wandering about Germany. He also went as a Crusader to the Holy Land. His poems belong to the decadence of the Minnesang, and combine a didactic display of learning with descriptions of peasant-life in a somewhat coarse tone. His adventurous life led him to be identified, in the popular imagination, with the knight Tannhäuser who, after many wanderings, comes to the Venusberg, or Hörselberg, near Eisenach. He enters the cave where the Lady Venus—the Frau Hulda of German folk-lore—holds her court, and abandons himself to a life of sensual pleasure. By and by he is overcome by remorse, and, invoking the aid of the Virgin Mary, he obtains permission to return for a while to the outer world. He then goes as a pilgrim to Rome, and entreats Pope Urban to secure for him the forgiveness of his sins. The pope declares it is as impossible for him to be pardoned as for the staff he has in his hand to blossom. Tannhäuser departs in despair, and returns to the Venusberg. In three days the staff begins to put forth green leaves, and the pope sends messengers in all directions in search of the penitent, but he is never seen again. This legend was at one time widely known in Germany, and as late as 1830 it survived in a popular song at Entlebuch in Switzerland, a version of which was given by Uhland in his *Alte hoch- und niederdeutsche Volkslieder*. Among the attendants of Hulda was the faithful Eckhart, and in the preface to the *Heldenbuch* he is said to sit before the Venusberg, and to warn passers-by of the dangers to which they may be exposed if they linger in the neighbourhood. The legend has been reproduced by several modern German poets, and by R. Wagner in an opera.

For Tannhäuser's lyric poetry, see F. H. von der Hagen's *Minnesinger*, ii. (1838); K. Bartsch, *Deutsche Liederdichter des 12. bis 14. Jahrhunderts* (3rd ed. 1893), No. 47. See also F. Zander, *Die Tannhäusersage und der Minnesinger Tannhäuser* (1858); J. G. T. Grässe, *Die Sage von Tannhäuser* (1846; 2nd ed. 1861); A. Öhlke *Zu Tannhäusers Leben und Dichten* (1890); J. Siebert, *Tannhäuser, Inhalt und Form seiner Gedichte* (1894).

TANNIN, or TANNIC ACID, the generic name for a widely disseminated group of vegetable products, so named from their property of converting raw hide into leather (*q.v.*). They are soluble in water, their solutions having an acid reaction and an astringent taste; the solutions are coloured dark blue or green by ferrous salts, a property utilized in the manufacture of ink (*q.v.*). Their chemistry is little known. Some appear to be glucosides of gallic acid, since they yield this acid and a sugar on hydrolysis, *e.g.* oak tannin; whilst others yield protocatechuic acid and phloroglucin, *e.g.* moringa-tannin; common tannin, however, is a digallic acid.

Common tannin, or tannic acid, $C_{14}H_{10}O_9 \cdot 2H_2O$, occurs to the extent of 50% in gall-nuts, and also in tea, sumach and in other plants. It may be obtained by extracting powdered gall-nuts with a mixture of ether and alcohol, whereupon the tannin is taken up in the lower layer, which on separation and evaporation yields the acid. When pure the acid forms a colourless, amorphous mass, very soluble in water, less so in alcohol, and practically insoluble in ether. Common salt precipitates it from aqueous solutions. It forms a penta-acetate. It may be obtained artificially by heating gallic acid with phosphorus oxychloride or dilute arsenic acid (cf. P. Biginelli, *Gazetta*, 1909, 39, ii. pp. 268 *et seq.*); and conversely on boiling with dilute acids or alkalis it takes up a molecule of water and yields two molecules of gallic acid, $C_7H_6O_5$. It is optically active—a fact taken account of in J. Dekker's formula (*Ber.*, 1906, 39, p. 2497). The chemistry has also been investigated by M. Nierenstein and L. F. Iljin (see papers in the *Ber.*, 1908, *et seq.*).

The tannin of oak, $C_{19}H_{16}O_{10}$, which is found, mixed with gallic acid, ellagic acid and quercite, in oak bark, is a red powder; its aqueous solution is coloured dark blue by ferric chloride, and boiling with dilute sulphuric acid gives oak red or phlobaphene. The tannin of coffee, $C_{30}H_{18}O_{16}$, found in coffee beans, is not precipitated from its solutions by gelatin. Hydrolysis by alkaline solutions gives a sugar and caffeic acid; whilst fusion with potassium hydroxide gives protocatechuic acid. Moringa-tannin or maclurin, $C_{13}H_{10}O_6 \cdot H_2O$, found in *Morus tinctoria*, hydrolyses on fusion with caustic potash to phloroglucin and protocatechuic acid. Catechu-tannin occurs in the extract of *Mimosa catechu*; and kino-tannin is the chief ingredient of kino (*q.v.*).

MEDICINE.—Tannic acid is official in both the British and United States Pharmacopoeias. It is incompatible with mineral acids, alkalis, salts of iron, antimony, lead and silver, alkaloids and gelatin. The British pharmacopoeial preparations are (1) *glycerinum acidi tannici*; (2) *suppositoria acidi tannici*; (3) *trochiscus acidi tannici*. The United States also has a *collodium stypticum* and an ointment. From tannic acid is also made *gallic acid*, which resembles tannic acid but has no astringent taste. When applied to broken skin or exposed surfaces it coagulates the albumen in the discharges, forming a protecting layer or coat. It is moreover an astringent to the tissues, hindering the further discharge of fluid. It is a powerful local haemostatic, but it only checks haemorrhage when brought directly in contact with the bleeding point. It is used in the treatment of haemoptysis in the form of a fine spray, or taken internally it will check gastric haemorrhage. In large doses, however, it greatly disorders the digestion. In the intestine tannic acid controls intestinal bleeding, acting as a powerful astringent and causing constipation; for this reason it has been recommended to check diarrhoea.

Tannic acid is largely used in the treatment of various ulcers, sores and moist eruptions. The glycerin is used in tonsillitis and the lozenges in pharyngitis. For bleeding haemorrhoids tannic acid suppositories are useful, or tannic acid can be dusted on directly. The collodium stypticum is a valuable external remedy. Tannic acid is absorbed as gallic acid into the blood and eliminated as gallic and pyrogallic acids, darkening the urine. Gallic acid does not coagulate albumen when used externally. It has been used internally in haemoptysis and haematuria. Combined with opium it is an efficient remedy in *diabetes insipidus*.

TANN-RATHSAMHAUSEN, LUDWIG SAMSON ARTHUR, FREIHERR VON UND ZU DER (1815–1881), Bavarian general, was born at Darmstadt on the 18th of June 1815, the day of Waterloo. He was descended from the old family of von der Tann, which had representatives in Bavaria, Alsace and the Rhine countries, and assumed his mother's name (she being the daughter of an Alsatian, Freiherr von Rathsamhausen) in 1868 by licence of the king of Bavaria. Ludwig, the first king of Bavaria, stood sponsor for the child, who received his name and in addition that of Arthur, in honour of the duke of Wellington. He received a careful education, and in 1827 became a page at the Bavarian court, where a great future was predicted for him. Entering the artillery in 1833, he was after some years placed on the general staff. He attended the manoeuvres of the Austrian army in Italy under Radetzky (*q.v.*) and, in the spirit of adventure, joined a French military expedition operating in Algiers against the Tunisian frontier. On his return he became a close personal friend of the Crown Prince Maximilian Joseph (afterwards King Maximilian). In 1848 he was made a major, and in that year he distinguished himself greatly as the leader of a Schleswig-Holstein light corps in the Danish war. At the close of the first campaign he was given the order of the Red Eagle by the king of Prussia, and his own sovereign gave him the military order of Max-Joseph without his asking for it, and also made him a lieutenant-colonel. In 1849 he served as chief of staff to the Bavarian contingent at the front, and distinguished himself at the lines of Düppel, after which he visited Haynau's headquarters in the Hungarian war, and returned to Schleswig-Holstein to serve as v. Willisen's chief of staff in the Idstedt campaign. Then came the threat of war between Prussia and Austria, and von der Tann was recalled to Bavaria. But the affair ended with the "surrender of Olmütz," and he saw no further active service until 1866, rising in the usual way of promotion to colonel (1851), major-general (1855), and lieutenant-general (1861). In the earlier years of this period he was the aide-de-camp and constant companion of the king. In the war of 1866 he was chief of the staff to Prince Charles of Bavaria, who commanded the South German contingents. The almost entirely unfortunate issue of the military operations led to his being vehemently attacked in the press, but the unreadiness and unequal efficiency of the troops and the general lack of interest in the war on the part of the soldiers foredoomed the South Germans to failure in any case. He continued to enjoy the favour of the king and received promotion to the rank of general of infantry (1869), but the bitterness of his disappointment of 1866 never left him. He was grey-haired at forty-two, and his health was impaired. In 1869 von der Tann-Rathsamhausen, as he was now called, was appointed commander of the I. Bavarian corps. This corps he commanded in the Franco-German War, and therein he retrieved his place as one of the foremost of German soldiers. His gallantry was conspicuous at Wörth and Sedan. Transferred in the autumn to an independent command on the Loire, he conducted the operations against d'Aurelle de Paladines, at first with marked success, and forced the surrender of Orleans. He had, however, at Coulmiers to give way before a numerically larger French force; but reinforced, he fought several successful engagements under the Grand Duke of Mecklenburg near Orleans. On the termination of the war he was reappointed commander-in-chief of the I. Bavarian corps, a post which he held until his death at Meran on the 26th of April 1881. He had the grand cross of the Bavarian military orders, and the first class of the Iron Cross and the *pour le mérite* from the king of Prussia. In 1878 the emperor named von der Tann chief of a Prussian infantry regiment, decreed him a grant, and named one of the new Strassburg forts after him.

See Life by Lieutenant-colonel Hugo von Helvig in *Mil. Wochenblatt*, Supplement, 1882.

TANSA, a small river in Salsett island, in the Thana district of Bombay, which provides the city of Bombay with its water-supply. It is embanked by one of the largest masonry dams in the world, built in 1892. The embankment is nearly 2 m. long, 118 ft. high, and 110 ft. thick at the base.

TANTA, a town of Lower Egypt, in a central position nearly midway between the two main branches of the Nile, and converging-point of several railways traversing the Delta in all directions. It has a population (1907) of 54,437, is the capital of the rich province of Gharbia, and is noted for its fairs and Moslem festivals, which are held three times a year in honour of Seyyid el-Bedawi, and are sometimes attended by 200,000 pilgrims and traders. There are a large railway station, a very fine mosque (restored), and a palace of the khedive. Seyyid el-Bedawi, who lived in the 13th century A.D., was a native of Fez who, after a pilgrimage to Mecca, settled in Tanta. He is one of the most popular saints in Egypt.

TANTALUM [symbol Ta, atomic weight 181·0 (O=16)], a metallic chemical element, sparingly distributed in nature and then almost invariably associated with columbium. Its history is intermixed with that of columbium. In 1801 C. Hatchett detected a new element, which he named columbium, in a mineral from Massachusetts, and in 1802 A. G. Ekeberg discovered an element, tantalum, in some Swedish yttrium minerals. In 1809 W. H. Wollaston unsuccessfully endeavoured to show that columbium and tantalum were identical. In 1844 H. Rose detected two new elements in the columbites of the Bodenmais, which he named *niobium* and *pelopium; dianium* was discovered by W. X. F. von Kobell in various columbites; and *ilmenium* and *neptunium* were discovered by R. Hermann. The researches of C. W. Blomstrand, and others, especially of Marignac, proved the identity of columbium, dianium and niobium, and that ilmenium was a mixture of columbium and tantalum. It is very probable that neptunium is a similar mixture. Berzelius, who prepared tantalic acid from the mineral tantalite in 1820, obtained an impure metal by heating potassium tantalofluoride with potassium. In 1902 H. Moissan obtained a carbon-bearing metal by fusing the pentoxide with carbon in the electric furnace. The preparation of the pure metal was successfully effected by Werner von Bolton in 1905, who fused the compressed product obtained in the Berzelius process in the electric furnace, air being excluded. An alternative method consisted in passing an electric current through a filament of the tetroxide in a vacuum. The metal is manufactured, for use as filaments in electric lamps, by the action of sodium on sodium tantalofluoride.

The pure metal is silver-white in colour, is very ductile, and becomes remarkably hard when hammered, a diamond drill making little impression upon it. Its tensile strength is higher than that of steel. It melts between 2250° and 2300°, its specific heat is 0·0365, coefficient of expansion 0·0000079, and specific gravity 16·64. When heated in air the metal burns if in the form of thin wire, and is superficially oxidized if more compact. At a red heat it absorbs large volumes of hydrogen and nitrogen, the last traces of which can only be removed by fusion in the electric furnace. These substances, and also carbon, sulphur, selenium and tellurium, render the metal very brittle. Tantalum is not affected by alkaline solutions, but is disintegrated when fused with potash. Hydrofluoric acid is the only acid which attacks it. It alloys with iron, molybdenum and tungsten, but not with silver or mercury.

In its chemical relationships tantalum is associated with vanadium, columbium and didymium in a sub-group of the periodic classification. In general it is pentavalent, but divalent compounds are known.

Tantalum tetroxide, Ta_2O_4, is a porous dark grey mass harder than glass, and is obtained by reducing the pentoxide with magnesium. It is unaffected by any acid or mixture of acids, but burns to the pentoxide when heated.

Tantalum pentoxide, Ta_2O_5, is a white amorphous infusible powder, or it may be crystallized by strongly heating, or by fusing with boron trioxide or microcosmic salt. It is insoluble in all acids. It is obtained from potassium tantalofluoride by heating with sulphuric acid to 400°, boiling out with water, and decomposing the residual compound of the oxide and sulphuric acid by ignition, preferably with the addition of ammonium carbonate.

Tantalic acid, $HTaO_3$, is a gelatinous mass obtained by mixing the chloride with water. It gives rise to salts, termed the tantalates. The normal salts are all insoluble in water; the complex acid, hexatantalic acid, $H_8Ta_6O_{19}$ (which does not exist in the free state), forms soluble salts with the alkaline metals. *Pertantalic acid*, $HTaO_4$, is obtained in the hydrated form as a white precipitate by adding sulphuric acid to potassium pertantalate, $K_3TaO_8 \cdot \frac{1}{2}H_2O$, which is formed when hydrogen peroxide is added to a solution of potassium hexatantalate.

Tantalum pentafluoride, TaF_5, for a long time only known in solution, may be obtained by passing fluorine over an alloy of tantalum and aluminium, and purifying by distillation in a vacuum. It forms colourless, very hygroscopic prisms, which attack glass, slowly at ordinary temperatures, more rapidly when heated (*Ber.*, 1909, 42, p. 492). Its double salts with the alkaline fluorides are very important, and serve for the separation of the metal from columbium and titanium. *Tantalum pentachloride*, $TaCl_5$, is obtained as light yellow needles by heating a mixture of the pentoxide and carbon in a current of chlorine. By heating with sodium amalgam and separating with hydrochloric acid, the dichloride, $TaCl_2 \cdot 2H_2O$, is obtained as emerald green hexagonal crystals. The pentabromide exists, but tantalum and iodine apparently do not combine. Tantalum forms a sulphide, TaS_2, and two nitrides, TaN_2 and Ta_3N_5, have been described.

Marignac determined the atomic weight to be 181, but Henrichsen and N. Sahlbom (*Ber.*, 1906, 39, p. 2600) obtained 179·8 (H = 1) by converting the metal into pentoxide at a dull red heat.

TANTALUS, in Greek legend, son of Zeus (or Tmolus) and Pluto (Wealth), daughter of Himantes, the father of Pelops and Niobe. He was the traditional king of Sipylus in Lydia (or of Phrygia), and was the intimate friend of Zeus and the other gods, to whose table he was admitted. But he abused the divine favour by revealing to mankind the secrets he had learned in heaven (Diod. Sic. iv. 74), or by killing his son Pelops (*q.v.*) and serving him up to the gods at table, in order to test their powers of observation (Ovid, *Metam.* vi. 401). Another story was that he stole nectar and ambrosia from heaven and gave them to men (Pindar, *Ol.* i. 60). According to others, Pandareus stole a golden dog which guarded the temple of Zeus in Crete, and gave it to Tantalus to take care of. But, when Pandareus demanded the dog back, Tantalus denied that he had received it. Therefore Zeus turned Pandareus into a stone, and flung down Tantalus with Mount Sipylus on the top of him (Antoninus Liberalis, 36). The punishment of Tantalus in the lower world was famous. He stood up to his neck in water, which flowed from him when he tried to drink of it; and over his head hung fruits which the wind wafted away whenever he tried to grasp them (*Odyssey*, xi. 582). This myth is the origin of the English word "tantalize," and also of the common name "tantalus" for a set of spirit decanters kept under lock and key. Another story is that a rock hung over his head ready to fall and crush him (Euripides, *Orestes*, 5). The sins of Tantalus were visited upon his descendants, the Pelopidae. Ancient historical reminiscences and natural phenomena, especially volcanic catastrophes, are at the bottom of the legend. The tomb of Tantalus on Mount Sipylus was pointed out in antiquity, and has been in modern times identified by C. F. Texier with the great cairn beneath Old Magnesia; but Sir W. M. Ramsay inclines to a remarkable rock-cut tomb beside Magnesia.

The story of Tantalus is an echo of a semi-Greek kingdom, which had its seat at Sipylus, the oldest and holiest city of Lydia, the remains of which are still visible. There was a tradition in antiquity that the city of Tantalus had been swallowed up in a lake on the mountain; but the legend may, as Ramsay thinks, have been suggested by the vast ravine which yawns beneath the acropolis. According to S. Reinach (*Revue archéologique*, 1903), Tantalus was represented in a picture standing in a lake and clinging to the branches of a tree, which gave rise to the idea that he was endeavouring to pluck its fruit. The punishment of the overhanging rock refers to the dangerous position of the town of Tantalis below the summit of Mount Sipylus.

See Pelops, Phrygia; Sir W. M. Ramsay in *Journal of Hellenic Studies*, iii.; Frazer's *Pausanias*, iii. p. 555, v., p. 392; J. Hylén, *De Tantalo* (Upsala, 1896), who considers the story of the thirst of Tantalus in the underworld to be due to the Orphic interpolator in the Νέκυια of the *Odyssey*, and the Pandareus story to be an innovation of the Alexandrine poets. The essay contains a copious list of authorities and a history of the legend. According to V. Henry (*Revue des Études grecques*, 1892), Tantalus is the sun: the fruits which elude his grasp are the stars suspended on the tree of heaven, which disappear at the rising of the sun; the water into which the sun descends without drinking, is the sea. Tantalus's betrayal of the secrets of the gods refers to the sun unveiling the secrets of heaven; the slaying of Pelops denotes the going-down of the sun, Pelops meaning the "gray one," an epithet of the gloomy sky in which the last rays of the sun are extinguished.

TANTIA TOPI (*c.* 1819–1859), rebel leader during the Indian Mutiny, was a Mahratta Brahman in the service of Nana Sahib. He instigated the massacre of Cawnpore, and commanded at the battle of Bithur, where he was defeated by General Havelock. With the aid of the Gwalior contingent he pressed General Windham hard at Cawnpore on the 27th and 28th of November 1857, but was defeated by Sir Colin Campbell on the 6th of December. Together with the Rani of Jhansi he was besieged by Sir Hugh Rose in the Jhansi fort, but escaped and collected a force of 20,000 men which Sir Hugh defeated without relaxing the siege. This was the decisive action of the campaign in Central India, and Tantia Topi was obliged to seek refuge in the jungles of Rajputana and Bundelkhand, where he was taken by Major Meade, condemned, and executed on the 18th of April 1859. He was the only rebel leader in the Mutiny who showed any conspicuous military talent.

TAOISM, a form of religion in China, the name of which is taken from the ancient treatise called *Tâo Teh King*, supposed to be the work of the sage Lao-tsze (*q.v.*). The later characteristics of Taoism as a form of worship represent a corruption of the earlier doctrines of Lao-tsze, and the infusion of Buddhist and other ideas.

TAORMINA (ancient *Tauromenium*), a town on the E. coast of Sicily, in the province of Messina, from which town it is 30 m. S.S.W. by rail. Pop. (1901) 4110. It has come into great favour as a winter resort, especially with British and German visitors, chiefly on account of its fine situation and beautiful views. It lies on an abrupt hill 650 ft. above the railway station, and was founded by the Carthaginian Himilco in 397 B.C. for a friendly tribe of Sicels, after the destruction, by Dionysius the Elder of Syracuse, of the neighbouring city of Naxos. In 395 Dionysius failed to take it by assault on a winter's night, but in 392 he occupied it and settled his mercenaries there. In 358 the exiles from Naxos, after wandering up and down Sicily, at last found a home there. Its commanding site gave it considerable importance. It was the city at which both Timoleon and Pyrrhus first landed. During the First Punic War it belonged to the kingdom of Hiero, and after his death it enjoyed an exceptionally favoured position with regard to Rome, being like Messana and Netum, a *civitas foederata*. During the first Servile War it was occupied by Eunous and some of his followers, but was at length taken by the consul Publius Rupilius in 132. It was one of the strongholds of Sextus Pompeius, and after defeating him Augustus made it into a *colonia* as a measure of precaution, expelling some of the older inhabitants. In the time of Strabo it was inferior in population, as we should expect, to Messana and Catana; its marble, wine and mullets were highly esteemed. In A.D. 902 it was taken and burnt by the Saracens; it was retaken in 962, and in 1078 fell into the hands of the Normans.

The ancient town seems to have had two citadels; one of these was probably the hill above the town to the W. now crowned by a medieval castle, while the other was the hill upon which the theatre was afterwards constructed (E. A. Freeman, *History of Sicily*, iv. 506). There are some remains of the city walls, belonging to more than one period. It is indeed possible that one fragment of wall belongs to a period, before the foundation of the city, when the Naxians had a fortified port here (Evans in Freeman, *op. cit.*, iv. 109 n. 1). The church of San Pancrazio, just outside the modern town, is built into a temple of the 3rd century B.C., the S. wall of the cella of which is alone preserved. Inscriptions prove that it was dedicated to Serapis. The other ruins belong in the main to the Roman period. The most famous of them is the theatre, largely hewn in the rock, which, though of Greek origin, was entirely reconstructed. The seats are almost entirely gone, but the stage and its adjacent buildings, especially the wall, in two storeys, at the back, are well preserved: some of its marble decorative details were removed for building material in the middle ages, but those that remained have been re-erected. The view from the theatre is of exceptional beauty, Mount Etna being clearly seen from the summit to the base on the S.W., while to the N. the rugged outlines of the coast immediately below, and the mountains of Calabria across the sea to the N.E. make up one of the most famous views in the world. There are also remains of a much smaller theatre (the so-called Odeum), and some large cisterns; a large bath or tank which was apparently open, known as the Naumachia, measures $426\frac{1}{2}$ ft. in length and $39\frac{1}{2}$ in width: only one of its long sides is now visible, and serves as a foundation for several houses in the main street of the modern town. The aqueducts which supplied these cisterns may be traced above the town. There are remains of houses, tombs, &c., of the Roman period, and fine specimens of Romanesque and Gothic architecture in the modern town.

See Rizzo, *Guida di Taormina e dintorni*, Catania, 1902. (T. As.)

TAPACULO, the name[1] given in Chile to a bird of singular appearance—the *Pteroptochus albicollis* of ornithology, and applied in an extended sense to its allied forms, which constitute a small family, *Pteroptochidae*, belonging to the *Clamatores* division of *Passeres*, peculiar to South America. About 20

Tapaculo.

species, disposed by P. L. Sclater (*Ibis*, 1874, pp. 189–206) in 8 genera, are believed to belong to this group.

The species of the Family first made known is *Scytalopus magellanicus*, originally described in 1783 by J. Latham (*Synopsis*, iv. p. 464) as a Warbler. Even in 1836 J. Gould not unnaturally took it for a Wren, when establishing the genus to which it is now referred; but some ten years after Johannes Müller found that *Scytalopus*, together with the true Tapaculo, which was first described by Kittlitz in 1830, possessed anatomical characters that removed them far from any position previously assigned to them, and determined their true place as above given. In the meanwhile a kindred form, *Hylactes*, also first described in 1830, had been shown by T. C. Eyton to have some very exceptional osteological features, and these were found to be also common to *Pteroptochus* and *Scytalopus*. In 1860 J. Cabanis recognized the *Pteroptochidae* as a distinct Family, but made it also include *Menura* (see LYRE-BIRD), and in 1874 P. L. Sclater (*ut supra*) thought that *Atrichia* (see SCRUB-BIRD) might belong here. It was A. Garrod in 1876 and 1877 who finally divested the Family of these aliens, but until examples of some of the other genera have been anatomically examined it may not be safe to say that they all belong to the *Pteroptochidae*.

The true Tapaculo (*P. albicollis*) has a general resemblance in plumage to the females of some of the smaller Shrikes (*Lanius*), and to a cursory observer its skin might pass for that of one; but its shortened wings and powerful feet would on closer inspection at once reveal the difference. In life, however, its appearance must be wholly unlike, for it rarely flies, hops actively on the ground or among bushes, with its tail erect or turned towards its head, and continually utters various and strange notes,—some, says Darwin, are "like the cooing of doves, others like the bubbling of water, and many defy all similes." The "Turco," *Hylactes megapodius*, is larger, with greatly developed feet and claws, but is very similar in colour and habits. Two more species of *Hylactes* are known, and

[1] Of Spanish origin, it is intended as a reproof to the bird for the shameless way in which, by erecting its tail, it exposes its hinder parts. It has been sometimes misspelt "Tapacolo," as by C. Darwin, who gave (*Journal of Researches*, chap. xii.) a brief but entertaining account of the habits of this bird and its relative, *Hylactes megapodius*, called by the Chilenos "El Turco."

one other of *Pteroptochus*, all of which are peculiar to Chile or Patagonia. The species of *Scytalopus* are as small as Wrens, mostly of a dark colour, and inhabit parts of Brazil and Colombia, one of them occurring so far northward as Bogota. (A. N.)

TAPER (probably of Celtic origin, cf. Irish *tapar*, Welsh *tampr*, taper, torch), a small thin candle of tallow or wax (see CANDLE); from its early shape, in which the circumference of the top was smaller than that of the base, the word came to be used in the sense of "slender," particularly of something diminishing in size at one end. In architecture the word is used of the gradual diminishing of a spire or column as it rises. The spire tapers almost to a point, where it is terminated by a finial or vane: the column tapers only to a less diameter at the top, and as a general rule the more ancient the column the greater its diminution or taper; thus in one of the early temples at Selinus in Sicily the upper diameter is about half the lower diameter, while in the Parthenon it is about one-fifth.

TAPESTRY. The Gr. τάπης and Lat. *tapesium*, from which our word "tapestry" is descended, implied a covering to both furniture and floors, as well as curtains or wall hangings, and neither of them really defines the particular way in which such articles were made. The decorations on these Greek and

FIG. 1.—Gobelins high-warp tapestry frame, with weaver (18th century), holding in right hand (*a*) bobbin with weft thread wound round its thick end, and with his left hand taking (*e*) some of the *lisses* or strings with a loop at one end of each of them, through which a warp thread is passed, and thus pulling forward those warp threads in between which he will pass his weft. *mm* is the tapestry he has woven, which has been wound round (*p*) the cylinder. The other letters in this diagram relate to details in the frame which are of subsidiary interest. The description of them would not further elucidate the act of weaving which is here in question.

Roman coverings were effected by painting, printing, embroidery, or a method of weaving with coloured threads; and specimens and other conclusive evidence show that early Egyptians, Babylonians, Chinese, Indians, Greeks and Romans employed some at least of the means above-named.

Process of tapestry-weaving. The purpose of this article is to give some account of those decorated stuffs which are produced by weaving coloured threads on to warp threads in a manner that differs from shuttle-weaving, and at the present day is called tapestry-weaving, such for instance as is practised at the famous Gobelins and Beauvais tapestry manufactories in France. At the Gobelins, the warp threads are stretched in frames standing vertically (high warp or *haute lisse*): at Beauvais in frames placed horizontally with the ground (low warp or *basse lisse*). In the one case the worker sits up to his work, in the other he bends over it. In each he is supplied with the design according to which he weaves, and notwithstanding the varied positions the method of weaving is the same. The thread-supply of each separate colour required in the design is wound upon its appointed peg or bobbin, which is a simpler implement or tool than a loom weaver's shuttle. Fig. 1 shows a Gobelins high-warp tapestry weaver of the 18th century at work. With his left hand he is pulling above his head a few of the looped strings (*lices* or *lisses*) through which the warp threads (*chaine*) pass, so as to bring forward the particular warp threads, in between and around which he has to place the weft threads of the selected colour. In fig. 2 the workman's left hand pulls forward groups of warp threads upon the lower part of which the weaving has been finished; and with a comb-like implement in his right hand he presses down and compacts the weaving. In the story of the competition between Minerva and Arachne (*Metamorphoses*, vi. 55–69), Ovid appears to be describing this very process, and a great number of specimens of 2nd to 5th century Egypto-Roman workmanship corroborate the presumption of its existence in Ovid's time. The absence of evidence to show that loom and shuttle weaving was capable at that period of producing elaborate figured fabrics is remarkable, and supports the probability that the tapestry-weaving process was that

High and low warp frames.

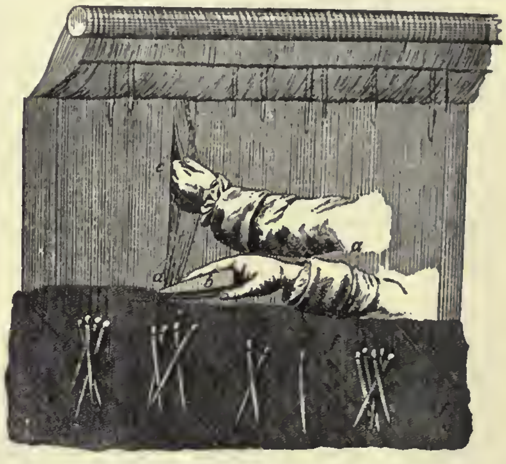

FIG. 2.—Gobelins tapestry-weaving, showing (*a*) the left hand of the weaver pulling forward (*c*) a group of warp threads, into which with (*b*) the comb in his right hand he is compressing at point (*d*) the weft threads which have been passed around and in between the warp threads; (*e*) are various bobbins, hanging at rest, suspended by their weft threads; and (*f*) is the tapestry as woven and compressed.

commonly known and practised for most if not all woven decoration and ornament. It was certainly as freely used for costumes as for hangings, couch and cushion covers and the like (see CARPET). The frames in which the work was done varied according to size from small and easily handled ones to large and substantially constructed frames. As mentioned in the article EMBROIDERY, ornament of tapestry-weaving occurs in a fragment of Egyptian work 1450 B.C., and Greeks in the 3rd or 4th century B.C. also worked in this method, as is demonstrated by specimens, now in the Hermitage at St Petersburg, which were found in the tomb of the Seven Brothers at Temriouck, formerly a Greek settlement in the province of Kouban on the north-eastern shore of the Black Sea.[1] The simplicity of the process is so obvious that it is found to be widely employed in expressing a variety of primitive textile decoration of which pieces from Borneo, Central Asia, Tibet, the Red Indians of America, and the ancient inhabitants of Peru[2] (see fig. 10) are to be seen in museums.

[1] See *Compte rendu. Com. Arch.*, 1878–79.
[2] See *Account of Graves at Ancon*, Asher & Co.; see also specimens from Graves at Lima in the Victoria and Albert Museum, London.

As regards the antiquity of the two sorts of frames (the low and high warp) the Beni Hassan wall paintings (1600 B.C.) include diagrams of horizontal (low warp) frames, with weavers squatting on the ground at work on them; while a vertical or high warp frame is represented on a Greek vase of the 5th century B.C. found at Chiusi (fig. 3), and corresponds with frames used in Scandinavian countries.[1] In both these last-named the lower ends of the warp threads are merely weighted, thus presenting

FIG. 3.—Penelope's tapestry-weaving frame, from a Greek vase of the 5th century B.C. The standing figure is that of Telemachus.

some difficulty to the act of weaving, and of subsequently compacting the weft upwards, the warp not being taut and fastened to a beam, according to more ordinary usage, as, for instance, in the high warp frame illustrated in the codex of Rabanus Maurus, 9th century A.D., preserved at Monte Cassino (fig. 4). The words "*de Geneceo*" in this illustration point to a medieval survival of the earlier *gunaikonites* of the Greeks and the *gynaecea* of the Romans, which were the quarters set apart in the house of the well-to-do for the spinning, weaving and embroidery done by women for the household. From such ancient frames to similar *haute* and *basse lisse* frames of the French *tapissiers nostrez* and *tapissiers sarrasinois* governed under edicts (1226–70) of Louis IX., and so on to present-day Gobelins and Beauvais frames, the transition can be easily realized. The texture of all tapestry weavings presents no radical difference in appearance, no matter when or where produced.

Within reasonable limits it is not practicable to sketch in a complete form the history, from the middle ages onwards, of the prosecution of the art by each of the many European towns that have become engaged in tapestry weaving. But the foregoing remarks will suggest, what seems to have been the fact, that a continuity in the knowledge of the art was kept up so that as favourable conditions occurred it would be called into practice.

Roman tapestry-weaving.

Artificers (male and female) such as the Roman *plumarii* wove tapestries with figures of Britons (Virgil, *Georg.*, iii. 25)—"*Purpurea intexti tollant aulaea Britanni,*"—others with scenes from the story of Theseus and Ariadne (Catullus, *Argon.*, xlvi. 267), besides many more for emperors and the wealthy. The demand for such production of the *textrinae* or trade workshops, and of the more private *gynaecea*, as well as the organization of workmen's societies, *collegia opificum*, are evidence of circumstances lasting for some centuries in Rome that were favourable to tapestry-weaving there. Suggestive of Roman designs are the illustrations of part of a curtain or wall hanging (fig. 5), and of a hanging or couch cover (fig. 6); whilst the daintiest quality of tapestry-weaving for the ornamentation of a tunic is displayed in fig. 7. The ornamentation in fig. 5 —a hanging 5 ft. 3 in. by 19¾ in.—consists of a series of horizontal leafy bands or garlands and other devices: between the upper bands on a red ground is a bird on a leafy twig. This is Egypto-Roman work of about the 3rd century A.D. A portion of a linen cloth or couch cover ornamented with tapestry woven in coloured wools and linen thread is shown in fig. 6. At the top there is a fragment of a horizontal border of floral and leaf ornament beneath which, and enclosed by festoons of leaves, are two boys floating in the air and holding ducks; elsewhere are figures of boys running and carrying baskets of fruit, and large and small blossom forms or rosettes. This also is Egypto-Roman work, about the 4th century, and is 4 ft. 5 in. by 4 ft. 1 in. Fig. 7 presents a square (from a small tunic) of very fine warp and weft tapestry-weaving, with a child mounted on a white horse: in the border about him are ducks, fish and (?) peaches. This too is Egypto-Roman work of about the 2nd or 3rd century and is about 4 inches square. The square in fig. 8 is from a tunic or robe and is of tapestry-weaving in bright-coloured wools, with a representation of Hermes holding the caduceus in one hand and a purse in the other. About his head is a nimbus and his name in Greek characters. This again is Egypto-Roman work of about the 1st or 2nd century and is 6½ inches square. The panel of tapestry-weaving in fig. 9 is from a couch or bed covering, and is wrought in purple wools and linen threads. The design recalls the description of the *toralia* or couch-covering alluded to in Petronius Arbiter's account of Trimalchio's banquet, "on which were depicted men in ambush with hunting poles and all the apparatus of the chase." This piece is also of Egypto-Roman work about the 2nd or 3rd century, about 12 in. by 10 in.

The well-known 6th-century Ravenna mosaics of the Emperor Justinian and the Empress Theodora are rich with hangings and costumes decorated presumably with tapestry weavings similar to those just described.

Tapestry-weaving in monasteries, 5th to 9th century.

From the 5th century and for many centuries later, monasteries,[2] nunneries and the like, under ecclesiastical control or influence, became centres of activity in this and cognate arts, stimulated by the patronage of the Church and courts; and in the 8th and 9th centuries the Emperor Charlemagne's body of travelling inspectors, *missi dominici*, appears to have exercised for a time a helpful influence upon such centres throughout France and in parts of Germany. Two centuries later, free, as distinct from bond, handicraftsmen were forming local associations for their industries, and in this movement the weavers took the lead throughout England, Flanders and Brabant, France being a little later.[3]

Gilds of weavers.

The gilds of weavers in London and Oxford were granted charters by Henry I. In the 11th century gilds of wool weavers existed at Cologne and Mainz, and in the following century there was a similar gild at Spires: it is quite probable that some of their weaving would be of tapestry.[4] The fragment in fig. 11 is considered by authorities to be of 12th-century north European work, possibly from some Rhenish place. At one time the whole piece

FIG. 4.—High warp frame from MS. Codex by Rabanus Maurus (9th century).

[1] See modern Faroese frame figured by Worsaae. *Afbildinger fra det K. Museum* for Nordiske Old Sager. Copenhagen, 1854, p. 123.

[2] See *Recherches sur l'usage et l'origine des tapisseries à personnages*, by A. Jubinal, 1840, p. 13.

[3] See L. Brentano's *History and Development of Guilds*, § IV. "The Craft Guilds."

[4] Eugène Müntz quotes a deed (between 1164 and 1200) witnessed by "Meginwart of Welt in burch," a tapetiarius, as well as another (1177) in which mention is made of Fredericus, *tapifex de familia ecclesiae.*

FIGS. 5–9.—Specimens of Egypto-Roman tapestry weaving of about the 2nd to 5th century A.D. Victoria and Albert Museum.

TAPESTRY

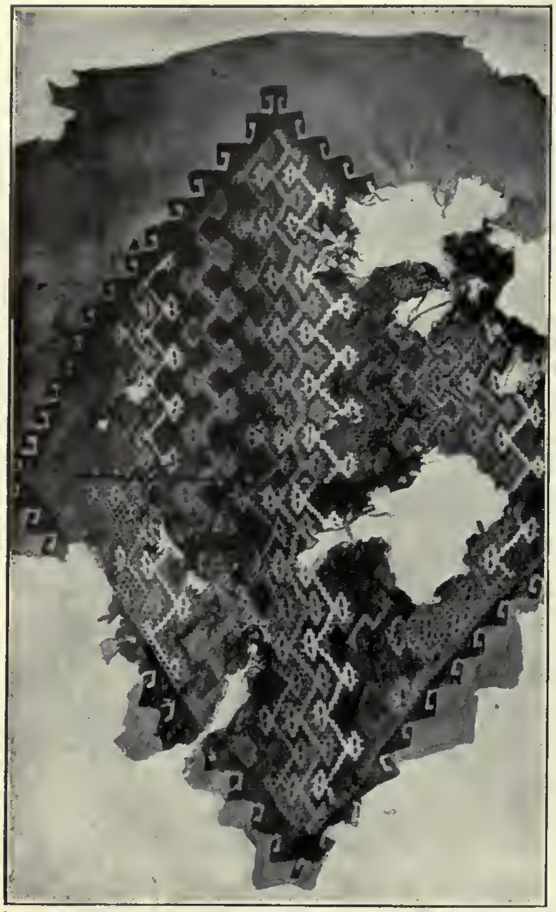

FIG. 10.—Fragment of coarse linen material with a large diamond panel of tapestry weaving in coloured threads—Peruvian-made, before the conquest of Peru by Pizarro. About 3 ft. by 2 ft. 6 in.

FIG. 11.—Portion of wall-hanging from the church of St Gereon, Cologne. North French or German manufacture of the 11th or 12th century. About 2 ft. by 2 ft. 6 in.

FIG. 12.—An antependium, or altar hanging of tapestry woven in coloured wools, with the Adoration of the Magi, probably from a design by Wohlgemuth (1434–1519). The tapestry is reputed to have been executed in a convent at Bamberg; below the folds of the Virgin's cloak, to the right, the "tapissière" has woven a figure of herself at work. German, 15th century. This interesting piece is in the museum at Munich. About 5 ft. 6 in. by 2 ft.

FIG. 13.—One of a series of designs (the Trojan War) by Jean Foucquet (1415–1485) from which tapestry hangings were woven, probably at Arras in the middle of the 15th century.

FIG. 14.—Part of the tapestry (13 ft. high) woven from the design in Fig. 13. Arrival of Queen Penthesilea at the court of King Priam.

FIG. 15.—Part of the tapestry (10 ft. high) woven from the design in Fig. 13. Queen Penthesilea overcoming Diomedes.

FIG. 16.—Long and narrow tapestry (8 ft. 10 in. by 22 in.), German work of the 15th century. Field labours, &c.

FIG. 17.—Part of a wall hanging of tapestry woven (probably at Brussels early in the 16th century) with coloured wools and silks, which is one of a series designed, probably by some member of the school of Roger van der Weyden, to illustrate the Triumphs written by Petrarch. The episode represented is the Triumph of Chastity over Love. Falling from a triumphal car fitted with flaming altars or torches of love, and drawn by four winged white horses, is Cupid, whose left arm is grasped by Chastity mounted on a unicorn and carrying the column symbolizing Strength or Constancy. Foremost in the multitude about the car of Love are Cleopatra and Julius Caesar. In another part of this hanging is the date 1507. The height of this piece is 14 ft. This, with tapestries of the Triumph of Death and Fame, is in the Victoria and Albert Museum: one hanging of the Triumph of Time is at Hampton Court.

belonged to the church of St. Gereon at Cologne; a large bit of it is now in the museum at Lyons; another at Nuremberg; whilst a small part of the border only is in the Victoria and Albert Museum, South Kensington. The pattern consists of repeated roundels within each of which is a chimerical bird and bull (? St. Luke), elsewhere is a small eagle (? St. John). The style of design, strong in oriental and Byzantine character, is frequently found in shuttle-woven silks of the period.

Tapestries from the 13th century onwards. The renaissance of literature in the 12th century, infused with romantic, mystical and religious tendencies, supplied subjects for wall decoration by fresco painting, the practice of which was revived then and came into vogue in Italy and the south, whilst its analogue in the northern and more weather-wearing countries is to be found chiefly in decorative tapestry weavings. Much tapestry is certainly indebted for its cartoons to wall painting, but illustrations in MSS. also furnished subjects from which tapestry was made by the *tapissiers nostrez* and *tapissiers de la haute lisse* in France, Germany and Flanders.[1] The earlier tapestries usually seem to have been narrow and long, *e.g.* the "*toile à broderie*" of Bayeux (see EMBROIDERY) and the 12th-century tapestries of Halberstadt cathedral. Although the making such narrow, long tapestries survived into the 14th and 15th centuries (see fig. 16), larger shapes (see figs. 14 and 15) suitable as curtains and as hangings to cover large wall-spaces became the more frequent. From this time forward the output from many European towns of big pieces, mostly woven with coloured wools, was continuous and considerable. The more sumptuous examples from the 14th to the 17th century were enriched with gleaming silks and metallic threads.[2]

Variety of designs in tapestries. The subjects of the cartoons from which tapestries were woven varied of course with the tastes of the times, the more frequent of the earlier ones being religious (see fig. 12) or illustrative of moralities. Types of romantic, legendary subjects are displayed in figs. 14 and 15 of the Siege of Troy, and fig. 23 of Dido and Aeneas. Historical design occurs in fig. 20, which is one of a set of tapestries woven possibly at the royal factory of Fontainebleau about 1540, to commemorate the fêtes on the occasion of the marriage of Henri II. with Catherine de Medicis; and again in fig. 25, of the "Glorious Defence of Londonderry." Pastoral incidents are shown in fig. 16, and social life episodes and incidents in fig. 22, which was woven at the celebrated Medici factory, Florence, in 1639 by a French weaver—Pierre Fevre—from a design in the style of F. d'Albertino (il Bacchiaca), 16th century, entitled "*L'inverno*" (winter). Less human in interest are tapestries, mostly of the late 15th century, wrought from leafy designs, usually termed "*verdures*," of which several were made at Brussels during the 16th century. Heraldic and floral devices were also frequently used, see fig. 19, from a piece of the late 15th century in Winchester College, and fig. 18, which is at Haddon Hall and was woven early in the 16th century. It is very similar to hangings which are at Bern and are said to have been captured from Charles the Bold at the battle of Granson. Many curiously designed tapestries of German 15th-century origin are to be seen in the museum at Basel—one of them (fig. 21) displays strange beasts, unicorns, stags in the midst of Gothic foliage, and labels with legends. Other tapestries, worked from still later phases of ornamental design, are fantastic with schemes of abstract ornament into which are introduced as subsidiary details figure subjects set in panels and medallions.

The treatment of the compositions in cartoons for tapestry follows that adopted by painters. Thus examples from the 11th to the end of the 15th century are formal in the drawing of the forms introduced into them, and comparatively limited in range of colours, lights and shades, in accordance with the mannerisms of the earlier painters whether illuminators of MSS. or wall and panel painters. It has been argued from this that the designers of such early tapestry work possessed a sense of the limitations imposed by the process and materials. But in their day the relatively small number of dyes available involved conventionality in colour, quite as much as the earlier styles of drawing involved conventionality in form.

Fig. 13 is from an interesting design by Jehan Foucquet (1415–1485): and is one of a set, made by him to illustrate the Trojan War, now in the Louvre. From these drawings tapestries were woven at Arras probably in the middle of the 15th century. One of these hangings in the Victoria and Albert Museum (see figs. 14 and 15) is from Foucquet's design, representing the arrival of Queen Penthesilea and her warrior women at Troy and the part she took in a fight in which she vanquished Diomedes. This episode was introduced by Quintus Calaber (or Smyrnaeus), a 4th-century writer, in his version of the Homeric story. A tapestry from another of Foucquet's designs displaying King Priam in the midst of his court is in the Palais de Justice at Issoire.

Introduction of realism in designs for tapestries. When Raphael, master of a freer and more realistic style in rendering form and colour, produced his cartoons of the Acts of the Apostles for a set of hangings for Pope Leo X., a new condition naturally came into play, and practically became a principal source of the contrast which is observable between the designs of tapestries made before his time and those made after the early part of the 16th century. The provision of a bigger scale of dyes for the wools and silks was stimulated to secure success in weaving these more realistic representations of forms and greater subtleties in colour, as well as the developed effects of perspective: compare, for instance, the treatment in fig. 14 with that in fig. 22. The restraint or limitations of the earlier styles were thus gradually supplanted by the comparative complexities of the later; and it is a point of interest to note that provision for still further inventing and improving dyes and so helping tapestry to assimilate to painting is specially included in the regulations (1667) of the state manufactory of the Gobelins, where under M. Chevreul (director of the dye-works for more than fifty years during the 19th century) 14,400 tones of colour have been used.

Sizes of borders indications of date. A chronological succession of styles may also be traced in the borders enclosing such varieties of design as those just referred to. As a rule borders consisting of a selvage or plain band come first (see fig. 12), followed by those in which labels with block-letter legends (figs. 14 and 15 and fig. 17) are features; after them are narrow borders filled in with closely and well-arranged floral forms (see lower border in fig. 17), to which succeed borders of greater width containing elaborate detail (fig. 20). Such as these date from soon after the beginning of the 16th century, and those rather wider and more extravagant in ornament follow on somewhat later (see figs. 22 and 23). In the 18th century massive rococo proscenium frames, as in fig. 25, are sometimes adopted.

Notable centres of the industry. Of the notable centres where the industry of tapestry-weaving has been in considerable practice, Arras in the 14th and 15th centuries, Brussels in the 15th and 16th, Middelburg and Delft in the late 16th and early 17th centuries,[3] Paris in the 16th and 17th centuries and down to the present time, with Mortlake in the 17th century, probably stand foremost; and from them the services of experienced workmen equipped with frames and implements were requisitioned and secured at most of the short-lived contemporaneous centres in almost all parts of Europe. Several names of tapestry-weavers working during the first half of the 14th century in Arras, Paris, Valenciennes, St. Omer and Reims, for Burgundian, Flemish and French nobles, have been recorded.[4] Throughout that century a few weavers and many tapestries came from Arras into England, where the term "arras" became the generic name for woven wall-hangings. Arras tapestries also went in quantities into Italy where they were called "*Arazzi*," and into Spain where they bore the name "*pannos de raz*." The tapicers of London received their statutes in 1331, and Edward III. caused an inquiry to be held into the *mistera tapiciariorum*.[5] The industry at Arras began to decline soon after 1460, and was succeeded about this date by works at Bruges, Ghent, Tournai, Lille, Oudenarde, but more especially at Brussels, at which last city the industry grew to an importance even greater than it had enjoyed previously at Arras or elsewhere. The regulations of the Brussels corporation of *tapissiers* were framed in 1451. Under them *tapissiers* might draw for one another the stuffs of hangings or of costumes in their figure compositions, trees, animals, boats, grasses, &c., in their "*verdures*," or leafy

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[1] Guiffrey's *Nicolas Bataille* contains particulars of the loan by Charles V. of France to his brother Louis, duke of Anjou, of an illuminated MS. from which Hennequin or Jean of Bruges, painter in ordinary and *valet de chambre* to the king, made the cartoons used by Nicolas Bataille (*tapissier de Paris*) in weaving two hangings representing the Apocalypse (1377).

[2] "*Tapis de haute lice de fin fil d'arras ouvré à or de Chipre*" (A.D. 1395). One of the largest and most delicately wrought tapestry hangings in which gold and silver threads are freely used is that of the Adoration of the Eternal Father: on the left of this is the story of the Emperor Augustus and the Tiburtine Sibyl: on the right the story of Esther and Ahasuerus. It was bought by Mr Pierpont Morgan.

[3] Only one or two of the tapestries representing the several engagements between the English and Spanish fleets in 1588 which used to hang in the House of Lords (see Pine, *Tapestry of the House of Lords*, London, 1739) were saved from the fire (1835), and are now at Hampton Court. They closely correspond with a set commemorating engagements between the Dutch and Spanish fleets (1572 and 1576) which are in the great Assembly Hall of the Provincial States of Zeeland. These latter were woven chiefly at the tapestry works at Middelburg, 1595–1629; the former were woven at Francis Spiring's works (or Spierincx) at Delft. Both, it appears, were designed by H. Cornelius Vroom of Harlem. For interesting details of the Middelburg works see van der Graft's *De Tapijt-Fabrieken* (Middelburg, 1869), and supplementary documents by De Waard (Oud-Holland, xv., 65, 1897).

[4] See lists in W. G. Thomson's *History of Tapestry*.

[5] Rot. Pat. 38 Ed. III., Hardy's *Record Rymer*, vol. 3, part 2, p. 736.

compositions, and the flowers, &c., as in the ground of Fig. 18, and might complete or correct their cartoons with charcoal or chalk, but for every other style of work they were bound to apply to professional painters under pain of fine.[1]

In 1528 the Brussels *tapissiers* and dealers in tapestries were required to mark their weavings, and Charles V. ordered all tapestry makers in the Low Countries to do the same.[2] This practice was followed in other countries into which emigrant Flemish or French weavers had carried the industry, making their tapestries very often from copies they took with them of cartoons designed by noted Italian and Flemish painters. Makers' marks have in so many cases been cut from tapestries that it becomes practically impossible to identify the places where they were made, and the dates of their production can only be conjectured from the styles of designs, supplied for instance by such artists (or their followers) as the Van Eycks, Roger van der Weyden, Mantegna, Leonardo da Vinci, Raphael, Bernard van Orley, Lancelot Blondeel and John van der Straaten or Stradanus; this last-named was for many years employed in connexion with the important "Arrazeria Medici" founded in Florence by Cosmo I., duke of Tuscany (1537), which lasted until the beginning of the 18th century; Stradanus's style of design is similar to that of episodes in the story of Dido and Aeneas shown in fig. 23 from an Oudenarde tapestry of the early 17th century. Reverting to the 16th century, reference must be made to Cardinal Wolsey and Henry VIII., who possessed enormous quantities of the best Flemish tapestries of their time and earlier, and a fair number of them are still preserved at Hampton Court Palace.[3] The king had in his service not only agents especially in Brussels to buy hangings, but also a considerable staff of "Arras-makers." In Ireland, the taste for tapestry was evidenced by a manufactory at Kilkenny of "tapestry, Turkey carpets and diapers," founded early in the 16th century at the instance of Piers, 8th earl of Ormond and his lady, Margaret FitzGerald, and giving employment to workmen introduced by him from Flanders.[4] At a rather later date tapestry works were established by William Sheldon at Weston and Barcheston in Warwickshire, with a view to which he previously sent Richard Hickes to the Low Countries to learn tapestry-weaving. A few Flemings were probably brought over by him and set to work at Barcheston and Weston, where he was appointed "master weaver." In his will (1569) Sheldon calls Hickes, somewhat erroneously perhaps, "the only auter and beginner of tapestry and Arras within this realm." His son, Francis Hickes, was educated at St Mary Hall, Oxford (1579–83), and about 1640 he caused some tapestry maps to be woven.[5] Made before them are a set of hangings of the "Four Seasons," now preserved at Hatfield. These are most probably from designs by Francis Hickes. They were bought by the marquis of Salisbury very shortly before the first visit of Queen Victoria to Hatfield. The borders of these pieces with small medallions and Latin mottoes are attractively amusing and interesting. In the lower border (fig. 24) one may read "VIA. VIRTUTI. ENCYCLOPEDIA"; in the upper border a date, "1611," occurs in one medallion. In the upper border of each hanging is an important coat of arms with several quarterings, chief of which are those of Tracey of Toddington in Gloucestershire impaling those of Shirley of Wiston in Sussex. The designer's inventiveness and fancy in illustrating attributes, &c., of the "Seasons" are almost exuberant, however restricted and quaint his graphic power seems to be.

Tapestry makers' marks.

Artists who designed cartoons for tapestry.

Philip II. is mentioned as having encouraged a manufacture of tapestry by Flemings in Madrid in 1582. In 1539, Francis I. started a royal factory for tapestry at Fontainebleau (see fig. 20), and employed Primaticcio amongst other artists to furnish the necessary designs. Henry II., whilst continuing work at Fontainebleau, caused a second factory to be set going in Paris at the Hôpital de la Trinité. Henry IV. continued this royal patronage in lavish fashion and added yet another factory, that in the Faubourg St. Antoine, which in 1603 was transferred to workrooms in the Louvre. As Paris thus came to the fore, so Brussels gradually declined. Upon the death of Henry IV. in 1610 Paris tapestry-making suffered a check, which may perhaps have contributed somewhat favourably to the start made by James I. to organize the Mortlake works, where several foreign workmen were employed under the direction of Sir Francis Crane.[6] Both James I. and Charles I. supplied considerable sums of money for the Mortlake works, and tapestries were made there, as fine as any comtemporaneously at Paris or Brussels, *e.g.* those from Raphael's cartoons of "the Acts of the Apostles,"[7] Rubens's "Story of Achilles," and portraits by Van Dyck. After the execution of Charles I., Mortlake declined, and new life was infused into the industry at Paris under the influence of Colbert, to whose strong personal interest in the arts is due the organization in 1667 of the Hôtel des Gobelins under the painter Charles le Brun as the *Manufacture Royale des Meubles de la Couronne*, which for large hangings became the premier tapestry-weaving centre in Europe. Three years previously Colbert had initiated a similar manufactory, chiefly with low-warp frames, at Beauvais, which is noted for sofa and chair seats and backs, screens and small panels.

Efforts to establish the industry in Rome were made during the 17th century, but it is only since the pontificate of Clement XI. in 1702 that a papal factory has been successfully conducted and is still carried on in the Vatican. The manufactory of Santa Barbara in Madrid was founded by Philip V. in 1720, and although it was closed in 1808 it re-opened in 1815 and is still at work.

Tapestry-weaving during the 18th century under private enterprise was pursued with success and still continues at Aubusson, Felletin; it was carried on for a short time only at Fulham, Soho, Exeter, and for rather longer periods at Lille, Cambrai, Gisors, Nancy, Naples, Turin, Venice, Seville, Munich, Berlin, Dresden, Heidelberg and St Petersburg, maintaining, however, no very prolonged existence at any of these latter places. In more modern times English tapestries woven after 1878 at the Merton works from designs by William Morris (see fig. 26), as well as by Sir Edward Burne-Jones[8] and Mr Walter Crane, have great distinction in vigorous style reminiscent of virile medieval work. In mere technique of weaving with fine warp and weft they are outdone by the comparatively effeminate and delicate painting-like fabrics now made at the Gobelins and Aubusson.

18th and 19th century tapestry-weaving.

Towards the end of the 17th century as well as early in the 18th century some tapestry-weaving was carried on in Ireland. For about twenty years at Chapelizod, near Dublin, tapestry frames were worked by Christopher and John Lovett, the latter of whom had to leave Dublin, bringing with him into England some thirty-eight pieces of tapestry of "Their Majesties' Manufacture of Ireland." In the Bank of Ireland, in College Green, Dublin, are two large hangings which were executed by Robert Baillie, who is said to have held the appointment of upholsterer to the Irish government in 1716.[9] One of them represents the Battle of the Boyne, the other the "Glorious Defence of Londonderry" (see fig. 25). Lough Foyle and the hill surmounted by the city of Londonderry are represented in the landscape: to the left in the foreground is James II., by whom is the Commander Hamilton with his hat off, and near at hand cavalry: on the right are mortars, cannon and foot soldiers. The border of this tapestry is fantastic in design and rather in the style of an over-elaborated theatre proscenium, upon which hang medallions containing portraits of Captain Baker, the Rev. Dr Walker and the captain of the frigate "Dartmouth," in which the supplies were brought to the besieged which led to the relief of the city and the defeat of the investing army. The designs for these Dublin tapestries are credited to John Vanbeaver, a Flemish weaver, who seems to have been a moderate draughtsman. They are clearly adaptations of designs of historical events, by Le Brun and van der Meulen, from which tapestries were woven at the Gobelins factory to the order of Louis XIV. at the end of the 17th century. These Dublin hangings were woven about 1735, and Baillie was commissioned to make four others representing the landing of the prince of Orange, his army at Carrickfergus, the Battle of Aughrim, and the taking of Cork and Kinsale by Marlborough.[10] These, however, were not completed, and Baillie was paid £200 as compensation.

Tapestry-weaving as a possible cottage or home industry is practised in a few places in Ireland and England. In the Far East, China and Japan, the art, adopted presumably from western Asia, is sometimes resorted to in making silken robes and intricately figured hangings. The Japanese call their tapestry-weaving *tsu-zu-re-ori.*

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[1] *Bulletin des commissions royales d'art et d'archéologie.* Wauters, *Les tapissiers de haute et basse lisse à Bruxelles.*

[2] See list of tapestry marks, pp. 472–81 in Thomson's *History of Tapestry.*

[3] See Law's *Hampton Court Palace*, 1885.

[4] See *Transactions of the Kilkenny Archaeological Society*, 1852, "Ancient Tapestry at Kilkenny Castle," by the Rev. James Graves.

[5] See "Tapestry Maps in the Museum at York" (paper read before Royal Geographical Society by Rev. W. K. R. Bedford, printed 10th Dec. 1896, and included in vol. i. of the society's *Transactions* for 1897), also in Bodleian Library.

[6] A half-length portrait by Van Dyck of Sir Francis Crane worked in tapestry, and one or two small fine-warp tapestry panels of the Virgin Mary and Jesus Christ, hang at Lord Petre's, Thorndon Hall, Brentwood. Ancestors of the late Lady Petre were related to the Crane family, as well as to the Markham family with which Edward Sheldon by his marriage early in the 17th century became connected. The Sheldon and Markham arms occur in the border of one of the map tapestries in the Bodleian Library.

[7] The original cartoons, the property of the Crown, are exhibited in the Victoria and Albert Museum.

[8] A very fine set of Merton tapestries made from Burne-Jones's designs are in the Municipal Museum at Birmingham.

[9] References to his employment in making tapestries occur in the *Journal* of the Irish House of Lords.

[10] See Gilbert's *History of Dublin*, vol. iii. p. 79.

FIG. 18.—Brussels, early 16th century, hanging, covered with masses of flowers, on which are shields bearing the royal arms. Now at Haddon Hall. The property of the duke of Rutland.

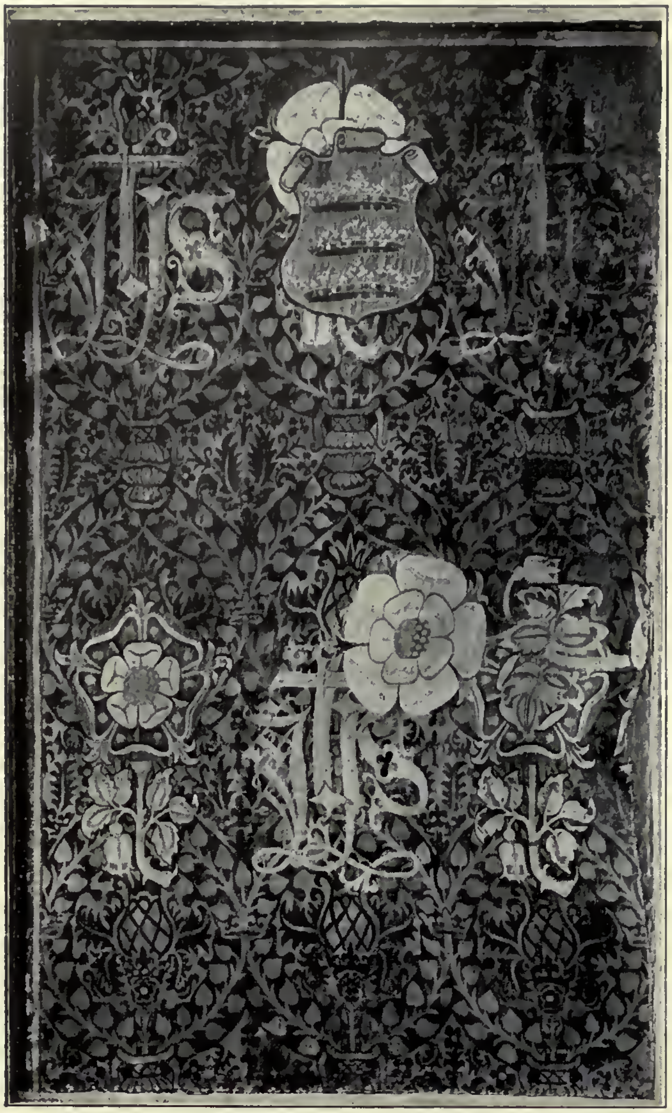

FIG. 19.—Brussels tapestry (about 6 ft. high), late 15th century, with a shield bearing three crowns, red and white roses, and the monogram I.H.S. repeated three times. From Winchester College.

FIG. 20.—Tapestry hanging (about 10 ft. high) possibly of Fontainebleau manufacture about 1540. Fêtes in honour of Henri II. and Catherine de Medicis.

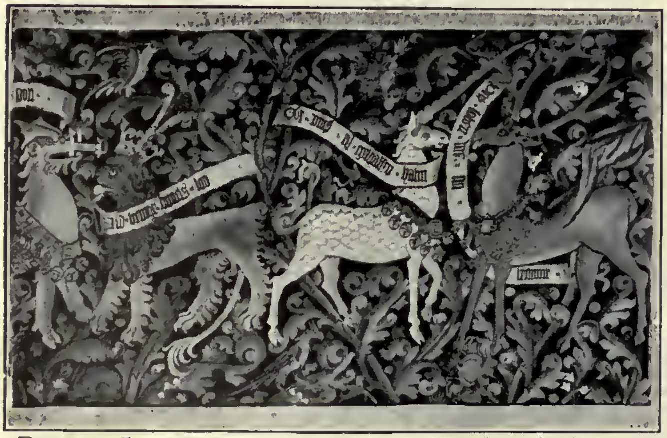

FIG. 21.—German tapestry hanging (about 4 ft. 6 in. long by 3 ft. high) for a sideboard or buffet, middle of the 15th century. In the museum at Basel.

FIG. 22.—Tapestry hanging (about 10 ft. high) made at the Medici factory in Florence, 1639. Domestic scene, *l'Inverno*, winter.

FIG. 23.—Oudenarde tapestry, early 17th century. The design, "Dido and Eneas," rather in the style of J. van Straeten.

FIG. 24.—One of the four tapestry hangings of the "Seasons," of Winter with Aeolus in the centre, probably woven under the direction of Francis Hickes at William Sheldon's manufactory at Barcheston, in Warwickshire, early in the 17th century, and now at Hatfield House.

TAPESTRY

FIG. 25.—Defence of Londonderry. Irish (Dublin) tapestry, early 18th century.

FIG. 25.—Tapestry woven at Merton Abbey, from a design by William Morris (1834–1896). The subject is from his poem "The Orchard." Victoria and Albert Museum.

Fine examples of early and later European tapestries are to be seen in the cathedrals of Reims, Bruges, Tournai, Angers, Beauvais, Aix, Sens, in the Victoria and Albert Museum, London, Windsor Castle, Hampton Court, St Mary's Hall Coventry, the Louvre and Cluny Museums in Paris, at Chantilly, Chartres, Amiens, Dijon, Orleans, Auxerre, Nancy, Bern, Brussels, Basel, Munich, Berlin, Dresden, Vienna and Nuremberg. In Italy the largest collections (mostly of 16th and 17th century work) are those of the Vatican at Rome, and the *Reale Galleria degli Arazzi* at Florence. Many fine pieces are in the royal palace at Turin, the *Palazzo del Tè* at Mantua, the royal palace at Milan, in the cathedral of Como, and the museum at Naples. The collection at the palace of Madrid is one of the largest in Europe, and comprises more than one thousand examples, the older of which, of splendid Flemish design and weaving, belonged to Ferdinand and Isabella, Philippe le Bel and the Emperor Charles V.[1] The principal cathedrals of Spain also possess important tapestries; those preserved at the cathedral of Toledo are more than enough to supply hangings for the outside and inside of that building on the feast of Corpus Christi. Throughout the European continent, in the United States of America, and in Great Britain almost uncountable tapestries are displayed or stored in mansions, castles, *châteaux* and *palazzi*, belonging to noble and wealthy families. A large number of books have been written and published on the subject generally, and many of them, containing good illustrations, are of recent date.

Places where fine tapestries are now preserved.

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(A. S. C.)

[1] *See Report of Señor I. F. Riaño to the Director of the South Kensington Museum*, 1875.

TAPEWORMS. The Cestodes or Tapeworms form a class of purely endoparasitic Platyelmia, characterized by their elongate shape, segmented bodies, and the absence of a digestive system. With few exceptions they are composed (1) of a minute organ of fixation (the scolex), which marks the proximal attached end of the body; (2) of a narrow neck from which (3) a number of segments varying from three to several thousands are budded off distally. These segments, or "proglottides," become detached in groups, and if kept moist retain their powers of movement and vitality for a considerable time. This fact gave rise in ancient times to the false idea that the tapeworm originated from the union of these segments; and in modern times it has led to the view that the tapeworm is not a segmented organism (the monozoic view), but is a colony composed of the scolex which arises from the embryo and of the proglottides, which are asexually produced buds that, upon or before attaining their full size and maturity, become separated, grow, and, in some cases, live freely for a time, just as the segments of a strobilating jelly-fish grow, separate and become sexual individuals (the polyzoic view). Whether this view is soundly based is discussed below; the fact remains, however, that a tapeworm is, with few and rare exceptions, not directly comparable at all points with a liver-fluke or indeed with any other organism. The influence of parasitism has so profoundly influenced its structure that its affinities are obscured by the development of specialized and adaptive features.

In contrast to these segmented or "merozoic" Cestodes, a few primitive forms have preserved a unisegmental character and form the Monozoa or Cestodaria. We may therefore divide Cestodes into the Monozoa and the Merozoa.

Order I.—MONOZOA

This order comprises a few heterogeneous forms which probably constitute at least three families.

Family I. *Amphilinidae.*—Oval or leaf-shaped animals found in the sturgeon and certain other fish.

Amphilina foliacea (fig. 1) is in many ways closely allied to the Trematoda, from which, however, it is distinguished by the want of a digestive system. One end of the body (usually designated anterior) is provided with a glandular pit (fig. 1, A*a*) which is regarded as a sucker or as related to the uterine opening (birth-pore). The excretory system consists of peculiar cells, each of which bears several "flames" or bunches of synchronously vibrating cilia. These cells are imbedded in the peripheral parenchyma, and lead into convoluted excretory tubes that form an anastomosis opening to the exterior by a pore at the "hinder" end of the body. The epidermis consists of pyriform cells, which send richly branched processes to the superficial cuticle. The parenchyma is made up of stellate cells the processes of which form a reticulum. The reproductive organs consist of the parts shown in fig. 1, A, and it will be seen that, in addition to the openings of the male

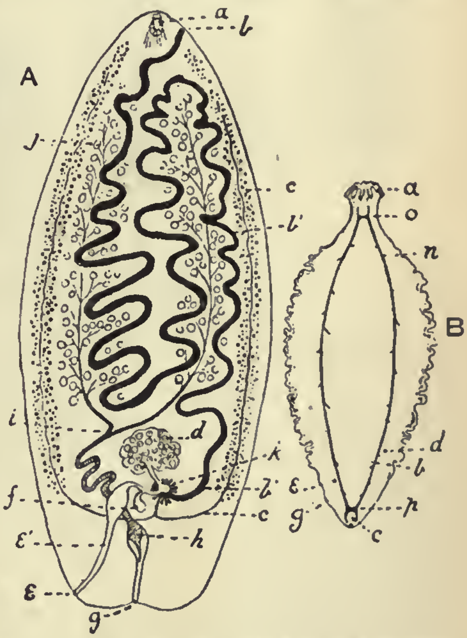


FIG. 1.—A, reproductive system of *Amphilina foliacea*: *a*, glandular pit; *b*, opening of uterus; *b'*, uterus (black); *c*, yolk-gland and its duct; *d*, ovary; *e*, *e'*, opening and duct of vagina; *f*, spermotheca; *g*, male genital opening (gonopore); *h*, penis; *i*, vas deferens; *j*, testes; *k*, shell-gland. B, *Amphiptyches* (*Gyrocotyle*) *urna*. Outline of the ventral surface to show the external apertures and nervous system; *a*, rosette-organ; *b*, uterine pore; *c*, terminal sucker; *e*, vaginal pore; *g*, male gonopore; *n*, *o*, *p*, nervous system. (From Lankester's *Treatise on Zoology*, part iv.)

and of the female (vaginal) ducts, there is a distinct uterine opening at the opposite end of the body (*b*). Moreover, in *Amphilina liguloidea* a fourth duct (the anterior vagina) begins close to the origin of the female duct, and after running forward a short distance ends blindly (see fig. 7, C). The egg gives rise to an oval larva, one half of which is ciliated and bears gland-cells, the opposite end carrying ten hooks. The fate of the larva is unknown.

Family II. *Gyrocotylidae.*—Leaf-shaped animals with crenate margins. One extremity carries a pedunculate rosette-organ. It is traversed by a canal from which a peculiar proboscis-like structure can be exserted. The opposite end is pointed and provided with a terminal sucker. *Amphiptyches* (=*Gyrocotyle*) *urna* (fig. 1, B) is found in the intestine of *Chimaera* and *Callorhynchus*, and has been almost fully described by Spencer (7). The embryo is provided with ten hooks, and appears to select Lamellibranchs (*Mactra*) for its intermediate host.

Family III. *Caryophyllaeidae.*—Elongated cylindrical animals either with a single subterminal sucker at the proximal end, or with the corresponding end of the body converted into a mobile undulatory fold. *Caryophyllaeus mutabilis* occurs in the roach and other fresh-water fish, and passes its earlier stages of development in fresh-water Oligochaets (*Tubifex*). *Archigetes appendiculatus* lives throughout life in the coelom of *Tubifex* and of *Limnodrilus.*

Archigetes and *Caryophyllaeus* are the only Cestodes that become fully differentiated in an invertebrate host. The former indeed

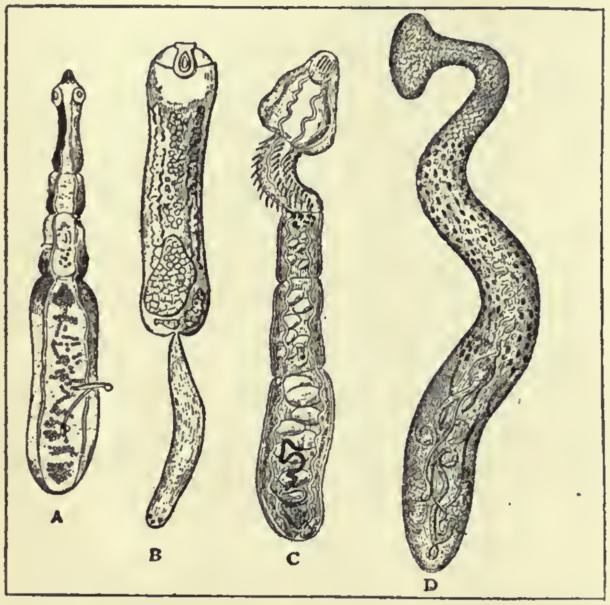


FIG. 2.— Various Forms of Tapeworms. A, *Taenia echinococcus*; × 12 (from Leuckart). B, *Archigetes sieboldi;* × 60 (from Leuckart). C, *Echinobothrium typus;* × 10 (from Van Beneden). D, *Caryophyllaeus mutabilis;* × about 5 (from Carus).

is said to produce fully developed gonads, and if kept in aquaria with *Tubifex*, the number of infected worms steadily increases, a fact pointing to the whole cycle being passed through, without the intermediation of a vertebrate host. Conclusive evidence, however, has not yet been adduced to prove this point. The two genera agree closely in form and structure and may possibly belong to the cycle of the same or of allied species. *Archigetes* (3 mm. long) consists of a subcylindrical body and a caudal appendage. The former bears two terminal suckers on the flattened dorsal and ventral surfaces, the latter six hooks near the tip of the tail. The finer structure of the animal has been investigated by Mrazek (10), whose account, however, is published in the Hungarian language. It shows a close agreement with that of *Caryophyllaeus.* A well-developed cellular parenchyma forms a matrix in which the muscular, excretory and generative organs are imbedded. The nervous system consists of a ring below the suckers and of a large number of radially arranged tracts running forwards and backwards. *Caryophyllaeus* is an elongated, flattened worm provided with one extremely mobile extremity, the other being drawn out during the animal's sojourn in *Tubifex* into a short hexacanth tail. It becomes fully developed in its invertebrate host, but apparently cannot produce eggs until transferred into the intestine of a fish.

Order II.—MEROZOA

The Merozoa, to which the ordinary tapeworms of man and domestic animals belong, includes the great majority of the Cestodes. They occur in vertebrate animals throughout the globe, though varying in abundance in different districts and at different times. With few exceptions tapeworms select the small intestine for their station, and in this situation execute active movements of extension and contraction. The body, or "strobila," consists of a usually minute organ of attachment (scolex or its representative) which is imbedded in the intestinal membrane, and of a series of segments that arise from the base of the scolex and increase in size distally. In one family (*Ligulidae*) the segmentation is only expressed in the metameric distribution of the generative organs and the worm is externally unisegmental. In the remainder the segmentation involves primarily the genitalia and includes the integument, muscles and part of the excretory system. The nervous system is, however, not segmented, and the excretory system is continuous throughout the worm.

Scolex.—The scolex is biradially constructed, the proglottides flattened, quadrangular and bilaterally symmetrical. In them a ventral surface containing the usually median male and female genital apertures is generally distinguishable from the smooth

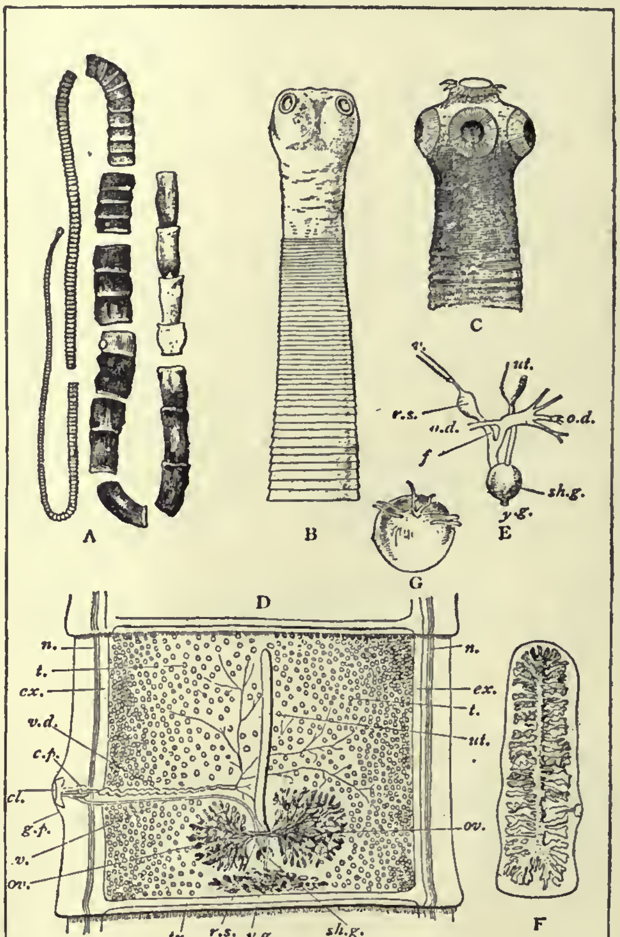


FIG. 3.—Anatomy of *Taenia* (from Leuckart). A, portions of *Taenia saginata*; × ½. B, head of the same; × 8. C. head of *T. solium*, showing the crown of hooks; × 22. D, a segment of *T. saginata*, showing the generative organs: *n.*, nervous system; *ex.*, longitudinal excretory tubes; *tr.*, transverse vessel; *g.p.*, genital papilla; *cl.*, cloaca; *c.p.*, cirrus pouch; *v.d.*, vas deferens; *t.t.*, testes; *v.*, vagina; *ov. ov.*, ovaries; *sh.g.*, shell gland; *y.g.*, yolk gland; *r.s.*, receptaculum seminis; *ut.*, uterus; × 7. E., the connexions of the generative organs, lettering as above: *o.d.*, *o.d.*, oviducts; *f.*, fertilizing canal; × 30. F, detached segment of *T. saginata*, showing ripe uterus; × 2. G, six-hooked embryo, highly magnified.

dorsal surface, but in those Cestodes which possess marginal gonopores this distinction of surface is obscured. In such cases the male organs are regarded as indicating the dorsal surface, the female organs as belonging to the ventral surface.

The scolex is usually a conical muscular structure. It bears adhesive organs that are either suckers or hooks, and may develop into the most varied outgrowths in order to give increased firmness of attachment to its host. Thus, starting from the two shallow pits, one dorsal and the other central, in the simplest forms, we find them becoming two elongated suckers (bothria) in the large family *Bothriocephalidae* (fig. 8); and by fusion of the lips they are transferred into two tubes (*Solenophoridae*); and by the closure of the lower aperture reconstituted into two suckers, the margins of which are produced and folded so as to resemble the leaf-like outgrowths of the next group. In this division (Tetraphyllidea) four suckers or bothria are developed on the scolex, but their cavities are extremely shallow and their lips extremely mobile and variable in shape. Hence they are called phyllidia (fig. 4). These organs may be raised on a short stalk, their cavity subdivided into loculi, and provided in some cases with hooks. A peculiar modification of this type of scolex occurs in the *Echinobothridae*, in which the axial part of the organ (the rostellum) is elongated and provided with several rows of hooks, whilst the phyllidia have partially fused. This elaborate type of scolex appears to be an adaptation to grasp the spiral intestinal valve of sharks and rays. But perhaps the most elaborate scolex is that of the Tetrarhyncha (fig. 5), which are also parasitic in Selachians. The four suckers are here united to form two pairs or fused into a single pair. Internal to the suckers are the four complex hooked proboscides. Each consists of an eversible hollow tentacle provided with hooklets and capable of introversion within a membranous sheath filled with fluid. The sheath terminates in an elongated muscular bulb. The muscles are arranged in ten or more layers, and are transversely striated. These complex organs have apparently arisen by the increase in depth and differentiation of an accessory sucker such as is borne on the phyllidia of the former group. Lastly, the scolex of the more familiar *Taeniidae* (Tetracotylea) carries a rostellum encircled with hooks and four cup-shaped suckers the margins of which do not project beyond the surface of the body. It seems probable that these suckers are not the true "bothria" but are developed from accessory suckers, the bases of which have disappeared almost completely. In one genus (*Polypocephalus*) the place of a rostellum is taken by a crown of retractile tentacles. This order is almost exclusively parasitic in warm-blooded animals.

FIG. 4.—Scolex of *Calyptobothrium riggii* from the Torpedo, magnified to show the four "phyllidia," each of which has a sucker. (From Braun, in Bronn's *Klassen u. Ordnungen d. Thierreichs*, by permission of C.S. Winter'sche Verlagshandlung).

The extraordinary variety of form and complication of structure exhibited by the appendages of the scolex are adaptations to fix the worm and to resist the peristaltic action of the intestine in which it lives, and are not connected directly with the absorption of food.

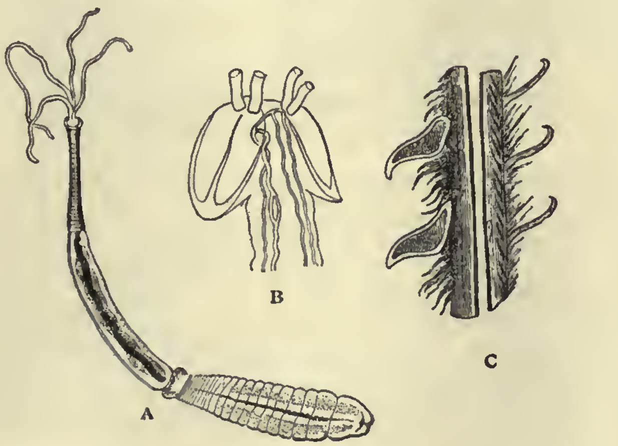


FIG. 5.—*Tetrarhynchus*. A, general view of the worm; × 4. B, head showing the suckers, proboscides and excretory canals; × 25. C, portion of a proboscis showing the two forms of hooks; highly magnified. (All from Pintner.)

Proglottides.—The segments into which the body is divided vary considerably in number, size and form. *Taenia echinococcus* has only three, *Echinobothrium* four, *Bothriocephalus* three thousand. In every species the segments develop from the scolex distally and increase in size with the maturation of the contained female genital organs. When this is reached, growth of the proglottides ceases. As a general rule the ripe proglottides are detached in chains and replaced by others which in their turn become detached, the process being repeated for a year or so until the worm weakens and is cast out. In special cases, however, a proglottis may be detached before attaining full growth, and with its generative organs in an imperfectly developed condition. The minute *Taenia* (*Davainea*) *proglottina* (·5 to 1 mm. in length) from the common fowl detaches its four or five segments into the intestine, where they attain a length of 2 mm., and a breadth of 1·25; that is, more than twice the size of the parent. The Cestodes of Elasmobranch fish offer more convincing examples of independent growth of the proglottides, for these are often set free with only the male organs developed, and each attains twice the size of the parental strobila.

The form of the proglottides is most generally a rhombic or trapezoidal figure. The hinder border is often drawn out into mobile processes and hollowed out around the insertion of the next segment. At this neck-like zone the muscles are absent, and across it falls the line of fracture when the proglottis separates from its fellows.

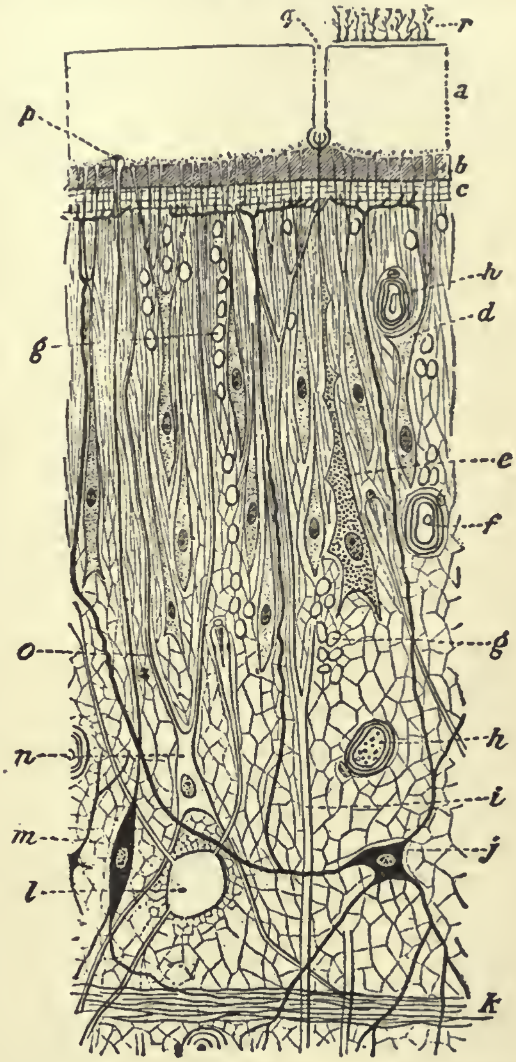


FIG. 6.—Diagram of a transverse section through the body-wall of a young *Ligula*, illustrating the microscopic structure of tapeworms. *a*. cuticle; *b*, basal membrane; *c*, outer circular muscles; *d*, epidermal cells depressed below the surface usually occupied by them in other animals; *e*, gland cell; *f*, "flame-cell" (the reference line stops a little short); *g*, outer longitudinal muscles; *h*, a calcareous corpuscle; *i*, dorso-ventral muscles; *j*, a "parenchyma" cell (probably nervous); *k*, nerve-plexus; *l*, excretory vessel giving off capillaries ending in flame-cells; *m*, a sense-cell; *n*, a muscle-cell; *o*, ending of the same; *p*, ending of sense-cell; *q*, opening of gland-cell; *r*, superficial cuticle. (From Lankester's *Treatise on Zoology*, part iv.)

Structure.—The anatomy of the Cestoda differs in only two or three important features from that of Trematodes. In both classes the body is encased by a thick non-cellular cuticle, the deepest layer of which—the subcuticle or basal membrane (fig. 6 *b*)—is perforated by the branched free ends of the isolated epidermal cells, which have sunk into the body, and by the endings of gland-cells and nerve-cells (fig. 6). The mass of the body consists of richly branched stellate cells—the mesenchyma—and imbedded in this plasmic tissue are the nervous, excretory, muscular and generative organs.

The excretory organs consist of flame-cells, richly convoluted canaliculi, and a pair of longitudinal canals leading to the exterior by one or more pores. The muscles are composed of outer circular and inner longitudinal layers, and of branched dorso-ventral fibres. The generative organs are of the complex hermaphroditic type described in Trematoda (*q.v.*). In these broad anatomical features both classes agree. But whilst in Trematoda a digestive sac is invariably present except in the sporocyst larval stage, the Cestodes possess no trace of this organ at any stage of their development. They obtain food entirely by osmosis through the striated cuticle, and this food consists not of blood, as in flukes, but of chyle, by which they are bathed in their favourite site, the small intestine.

The second point of difference between tapeworms and Trematodes lies in the absence of a definitely demonstrable "brain." The concentration of nervous matter and ganglionic substance at the oral end of Trematodes is equivalent to the "brain" of the Planarians, but the similar thickening in the scolex of Cestodes is by no means so certainly to be called by that name. It appears to be primarily related to the organs of attachment and to have attained greater elaboration than the rest of the nervous system because the proximal end is the most specialized and most stimulated portion of the worm. Those Cestodes which possess no very distinct organ of attachment (such, for example, as *Gyrocotyle*) have no distinct ganglionic thickening more pronounced at one end of the body than at the other; and as these are forms which have retained more primitive features than the rest, and show closer affinity to the Trematodes, it seems highly probable that the complicated nervous thickening found in the scolex, and often compared with the "brain" of other Platyelmia, is a structure *sui generis* developed within the limits of the sub-class. In the opinion of several zoologists it marks the tail-end and not the head-end of the worm.

The third important contrast in structural features has also been acquired by the Cestoda Merozoa, namely, the repetition of certain organs in a metameric fashion. The Monozoa are unsegmented; the *Ligulidæ* have segmented gonads and gonopores without any trace of somatic metamerization except secondary excretory pores in addition to the usual terminal one; the remaining Cestodes are unisegmental only in their larval stage, and all of them show in their later stages repetition of the reproductive organs and of the musculature. In addition, some show duplication of the gonads and of their ducts, so that we find both transverse and longitudinal repetition of these organs, without corresponding multiplication of the nervous ganglia mesenchyma, or excretory opening.

The last structural peculiarity of the group is the absence of the functions of regulation and reparation which are so highly developed in the more primitive Planarians. This statement is quite consistent with the continuous production of new segments at the neck of the scolex, for such a process is analogous to the development of the segments in a Chaetopod, which is a perfectly distinct phenomenon from the regeneration of new segments to supply the place of a head or tail-end or some other portion that has been lesioned. The replacement of detached mature proglottides at the distal end of the Cestode-body by others is not regeneration, for the replacing set has already developed, and in certain cases they can complete their development quite independently after being detached from the parent. More convincing evidence of the absence of true regeneration, however, is the argument from malformation and the phenomenon known as "pseudo-scolex." It has long been known that proglottides of the same species often exhibit sporadic malformation from the normal shape, and the evidence goes to show that the variation was due to arrested growth or some unusual stress or pressure which, acting upon the young strobila, produced a deformation, and that the proglottides so affected could not regain their normal form. The power of reparation, so conspicuous a feature of Turbellarians, is slight or absent in Cestodes. Moreover, injury to the scolex, or amputation of that organ, reveals the concomitant absence of a regulative mechanism such as that which generally controls the form and fitness of regenerated organs. In such an event, a Cestode cannot replace the injured or severed portion. The first two or three proglottides merely become deformed and produce an appearance known as the pseudo-scolex. The absence of these functions of regeneration and of regulation affords, therefore, corroborative evidence of the highly specialized nature of the Cestode organization.

Reproduction.—The reproductive organs are usually repeated in each proglottis, and in some families two complete sets of such organs occur in each segment; in a few cases, parts only of the system are duplicated. The structure of these organs is seen in figs. 3, 6 and 7, and, as we have said, agrees closely with that of Trematodes. The chief difference between the reproductive organs of the two classes is the presence in Cestodes of a separate vagina and uterus, each of which opens in some families to the exterior by an independent pore. The vagina of Cestodes is undoubtedly comparable with the so-called "uterus" of Trematodes, but the nature of the Cestode uterus is not so clear. It has been compared with the canal of Laurer of Trematodes (the vitello-intestinal duct of the ectoparasitic flukes), but if we take the more primitive Cestodes, and especially *Amphilina*, into consideration we find that they possess, in addition to the uterus, an anterior vagina (usually present in Cestodes) and a posterior one. This last tube is probably the homologue of Laurer's canal (Goto, 8). The single anterior vagina is then comparable with the similarly named duct of ectoparasitic Trematodes, in which group it is either single or double. The accompanying figure will assist this description.

Life-histories.—The life-history of Cestodes consists of larval and adult stages, which are usually passed through in different hosts. The egg gives rise in the uterus to a six-hooked embryo, which reaches the first host in a variety of ways. It may hatch out as a ciliated organism (fig. 8, D) capable of living freely in water for at least a week (*Bothriocephalus*), which then, if eaten by a stickleback, throws off its ciliated envelope, and creeps by the aid of the hooks through the intestinal wall into the body-cavity of the fish. Here it develops into a larval, or rather an adolescent form. In other cases the infection of the first host is brought about by the ingestion

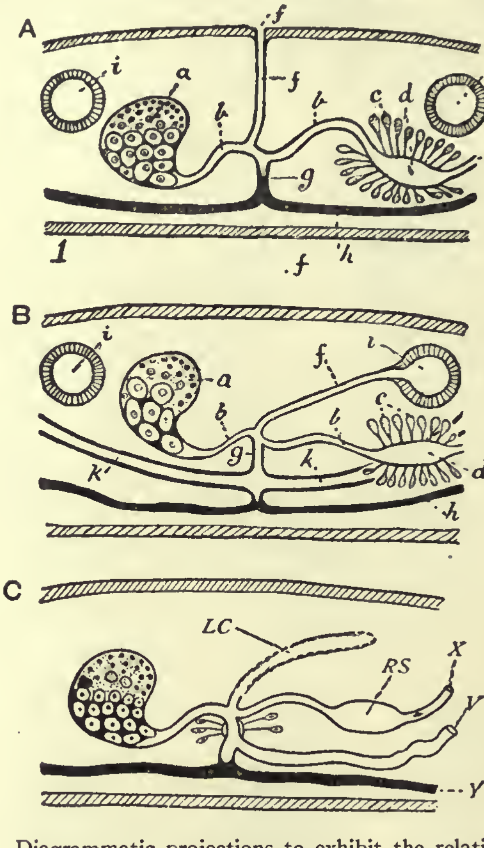


FIG. 7.—Diagrammatic projections to exhibit the relations of the female genital ducts in Trematodes with those in Cestodes. A, in endoparasitic Trematodes (Malacotylea). B, in ectoparasitic Trematodes (Heterocotylea). C, in Cestoda. (The ovary (*a*) leads into (*bb*) the oviduct, which is joined at (*g*) by the duct of the yolk-glands (*h*, *h*, *Y*). In B it is also joined by a paired vagina *k*, *k*, and by the "vitello-intestinal duct" (Laurer's canal, *f*). In the Cestodes the vagina is present (*V*); the canal of Laurer (*LC*) is now vestigial (present in *Caryophyllaeus* as the posterior vagina). The uterus (*X* in figure C) begins in all cases at the shell gland (*c*, *d*) and may exhibit a swelling (*R S*) for the retention of the spermatozoa. *ii* are sections of the intestine. (A and B from Lankester's *Treatise on Zoology*, part iv., C original.)

of proglottides or of eggs which are disseminated along with the faeces of the final host and subsequently eaten by herbivorous or omnivorous mammals, insects, worms, molluscs or fish. Man himself, as well as other mammals, is the intermediate host of the dangerous parasite, *Taenia echinococcus*, in countries where cleanliness is neglected; the pig is the host of *Taenia solium*, and other cases may be seen from the table at the end of this article. The transition of the larva from the intermediate to the final host is accomplished by the habits of carnivorous animals. The Elasmobranchs swallow infected molluscs or fish; pike and trout devour smaller fry; birds pick up sticklebacks, insects and worms which contain Cestode larvae; and man lays himself open to infection by eating the uncooked or partially prepared flesh of many animals.

The peculiar feature of the larval history of Cestodes is the development in most cases of a cyst or hydatid on the inner wall of which the scolex is formed by invagination. The cyst is filled with a toxic fluid and may bud off new or daughter scolices. In this way bladders as large as an orange and containing secondary bladders, each with a scolex, may arise from a single embryo. We have, in fact, a form of larval multiplication that recalls the development of digenetic Trematodes.

The eggs of Cestodes consist of oval or spherical shells ($\frac{1}{500}$ in.

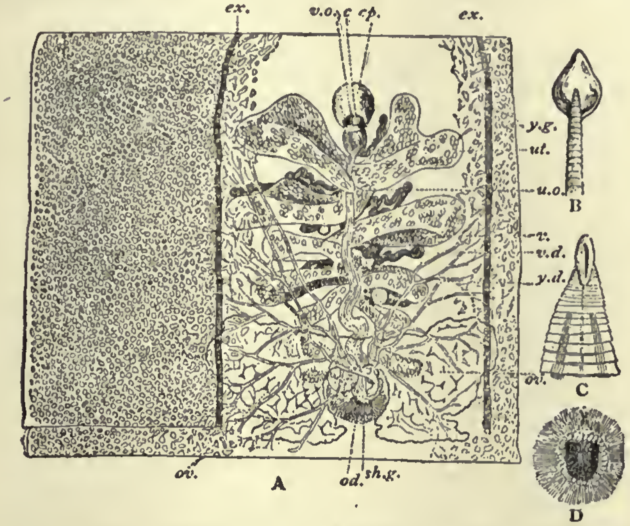


FIG. 8.—*Bothriocephalidae.* A, a segment of *Bothriocephalus latus*, showing the generative organs from the ventral surface; *ex.*, excretory vessels; *c.*, cirrus; *c.p.*, cirrus pouch; *v.d.*, vas deferens; *v.o.*, vaginal opening; *v.*, vagina; *sh.g.*, shell-gland; *od.*, oviduct; *ov.*, ovary; *y.g.*, yolk-gland; *y.d.*, its duct; *ut.*, uterus; *u.o.*, uterine opening; the testes are not visible from this side; × 23 (from Sommer and Landois). B, C, marginal and lateral views of the anterior part of *B. cordatus*, showing the bothria; × 5 (from Leuckart). D, *ciliated* embryo of *B. latus*; × 60 (from Leuckart).

diameter), containing a fertilized ovum surrounded usually by many yolk-cells. The shell is thick, and operculate in some forms; thin, and provided with filaments, in others; in the latter cases it may contain only a few yolk-granules suspended in an albumen-like substance. The development of the six-hooked embryo or "oncho-

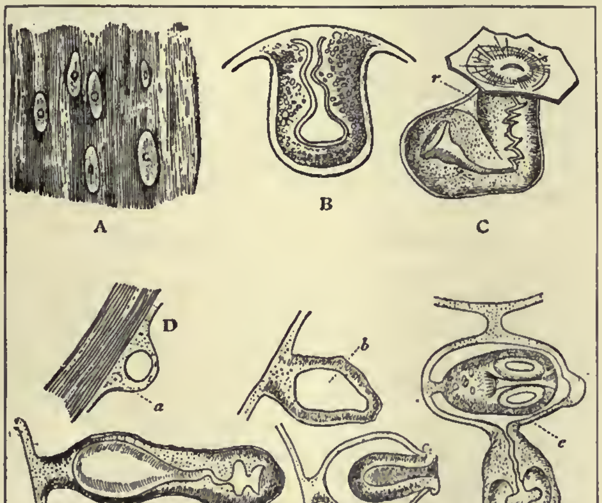


FIG. 9.—Development of *Taenia* (from Leuckart). A, *Cysticercus bovis* in beef; nat. size. B, invaginated head of a *Cysticercus* before the formation of the suckers; × 25. C, invaginated head of *Cysticercus cellulosae*, showing the bent neck and receptacle *r*; × 30. D, stages in the development of the brood-capsules in *Echinococcus*: *a*, the thickening of the parenchyma of the bladder; *b*, subsequent formation of a cavity in it; *c*, development of the suckers; *d*, a capsule with one head inverted into its cavity; *e*, a capsule with two heads; × 90.

sphere" takes place in the uterus. The ovum first divides into (*a*) a granular cell, and (*b*) a cell full of refringent spherules. The former divides into (*c*) small cells or micromeres, and (*d*) large cells or megameres. (*c*) forms the body of the embryo, (*b*) and (*d*) enclose it and form a covering. The embryo undergoes differentiation into an outer layer of cells that produce a chitinoid coat, a middle layer of cells, and a central spherical hexacanth body closely enveloped by the middle coat. In a few genera the place of the chitinoid coat is taken by a ciliary investment and in most families the structure of the layers is characteristic.

Arrived in the intestine of the intermediate host, the hooked embryo is set free and works its way to some distant site. Here it undergoes a change into a cystic or "metacestode" state. A cavity appears in its centre and it acquires a pyriform shape. The thicker portion develops a terminal muscular rostellum and two or four suckers, the thinner end ("tail") is vesicular, more or less elongated, and contains the six embryonic hooks. By a process of infolding, the thicker end is partially invaginated, the middle portion or "hind-body" and the organism may now present a superficial likeness to a cercaria. An excretory system develops, opening at

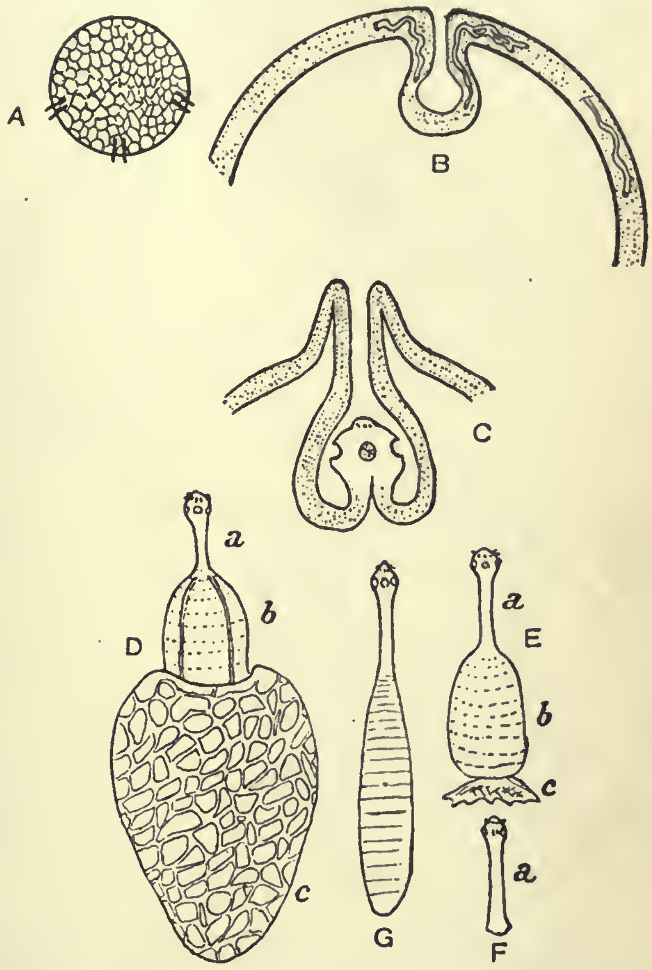


FIG. 10.—The development of a Cestode from a cysticercus (bladder-worm or hydatid). A, the six-hooked embryo. B, portion of the bladder (hind-body and tail), showing the invaginated portion (scolex) and traces of the excretory system. C, further stage in the development of the scolex. D, the entire bladder-worm with scolex everted (drawn from *Cysticercus pisiformis*, common in the rabbit): *a*, scolex; *b*, fore-body; *c*, hind-body and tail. E, F, result of digestion of cysticercus in the stomach of the dog. G shows formation of proglottides. (From Lankester's *Treatise on Zoology*, part iv.)

the base of the tail; nervous and muscular systems arise; and finally the rostellum and suckers become completely enclosed in the sac formed by the lateral extension of the "hind-body." When swallowed by the final host such a "*cysticercoid*" larva evaginates its scolex, throws off its hooked vesicular tail, and begins to bud off proglottides at its free end (fig. 10).

Such is the general history of Cestodes whose intermediate host is an Invertebrate. In most other cases the tail is not distinguishable, and the body of the larva is separable only into a scolex invaginated with a bladder (=hind-body and tail). This form of larva is known as a *cysticercus*. In some genera a "urocyst" is formed, the tail of which gives rise to a new cyst and a fresh scolex.

The most remarkable feature of this cystic development is the formation in many genera of several internal buds within a common cyst, each of which forms an independent inverted scolex (*Coenurus*, *Polycercus*); or these internal vesicles may bud off a large number of scolices on their external surface (*Staphylocystis*).

Morphology of the Cestodes.—With regard to the vexed questions of the morphological nature and of the affinities of the Cestodes, divergent views are still held. One view, the monozoic, regards the whole development as a prolonged metamorphosis; another, the polyzoic view, considers that not only is the Cestode a colony, the proglottides being produced asexually, but that the scolex which buds off these individuals is itself a bud produced by the spherical embryo or onchosphere. On this view, therefore, at least two asexual generations (embryo and scolex) alternate with a sexual one (proglottides); and in the case of *Staphylocystis* the cyst contains two asexually produced generations, so that in such forms three stages (embryo, primary scolex-buds, secondary scolices) intervene between the proglottis of a Cestode and that of its offspring. The polyzoic view is ably championed by Braun (2) and (3).

The more valuable point of view is undoubtedly the monozoic one. In accordance with this we can regard the development as an adaptive one and the scolex as invaginated for protective purposes inside the cyst, which is itself an organ comparable to an amnion. On this view, multiple scolices are, therefore, not buds, but an example of the unlocalized organization of the embryo such as occurs in other groups of animals, and is demonstrated by experiment. The evolution of the cysticercoid, cysticercus and other forms of larvae is a varied adaptive phenomenon. With regard to the adult worm we have to remember that its two extremities, scolex and terminal proglottis, are different from the intervening region. The terminal or first-formed proglottis is sterile, and contains the primitive and (except in a few genera) the only excretory pore. The excretory tubes, the nervous system, and the parenchyma and integument are continuous from one end of the worm to the other. The repetition of the genitalia is the real mark of the Cestodes, and we can trace the independence of the somatic from the gonidial metamerism in such forms as *Triaenophorus* and others. In fact, the whole history of the Platyelmia is marked by a great specialization of the reproductive evolutionary history, accompanied by a simple somatic line of evolution. We therefore regard the body of a Cestode as a single organism within which the gonads have become segmented, and the segmentation of the body as a secondary phenomenon associated with diffuse osmotic feeding in the narrow intestinal canal. The origin of the repetition of the gonads has yet to be investigated.

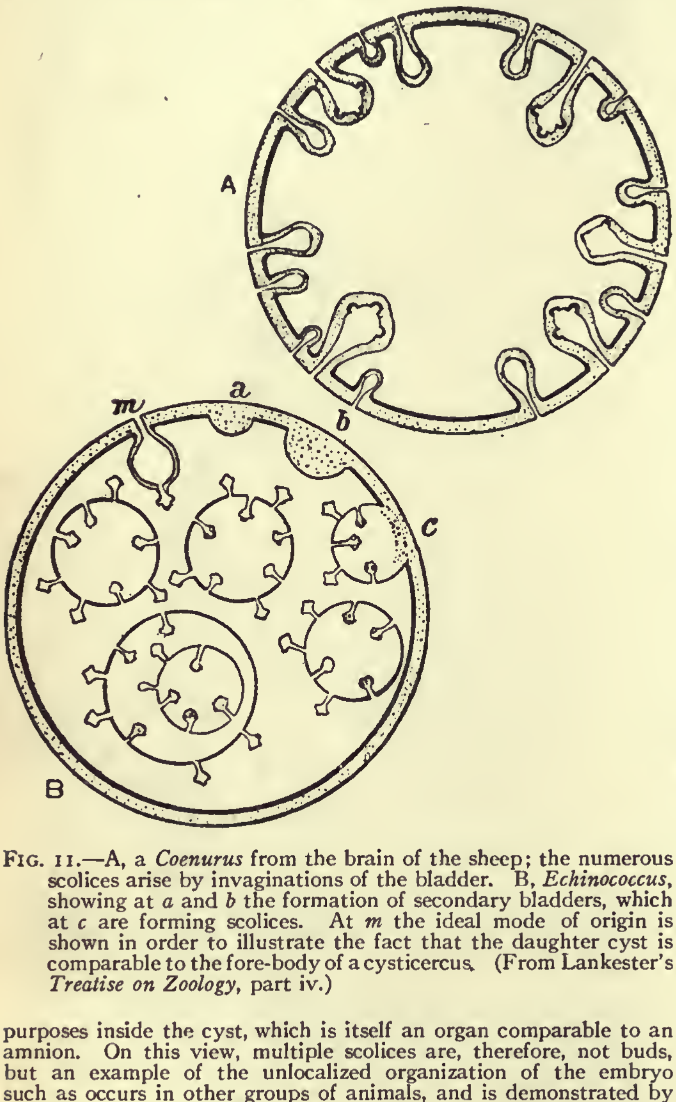


FIG. 11.—A, a *Coenurus* from the brain of the sheep; the numerous scolices arise by invaginations of the bladder. B, *Echinococcus*, showing at *a* and *b* the formation of secondary bladders, which at *c* are forming scolices. At *m* the ideal mode of origin is shown in order to illustrate the fact that the daughter cyst is comparable to the fore-body of a cysticercus. (From Lankester's *Treatise on Zoology*, part iv.)

The Effects of Cestodes on their Hosts (Shipley and Fearnsides [4].)—1. *By their presence.* This depends largely on the station adopted by the parasite. *Cysticercus cellulosae* may be comparatively innocuous in a muscle or subcutaneous tissue, but most hurtful in the eye or brain. Of all parasites the one which by its mere presence is the most dangerous is the larva of *Taenia echinococcus.* Its bulk alone (equal to that of an orange) causes serious disturbances, and its choice of the liver, kidneys, lungs, cranial cavity and other deep-seated recesses, gives rise to profound alterations.

2. *By their migrations.* The migration of the Cestode-larvae through the walls of the intestine into the blood of their host is the cause of grave disturbances, due largely to the perforation of the tissues, inflammation of the vessels and peritoneum, and other effects of these immigrants.

3. *By feeding in their host.* The loss of nutrient fluid caused by the presence of intestinal Cestodes is probably slight, indeed, the sharper appetite that accompanies their presence may be the means of fully compensating for it. The tapeworm, *Taenia saginata,* throws off eleven proglottides a day during its mature stage, and if this rate of increase were maintained for a year the total weight of its progeny would be about 550 grammes. The broad worm, *Dibothriocephalus latus,* is similarly estimated to discharge 15 to 20 metres of proglottides, weighing 140 grammes. The loss of substance represented by this growth is probably only of serious account when the host is a young growing animal that needs all available nourishment.

4. *By producing Toxins.* It is generally admitted that Cestodes, both adult and larval, contain toxins of great virulence, though in what way and in what organs these substances are produced is uncertain. Injection of the fluid-extract of such worms into the blood or coelom of their host causes grave disturbance. Thus Echinococci contains a leucomaine which sets up an urticaria; *Cysticercus tenuicollis* occasions anaemia and death if injected into rabbits; and the cystic fluid of the common *Coenurus serialis* is said to be used by Kirghizes to poison wolves. But the evidence in favour of the view that tapeworms normally excrete toxin into the body of their host in such amount as to occasion disease is not generally accepted as conclusive. This evidence is, however, strengthened by the results of recent work on changes in the blood of patients suffering from helminthiasis. The occurrence of the broad tapeworm in man is often associated with anaemia of a most severe type. The coloured constituents of the blood are most affected. New elements appear in addition to degenerative changes in the normal red corpuscles. Large nucleated red blood-cells make their appearance. The white blood-cells, or leucocytes, undergo other changes. In hydatid disease there is, as a rule, a marked increase in the number of those white corpuscles which possess a specially staining affinity with the dye eosin, and are therefore known as eosinophile cells. This change, which is called eosinophilia, indicates the production of a noxious substance in the blood. The fact of this increased leucocytic activity during the early stages, or the whole course of infection by Cestodes, is indirect proof that these parasites do normally discharge toxic substances into their hosts.

Classification of the Cestoda Merozoa

ORDER I.—*Dibothridiata.* Scolex with two "bothria," or modification thereof, usually devoid of hooks. Male and female copulatory ducts open by a common pore. Uterine pore present. The majority parasitic in fish. Selected forms: *Dibothriocephalus latus* in man; Russia, Switzerland, southern France, North America. *Ligula*, unsegmented externally, occurs in birds. *Schistocephalus* becomes fully segmented in *Gasterosteus* and mature in aquatic birds (ducks, &c.). *Triaenophorus*, indistinctly segmented, occurs in the pike.

ORDER II.—*Tetraphyllidea* (Tetrabothridiata). Scolex with four outgrowths forming organs of adhesion and probably also of locomotion. Uterine pore absent. Almost exclusively parasitic in the intestine of Elasmobranch fish. The metacestode-larva occurs free in the intestine of fish, Cephalopods and crabs, and is known as *Scolex polymorphus*.

ORDER III.—*Diphyllidea.* Scolex with a long head-stalk armed with several rows of hooklets. A rostellum and four phyllidia united to form a pair. Few proglottides are developed. Selected form: *Echinobothrium affine* in the intestine of Elasmobranchs. It occurs immature in the gastropod *Nassa.*

ORDER IV.—*Tetrarhyncha* (Trypanorhyncha). Scolex with four complex eversible proboscides. The adults occur in Elasmobranch fish, the metacestode encysted in Teleosts.

ORDER V.—*Tetracotylea* (Taeniidae). Scolex with four suckers, rarely hooked, and with a rostellum. Mostly parasitic in homoiothermic (warm-blooded) vertebrates. Selected forms: *Taenia solium*, intestine of man (fig. 3, C). *T. saginata* (fig. 3) without hooklets on the rostellum; intestine of man. *T. murina*, in the rat and mouse, the adult in the lumen of the intestine, the larvae in the villi. This species therefore undergoes no change of host. *Cystotaenia coenurus*, intestine of dog and wolf, larva (a coenurus, fig. 11) in the brain of sheep; allied forms occur mature in the dog and larval in the rabbit. *Echinococcifer echinococcus*, a minute form with only three to five proglottides, in dog, wolf, jackal. Larval stage a multilocular sac (fig. 11 B) with many scolices; found in man, ungulates, carnivores, rodents and monkeys.

Table of Cestodes found in Man

Species.	Larva.	Intermediate Host.
Dibothriocephalus latus (L.)	Plerocercoid	Pike, perch, trout, &c.
Dibothriocephalus cordatus (Leuck.)	Unknown	...
Diplogonoporus grandis (Blanch.)	,,	...
Dipylidium caninum (L.)	Cysticercoid	*Trichodectes canis; Pulex serraticeps; P. irritans*
Hymenolepis diminuata (Rud.)	Cysticercus	*Asopia farinalis*, *Anisolabis annulipes*, *Acisspinosa*, *Seaurus striatus* } Insecta
H. nana (v. Sieb.)	Cysticercus	Insects and myriapods
Drepanidotaenia lanceolata (Bloch)	Cysticercoid	*Cyclops*, *Diaptomus*
Davainea madagascarensis (Dav.)	Unknown	...
Davainea (?) *asiatica*	,,	...
Taenia solium (L.)	*Cysticercus cellulosae*	*Sus scrofa*
T. saginata (Götze)	*Cysticercus bovis*	*Bos taurus*
T. africana (v. Linst.)	Unknown	...
T. confusa (Ward)	,,	...
T. echinococcus (v. Sieb.)	*Echinococcus veterinorum*; *E. multilocularis*	Man and domestic cattle, sheep, pig
T. hominis (v. Linst.)	Unknown	...

LITERATURE.—(1) Leuckart, *The Parasites of Man* (Edinburgh, 1886); (2) Braun, *The Animal Parasites of Man* (London, 1906); (3) *Id.*, "Cestodes" in Braun's *Klassen u. Ordnungen d. Thierreichs*, vol. ii. (1894); (4) Shipley and Fearnsides, "Effects of Parasites," *Journ. Economic Biology*, vol. i. No. 2, 1906; (5) W. B. Benham in Lankester's *Treatise on Zoology*, part iv. 1901; (6) A. E. Shipley and J. Hornell, Ceylon Pearl Oyster Report, London, The Royal Society, part ii. p. 77, part iii. p. 49, part v. p. 43, 1903–7; (7) W. B. Spencer "Gyrocotyle = Amphiptyches," *Trans. Roy. Soc.*, Victoria, vol. i. (1889); (8) S. Goto, "Homology of Genital Ducts," *Centralbl. f. Bact. u. Parasitenkunde*, vol. 14 (1893), p. 797; (9) Mrazek, "Archigetes," *Verhandl. d. böhm. Akad. Sci.* (Prague, 1897). Full references to further literature will be found in Braun's works. (F. W. GA.)

Medicine.—For practical purposes we have only three varieties of tapeworms to deal with as inhabitants of the human alimentary canal: *Taenia saginata*, the beef tapeworm; *Taenia solium*, the pork tapeworm; and *Dibothriocephalus latus*, the fish tapeworm. The first of these is prevalent in countries where much and imperfectly cooked beef is eaten, and where cattle in their turn are exposed to the infection of the tapeworm ova. Comparatively uncommon in Western Europe, the *Taenia saginata* is common in Eastern Europe, Asia and South America. It is calculated that in the North-West Provinces of India 5 per cent. of the cattle are affected with cysticerci owing to the filthy habits of the people. Measly beef (that infected with the *Cysticercus bovis*) is easily recognized. In Berlin the proportion of cattle said to be found infected on inspection in 1893 was 1 in 672. Cold storage for a period of over three weeks is said to kill the cysticercus.

The tapeworm most frequently found in man in Western Europe is the *Taenia solium*, which is constant wherever pork is consumed, and is more common in parts where raw or imperfectly cooked pork is eaten. In North Germany the mature tapeworm was found on post-mortem examination once in every 200 bodies examined, while its embryo, the *Cysticercus cellulosae*, was found in 1 in every 76 bodies. In France, Great Britain and the United States the prevalence is not so great. The *Dibothriocephalus latus* is not generally found except in districts bordering the Baltic Sea, the districts round the Franco-Swiss lakes and Japan. In St Petersburg 15 per cent. of the inhabitants are said to be affected. The eggs are free in fresh-water lakes and rivers, where they enter the bodies of pike, turbot and other fishes, and are thus eaten by man.

In many instances the existence of a tapeworm may not cause any inconvenience to its host, and its presence may be only made known by the presence of the proglottides or mature segments in the stools. In the *Taenia solium* it takes 3 to 3½ months from the time of ingestion of the embryo to the passage of the matured segments, but in the *Taenia saginata* the time is only about 60 days. The segments of the *Taenia solium* are usually given off in chains, those of the *Taenia saginata* singly. In a number of cases there are colicky pains in the abdomen, with diarrhoea or constipation and more or less anaemia, while the *Dibothriocephalus latus* is capable of producing a profound and severe anaemia closely resembling pernicious anaemia. The knowledge of the presence of the parasite adversely affects nervous people and may lead to mental depression and hypochondria. Nervous phenomena, such as chorea and epileptic seizures, have been attributed to the presence of the tapeworm.

The prophylaxis is important in order to limit the spread of the parasites. All segments passed should be burnt, and they should never be thrown where the embryos may become scattered. Attention should be paid to the careful cooking of meat, so that any parasite present should be killed. Efficient inspection of meat in the abattoirs should eliminate a large proportion of the diseased animals.

In the treatment of a case where the parasite is already present, for two days previous to the employment of a vermifuge a light diet should be given and the bowels moved by a purgative. For twelve hours previously to its administration no food should be given, in order that the intestinal tract should be empty so as to expose the tapeworm to the full action of the drug. The vermifuge is given in the early morning, and should consist of the liquid extract of felix mas, male fern, one drachm in emulsion or in capsules to be followed in half an hour by a calomel purgative. Castor-oil should not be used as a purgative. Pomegranate root, or, better, the sulphate of pelletierine in dose of 5 grains with an equal quantity of tannic acid, may be used to replace the male fern. In from 50 to 80 per cent. of cases the entire tapeworm is expelled. The head must be carefully searched for by the physician, as should it fail to be brought away the parasite continues to grow, and within a few months the segments again begin to appear.

TAPIOCA (a native Brazilian word), a farinaceous food substance prepared from cassava starch, the product of the large tuberous roots of the cassava or manioc plant (see CASSAVA). Cassava starch, separated from the fibrous and nitrogenous constituents of the roots, is spread, while in a moist condition, upon iron plates, and with constant stirring exposed to such heat as causes a partial rupture of the starch granules, which agglomerate into irregular pellets, becoming hard and translucent when cooled. In this condition the starch forms the tapioca of commerce, a light, pleasant and digestible food, much used in puddings and as a thickener for soups.

TAPIR, any existing representative of the perissodactyle section of ungulate mammals with five front and three hind toes, and no horn. Tapirs are an ancient group with many of the original characters of the primitive Ungulates of the Oligocene period, and have undergone but little change since the Miocene. On the fore-feet the four toes correspond to the second, third, fourth and fifth fingers of the human hand. The toes are enclosed in hoofs, and the under surface of the foot rests on a large pad. Tapirs are massively built, with short stout limbs, elongated head, and the nose and upper lip produced to form a short flexible trunk.

The five existing species may be grouped into two sections, the distinctive characters of which are only recognizable in the skull. (A) With a great anterior prolongation of the ossification of the nasal partition, extending in the adult far beyond the nasal bones, and supported and embraced at the base by ascending plates from the upper jaw, forming the genus or sub-genus *Tapirella*. To this division belong two species, both from Central America, *Tapirus bairdi* and *T. dowi*. The former is found in Mexico, Honduras, Nicaragua, Costa Rica and Panama; the latter in Guatemala, Nicaragua and Costa Rica. (B) With the bony partition not extending farther forward than the nasal bones (*Tapirus* proper). This includes three species, *T. indicus*, the largest of the genus, from the Malay Peninsula (as far north as Tavoy and Mergui), Sumatra and Borneo, distinguished by its peculiar coloration, the head, neck, fore and hind limbs being glossy black, and the intermediate part of the body white, the height at the shoulder from 3 ft. to 3 ft. 6 ins., and 4 ins. higher at the rump; *T. terrestris*, the common tapir of the forests and lowlands of Brazil and Paraguay; and *T. roulini*, the Pinchaque tapir of the high regions of the Andes. All the American species are of a nearly uniform dark brown or blackish colour when adult; but it is a curious circumstance that when young (and in this the Malay species conforms with the others) they are conspicuously marked with spots and longitudinal stripes of white or fawn colour on a darker ground.

In habits all tapirs appear to be very similar. They are solitary, nocturnal, shy and inoffensive, chiefly frequenting the depths of shady forests and the neighbourhood of water, to which they frequently resort for the purpose of bathing, and in which they often take refuge when pursued. They feed on various vegetable substances, as shoots of trees and bushes,

American Tapir (*Tapirus*).

buds and leaves, and are hunted by the natives of the lands in which they live for the sake of their hides and flesh.

The singular fact of the existence of animals so closely allied as the Malayan and the American tapirs in such distant regions of the earth and in no intervening places is accounted for by the geological history of the race, for the tapirs once had a very wide distribution. There is no proof of their having lived in the Oligocene epoch, but in deposits of Miocene and Pliocene date remains undistinguishable generically and perhaps specifically from the modern tapirs (though named *T. priscus*, *T. arvernensis*, &c.) have been found in France, Germany and in the Red Crag of Suffolk. Tapirs appear, however, to have become extinct in Europe before the Pleistocene period, as none of their bones or teeth have been found in any of the caves or alluvial deposits in which those of elephants, rhinoceroses and hippopotamuses occur in abundance; but in other regions their distribution at this age was far wider than at present, as they are known to have extended eastward to China (*T. sinensis*) and westwards over the greater part of the southern United States of America, from South Carolina to California. Thus there is no difficulty in tracing the common origin in the Miocene tapirs of Europe of the now widely separated American and Asiatic species. It is, moreover, interesting to observe how slight an amount of variation has taken place in forms isolated during such an enormous time. See PERISSODACTYLA. (W. H. F.; R. L.*)

TAPTI, a river of western India. It rises in Betul district of the Central Provinces, flows between two spurs of the Satpura Hills, across the plateau of Khandesh, and thence through the plain of Surat to the sea. It has a total length of 450 m. and drains an area of 30,000 sq. m. For the last 32 m. of its course it is a tidal river, but is only navigable by vessels of small tonnage; and the port of Swally at its mouth, famous in Anglo-Portuguese history, is now deserted, owing to silting at the outflow of the river. The waters of the Tapti are nowhere used for irrigation.

TAR, a product of the destructive distillation of organic substances. It is a highly complex material, varying in its composition according to the nature of the body from which it is distilled,—different products, moreover, being obtained according to the temperature at which the process of distillation is carried on. As commercial products there are two principal classes of tar in use—(1) wood tar, the product of the special distillation of several varieties of wood, and (2) coal tar (*q.v.*), which is primarily a by-product of the distillation of coal during the manufacture of gas for illuminating purposes. These tars are intimately related to bitumen, asphalt, mineral pitch and petroleum.

Wood Tar.—Wood tar, known also as Stockholm and as Archangel tar, is principally prepared in the great pine forests of central and northern Russia, Finland and Sweden. The material chiefly employed is the resinous stools and roots of the Scotch fir (*Pinus sylvestris*) and the Siberian larch (*Larix sibirica*), with other less common fir-tree roots. A large amount of tar is also prepared from the roots of the swamp pine (*P. australis*) in North and South Carolina, Georgia and Alabama, in the United States. In the distillation of wood a series of products, including gas, tar, pyroligneous acid, acetone, wood spirit (see METHYL ALCOHOL) and charcoal may be obtained, and any of these may be the primary object of the operation.

The carbonization of wood can be effected in two ways: (1) by stacking and firing as in the manufacture of charcoal: this method is very wasteful as it is impossible to recover the valuable by-products; and (2) by distilling from retorts, ovens or kilns (after the manner of coke production from coal): this method is more economical as it leads to the isolation of all the by-products. The retorts may be horizontal or vertical and the heating effected by any available fuel, or by the inflammable gases and less valuable grades of tar obtained in previous operations. The condensing plant is also of variable design; a common pattern consists of a connected series of slightly inclined copper pipes contained in a rectangular tank of water (see COAL TAR). After settling the distillate separates into three layers: the lowest consists chiefly of tar and creosote oils with a little acetic acid; the middle layer consists of water, containing pyroligneous acid, wood spirit, acetone with a little tarry matter; whilst the upper consists of light hydrocarbons. The tarry layer is run off by means of a cock near the base of the tank, and is then distilled from retorts resembling coal tar stills. At first, between 110° and 120° C., water and acetic acid comes over; then, between 120°—230° C., the heavy or creosote oils; the residue in the still is wood pitch, which finds application in making briquettes, artificial asphalts, certain varnishes, &c. The crude tar and pitch are also largely used as protective coatings for woodwork exposed to atmospheric conditions. The heavy oils on further fractional distillation yield more acetic acid, and then mixtures of carbolic acid, creosols, &c.

Wood tar is a semi-fluid substance, of a dark brown or black colour, with a strong pungent odour and a sharp taste. Owing to the presence of acetic acid, it has an acid reaction; it is soluble in that acid, as well as in alcohol and the fixed and essential oils, &c. Some varieties of tar have a granular appearance, from the presence of minute crystals of pyrocatechin, which dissolve and disappear on heating the substance.

See P Dumesny and J. Noyer, *Wood Products, Distillates and Extracts* (Engl. trans. 1908).

Medicine.—Wood tar is used in medicine under the name of *Pix liquida*. Its preparation *unguentum picis liquidae* is composed of wood tar and yellow beeswax. Externally tar is a valuable stimulating dressing in scaly skin diseases, such as psoriasis and chronic eczema. Internally wood tar is a popular remedy as an expectorant in subacute and chronic bronchitis. It is usually given as tar water, 1 part of wood tar being stirred into 4 parts of water and filtered. Given internally tar is likely to upset the digestion; taken in large quantities it causes pain and vomiting and dark urine, symptoms similar to carbolic acid poisoning.

Coal tar is used in medicine as *Pix liquida preparata*. From it is made *Liquor picis carbonis*, prepared with tincture of quillaia. Coal tar is rarely prescribed for internal use. Its external use is similar to that of wood tar: the *Liquor carbonis detergens*, a proprietary preparation, owes its properties chiefly to the contained phenol. It is used in water as a lotion for skin diseases, and also in an inhaler in the treatment of whooping-cough, croup and bronchitis.

TARA, VISCOUNTS AND BARONS. The 1st Viscount Tara was Thomas Preston (1585–1655), a descendant of Sir Robert de Preston, who in 1363 purchased the lands of Gormanston, Co. Meath, and who was keeper of the Great Seal in Ireland some years later. Sir Robert's great-grandson, Robert Preston, was created Viscount Gormanston in 1478; and the latter's great-grandson was Christopher, 4th Viscount Gormanston (d. 1599), whose second son was Thomas Preston, Viscount Tara. The latter was in the same Irish regiment in the Spanish service as Owen Roe O'Neill, and distinguished himself in the defence of Louvain against the French and Dutch in 1635. Between him and Owen Roe O'Neill there was from the first intense jealousy. Preston, who was appointed general of Leinster, took a prominent and not unsuccessful part in the war of factions that raged intermittently in Ireland from 1642 to 1652. In 1650 Charles II. while in exile created him Viscount Tara; and after his departure from Ireland in 1652 he offered his services to Charles in Paris, where he died in October 1655. His wife was a Flemish lady of rank, by whom he had several children, one of his daughters being the second wife of Sir Phelim O'Neill. His son Anthony succeeded him as 2nd Viscount Tara, a title that became extinct on the death of Thomas, 3rd Viscount, in 1674.

In 1691 Meinhart de Schomberg, 3rd duke of Schomberg, second son of William III.'s famous general, was created Baron Tara, earl of Bangor, and duke of Leinster, in the peerage of Ireland, all of which titles became extinct at his death without sons in 1719. The title of Baron Tara was again revived in 1800 in favour of John Preston of Bellinter, Co. Meath, as a reward for his vote in favour of the Union in the Irish House of Commons, in which he sat as member for Navan. At his death without issue in 1821, the peerage became extinct.

TARA, a village of Co. Meath, Ireland. It is celebrated for the Hill of Tara, well known through Thomas Moore's ballad, and for many centuries a royal residence and the scene of great meetings of the people. The hill, upon which five highroads converged from different parts of Ireland, is about 510 ft. in height, and stands isolated. On its summit or flanks are six raths or circular earthworks, the largest of which, called the king's rath (*rath-na-riogh*) encloses other works, among which is the *forradh* or meeting-place, a flat-topped mound. On this (but not in its original position) stands a pillar stone, which has been held to be the stone of destiny on which the Irish kings were crowned. An oblong enclosure, 759 ft. in length by 46 ft. in breadth, formed of earthworks, with entrances at intervals on each side, represents the banqueting hall. In the middle of the 3rd century A.D. King Cormac Mac Art, about whom there are many records in connexion with Tara, is said to have founded here schools of military science, law and literature. In the time of St Patrick Tara is indicated as the chief seat of druidism and idolatry, and in or about 560 it was abandoned as a royal residence, having fallen under the curse of St Ruadan. In 980 the Danish power of Meath was overthrown in battle here; in 1798 a severe defeat of the insurgents took place here (26th of May); and in 1843 the hill of Tara, as a site sacred to Irish traditions, was the scene of one of Daniel O'Connell's mass meetings in support of the repeal of the legislative union (15th of August).

TARAFA ['Amr ibn ul-'Abd ul-Bakrī] (6th cent.), Arabian poet, who, after a wild and dissipated youth spent in Bahrein, left his native land after peace had been established between the tribes of Bakr and Taghlib and went with his uncle Mutalammis (also a poet) to the court of the king of Hira, 'Amr ibn Hind (died 568–9), and there became companion to the king's brother. Having ridiculed the king in some verses he was sent with a letter to the ruler of Bahrein, and, in accordance with the instructions contained in the letter, was buried alive. One of his poems is contained in the *Moallakat* (*q.v.*).

His diwan has been published in W. Ahlwardt's *The Diwans of the Six Ancient Arabic Poets* (London, 1870). Some of his poems have been translated into Latin with notes by B. Vandenhoff (*Berlin*, 1895). (G. W. T.)

TARAI, or TERAI (*i.e.* "moist land"), the name of the submontane strip of marshy jungle stretching beneath the lower ranges of the Himalaya in northern India. This strip may be said to extend roughly from the Jumna river on the west to the Brahmaputra on the east, though the term is now officially confined to a subdivision of Naini Tal district in the United Provinces; area, 776 sq. m.; population (1901) 118,422. At its northern edge, where the waterless forest tract of the Bhabar ends, a series of springs burst from the surface, and these, increasing and uniting in their progress, form the numerous streams that intersect the Tarai. The Deoha is the great river of the Tarai proper, and is navigable at Pilibhit. Elephants, tigers, bears, leopards and other wild animals are found. Everywhere it is most unhealthy, and inhabited only by tribes who seem proof against malaria. A large portion lies within Nepal.

TARANTO (anc. *Tarentum*, *q.v.*), a seaport of Apulia, Italy, in the province of Lecce, 50 m. from that town W. by N. by road, and 68 m. by rail (44 m. W. by S. from Brindisi). Pop. (1901) 50,592 (town); 60,331 (commune). The city proper is situated on a rocky island 56 ft. above sea-level, which in ancient times was a peninsula, the isthmus on the west having been cut through by Ferdinand I. of Aragon. This island separates the Gulf of Taranto from the deep inlet of the Mare Piccolo, and is sheltered by two other flat islands, San Pietro and San Paolo; the latter is occupied by a lighthouse. This rock is the site of the citadel of the ancient town; its population is confined within small houses and narrow streets. The Strada Garibaldi along the Mare Piccolo is inhabited by fishermen whose language retains traces of Greek. The cathedral, dedicated to San Cataldo, an Irish bishop, dating from the 11th century, has externally some remains of Saracenic Gothic; internally it has been completely modernized, and the shrine of the patron saint has been termed "an orgy of rococo." Below it is an early Christian basilica excavated in 1901. There is a fine museum in the former convent of San Pasquale containing antiquities unearthed in the neighbourhood. Adjacent is the Palazzo degli Uffizi, completed in 1896, containing various public offices. To the south, outside the Porta di Lecce, is the Citta Nuova, on the site of the main part of the ancient town. The chief industry is the cultivation of oysters in four large beds in the Mare Piccolo; besides oysters, Taranto carries on a large trade in *cozze*, a species of large black mussel, which is packed in barrels with a special sauce. The other trades are olive-oil refining, barrel-making and soap-boiling; corn, honey and fruit are largely exported. Excellent fish abound in the Mare Piccolo, ninety-three different species being found. The ebb and flow of the tide is distinctly visible here, Taranto being one of the few places in the Mediterranean where it is perceptible. In 1861 the strategic importance of Taranto was recognized by the Italian government, and in 1864 a Naval Commission designated it as third maritime arsenal after Spezia and Venice. Work was begun on the arsenal in 1883 and continued as the finances of the state permitted; it is capable of turning out new warships and of executing repairs of all kinds for the Mediterranean squadron. The arsenal extends for a mile and a half along the southern coast of the Mare Piccolo, which constitutes its chief basin. The receiving-dock and the anchorage for torpedo boats, with its wide landing-stage, form dependencies. The dock, 655 ft. long, 130 ft. wide and 37 ft. deep, is divided into two compartments, each capable of containing a full-sized battleship, and can be pumped dry in eight hours by two 600 h.p. steam pumps. The Mare Grande is connected with the Mare Piccolo by a channel 875 yds. long, large enough to permit the passage of the largest battleship; the channel was bridged in 1887 by an iron swivel bridge, which when open leaves a passage way 196 ft. broad. In its present form the Mare Piccolo provides a well-sheltered anchorage, 36 ft. deep and 6325 acres in extent. The commercial harbour lies S. of the railway station outside the Mare Piccolo. In 1905 nearly 180,000 tons of shipping cleared the port.

In 927 Taranto was entirely destroyed by the Saracens, but rebuilt in 967 by Nicephorus Phocas, to whom is due the construction of the bridge over the channel to the N.W. of the town, and of the aqueduct which passes over it. The town was taken by Robert Guiscard in 1063. His son Bohemond became prince of the Terra d'Otranto, with his capital here. After his death Roger II. of Sicily gave it to his son William the Bad. The emperor Frederick II. erected a castle (Rocca Imperiale) at the highest point of the city. In 1301 Philip, the son of Charles II. of Anjou, became prince of Taranto. The castle dates from the Aragonese period. The tarantula (see below), inhabits the neighbourhood of Taranto. The wild dance, called *tarantella*, was supposed, by causing perspiration, to drive out the poison of the bite. (T. As.)

TARANTULA, strictly speaking, a large spider (*Lycosa tarantula*), which takes its name from the town of Taranto (Tarentum) in Apulia, near which it occurs and where it was formerly believed to be the cause of the malady known as "tarantism." This spider belongs to the family Lycosidae, and has numerous allies, equalling or surpassing it in size, in various parts of the world, the genus *Lycosa* being almost cosmopolitan in distribution. The tarantula, like all its allies, spins no web as a snare but catches its prey by activity and speed of foot. It lives on dry, well-drained ground, and digs a deep burrow lined with silk to prevent the infall of loose particles of soil. In the winter it covers the orifice of this burrow with a layer of silk, and lies dormant underground until the return of spring. It also uses the burrow as a safe retreat during moulting and guards its cocoon and young in its depths. It lives for several years. The male is approximately the same size as the female, but in neither sex does the length of the body surpass three-quarters of an inch. Like all spiders, the tarantula possesses poison glands in its jaws, but there is not a particle of trustworthy evidence that the secretion of these glands is more virulent than that of other spiders of the same size, and the medieval belief that the bite of the spider gave rise to tarantism has long been abandoned. According to traditional accounts the first symptom of this disorder was usually a state of depression and lethargy. From this the sufferer could only be roused by music, which excited an overpowering desire to dance until the performer fell to the ground bathed in profuse perspiration, when the cure, at all events for the time, was supposed to be effected. This mania attacked both men and women, young and old alike, women being more susceptible than men. It was also considered to be highly infectious and to spread rapidly from person to person until whole areas were affected. The name tarantella, in use at the present time, applies both to a dance still in vogue in Southern Italy and also to musical pieces resembling in their stimulating measures those that were necessary to rouse to activity the sufferer from tarantism in the middle ages. In recent times the term tarantula has been applied indiscriminately to many different kinds of large spiders in no way related to *Lycosa tarantula*; and to at least one Arachnid belonging to a distinct order. In most parts of America, for example, where English is spoken, species of Aviculariidae, or "Bird-eating" spiders of various genera, are invariably called tarantulas. These spiders are very much larger and more venomous than the largest of the Lycosidae, and in the Southern states of North America the species of wasps that destroy them have been called tarantula hawks. In Queensland one of the largest local spiders, known as *Holconia immanis*, a member of the family Clubionidae, bears the name tarantula; and in Egypt it was a common practice of the British soldiers to put together scorpions and tarantulas, the latter in this instance being specimens of the large and formidable desert-haunting Arachnid, *Galeodes lucasii*, a member of the order Solifugae. Similarly in South Africa species of the genus *Solpuga*, another member of the Solifugae, were employed for the same purpose under the name tarantula. Finally the name *Tarantula*, in a scientific and systematic sense, was first given by Fabricius to a Ceylonese species of amblypygous Pedipalpi, still sometimes quoted as *Phrynus lunatus*. (R. I. P.)

Galeodes lucasii, an Arachnid of the order Solifugae, commonly but wrongly called tarantula in Egypt.

TARAPACÁ, a northern province of Chile, bounded N. by Tacna, E. by Bolivia, S. by Antofagasta, and W. by the Pacific. Area 18,131 sq. m. Pop. (1895) 89,751; (1902, estimated) 101,105. It is part of the rainless desert region of the Pacific coast of South America, and is absolutely without water except at the base of the Andes where streams flow down into the sands and are lost. In some of these places there is vegetation and water enough to support small settlements. The wealth of Tarapacá is in its immense deposits of nitrate of soda (found on the Pampa de Tamarugal, a broad desert plateau between the coast range and the Andes, which has an elevation of about 3000 ft.). The mining and preparation of nitrate of soda for export maintain a large population and engage an immense amount of capital. Silver is mined in the vicinity of Iquique, the capital. The ports of the province are Pisagua, Iquique and Patillos, from which "nitrate railways" run inland to the deposits. Tarapacá was ceded to Chile by Peru after the war of 1879–1883, and was organized as a province in 1884.

TARARE, a town of east-central France, in the department of Rhone, on the Turdine, 28 m. W.N.W. of Lyons by rail. Pop. (1906) 11,643. It is the centre of a region engaged in the production of muslins, tarletans, embroidery and silk-plush, and in printing, bleaching and other subsidiary processes. Till 1756, when the manufacture of muslins was introduced from Switzerland, the town lay unknown among the Beaujolais mountains. The manufacture of Swiss cotton yarns and crochet embroideries was introduced at the end of the 18th century; at the beginning of the 19th figured stuffs, open-works and zephyrs were first produced. The manufacture of silk-plush for hats and machine-made velvets was set up towards the end of the 19th century. A busy trade is carried on in corn, cattle, linen, hemp, thread and leather.

TARASCON, a town of south-eastern France, in the department of Bouches-du-Rhone, 62 m. N.W. of Marseilles by rail. Pop. (1906) town, 5447; commune, 8972. Tarascon is situated on the left bank of the Rhone opposite Beaucaire, with which it is connected by a railway bridge and a suspension bridge. The church of St Martha, built in 1187–97 on the ruins of a Roman temple and rebuilt in 1379–1449, has a Gothic spire, and many interesting pictures in the interior. Of the original building there remain a porch, and a side portal flanked by marble columns with capitals like those of St Trophimus at Arles. The former leads to the crypt, where are the tombs of St Martha (1658), Jean de Gossa, governor of Provence under King René, and Louis II., king of Provence. The castle, picturesquely situated on a rock, was begun by Count Louis II. in the 14th century and finished by King René in the 15th. It contains a turret stair and a chapel entrance, which are charming examples of 15th-century architecture, and fine wooden ceilings. The building is now used as a prison. The hôtel-de-ville dates from the 17th century. The civil court of the arrondissement of Arles is situated at Tarascon, which also possesses a commercial court, and fine cavalry barracks. The so-called Arles sausages are made here, and there is trade in fruit and early vegetables. In *Tartarin de Tarascon* Alphonse Daudet has satirized the provincial life of Tarascon. Its uneventfulness is varied by the fair of Beaucaire, and it used to be the scene of the two fêtes of La Tarasque, the latter in celebration of St Martha's deliverance of the town from a legendary monster of that name. King René presided in 1469, and grand exhibitions of costume and strange ceremonies take place during the two days of the festival. Tarascon was originally a settlement of the Massaliots, built on an island of the Rhone. The medieval castle, where Pope Urban II. lived in 1096, was built on the ruins of a Roman camp. The inhabitants of Tarascon preserved the municipal institutions granted them by the Romans, and of the absolute power claimed by the counts of Provence they only recognized the rights of sovereignty. Tarascon played a bloody part in the White Terror of 1815.

TARAXACUM, the name usually applied in medical practice to the common dandelion (*q.v.*).

TARBELL, EDMUND C. (1862–), American artist, was born at West Groton, Mass., on the 26th of April 1862. He was a pupil of the schools of the Boston Museum of Fine Arts and of Boulanger and Lefebvre, Paris, and became a distinguished painter of the landscape, of the figure, and of portraits, winning various important prizes and medals at exhibitions. In 1906 he was elected a National Academician, besides being a member of the Ten American Painters, and he became instructor of painting in the Boston Museum of Fine Arts.

TARBERT, a fishing village at the head of East Loch Tarbert, an arm of the sea on the west shore of the mouth of Loch Fyne, Argyllshire, Scotland. Pop. (1901) 1697. The harbour, though it has a narrow entrance, is absolutely safe and can shelter the whole of the Loch Fyne fishing fleet. The pier for the passenger steamers that call here is about ¾ m. from the village. The coast of the bay is rocky and the cliffs are fringed with young firs, the village itself being quite a pretty place. The herring fishery—including a large trade in curing—forms the only industry. The parish church occupies a fine situation. Overlooking the harbour are the ruins of a castle built by Robert Bruce in 1326. The isthmus connecting the districts of Knapdale and Kintyre is little more than one mile wide, and boats used once to be dragged across to the head of West Loch Tarbert, a narrow sea loch nearly ten miles long. A proposal to cut a canal across to shorten the sail to Islay and Jura has never progressed further.

TARBES, a town of south-western France, capital of the department of Hautes-Pyrénées, 98 m. W.S.W. of Toulouse on the Southern railway. Pop. (1906) town, 20,866; commune, 25,869. Tarbes is situated in a beautiful and fertile plain, in full view of the Pyrenees, on the left bank of the Adour, streams from which are conducted through all parts of the town. The lines of the Southern railway from Morcenx to Bagnères-de-Bigorre and Lourdes and from Toulouse to Bayonne cross here. Chief among the many open spaces is the Jardin Massey (35 acres), given to his native town by a director of the gardens of Versailles and containing a museum of sculptures, paintings and antiquities. Near a small lake stands a cloister (15th century) transferred from the abbey of St Sever-de-Rustan, 14 m. N.E. of Tarbes, and a bust of Théophile Gautier, a native of Tarbes. The architecture of the cathedral, Notre Dame de la Sède, is heavy and unpleasing, but the cupola of the transept (14th century), the modern glass in the 12th-century apse, and a rose window of the 13th century, in the north transept, are worthy of notice. There is also a modernized Carmelite church originally built in the 13th century. Tarbes is a well-known centre for the breeding of Anglo-Arabian horses, much used by light cavalry; and its stud is the most important in the south of France. The industrial establishments include tanneries, tile-works, saw-mills and turners' shops. There are important fairs and markets. Well-known race-meetings are held on the Laloubère course.

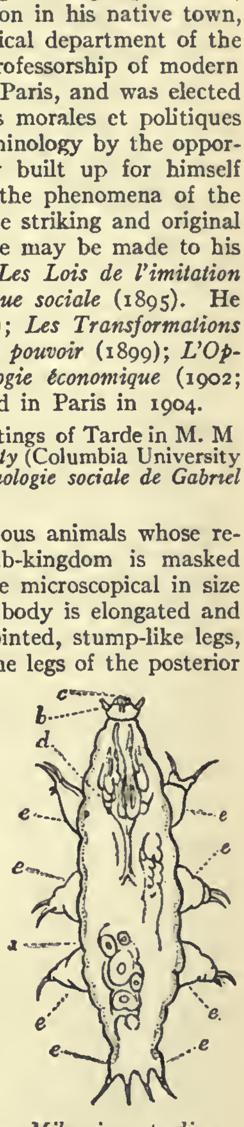
Under the Roman dominion *Turba*, which was about 11 m. S.E. of the present town of Tarbes, was the capital of the Bigerriones, one of the states of Novempopulania. The bishopric of Tarbes dates from the 5th century, and in feudal times its bishops held the chief temporal authority, that of the counts of Bigorre, of which Tarbes was capital, being limited to the quarter of the town where their castle was built. The English held the town from 1360 to 1406. In 1569 Tarbes was burnt by Gabriel, count of Montgomery, and the inhabitants were driven out. This happened a second time, but in August 1570 the peace of St Germain allowed them to return. Subsequently Tarbes was several times taken and re-taken, and a number of the inhabitants of Bigorre were forced to take refuge in Spain, but in 1594 the members of the League were finally expelled. The English, under Wellington, gained a victory over the French near Tarbes in 1814.

TARBUSH (Arab *tarbūsh*), the close-fitting, flat-topped and brimless cap, in shape like a truncated cone, made of felt or cloth, worn by Mahommedan men throughout the East either as a separate headgear or forming the inner part of the turban. It is worn as the badge of a Turkish subject in Turkey and Egypt, where it is red in colour with a black or blue silk tassel. It is the same as the "fez" (see the plate illustrations to INDIA: § *Indian Costume*).

TARDE, GABRIEL (1843–1904), French sociologist, was born at Sarlat (Dordogne) in 1843. Entering the legal profession, he was for some time a juge d'instruction in his native town, becoming afterwards head of the statistical department of the ministry of justice. He also held the professorship of modern philosophy at the Collège de France in Paris, and was elected a member of the Académie des sciences morales et politiques in 1900. Attracted to the study of criminology by the opportunities of his profession, he gradually built up for himself a reputation as an acute observer of the phenomena of the subject, while at the same time he made striking and original deductions of his own. Special reference may be made to his theory of "imitation" as outlined in *Les Lois de l'imitation* (1890), and further elaborated in *Logique sociale* (1895). He also wrote *L'Opinion et la foule* (1901); *Les Transformations du droit* (1894); *Les Transformations du pouvoir* (1899); *L'Opposition universelle* (1897) and *Psychologie économique* (1902; Eng. trans., *Social Laws*, 1899). He died in Paris in 1904.

See bibliography of the sociological writings of Tarde in M. M Davis, *Psychological Interpretations of Society* (Columbia University Press, 1909); also A. Matagrin, *La Psychologie sociale de Gabriel Tarde* (Paris, 1910).

TARDIGRADA, apparently Arthropodous animals whose relationship to the great classes of this sub-kingdom is masked by degenerative modification. They are microscopical in size and live in damp moss or water. The body is elongated and furnished with four pairs of short, unjointed, stump-like legs, each terminated by a pair of claws. The legs of the posterior pair project from the hinder extremity of the body and the anus opens between them. The mouth, situated at the opposite end and armed with a pair of stylets, leads into an oesophagus, into which the ducts of a pair of so-called salivary glands open. Behind this point there is a muscular pharynx or gizzard, which communicates with the wide intestinal tract. No organs of circulation or respiration are known; but the nervous system is well developed, and consists of a pair of ganglia corresponding with the limbs and connected by longitudinal commissural chords. Anteriorly these chords embrace the oesophagus and unite with the cerebral mass which innervates the pair of eyes when present. The sexes are not distinct, the sexual organs being represented by a pair of testes and a single ovary, which open together into the posterior end of the alimentary canal. The Tardigrada have been regarded as degenerate Acari largely on account of their possessing four pairs of ambulatory limbs, which is considered



Milnesium tardigradum, Schrank. *a*, ovary; *b*, oval stylite (?); *c*, mouth; *d.*, alimentary canal; *e...e*, legs.

to be an Arachnidan characteristic. But they cannot be affiliated with this order on account of the total suppression of the abdomen, of their hermaphroditism and of the communication that exists between the generative organs and the alimentary tract. These last characteristics also separate them essentially from the Pycnogonida, some members of which resemble them to a certain extent in having only four pairs of limbs, no gnathites, no respiratory organs, a ganglionated ventral nervous system, and the abdomen reduced to a mere rudiment projecting between the last pair of legs.

Several genera and species of Tardigrada have been described, perhaps the best known being *Macrobiotus schultzii* and *Milnesium tardigradum*. (R. I. P.)

TARE AND TRET, in commerce, allowances or deductions. Tare is an allowance made from the gross weight of goods for the box, bag or other wrapping in which the goods are packed. It may be *real*, *i.e.* representing the actual weight of the wrapping; *customary*, when a uniform or established rate is allowed; *average*, when one or two packages among several are weighed, and the mean or average of the whole taken; or *super-tare*, an additional allowance when the package exceeds a certain weight. Tret is an allowance of 4 lb. in every 104 lb. of weight, made as compensation for loss by waste. "Tare" comes through the Fr. *tare*, cf. Sp. *tara*, from Arab. *ṭarha*, *ṭarh*, throwing, casting—the word meant originally loss, that which is thrown away; "tret" is an adaptation of Fr. *traite*, Lat. *trahere*, to draw, and meant a draught, transportation, also a payment on exports, an allowance on exportation.

TARENTUM (Gr. *τάρας*), a Greek city of southern Italy (mod. Taranto, *q.v.*), situated on the N. coast of the gulf of the same name, on a rocky islet at the entrance to the only secure harbour in it. It was a Spartan colony founded about the close of the 8th century B.C. (Jerome gives the date 708) to relieve the parent state of a part of its population which did not possess, but claimed to enjoy, full civic rights. Legend represents these *Partheniae* (so they are called) as Spartans with a stain on their birth, but the accounts are neither clear nor consistent, and the facts that underlie them have not been cleared up. The Greeks were not the first settlers on the peninsula: excavations have brought to light signs of a pre-Hellenic settlement. To the Greeks Taras was a mythical hero, son of Neptune, and he is sometimes confounded with the oecist (official founder) of the colony, Phalanthus. Situated in a fertile district, especially famous for olives and sheep, with an admirable harbour, great fisheries and prosperous manufactures of wool, purple[1] and pottery, Tarentum grew in power and wealth and extended its domain inland. Even a great defeat by the natives in 473 B.C., when more Greeks fell than in any battle known to Herodotus, did not break its prosperity, though it led to a change of government from aristocracy to democracy. A feud with the Thurians for the district of the Siris was settled in 432 by the joint foundation of Heraclea, which, however, was regarded as a Tarentine colony. In the 4th century Tarentum was the first city of Magna Graecia, and its wealth and artistic culture at this time are amply attested by its rich and splendid coins; the gold pieces in particular (mainly later than 360) are perhaps the most beautiful ever struck by Greeks (see NUMISMATICS). In the second half of the century Tarentum was in constant war with the Lucanians, and did not hold its ground without the aid of Spartan and Epirote *condottieri*. Then followed war with Rome (281) in consequence of the injudicious attack of the mob on the Roman fleet in the harbour of Tarentum and on the Roman garrison at Thurii, the expedition of Pyrrhus, whom Tarentum summoned to its aid, and at length, in 272, the surrender of the city by its Epirote garrison. Tarentum retained nominal liberty as an ally of Rome. In the Second Punic War it went over to Hannibal in 212, and suffered severely when it was retaken and plundered by Fabius (209), who sold thirty thousand citizens as slaves. After this it fell into decay, but revived again after receiving a colony in 123 B.C., which received the name of Neptunia. In the time of Augustus it was essentially Greek and a favourite place of resort (Horace, *Od.*, iii. 5, 53), but it declined afterwards. Belisarius ordered it to be re-fortified, but it was soon taken by Totila, who made it his treasure store. After his defeat by Narses, it was sold to the Byzantine Empire by its Gothic governor.

One of the most interesting discoveries of recent years has been that of a *terramara* on the so-called Scoglio del Tonno on the N.W. of the town, which in its type and in the character of the objects found there, is exactly identical with the *terremare* of the Po valley. It seems, however, to be an isolated colony, and not to prove a parallel development in north and south Italy (T. E. Peet in *Papers of the British School at Rome*, iv., 1907, 285). Almost the only relic of any building of the Greek city is a part of a Doric temple on the island—which the modern town occupies—two fluted columns, with a lower diameter of 6⅔ ft., and a height of 28 ft., and some fragments of the entablature, belonging probably to the beginning of the 6th century B.C., so that this is one of the earliest extant Doric temples. The condition of the site was, however, different in ancient times; the rock occupied by the modern town was, it is true, the citadel, but was connected with the land to the west by an isthmus, which was only cut through by Ferdinand I. of Aragon; and it was also a good deal less extensive. The line of the walls which defended the city on the east (land) side has been traced, and a few remains of well-cut blocks, with Greek masons' marks, still exist. In the centre of the Agora was the huge bronze Zeus by Lysippus, and facing on to it the Ποικιλή, or painted portico, with pictorial representations of the life of Phalanthus, and the foundation of the city, and the museum. There was also a fine gymnasium and other buildings mentioned by classical writers. Strabo's description of the site (vi. 3, 1) is a good one. Of all these structures no traces remain. The Roman amphitheatre, on the other hand, and remains of Roman baths by the seashore, have been found; the former perhaps occupies the site of the ancient theatre, in which the Roman ambassador was received in 281 B.C.

Three fine mosaics of the Roman period were found in the remains of a house in 1899, and transported to the museum (A. Avena, *Monumenti dell' Italia Meridionale*, Naples, 1903, 239). A fine silver jug and drinking-horn, found in Tarentum in 1889 (now in Triest) are illustrated by A. Puschi and F. Winter in *Jahreshefte des Österr. Arch. Instituts*, v. (1902) 112. Other silver vessels found in 1896 are in the important local museum (G. Patroni in *Notizie degli scavi*, 1896, 376), and at Bari (M. Mayer, *ibid.*, 1896, 547). All seem to belong to the 4th century B.C. To the N.W. of the town along the Massafia road, neolithic tombs and a fine Greek hypogaeum in masonry were discovered in 1900. (T. As.)

TARENTUM, a borough of Allegheny county, Pennsylvania, U.S.A., on the Allegheny river, about 20 m. N.E. of Pittsburg. Pop. (1890) 4627; (1900) 5472 (1173 being foreign-born); (1910) 7414. Tarentum is served by the Pennsylvania railway and by an electric line connecting with Pittsburg. Among manufactures are plate glass and bottles, table ware, paper, bricks, iron and steel articles, and steel sheets and billets. Coal mining is an important industry, and the borough is supplied with natural gas. Tarentum was first settled in 1796, was laid out in 1829 at the direction of Henry Marie Brackenridge (1786–1871),[2] who by marriage had come into possession of the site, and it was incorporated as a borough in 1842. The first glass manufactory was established in 1872.

TARGET, GUI JEAN BAPTISTE (1733–1807), French lawyer and politician, was born in Paris on the 17th of December 1733.

[1] Large heaps of the shells of the *murex*, or purple-yielding mussel, were visible on the shore before the extension of the arsenal.

[2] Brackenridge was a prominent lawyer, a native of Pittsburg, who practised in Maryland, Missouri and Louisiana, was a district judge in Louisiana in 1812–1814, secretary of the U.S. commission sent to South America in 1817, U.S. judge for the western district of Florida from 1821 to 1832, when he returned to Pennsylvania, and the author of a *Voyage to South America in 1817–1818* (1820), a *History of the Late War between the United States and Great Britain* (1817), *Recollections of Persons and Places in the West* (1834), and a *History of the Western Insurrection* (1859).

He acquired a great reputation as a lawyer, less by practice in the courts than in a consultative capacity. He strenuously opposed the "parlement Maupeou," devised by the Chancellor Maupeou to replace the old judiciary bodies, and refused to plead before it. He was counsel for the cardinal de Rohan in the affair of the Diamond Necklace (*q.v.*). In 1785 he was elected to the French Academy. In 1789 he was returned as one of the deputies of the Third Estate in Paris to the states-general, where he supported all such revolutionary measures as the union of the orders, the suspensive veto, the civil constitution of the clergy, &c. His excessive obesity, which in the Constituent Assembly made him the butt of the Royalists, had prevented him from practising at the bar for some years before 1789, and when Louis XVI. invited him to undertake his defence he excused himself on this ground. At the same time he published in 1792 some *Observations* in extenuation of the action of the king, from the constitutional point of view, which in the circumstances of the time argued much courage. For the rest, he took no part in public affairs during the Terror. Under the Directory he was made a member of the Institute (1796) and of the Court of Cassation (1798). He lived to collaborate in the earlier stages of the new criminal code. Among his writings may be mentioned a paper on the grain trade (1776) and a *Mémoire sur l'état des Protestants en France* (1787), in which he pleaded for the restoration of civil rights to the Protestants.

See Victor du Bled, "Les avocats et l'Académie Française," in the *Grand Revue* (vol. ii. 1899); H. Moulin, *Le Palais à l'Académie: Target et son fauteuil* (Paris, 1884); P. Boulloche, *Un avocat au 18ème siècle* (Paris, 1893).

TARGET, a mark to shoot at, so called from its resemblance in shape to the "targe" or small round shield, particularly the round wood and leather buckler, with metal bosses, and long spike protruding from the central boss, which was carried by the Highland clans; at the back was a leathern sleeve in which the left arm was inserted. In the 17th century, as body armour ceased to be used, the infantry soldier often carried a light shield of various forms which was known as a "target," which is a diminutive of targe; such soldiers were known as "targeteers." "Targe" is a word that has been the subject of much etymological discussion. On the one hand is found the O.E. *targe*, with hard *g*, a shield, cf. Icel. *targa*, shield, target, and O.H. Ger. *zarga*, frame, side, border; on the other is Fr. *targe*, Sp. and Port. *tarja*, Ital. *targa*, buckler, shield. The soft and hard *g*'s point to two distinct words. In Sp. and Port., is found *adarga*, a square target or buckler, which is an Arabic word, *al darkat* or *darakat*, a leather shield. The O.E. and Icel. words can hardly have come from an Arab. source, and the relation between the two words is an etymological puzzle (see Skeat, *Etym. Dict.*, 1910). The target as a mark to shoot at is, for archery, a circular canvas-covered frame stuffed with straw and marked with concentric rings surrounding the centre or bull's-eye. For shooting with the rifle the target is usually square.

In the days of the smooth-bore musket, and for many years after the introduction of small arms of precision, the targets used in musketry training were of a "match" and not a "service" character. The target was white with a black bull's-eye (counting 5 points) and two rings, invisible to the firer, called the "inner" and the "magpie," and scoring 4 and 3; the rest of the target was called the "outer" and counted 2 points. This system was the basis of all match shooting, whether with match or service rifles, and (with the trifling difference that the bull counted 4, the inner 3 and the magpie and outer alike 2) it was followed in military range practice. For collective fire regular rows of black silhouettes on white screens were employed. These were a compromise between bull's-eye and service targets which possessed the virtues of neither. But after the S. African war bull's-eye practices were eliminated from the musketry course of the British army, and in the musketry regulations of 1909 they were restricted to the earliest stages of recruits' training and trained soldiers' "refresher" courses. The use of the bull's-eye to-day is to teach the soldier to shoot uniformly, that is, to "group" his shots closely. The position of his shot group with reference to the bull's-eye does not matter; if his group is comprised within a 6 or 12-inch ring (at 100 yards range) he is passed on to more advanced practices at service targets. The latter are no longer coloured black-and-white, but are of the dull colours which are met with in the field, either brown head-and-shoulders painted on a green-grey canvas background or brown silhouettes held up against the face of the stop-butt. The National Rifle Association in 1910 followed the lead of the War Office to some extent as regards the targets used at the Bisley meeting in "service-rifle" competitions. For collective practices at the more important military stations large areas of ground are prepared with silhouettes in entrenchments, dummy guns, &c. Mechanical "running-man" and "disappearing" targets are also used for training in snap-shooting and rapid fire. The target used in naval gunnery is a large floating frame of timber either fixed by buoys or anchors or towed at a distance by a vessel (see ORDNANCE: § *Naval Gunnery*).

TARGUM. The Targums are the Aramaic translations—or rather paraphrases—of the books of the Old Testament, and, in their earliest form, date from the time when Aramaic superseded Hebrew as the *spoken* language of the Jews (see HEBREW LANGUAGE). In their origin they were designed to meet the needs of the unlearned among the people who had ceased to understand the Hebrew of the Old Testament. In the absence of any precise evidence on the point it is impossible to give more than a rough estimate as to the period at which Hebrew, as a spoken language, was finally displaced by Aramaic. It is, however, certain that the latter language was firmly established in Palestine in the 1st century A.D. By that time, as we know from many sources, Aramaic was not only the language in common use, but had also received official recognition,[1] despite the fact that Hebrew still remained the learned and sacred tongue. Hence we may reasonably infer that the mass of the people had adopted Aramaic at a considerably earlier period, probably, as early as the 2nd century B.C., and that the need of Aramaic translations of the sacred text made itself felt but little later. By the Jews[2] the introduction of Targums is ascribed to Ezra; but this tradition, which probably owes its origin to the Talmudic explanation of Neh. viii. 8,[3] is inconsistent with the linguistic evidence furnished by the post-exilic literature of the Old Testament, and must be rejected as unhistorical, if only because the process by which Aramaic took the place of Hebrew was admittedly a very gradual one. The Talmudic tradition, however, is, doubtless, correct in connecting the origin of Targums with the custom of reading sections from the Law at the weekly services in the synagogues, since the need for a translation into the vernacular must first have arisen on such occasions. As we know from the New Testament, the custom of reading in the synagogues both from the Law[4] and from the Prophets[5] was well established in the 1st century A.D.: its introduction, therefore, will date from a much earlier period. The practice of accompanying these readings with a translation into Aramaic is, further, so generally recognized by the 2nd century A.D. that the Mishna[6] takes it for granted, and merely inculcates certain regulations to be observed by the *Meturgemān* (translator), who had by this time acquired a definite status. From it we learn that the *Meturgemān*, who was distinct from the reader, translated each verse of the Law into Aramaic as soon as it had been read in Hebrew: in the readings from "the Prophets" three verses might be read at a time. Later regulations are also laid down in the Talmuds in order to prevent any appearance of authority attaching to the translation, and also to ensure reverential

[1] Cf. Dalman, *Die Worte Jesu*, p. 2 f.; *Grammatik des jüd.-paläst. Aramäisch*, 2nd ed., p. 9 f.

[2] *Sanhedrin*, 21*b*.; *Jer. Meg.*, i.

[3] *Nedarim*, 37*b*; *Jer. Meg.*, iv.—"and they read in the book, in the law of God, this is the Scripture, מפורש (R.V. *distinctly*), this is the Targum."

[4] Acts xv. 21.

[5] Luke iv. 16 f.; Acts xiii. 14, 27.

[6] *Meg.* iv. 4–6, 10.

treatment on the part of the translator.[1] Elsewhere,[2] we only find references to certain passages of Scripture, viz., the stories of Reuben and Tamar (Gen. xxxv. 22 and xxxviii.), the two accounts of the golden calf (Exod. xxxii.), the blessing of the priests (Num. vi. 22 f.), the stories of David and Amnon (2 Sam. xi., xii. and xiii.), which might be either read and translated, or only read and not translated, or (according to a different tradition) neither read nor translated. It is noticeable that none of the passages cited conveys any rules or information as to the character of the translation to be employed. Judging by the contents of our existing Targums, and the Targumic renderings given in Jewish literature, it is improbable that any definite system of interpretation was ever formally adopted, the rendering into the vernacular being left to the discretion of the individual *Meturgemān*. At first, no doubt, the translator endeavoured to reproduce the original as closely as possible, but, inasmuch as his object was to give an intelligible rendering, a merely literal rendering would soon be found to be insufficient, and he would be forced, especially in the more difficult passages, to take a more elastic view of his obligations. To prevent misconception he must expand and explain what was obscure, adjust the incidents of the past to the ideas of later times, emphasize the moral lessons to be learned from the national history, and, finally, adapt the rules and regulations of the Old Covenant to the conditions and requirements of his own age. As time went on the practice of introducing additional matter of an edifying character grew in popular favour, and was gradually extended. Thus, by degrees, the reproduction of the original text became of secondary importance, and merely served as a pretext for the discussion of topics that had little or no bearing on the context. The method, by which the text was thus utilized as a vehicle for conveying homiletic discourses, traditional sayings, legends and allegories, is abundantly illustrated by the Palestinian and later Targums, as opposed to the more sober translations of Onkelos and the Targum to the Prophets.

It would, however, be incorrect to suppose that the translation of the text was left entirely to the individual taste of the translator. The latter is rather to be regarded as the representative of the age in which he lived, and his interpretation is to be taken as reflecting the exegesis of that period. That there were certain limits beyond which the translator might not venture, without incurring the censure of the authorities, may be inferred from the few instances of translation which are mentioned with disapproval in the Mishna and elsewhere. Thus the rendering of Lev. xviii. 21 [a] by "Thou shalt not give any of thy seed to an Aramean woman to make her conceive" is censured, presumably because the prohibition of Molech worship is thereby ignored.[3] In the same Mishnic passage it is forbidden to render Lev. xviii. 7 as if the text had "*his* father" and "*his* mother."[4] Yet another translation (that of Lev. xxii. 28) is mentioned with disapproval in the Jerusalem Talmud,[5] though it has been preserved in the Targum Pseudo-Jonathan *ad loc.*[6] A definite rule for guidance in translating is apparently preserved in the *Tosefta*,[7] where it is stated that "he who translates quite literally is a liar, while he who adds anything is a blasphemer," Exod. xxiv. 10, "and they saw the God of Israel" is cited as an example. It is argued that the literal rendering of this passage is inadmissible, because no man has ever seen God; on the other hand, the insertion of the word "angel" before God would be blasphemous. The correct rendering is stated to be "and they saw the glory of God." But it is doubtful if the rule here given was ever intended to apply to more than the particular type of passage exemplified: if it had been applied generally, it would have clashed with the whole trend of Midrashic and Targumic paraphrase.

There can be little doubt that the Targums existed for a long time in oral form. They belonged to the class of traditional literature which it was forbidden to write down, and, so long at least as the Targum tradition remained active, there would be little temptation to commit it to writing. But it is highly probable that this prohibition, in the case of the Targums, was mainly enforced with respect to those parts of the Old Testament which were read in the synagogal services, *e.g.* the Law and the Prophets, and that it was less rigidly observed in regard to the other portions of Scripture: a written translation of the latter would be of special value for the purpose of private study. Hence there is no need to reject the tradition as to the existence of a written Targum on Job in the time of Gamaliel I.[8] (1st century A.D.), especially as references to Targum MSS. occur in the Mishna and elsewhere.[9] But, as Dalman has pointed out,[10] it was not these manuscripts, but the living tradition of the learned which was recognized as authoritative throughout the period which closes with the compilation of the Talmud. . . . The official recognition of a written Targum, and therefore the final fixing of its text belongs to the post-Talmudic period, and is not to be placed earlier than the 5th century.

I. Targums on the Pentateuch

(1) The so-called Targum of Onkelos admittedly owes its name to a mistaken reference in the Babylonian Talmud.[11] In its original context, that of the Jerusalem Talmud,[12] the passage refers to the Greek translation of Aquila. With the exception of this one reference, the Targum is always introduced in the Babylonian Talmud by the phrase "as we translate" (כדמתרגמינן), or "our Targum" (תרגום דידן): it is probable, therefore, that the name of the author, or authors, was unknown to the Babylonian Jews. It is first quoted under the title of the Targum of Onkelos by Gaon Sar Shalom (d. A.D. 859). According to Dalman,[13] its language differs in many material particulars from the Aramaic dialects of the Palestinian and Babylonian Talmuds, and is more closely allied to the biblical Aramaic. On the linguistic side, therefore, we may regard Onkelos "as a faithful representative of a Targum which had its rise in Judaea, the old seat of Palestinian literary activity." It is not, however, to be regarded as a reproduction in written form of a Palestinian translation, but rather as an official translation of the Law, in the Judaean dialect, which was carried out in Babylon, probably about the 4th century A.D.: in its final form, according to Dalman (*l.c.*) it cannot be earlier than the 5th century. The translation, as a whole, is good, and adheres very closely to the Hebrew text, which has not been without its influence on the Aramaic idiom; at times, especially in the poetical passages, a freer and more paraphrastic method is employed, and the version shows evident traces of Halakhic and Haggadic expansion. The Hebrew text used by the translators appears to have been practically identical with the Massoretic. The version was held in high esteem in Babylon, and, later, in Palestine, and a special Massora was made for it. The latest edition is Berliner's reprint (1884) of the *Editio Sabbioneta* (1557).

Of all the extant Targums that of Onkelos affords perhaps the most characteristic and consistent example of the exegetical methods employed in these works. Two principles may be said to have guided the translators. On the one hand, they had, as their primary object, to produce a faithful rendering of the original which at the same time would be intelligible to the people: for this purpose a purely literal translation would be insufficient. On the other hand, they regarded it as necessary to present the sacred text in such a manner as best to convey the particular form of interpretation then current. But later Jewish exegesis was especially concerned to eliminate everything in the sacred writings that might give rise to misconception with respect to God on the part of the unlearned. Hence we find various expedients adopted in the Targums for avoiding any reference to the Deity, which might be misunderstood by the people, or which involved apparent irreverence. Examples of this peculiarly Targumic method are: (1) the insertion of "word" (מימרא), "glory" (יקרא), "presence" (שכינא) before the divine name, when God is referred to in his

[1] *Tos. Meg.*, 3; *Jer. Meg.*, iv. 1–3; *Sota*, 39*b*; *Sopherim*, xi. 1, xii. 7, xiv. 2.

[2] *Meg.*, 25, 25*b*; cf. Ginsburger, *M.G.W.J.*, xliv. 1 f.

[3] *Meg.*, iv. 9; cf. *Jer. Meg.*, iv. 9; *Sanhed.*, ix. 1, where the meaning is given as—"He who marries an Aramean woman and raiseth up children by her raiseth up enemies to God"; for another explanation, see Ginsburger, *M.G.W.J.*, xliv. 5 f.

[4] Cf. Berliner, *Targum Onkelos*, ii. p. 85 f.

[5] *Meg.*, iv. 10.

[6] Cf. Ginsburger, *l.c.*

[7] *Tos. Meg.*, end.

[8] *Tos. Shabb.*; cf. *Jer. Shabb.*, xvi.; *Bab. Shabb.*, 115*a*; *Sopherim*, v. xv.

[9] *Jad.* iv. 5, and see the preceding references.

[10] *Grammatik des jüdisch-palästinischen Aramäisch*, p. 12 f.

[11] *Meg.* 3*a*.

[12] *Meg.* i. 9.

[13] *Gramm.* p. 12 f.

dealings with men; (2) the insertion of the preposition "before" (קדם) when God is the object of any action; (3) the use of the passive for the active voice, *e.g.* גלי קדם for ידע or ראה; שמיע ק״ for שמע; אתגלי for עבר, יצא, ירד, בוא; דכיר for זכר; (4) the use of periphrasis for the more pronounced anthropomorphisms, such as "to smell," "to taste," or when the use of the *status constructus* might seem to bring God into too close connexion with men or things; (5) the use of different expressions, or the insertion of a preposition before the divine name, when God is compared to man, or the same action is predicated of God and man; (6) the use of ״ for יהוה and אלהים, and the rendering דחלא or טעוא when אלהים denotes heathen gods. Instances of this endeavour to maintain, as it were, a respectful distance in speaking of God occur on every page of the Targums, but cases also occur, by no means infrequently, where human actions and passions are ascribed to God. The explanation of this phenomenon is to be found in the fact that anthropomorphisms, as such, were not necessarily avoided, but only in those cases where they might be misunderstood by the people.

(2) In addition to the Targum of Onkelos two other Targums to the Pentateuch are cited by Jewish authorities, under the titles of the *Targum Jerushalmi* and the Targum of Jonathan ben Uzziel. Of these the former contains only portions of the Pentateuch,[1] and is therefore usually designated the Fragmentary (Jerusalem) Targum. In a large number of cases this Targum gives merely a variant rendering of single words: where longer passages are given it presents a very paraphrastic translation, and bears all the marks of a late Haggadic composition. Its fragmentary character arises from the fact that it is simply a collection of *variae lectiones* and additions to the version of Onkelos, intended possibly for use at public services.[2] That this Targum was really intended to supplement that of Onkelos is shown by comparing the two texts. For the former is frequently unintelligible without the latter, since it offers no translation of those words, or clauses, for which it gave the same rendering as Onkelos. On the other hand, the version of Onkelos affords just the supplementary material that is required to restore sense to the shorter text. Moreover, in not a few cases the Fragmentary Targum itself attaches to its variant rendering the succeeding word from Onkelos, thus indicating that from this point onwards the latter version is to be followed. More conclusive still is the fact that in a number of old *Maḥzor* MSS. we find Targums to the Song of Moses and to the Decalogue, in which this process has been fully carried out, the text of Onkelos being given as well as the variants of the Fragmentary Targum.

The second Jerusalem Targum, or the so-called pseudo-Jonathan, admittedly owes its ascription to Jonathan ben Uzziel to the incorrect solution of the abbreviated form by which it was frequently cited, viz. ת״י, or *Targum Jerushalmi* (תרגום ירושלמי). This Targum represents a later and more successful attempt to correct and supplement the Targum of Onkelos by the aid of variants derived from another source. It is not, however, a revision of the Fragmentary Targum—for it is clearly independent of that version—but is rather a parallel, if somewhat later, production, in which the text of Onkelos is already combined with a number of variants and additions. It is noticeable that this Targum has been considerably influenced by the Targum of Onkelos, and in this respect, as in others, is far less trustworthy than the Fragmentary Targum, as a witness to the linguistic and other peculiarities of the source from which they were both derived. It exhibits, to a marked degree, that tendency to expand the text by additions of every kind, which has been already noted as characteristic of the later stages of Targumic composition. Homilies, legends, traditional sayings and explanations, in fact every form of Haggadic expansion are utilized by the Targumist, so that at times his works convey the impression more of a late *Midrash* than of a translation. This impression is fully confirmed by (*a*) a comparison of the Talmud and later Midrashic works with which it has obvious points of contact, and (*b*) the historical allusions, such as the mention of Constantinople (Num. xxiv. 19), of a wife and daughter of Mahomet (Gen. xxi. 21), and the references to Esau and Ishmael as representative world-powers (Gen. xlix. 26; Deut. xxxiii. 2; cf. Fragm. Tg. to Gen. xlix. 2; Deut. xxxiii. 2).[3] In its translation of the Hebrew pseudo-Jonathan is careful to avoid anthropomorphisms and to give the sense of all but the most simple metaphors, though his method is not so thorough as that of Onkelos. Every endeavour is made to gloss over, or modify, expressions which seemed derogatory to the ancestors of Israel, and to amplify everything which redounded to their credit. On the other hand, pseudo-Jonathan shows a tendency to condense those additions which it has in common with the Fragmentary Targum: in particular he omits all quotations from Scripture.

In regard to the source of the two Palestinian Targums to the Pentateuch, we must accept the conclusion of Bassfreund[4] that they both derived their variants from a complete *Targum Jerushalmi.* This conclusion is based on the following grounds: (1) Various Jewish works dating from the 11th to the 14th century contain a large number of quotations under the heading ת״י, *i.e. Targum Jerushalmi.* Of these rather less than a quarter are found in the Fragmentary Targum, the remainder being mostly taken from passages for which no translation of that Targum exists. This completer work, however, cannot be identified with the pseudo-Jonathan, for more than half of these quotations are missing from the latter; and further, in passages for which we possess both the Targums, the text of the Fragmentary Targum agrees much more closely with the quotations: the linguistic evidence also shows that the Fragmentary Targum is a more faithful representative of the original source; (2) the pseudo-Jonathan displays a curious inconsistency in its rendering of particular words and phrases, at one time following Onkelos, at another a different source. That this latter source is the *Targum Jerushalmi* is proved, in the majority of cases, by a comparison with the Fragmentary Targum; (3) quotations from Scripture preserved in the Fragmentary Targum point to a completer version than our present Fragmentary Targum. But though the existence of an older *Targum Jerushalmi* cannot be denied, it is clear that the form in which it was utilized by the two Palestinian Targums cannot be of an early date, for many of the latest elements in the Fragmentary and pseudo-Jonathan Targums were undoubtedly derived from their common source. Moreover, the existence of a written Palestinian Targum at an early date is expressly excluded by the evidence at our disposal. In the middle of the 2nd century A.D. R. Simon ben Gamaliel forbade the translation of the Pentateuch in any language but Greek;[5] and this command was upheld by R. Johanan in the 3rd century. Even in the time of the later Amoraim there is no mention of a written Palestinian Targum, though the official Babylonian Targum is repeatedly referred to in the Babylonian Talmud, in the Midrashim, and at times also by Palestinian Amoraim. These considerations are sufficient to disprove the theory of Geiger,[6] which has for so long been accepted in one form or another, that the Targum of Onkelos was merely a reproduction of the old *Targum Jerushalmi* revised in accordance with the "new Halakha" introduced by R. Aqiba. Yet it is impossible to hold that the Targum of Onkelos was the only representative of Targum tradition that existed among the Jews down to the 7th century A.D., the period to which the internal evidence compels us to assign the *Targum Jerushalmi* as used by the Fragmentary Targum and the pseudo-Jonathan. We must rather assume that a tolerably fixed Targum tradition existed in Palestine from quite early times. The language employed in the Targum of Onkelos is, admittedly, Palestinian or Judaean, and since language and thought are ever closely allied, we may conjecture that the current Judaean exegesis, which, in part at least, must go back to the 2nd century A.D., was not without its influence on the Babylonian translation. This old Targum tradition, however, never received official recognition in Palestine, and was unable, therefore, to hold its own when the new Babylonian version was introduced. We may infer that, as time went on, a reaction in favour of the older renderings made itself felt, with the result that these were collected in the form of variants and appended to Onkelos. But the authority enjoyed by the latter rendered it secure against any encroachments; hence any later expansions, especially those of a popular Haggadic character, naturally found their way into the less stereotyped *Targum Jerushalmi.* Unfortunately, we possess but little material for controlling the texts either of the Fragmentary Targum or of the pseudo-Jonathan. Of the latter only one manuscript (Brit. Museum Add. 27031) is known to exist, and this has been utilized by Ginsburger in his *Pseudo-Jonathan* (Berlin, 1903). The same scholar has also edited the Paris manuscript (110) of the Fragmentary Targum (*Das Fragmententhargum*, Berlin, 1899), to which he has added the variants from Cod. Vat. 440 and the manuscripts at Nuremberg and Leipzig. In the same edition are collected the various fragments of the *Targum Jerushalmi*, which are to be found in the early editions of the Pentateuch and in part also in various manuscripts.

II. Targums on the Prophets

The official Targum on the Prophets is stated by the Babylonian Talmud[7] to have been "said" by Jonathan ben Uzziel, the disciple of Hillel, and is usually known, therefore, as the *Targum Jonathan.* Elsewhere in the Talmud, however, the quotations from this Targum are given under the name of Joseph bar Chijah, head of

[1] According to Zunz, *Gottesdienstliche Vorträge*, 2nd ed., p. 80, its contents bear the following proportions:—$\frac{1}{3}$ to Genesis, $\frac{3}{20}$ to Exodus, about $\frac{1}{14}$ to Leviticus, $\frac{1}{5}$ to Numbers, and $\frac{1}{4}$ to Deuteronomy.

[2] Seligsohn, *De duabus Hier. Pent. paraphrasibus* (1858): for a fuller discussion see Bassfreund, "Das Fragmenten Targum" in *M.G.W.J.* xl.

[3] The view that Deut. xxxiii. 11 could only have been written by a contemporary of John Hyrcanus cannot be maintained; cf. Dalman, *Gramm.* p. 30 f., and, more fully, Bassfreund, *M.G.W.J.* xliv. (1900), pp. 481 f.

[4] *M.G.W.J.* xl.

[5] *Meg.* i. 11.

[6] *Urschrift* (1857), pp. 162 ff., 451 ff.; *Nachgelassene Schriften*, iv. p. 98 f.; *Jüdische Zeitschrift* (1871), ix. p. 85 f.

[7] *Meg.* 3*a*.

the school at Pumbadita in the 4th century A.D. Both in language—though naturally there is some variation of vocabulary—and style it closely resembles the Targum of Onkelos, and appears to have been modelled on that translation: in certain passages, indeed, it appears to have made use of it.[1] Probably, like Onkelos, it did not assume its final form in Babylon before the 5th century A.D. It naturally follows from the character of the original that the rendering of this Targum is less literal than that of Onkelos, especially in the prophetic books, but, when due allowance is made for the difficulty of the Hebrew, it may be described on the whole as a faithful reproduction of the original text. Its peculiarities of rendering are due to the same principles which were noted as underlying the translation of the Pentateuch. Anthropomorphisms, as a rule, are avoided by means of the same expedients as those employed by Onkelos, expressions derogatory to the dignity of God, or of the heroes of the nation, are softened down, while figurative language is either boldly transposed, or its character clearly shown by the introduction of the particle "as" or "like." There is, further, a tendency to narrow down the scope of the prophetic utterances, and to limit their application to Israel and its immediate enemies. Lastly, in the obscurer passages the Haggadic method of interpretation is employed to its fullest extent, while the translation throughout shows a marked tendency to explanatory additions.

Of a *Targum Jerushalmi* to the Prophets but little is known, though it is hardly doubtful that such a Targum existed, if only in oral form. Traces of this version have been discovered by Bacher[2] in the variants attached to the margin of the *Codex Reuchlinianus*, and printed by Lagarde in his edition of *Prophetae Chaldaice* (1872). These fragments, which have been preserved under the headings ירוש, יו״ר, תרג״ יר״, exhibit certain features in common with the Jerusalem Targums to the Pentateuch, and are demonstrably of post-Talmudic date. According to Kohut's list of Targum quotations in *'Arūk*, a Jerusalem Targum existed also for the Psalms, Proverbs, Job, Canticles, Lamentations, Ecclesiastes and Esther, but this list is scarcely reliable, and, as Dalman has pointed out,[3] the quotations in *'Arūk* to Kings, Ezekiel, Proverbs and Lamentations are the only ones that point with certainty to the existence of a *Targum Jerushalmi*.

III. Targums to the Hagiographa

These Targums possess but little interest for the student of Jewish literature as they are almost entirely the work of individuals, made in imitation of the older Targums. Despite the reference to a Targum of Job in the 1st century (see above), all the extant Targums to the Hagiographa are later in date than the Targums to the Law and the Prophets.

(1) *Targums to the Psalms and Job.*—These Targums present certain features in common and may therefore be treated under the same heading. Like all the later Targums they exhibit a large amount of explanatory addition, chiefly Haggadic in character. At the same time the translation of the original is not neglected; and, when separated from the later accretions, this is found to follow the Hebrew tolerably closely. Peculiar to these Targums are the double translations, which they give to many verses, one of which is usually Haggadic in character, while the other is more literal. Bacher[4] would assign these Targums to the 4th or 5th century, but, as Dalman has pointed out,[5] they exhibit linguistic features in common with the Jerusalem Targums to the Pentateuch. They cannot be earlier than the 7th century A.D., and possibly are of a considerably later date.

(2) *The Targum to the Proverbs* stands apart owing to the peculiarity of the language in which it is written. The influence of the Peshitta version is so clearly marked,[6] that Dalmân (*l.c.*) describes it as a Jewish revision of that version. But setting aside the Syriasms due to the use of the Peshitta, the Targum shows affinity to the Targums to the Psalms and Job. The translation is literal and almost entirely free from Haggadic additions.[7]

(3) *The Targums to the Megilloth.*—The chief characteristic of these Targums is their exaggerated use of paraphrase. They mark the final stage in the development of Haggadic interpretation, in which the translation of the text has practically disappeared in a mass of fantastic and irrelevant matter. The Targum of Esther is known to us in three recensions (1) that of the Antwerp Polyglot, almost a literal translation; (2) that of the London Polyglot, which gives practically the same text with many additions of a Haggadic character; (3) the so-called second (*shēni*) Targum, a much larger work, containing a collection of later *Midrashim* to this book. According to Zunz[8] this "second" Targum is quoted by Rashi (to Deut. iii. 4) as a Jerusalem Targum, and also (1 Kings x. 19) as the "Haggada" of the Megilloth Esther. The Targum to Canticles is of a similar character to that of the "second" Esther. Dalman assigns these Targums to a date half-way between the Babylonian Targums (Onkelos and that to the Prophets) and the Jerusalem Targums to the Pentateuch and those to the greater Hagiographa. The British Museum possesses three important Yemen manuscripts for the five Megilloth and the "second" Esther Targum in MSS. Or. 1302, 1476, and 2375.

(4) *The Targum to the Chronicles* was first edited from an Erfurt manuscript by M. F. Beck, 1680–1683. A more complete and accurate edition from a Cambridge manuscript was edited by D. Wilkins in 1715. In the translation, which at times is fairly literal, use appears to have been made of the Jerusalem Targums to the Pentateuch, and of the Targums to the books of Samuel and Kings. The text represented by the Erfurt manuscript is assigned to the 8th, that of the Cambridge manuscript to the 9th century A.D.[9]

No Targums have so far been discovered to Daniel and 'Ezra and Nehemiah. (J. F. St.)

[1] Berliner, *Targum Onkelos*, ii. p. 124 f.

[2] *Z.D.M.G.* xxviii. and xxix.

[3] *Gramm.* p. 29.

[4] *Jüdische Monatschrift*, xx. 208 f., xxi. 408 f., 462 f.

[5] *Gramm.* p. 34.

[6] Dathe, *De ratione consensus versionis chaldaicae et syriacae, proverbiorum Salomonis*, ed. Rosenmüller, 1814; cf. Maybaum and Nöldeke in Merx *Archiv.*, 1871, and Baumgartner, *Étude critique sur l'état du texte du livre des Proverbs*, 1890.

[7] Cf. Pinkuss, *Die syrische Uebersetzung der Proverbien*, *Z.A.T.W.*, 1894.

[8] *G. V.* p. 83.

[9] Rosenberg and Kohler in Geiger's *Jüdische Zeitschrift*, 1870.

TARIFA, a seaport of Spain, in the province of Cadiz, at the extreme south point of the Peninsula, 21 m. by rail W.S.W. of Gibraltar. Pop. (1900) 11,723. The town is nearly quadrangular, with narrow, crooked streets, and is still surrounded by its old Moorish walls. On its east side, just within these, stands the citadel. The rocky island in front of the town, connected with the mainland by a causeway, is strongly fortified; on the south side there is a modern lighthouse. Anchovy and tunny fishing is carried on, and there is some coasting trade, chiefly in live stock, salt fish and fruit. The manufactures (leather and earthenware) are unimportant. The oranges of Tarifa are famed for their sweetness.

Tarifa is the *Julia Joza* of Strabo, between Gades and Belon. According to that writer, it was colonized by Romans and the removed inhabitants of Zelis in Mauretania Tingitana. The *Julia Transducta* or *Traducta* of coins and of Ptolemy appears to be the same place. Its present name, dating from early in the 8th century, is derived from Tarif, whom Ṭāriq sent to Spain in command of the advance-guard of the Moorish invaders (see Caliphate and Spain: *History*). In 1292 Tarifa was taken by Sancho IV. of Castile from the Moors, who made several subsequent attempts to recapture it. In the defence of Tarifa Alphonso XI. gained the battle of Salado, a short distance to the westward, in 1340. In 1812 a French force of 10,000 men under Generals Victor and Laval vainly endeavoured to capture Tarifa, which was garrisoned by 2500 troops (mostly British) under General Gough.

TARIFF (adapted in English from the French; the word comes through the Spanish *tarifa*, a list or schedule of prices, from the Arabic, *ta'rifa*, information, an inventory, *'arf*, knowledge), a table or list of articles on which import or export duties are levied, with the amount of the duty specified, hence often used as a collective term for the duties imposed, or for the law or code of regulations imposing such duties or varying the scale of charges. The word is also used quite widely of any schedule of prices or charges, and, particularly in America, of the freight or other charges of a railway or steamship line.

Resort is made to tariffs, or duties on imports, partly to secure revenue, partly to affect the course of industry within a country. Strictly speaking, these two objects are inconsistent with each other; since a customs duty, in so far as it causes a domestic industry rather than a foreign to supply the market, ceases to be a source of revenue. But in a great number of cases the imposition of a duty causes only a partial displacement of the foreign supply, and hence brings some revenue from that which remains. This circumstance strengthens the hold of the protective system, especially in countries where customs duties are an important source of revenue, the combination of fiscal convenience and of protection to home industry being a highly attractive one. Where tariff duties are imposed solely for revenue, an equivalent excise tax is imposed within the country, so as to put the domestic producer precisely on the footing of his foreign competitor; and tariffs so maintained are in complete conformity with the principle of free trade.

Great Britain.—Between the close of the Napoleonic wars of 1815 and the year 1860, the tariff system of Great Britain was changed from elaborate protection to practically complete free trade. An attempt had indeed been made in 1786 to modify the rigidly protective legislation of the 18th century. In that year Pitt concluded a commercial treaty with France, providing for large reductions of duties in both countries. But the treaty was swept away with the outbreak of the wars with France, and accordingly the old system was still in force in 1815. The first important step, and in some respects the decisive step, towards modifying it was taken in 1824, under the policy of Huskisson. In that year, and again in 1825, great reductions were made in the duties on raw materials, especially on wool, raw silk, flax and iron, while considerable reductions were also made in the duties on manufactured goods. The most sharply contested of the changes was in regard to silks, which had been completely prohibited, and were now admitted at a duty of 30 per cent. A considerable breach was thus made in the protective system; and some further changes in the same direction were made in the next decade, especially under Lord Althorp in 1833. But in the decade from 1830 to 1840 the Corn Laws were the chief subject of contention. The great increase in population since the middle of the 18th century had made England a corn-importing country, especially with the rapid growth of manufactures in the early years of the 19th century. The first systematic Corn Laws imposing duties on grain had been passed in 1773. From 1861 onwards a series of measures were passed, all designed to maintain the high price of grain. The Act of 1816 prohibited the importation of wheat when the price was less than 80s. a quarter (=$2.50 a bushel). In 1822 the prohibitive point was lowered to 70s. In 1828 the sliding scale was introduced, under which the duty went up and down as the price of grain went down and up; and it was against this form of the Corn Law that the great agitation led by Cobden and Bright was directed after 1830. For a long time the anti-Corn Law agitation seemed to have no effect, although conducted with extraordinary skill and enthusiasm. In 1842, however, Sir Robert Peel made the first important concession, by modifying the sliding scale, his opponent, Lord John Russell, having proposed in the previous year a fixed duty of 8s. a quarter. In view of the bad harvest of 1845–46, and the famine in Ireland in 1846, Peel surrendered, and proposed in 1846 the admission of grain with only a fixed duty of 1s. a quarter as a registration fee. This change was carried, but Peel, being able to carry only a fraction of his party with him, was compelled shortly afterwards to resign. The Corn Laws had great political strength, serving as they did the interests of the landowners, whose hold on parliament was still very strong; but the general economic situation in Great Britain, from the rapid growth of the manufacturing population and the imperative need of more food, made the abolition inevitable. After having been maintained till the middle of the century, apparently with irresistible support, they suddenly collapsed under the strain of a season of exceptionally short crops. Both their continued maintenance and their final sudden abolition are in some respects divergent from the general course of British tariff history.

Corn Laws repealed, 1846.

The remodelling of the tariff system in the direction of free trade went on, little retarded by the maintenance of the Corn Laws and not much accelerated by their abolition. In 1842 great reductions of duty were made on a large number of articles; in 1846 still further reductions of duty were made; another series of changes came in 1853; and finally, in 1860, the last remnant of protective duties disappeared. The four acts of 1842, 1846, 1853, 1860—the first two under Peel's leadership, the second two under Gladstone's guidance—thus carried out gradually the policy of free trade in regard to other articles than grain. The first of them, in 1842, was signalized by the introduction of the Income Tax as a means of raising revenue to replace that lost by the diminished import duties. The last of them, in 1860, was largely influenced by the great commercial treaty with France. In that treaty the concessions made to France were the reduction by Great Britain of duties on wines and spirits, and the admission, free of duty, of some important French products, notably silk manufactures, gloves, and other products in which the French had superiority. Great Britain, instead of limiting the concessions to France, in 1860 made them applicable to all the world. The silk manufacture, as to which the first great changes had been made in 1824, and on whose products the duties had been kept higher in previous acts than on other manufactures, was thus compelled, notwithstanding violent opposition, to face unfettered foreign competition.

General changes in 1842–60.

Two general features should be noted in regard to the tariff history of Great Britain. In the first place, most of the reductions of duty on manufactured articles were of little practical significance. The great mass of manufactured commodities were produced in the United Kingdom more cheaply than in foreign countries, and would not have been imported, with duty or without, except in sporadic amounts for some special qualities. The changes hence involved little real readjustment of industry. There is thus some ground for the assertion that the policy of free trade was not adopted by the United Kingdom until its industries had reached the stage of being independent of protection. But this does not hold good of some manufactures; especially not of the silk industry, and some parts of the woollen and linen trades. Still less does it hold good of raw materials, many of which had been really affected by the duties, and were largely imported after their abolition. Such was the case not only with some metals, such as lead, zinc, copper, but still more strikingly with textile materials such as wool, flax, and the like, and most of all with agricultural products such as grain, meat and meat products, timber. In regard to all these, the abolition of protection meant a real sacrifice to domestic industries. The second feature to be noted is the simplification which resulted in the administrative features of the English tariff. A great number of articles had been enumerated in the earlier tariff acts, each of which was imported in very small quantity and yielded an insignificant revenue. The nature of the changes made between 1842 and 1860 is indicated by the following tabular statement:—

	Duties reduced.	Duties abolished.
1842–46	503	390
1846	112	54
1853	...	123
1860	...	371

After 1860 only forty-eight articles remained subject to duty, a number which has been still further reduced, the most notable change having been free admission of sugar in 1872. Since that date the English customs tariff has been simplicity itself. A very few articles (spirits, beer, wine, tobacco, tea, coffee, cocoa) yield practically all of the customs revenue, and, so far as these articles are produced within the country, they are subject to an excise duty, an internal tax precisely equal to the import duty. In 1901, to aid in meeting the expenses of the South African war, a moderate revenue duty was again imposed on sugar; and in 1902 the shilling duty on corn and flour (abolished in 1869) was restored, but again taken off in 1903. In this year began the "Tariff Reform" movement initiated by Mr Joseph Chamberlain (*q.v.*), but Free Trade retained a strong hold on the British electorate, and the return of the overwhelming Radical majority to parliament in 1906 involved its retention under the fiscal policy of that party. In January 1910 the Liberal government was again returned to power; but the Unionist party was now committed to Tariff Reform, which had made great strides in obtaining popular support.

France.—The tariff history of France in the 19th century divides itself into three periods: one of complete prohibition, lasting till 1860; second, of liberal legislation, from 1860 to 1881; third, of reversion to protection after 1881.

(1) During the first period the prohibitive legislation of the 18th century was retained, largely in consequence of the Napoleonic wars. The commercial treaty of 1786 between Great Britain and France has already been referred to as making a breach in the restrictive system of the 18th century; and in the early years of the French Revolution a similar wave of liberal policy is to be seen. But the great wars led to the complete prohibition of the importation of manufactures, reaching its climax in Napoleon's Continental system. The system of prohibition thus instituted, while aimed at Great Britain, was made general in its terms. Hence the importation into France of virtually all manufactured articles from foreign countries was completely interdicted; and such was the legislation in force when peace came in 1815. This system doubtless was not expected to last after the wars had ceased, but, as it happened, it did last until 1860. Successive governments in France made endeavours to break with the prohibitive system, but naturally met with strong opposition from the manufacturing interests, not prepared to meet the competition of Great Britain, whose industries had made, and were continually making, rapid strides. The political position of the governments of the Restoration and of Louis Philippe was such that they were unwilling to forfeit support by pushing measures in which, after all, they were not themselves deeply interested.

Treaty of 1860.

(2) It was not until Napoleon III. believed it to be to his political advantage to strengthen friendly relations with Great Britain by the moderation of the import duties that the change was finally made; while the despotic character of his government enabled him, when once the new policy was entered on, to bring about a radical change. After some secret negotiations, in which the English Corn Law agitator, Cobden, and the French economist, Cherbuliez, took an active part, Napoleon was persuaded to enter on the famous commercial treaty of 1860, and virtually to force its acceptance by the French legislature. In the treaty as finally framed duties on most manufactured commodities were reduced to a range of 10 or 15 per cent., some iron manufactures, however, being left at slightly higher rates. Before the treaty, all woollen and cotton manufactures, all manufactures of leather, of hardware, pottery, all glass ware, had been prohibited, while raw materials and such manufactures as were not prohibited had been subjected to heavy duties. The treaty thus made a radical change, revolutionizing the tariff system of France. It did so with relation not only to the United Kingdom, but, in its after effects, to the world at large. The French government at once set to work to enter into similar arrangements with other countries, and treaties were successively concluded in 1860–66 with Belgium, with the Zollverein (Germany), Italy, Switzerland, Sweden and Norway, Holland, Spain, Austria. All these countries made reductions of duty on French products, while France admitted other products at the rates of the British treaty tariff. Thus a network of treaties was spread over Europe, leading to much great freedom of trade and opening an era of freer international exchange.

Reaction since 1880.

(3) This more liberal policy, however, probably never had deep root in French public opinion. It received a check from the Franco-German War of 1870–71. The treaty of Frankfort in 1871 contained, in place of the previous detailed commercial treaty with Germany, the simple "most favoured nation" proviso. The guarantee which each country thus gave to the other of treatment as favourable as that given elsewhere became irksome to France, sore after her defeat in the war. More important, however, in undermining the liberal system, was the change in agricultural conditions which began to set in in the decade of 1878–88. Then the great improvements in transportation caused competition in agricultural products to be felt, especially from the United States. Agricultural prices declined; agricultural depression set in. The agricultural interest in France, hitherto indifferent about duties, now began to demand protection against competition from beyond the sea. To this factor was added the revival of national feeling and prejudice, with growing political complications and jealousies. Hence, by gradual steps, the customs policy of France has become more and more strongly restrictive. The first important step was taken in 1881, when a new general tariff was established, in which specific duties replaced the *ad valorem* duties chiefly applied in the treaty tariffs of 1860–66. The new rates were supposed to be no more than equivalent to those replaced by them, but in fact were in some cases higher. New treaty tariffs, less liberal than the earlier ones, were concluded with Belgium, Switzerland and Spain; while with other countries (*e.g.* Great Britain) a "most favoured nation" arrangement was substituted for the previous treaty régime. These new treaty arrangements expired in 1892: even before that date, duties had been raised on grain and meats; and finally, in 1892, a new and more highly protective general tariff was established on the recommendation of M. Méline, with high duties on agricultural products and raw materials as well as on manufactures, and with provisions for limited domestic bounties on silk, hemp and flax. Nevertheless, some provision was made for negotiations with foreign countries by establishing a minimum tariff, with rates lower than those of the general or maximum tariff, the rates of this minimum tariff being applicable to countries which might make concessions to France. As a rule the minimum tariff has been applied, after negotiation, and thus is the tariff in practical effect; yet its rates are still high, and, most significant of all, agricultural products are granted no reductions whatever as compared with the maximum tariff, there being heavy and unrelaxed duties upon grain, animals, meats and the like.

Tariff of 1892.

The Zollverein, 1834.

Germany.—The tariff history of Germany, up to the foundation of the German Empire, is the history of the Zollverein or German customs union; and this in turn is closely connected with the tariff history of Prussia. In 1818 Prussia adopted a tariff with much reduced duties, under the influence of the Liberal statesmen then still powerful in the Prussian government. The excitement and opposition in Germany to the Prussian tariff led to customs legislation by the other German states, some smaller states joining Prussia, while the southern states endeavoured to form independent customs unions. Finally, by gradual steps between 1831 and 1834, the complete Zollverein was formed, notwithstanding popular opposition. All the German states formed a customs union, with free trade between them, except so far as differing internal taxes in the several states made some modifications necessary. The customs revenue was divided among the several states in proportion to population. The tariff of the Zollverein was, in essentials, the Prussian tariff of 1818, and was moderate as compared with most of the separate tariffs previously existing. Within the Zollverein, after 1834, there was an almost unceasing struggle between the Protectionist and Free Trade parties, Prussia supporting in the main a Liberal policy, while the South German states supported a Protectionist policy. The trend of the tariff policy of the Zollverein for some time after 1834 was towards protection; partly because the specific duties of 1818 became proportionately heavier as manufactured commodities fell in price, partly because some actual changes in rates were made in response to the demands of the Protectionist states. In 1853 a treaty between the Zollverein and Austria brought about reciprocal reductions of duty between these two parties. After 1860 a change towards a more liberal policy was brought about by the efforts of Prussia, which concluded independently a commercial treaty with France, forcing on the other members of the Zollverein the alternative of either parting company with Prussia or of joining her in her relations with France. The second alternative was accepted, largely because Austria did not vigorously support the South German states, and in 1865 the Zollverein as a whole concluded a commercial treaty with France, bringing about important reductions of duty. The régime of comparatively free

French treaty and low tariff, 1865.

trade thus established lasted for about fifteen years. After the foundation of the German Empire, the duties of the Zollverein became those of Germany, and for a time the liberal régime was maintained and extended, with respect to the tariff as with respect to other matters. But in Germany, as in France, a combination of political and of economic forces led before long to a reaction towards protection. Bismarck broke with the National Liberals, who were the champions of free trade; at the same time the agricultural depression set in, and the agricultural interest demanded protection against American and other foreign competition. The manufacturers, especially of iron, also manoeuvred for protection. The reaction came in 1879, when duties were increased on manufactured articles as well as on agricultural articles. Other advances of duty were made in later years, especially on grain; and thus the policy of Germany has become distinctly Protectionist, though not to the same degree as in France. In 1892, however, the precise year in which France gave up her system of commercial treaties, some moderation was brought about in Germany's protective system by commercial treaties with Austria, Italy, Belgium, Switzerland, and shortly afterwards with Russia. These treaties provided for reductions of duties in all directions, the most important concessions being on certain agricultural products. Thus the duty on wheat, which had been gradually raised as high as 5 marks per hundred kilogrammes (roughly 1s. 3d., or about 30 c. a bushel) was reduced to 3·50 marks by the treaties. The rates of these treaties were extended to a number of other countries having "most favoured nation" relations with Germany. The tariff system of Germany, however, at the beginning of the 20th century, remained definitely Protectionist.

Protection reinstated, 1879.

In other important countries changes in policy have taken place similar to those noted in Germany and in France. The era of moderated tariffs, which began with the great treaty of 1860, lasted for about twenty years, and was followed in Italy, Austria, Belgium, Switzerland and Spain by a reversion to protection, although usually to a less high system of protection than had prevailed before 1860. The United Kingdom and Holland alone held consistently and unfalteringly to the principle of free trade. The factors which have brought about this reaction have been, as was already noted, partly economic, partly political: on the one hand, the pressure of competition from distant countries in agricultural products, a consequence chiefly of improved transportation; on the other hand, the revival of national sentiment and prejudice.

The United States.—The tariff history of the United States, like that of European countries, divides itself into two great periods, before and after the year 1860. But it is no more than an accident that this year constitutes the dividing line in both cases, the change in the United States being due to the Civil War, which so profoundly influenced the fiscal, economic and political history of the country in all directions. The period before 1860 may again be divided into three sub-periods, the first extending from 1789 to 1816, the second from 1816 to about 1846, the third from 1846 to 1860.

(1) The Tariff Act of 1789 was the first legislative measure passed by the United States. The Protectionists have pointed to it as showing the disposition of the first Congress to adopt at once a policy of protection; the Free Traders have pointed to it similarly as showing a predilection for their policy. Each had some ground for the claim. The duties of the act of 1789 were very moderate, and, as compared with those which the United States has had under any subsequent legislation, may be described as free trade duties. On the other hand, the spirit of the act of 1789 was protective. It had been the design of Madison, and of other firm supporters of the new constitution, to adopt in 1789 a very simple measure, designed solely to secure revenue. But the pressure from the representatives of some of the states, notably Pennsylvania and Massachusetts, compelled him to incorporate in the Tariff Act certain specific duties borrowed from the Tariff Acts then in force in these states, which had a distinctly protective aim. Thus the act of 1789, although the duties levied by it were moderate, yet had a protective intent. Such in the main remained the situation until 1816, duties being indeed raised from time to time in order to secure more revenue, but the arrangement and the general rate of the duties not being sensibly modified. There was not at this time any considerable public feeling on the subject of protection, chiefly because during most of the years of this period the Eastern states, and especially New England, where manufactures might be expected to develop first, were profitably engaged in an extensive export and carrying trade.

1789–1816.

(2) After the close of the War of 1812, however, a new spirit and a new policy developed. With the end of the Napoleonic wars, the opportunities for American commerce became less, while at the same time the expanding population necessarily led to diversified interests at home. A demand arose for two closely connected measures: protection to domestic manufactures, and internal improvements. Protection was demanded as a means both of aiding young industries and of fostering a home market for agricultural products. The chief spokesman of the new movement was Henry Clay, who remained throughout his life the constant advocate of this so-called "American system." Some disposition in this direction showed itself as early as 1816, when tariff duties were raised. Still greater changes were made in 1824, 1828, and 1832. In 1824 duties were considerably raised; and thereafter the New England states, which so far had been lukewarm in supporting the movement, joined in it unreservedly. The tariff of 1828 was affected by some political manipulation, which caused it to contain objectionable provisions, and to be dubbed "the tariff of abominations." But the so-called abominations were removed in 1832, when the protective system was deliberately and carefully rearranged. By this time, however, the opposition to it in the South had reached a pitch so intense that concessions had to be made. As a planting and slave-owning region, the South inevitably had no manufactures: it felt that its cotton was sure to find a foreign market, and would gain little from the establishment of a domestic cotton manufacture within the country; and it judged, rightly, that the protective system brought it only burden and no benefit. The extent of the burden was greatly exaggerated by the leaders of the South, especially in the heat of partisan controversy; and the subject was closely connected with the controversy as to the rights of the states, and the endeavour of South Carolina, under the influence of Calhoun, to nullify the Tariff Act of 1832. The nullification movement led in 1833 to the well-known compromise, by which the rates of duty as established by the Act of 1832 were to be gradually reduced, reaching in 1842 a general level of 20 per cent. The compromise served its turn in allaying political bitterness and staving off a direct conflict between the United States and South Carolina. But the reductions of duty made under it were never effectively carried out. In 1842, when the final 20 per cent. rate was to have gone into effect, the Protectionists again had control of Congress, and after a brief period of two months, during which this 20 per cent. rate was in force, passed the Tariff Act of 1842, which once more restored the protective system in a form not much less extreme than that of 1832.

1816–46.

(3) Four years later, however, in 1846, a very considerable change was secured by the South, and a new era was entered on. The Democratic party now was in control of legislation, and in the Tariff Act of 1846 established a system of moderate and purely *ad valorem* duties, in which the protected articles were subjected, as a rule, to a rate of 30 per cent., in some cases to rates of 25 and 20 per cent. The system then established has often been spoken of as a free trade system, but was in reality only a system of moderated protection. In 1857 duties were still further reduced, the rate on most protected commodities going down to 24 per cent., and remaining at this comparatively low level until the outbreak of the Civil War.

1846–60.

The second great period in the tariff history of the United States opens with the Civil War. It is true that the first steps towards a policy of higher protection were taken just before the war began. In the session of 1860–61, immediately preceding the outbreak of the conflict, the Morrill Tariff Act was passed by the Republican party, then in control because the defection of Southern members of Congress had already begun. It substituted specific duties for the *ad valorem* duties of 1846 and 1857, and made some other changes of significance, as in the higher duties upon iron and steel. Nevertheless, the advances then made were of little importance as compared with the far-reaching increases of duty during the Civil War. These formed part of the general resort to every possible fiscal device. The great struggle compelled every resource to be strained to the utmost: the issue of long-time bonds, continual borrowing in very large amounts on short-time inconvertible paper money, an elaborate and all-pervading system of internal taxes, and, finally, heavy import duties. The internal taxes of the war were applied not only in the form of income taxes, stamp taxes, licence and gross receipts taxes, but also as direct excise taxes on many commodities. The import duties were correspondingly raised, partly by way of off-set to the internal taxes, partly as a means of getting additional revenue, and finally in some degree because of a disposition to protect domestic industries. The most important acts were the great revenue acts of 1862 and 1864. Some further changes were made in 1865, and the close of the war thus left the United States with a complicated system of very high taxes both on imported duties and on domestic products.

The War tariff, 1862-64.

The main features of the tariff history of the United States since the Civil War have been that the internal taxes have been almost entirely swept away, the import duties on purely revenue articles similarly abolished, while those import duties that operated to protect domestic industries have been maintained, and indeed in many cases increased. The situation has had some analogy to that of France from 1815 to 1860, when similarly a highly restrictive system established during a period of war was unexpectedly retained long after peace had been established. This result in the United States came about by gradual steps and without premeditation. After the close of the war efforts were first directed to clearing the financial situation by funding the floating debt, and taking steps (never fully consummated) towards contracting the currency. Next the internal taxes were gradually done away with, until nothing was left except the excise on beer, spirits and tobacco. No further resort was made to internal taxes until the revenue act of 1898 was passed, at the outbreak of the Spanish War. Efforts were made also to reduce the tariff duties, but these naturally came last: they met with strong opposition, and in the end they were almost completely frustrated, thus leaving as the basis of the tariff the rates which had been levied in the course of the war. In 1870 some rearrangements were made, the duties on iron and on some other articles being reduced. In 1872 a more general reduction was carried out, strongly resisted by the Protectionists, and finally ending in a uniform cutting off of 10 per cent. from all the import protective duties. In 1875, however, when the revenue had become deficient after the crisis of 1873, the 10 per cent. reduction was repealed, and duties restored to their previous amounts. It deserves to be noted that in 1872 an important step was also taken towards removing entirely the duties on purely revenue articles, tea and coffee being then admitted free of duty. On the other hand, the maintenance of the protective duties, and the gradual consolidation of feeling in favour of a permanent policy of strong protection, led to other revisions and rearrangements in the direction of protection. In 1867 an important act on wool and woollens was passed, largely increasing the duties on both. In 1869 the duty on copper was raised. In 1870, while some duties were lowered, others were raised, as, for instance, those on steel rails and on marble. Thus the ten years immediately following the close of the war brought about the gradual transformation of the high duties levied on all commodities for revenue purposes into a system of high duties almost wholly on protective commodities. This transformation met with much opposition, not less in the Republican party than in the Democratic party. While the feeling in the Republican party had been from the outset in favour of protection, so high a range of duties met with much opposition. This opposition led to an important general revision in 1883, largely influenced by the recommendations of a special Tariff Commission which Congress created in 1882. The act of 1883 was passed in the main as a party measure by the Republicans, and on the whole served rather to put in order the protective system as it stood than to make any change of policy. Certain duties were reduced (though in no case greatly reduced) such as those upon wool, some woollens, cheaper grades of cotton cloths, iron, steel rails, copper. On the other hand, on many articles duties already high, but believed to be insufficient for the effective protection of the domestic producer, were raised; *e.g.*, on finer woollens and cottons, on some iron and steel manufactures.

Gradual consolidation of war duties.

Revision of 1883.

The tariff system as revised and codified in 1883 would probably have remained unchanged for many years had it not been for the turn taken by political and financial history. The decade from 1880 to 1890 was one of great prosperity, consequently of rising imports, consequently of swelling customs revenue. In the second half of the decade a continuous large surplus in the Treasury necessarily directed attention to the state of the revenue, and gave strength to the protests against excessive taxation. In addition, the Democratic party, which had long been committed, though in a half-hearted way, against the policy of high protection, was brought to a vigorous and uncompromising attack on it through the leadership of President Cleveland. In his Presidential Message of December 1887 he attacked the protective system in unqualified terms; and in the session of 1887–88 the Democratic majority in the House of Representatives prepared a bill providing for great reductions. The control of the Senate by the Republicans prevented any legislation. But the Republicans, as is almost inevitable under a party system, championed the policy opposed by the other side, and declared themselves not only in favour of the maintenance of existing duties, but of the consistent and unqualified further application of protection. The protection question thus became the main issue in the Presidential election of 1888, which resulted in the defeat of the Democrats. In the next ensuing session of Congress, in 1889–90, the Republicans passed a new tariff act, known as the McKinley Tariff Act, because Mr McKinley was then chairman of the House Committee in charge of the bill. It advanced duties materially on a considerable number of commodities, both raw materials and manufactured articles. The duties on wool were raised, corresponding changes made on woollen goods, the duties on cottons, linens, some silks, and velvets considerably raised. A further step towards consolidating the protective system was taken by abolishing the duty on sugar, mainly a revenue duty. The necessity for reducing the revenue and cutting down the continued surplus was met in this way rather than by lowering the protective duties. For consistency in maintaining the protective principle a direct bounty was given to the domestic producers of sugar in Louisiana. A turn in the political wheel brought an abrupt change four years later, in 1894. The tariff question was again the issue in 1892: President Cleveland, defeated four years before, was now again elected, and the Democratic party came into power, pledged to change the tariff system. Accordingly in the first ensuing session of the Congress elected in 1892 the tariff act of 1894 was passed, known as the Wilson Tariff, bringing about considerable reductions of duty. The measure, however, was less incisive than its chief sponsors had planned, because of the narrow majority commanded by the Democrats in the Senate. Some of the Democratic senators were lukewarm in their support of the party policy of tariff reduction, and joined with the Republicans in mitigating the changes. Nevertheless some crucial changes were made. The duty on wool, typical among the duties on raw materials, was completely abolished, and with this change came a great reduction in the duties upon woollen goods. Changes, but of less importance, were made on other

McKinley tariff of 1890.

Wilson tariff of 1894.

textile goods. The House had proposed to remove also the duties on coal and on iron ore, but the Senate permitted only a reduction in these. A duty was reimposed on sugar, chiefly as a means of securing needed revenue, but at a less rate than had existed before 1890. At the same time the differential duty on refined sugar, which operated as protection to the sugar trust, was not abolished, as the ardent tariff reformers had proposed, but kept in substance not greatly changed. This circumstance, as well as the failure to make other desired reductions, caused the ardent tariff reformers to be greatly disappointed with the act of 1894 as finally passed, and led President Cleveland to permit it to become law without its endorsement by his signature. The next election in 1896 brought still another turn in the political wheel, the Republicans being once more brought into power under the leadership of President McKinley. The currency issue had been foremost in the campaign, but the Republicans had also proclaimed themselves in favour of a return to the unqualified protective system. At the extra session which President McKinley called in 1897, almost the sole measure considered was the tariff act, known (again from the name of the chairman of the House Committee) as the Dingley Act. This reimposed the duties upon wool, on most qualities at the precise rates of 1890, on some qualities at even higher rates. Necessarily the duties on woollens were correspondingly raised, and here again made even higher than they had been in 1890. On other textiles, particularly on silks and linens, similar advances were made. As a rule, the duties of 1890 were either retained or somewhat advanced. To this policy, however, there was a significant exception in the iron and steel schedule, where the reduced duties of 1894 were left mainly unchanged. The iron industry in the United States had made extraordinary advances, and confessedly was not in need of greater protection than had been given in 1894. Some provisions for reciprocity arrangements with other countries, opening the way for possible reductions of duty by treaty arrangements, were also incorporated in the act of 1897, though with limitations which made it improbable that any considerable changes would ensue from this policy. Some such provisions had also been contained in the act of 1890, but here also without important results. The tariff system of the United States at the beginning of the 20th century thus remained rigidly and unqualifiedly protective, with rates higher than those of even the most restrictive tariffs of the countries of the European continent.

Dingley tariff of 1897.

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TARIJA, or TARIXA, a department and town of south-eastern Bolivia. The department lies on the northern frontier of Argentina, and is bounded W. by Potosí, N. by Chuquisaca, and E. by Paraguay. Pop. (1900) 102,887. Area, 33,036 sq. m. The eastern and larger part of the department belongs to the great Chaco region. The Chaco districts are inhabited by small nomadic tribes of Indians, and the grassy Llanos de Manzo by the Chiriguanos, one of the strong Indian nations of South America. They are considered a branch of the Guarany race, and live in permanent villages, breed horses, cattle and sheep, and till the soil. Near the Argentine frontier are the less civilized tribes of the Tobas, and in the mountainous districts are remnants of the Quichuas, once masters of an empire.

The capital, SAN BERNARDO DE TARIJA (pop. 1900, 6980; 1906, estimate, 7817), is the only town of importance in the department. It is situated on the Rio Grande de Tarija, about 100 m. E. of Tupiza. It is about 5800 ft. above sea level and its climate is mild and healthy. The town was founded in 1577 by Luiz de Fuertes, by orders of the Viceroy of Peru, as a military post to hold the Chiriguanos in check. About the same time the Jesuits established themselves here, and the most important building in the town is their convent, afterwards occupied by the Franciscans.

TARIM, the principal river of Chinese or Eastern Turkestan, in the middle of Asia. It rises in two head-streams, (1) the Kashgar-darya, which springs as the Kyzyl-su on the N. versant of the Pamir plateau, not far from another Kyzyl-su or the Vakhsh, which flows down the Alai valley to join eventually the Amu-darya, and (2) the Yarkand-darya, which gushes out under the name of the Raskan-darya, on the N. slope of the Karakorum Mountains, just under the Karakorum pass. The former stream flows almost due E. past the city of Kashgar until it joins the Yarkand or Yarkent-darya. The latter, after skirting, in a deep gorge and in a north-western direction, the S. foot of the Sughet Mountains and then of the Raskem Mountains, both constituent members of the western Kuen-lun, forces its way out into the lowlands of Eastern Turkestan and flows N. past the city of Yarkand, then turns N.E. and traverses in a gigantic arc the N.W., N., and E. margins of the vast desert of Takla-makan. Of these two streams Dr Sven Hedin concedes the honour of being the mother river to the Yarkand-darya, on the ground both of its length and of its volume; indeed for some months in the year the Kashgar-darya, mainly owing to the drain made upon it for irrigation purposes after it debouches upon the lowlands, fails to get through to the Yarkand-darya, whereas the Yarkand-darya, on the other hand, never dries up.

The Kashgar-darya enters the Yarkand-darya by a wide delta of anastomosing arms, beginning in the vicinity of Maral-bashi (39° 49′ N. and 78° 33′ E.). The conjoint river, bearing the name of the Yarkand-darya, flows for some 230 m. N.E. until it encounters the Ak-su-darya from the N. Along this part of its course the river is full of minor sinuosities, with a deep, narrow channel, a sluggish current, and high steep banks, bordered by forests of poplars and thickets of reeds. The Ak-su-darya, which rises at an altitude of 11,000 ft. as the Ak-sai near the S.W. extremity, but on the W. side, of the Kokshal-tau range of the Tian-shan Mountains, soon breaks through that range and proceeds to flow E.N.E. along its southern foot, but under the name of the Taushkan-darya, until it reaches the town of Ak-su in 80° 41′ E. and 40° 28′ N. Thence it flows S. and S.E. and effects a junction with the Yarkand-darya (Tarim) in about 81° E. The Ak-su, which is swift and brings down large quantities of sediment, infuses new vigour into the main river, giving it an impulse which carries it all the way down to the Kara-koshun.

About 20 m. farther down, the Yumalak-darya or Tarim, as the river then begins to be called, is joined on the right or S. by the Khotan-darya, a stream which rises in the N. ranges of the Kuen-lun Mountains, and fights its way across the all-engulfing sands of the desert of Takla-makan, but with such poor results that it is only about forty days in the year that it makes any contribution to the volume of the Tarim. Some 180 to 190 m. below the confluence of the Ak-su-darya, the river begins to come into direct conflict with the sand-dunes of the great desert, which it has thus far successfully skirted. At the same time it begins to waste its strength in filling marginal or lateral lakes, formed in the hollows between the big sand-dunes (they reach elevations of as much as 300 ft.).

In about 86° 30′ E., near the station of Karaul, the river begins to break up in deltaic fashion, and in a long secular process, using Karaul as a sort of pivot, appears to oscillate backwards and forwards like a pendulum from N. to S., and from S. back again to N. between the lake of Kara-koshun (N. M. Przhevalsky's Lop-nor) at the N. foot of the Astin-tagh (see LOP-NOR), and the basin at the S. foot of the Kuruk-tagh (see GOBI), which Baron von Richthofen and Dr Sven Hedin identify with the ancient Lop-nor of the old Chinese geographers. From Karaul down to Ayrilghan or Arghan, a distance of over 200 m., the Tarim skirts the N.E. front of the high sand-dunes of the great desert, spending itself in numerous marginal lakes all the way down, while on the opposite bank (left) it leaves numerous interlacing branches behind it, like the Kunchekish-tarim, Lashin-darya, Yätim-tarim, Ilek, and Tokuz-tarim. None of its marginal lakes is round in shape, but all are elongated, from N. to S. or from N.W. to S.E. This is the general rule, but there is a second series of lakes beside the river which are drawn out from N.E. to S.W. These owe their existence primarily to the action of the wind. Here too, in its delta, the Tarim overflows into more than one chain of a third category of lakes (*e.g.* Avullu-kol, Kara-kol, Tayek-kol, and Arka-kol), strung on one or other of its anastomosing deltaic arms. These generally act as regulators and clarifiers, the river emerging from them with crystal-bright water.

Near the head of its delta the Tarim is joined from the N. by the Koncheh-darya, a stream which issues from the lake of Bagrash-kul, its ultimate source being the Khaidu-gol or Khaidyk-gol, which drains the Yulduz valleys of the eastern Tian-shan Mountains. This river, which measures 290 m. from the Bagrash-kul to the Kara-koshun, serves, with the help of the poplar forest which grows along its left bank, as a dam to check the westward movement of the desert sands. Finally the Tarim enters, by a number of arms, the series of shallow, dwindling lakes of Kara-buran, which serve as a sort of lacustrine ante-room to the real terminal basin of the river, the Kara-koshun, which lies a little farther to the E., in 40° N., 89° 30′ E., at an altitude of 2675 feet above sea-level. In 1900–01 Dr Sven Hedin discovered several fresh desert lakes forming to the N. of Kara-koshun, and branches of the deltaic arms of the Tarim, or overflows of such branches, straining out in the same direction, facts which he interpreted as a tendency of the river to revert to its former more northerly terminal basin of the old (Chinese) Lop-nor.

The river not only dwindles vastly between the confluence of the Ak-su (*e.g.* 16,780 cub. ft. in the second in June) and its embouchure in the Kara-koshun (5650 cub. ft. in the second), but keeps on lifting its bed and its current, like the Po and the Hwang-ho, above the level of the adjacent country. The total fall from the confluence of the Ak-su-darya (3380 ft.) to the Kara-koshun (2675 ft.), a distance of some 665 m., is only 705 ft., giving an average of very little more than a foot per mile. The total length of the river is probably somewhere near 1000 m. On the whole the Tarim is step by step and year by year steadily but slowly working its way towards the S.W., for all along its lower course it is accompanied by a belt, some 50 m. wide, which lies at a lower level or altitude than itself. In its actual delta this tendency is counterbalanced by its incipient oscillation backwards towards the N., towards the desiccated lake basin of the old Lop-nor. Although the river drains the vast area of 354,000 sq. m., it is only from 172,000 sq. m. of this (48·8 per cent.) that it derives any augmentation of volume. The remaining 182,000 sq. m. (51·2 per cent.) of the potential catchment area fails to contribute one drop of water, being nothing but arid, rainless desert. Throughout the catchment-basin of the Tarim the precipitation is governed by the general law, that it increases from N. to S. and from E. to W. Hence, in conformity with this, the largest affluents are in the west. In general shape the basin of the Tarim is elliptical, but the lowest part lies near the extreme E. end of the ellipse. "If the deepest part of the basin lay beyond the long axis of the ellipse the symmetry would be ideal; but, situated as it is at the southern foot of the Tian-shan, it has occasioned a dislocation towards the N. of the main stream of the system. . . . If we compare the northern peripheral zone from the catchment area of the Kashgar-darya to the catchment area of the Kuruk-tagh, both inclusive, with the southern peripheral zone from the catchment area of the Yarkand-darya to the catchment area of the Astin-tagh, both again inclusive, we find that the former has an area of 82,990 sq. m., and the latter an area of 89,550 sq. m., or, in other words, that they are approximately of the same size. In the case of both the breadth decreases on the whole towards the E., until they each terminate in a narrow strip, the domain of the Kuruk-tagh on the one hand and that of the Astin-tagh on the other. But before they contract in this way the zones swell out into the Khaidu-gol and the Cherchen-darya and Kara-muran respectively. . . . A corresponding symmetry can also be seen in the rivers which gather off the encircling mountains into the depression," [1] the Kashgar-darya balancing the Yarkand-darya, the Ak-su-darya balancing the Khotan-darya, the Koncheh-darya balancing the Cherchen-darya, and so on.

The Tarim begins to freeze about the end of November and the freezing advances upwards against the current. When the ice of the river thaws in the beginning of March it sets up a spring flood, which in magnitude and volume falls little short of the flood caused by the melting of the snows on the mountains about the head-streams and feeders of the river, and the course of which can be traced all down the Tarim during the summer and autumn. The river abounds in fish, especially in the lower part of its course. Fish forms the staple food of a large part of the riverine population.

See Sven Hedin, *Scientific Results of a Journey in Central Asia, 1899–1902* (vols. i. and ii., Stockholm, 1905–06), and *Central Asia and Tibet* (2 vols., London, 1903). (J. T. Be.)

[1] Sven Hedin, *Scientific Results*, ii. 524–25.

TARKANI, or Tarkalanri, a Pathan tribe inhabiting the whole of Bajour (*q.v.*), on the border of the North-West Frontier Province of India. Subdivided into Mamunds, Isazai and Ismailzai, the tribe numbers some 100,000 persons.

TARLETON, SIR BANASTRE (1754–1833), English soldier, was the son of John Tarleton (1719–1773), a Liverpool merchant, and was born in Liverpool on the 21st of August 1754. Educated at Oxford he entered the army, and in December 1775 he sailed as a volunteer to America with Earl, afterwards Marquess, Cornwallis, and his services during the American War of Independence in the year 1776 gained for him the position of a brigade major of cavalry. He was present at the battle of Brandywine and at other engagements in 1777 and 1778, and as the commander of the British legion, a mixed force of cavalry and light infantry, he proceeded at the beginning of 1780 to South Carolina, rendering valuable services to Sir Henry Clinton in the operations which culminated in the capture of Charleston. He was responsible for a British victory at Waxhaw in May 1780, and he materially helped Cornwallis to win the battle of Camden in the succeeding August. He was completely victorious in an engagement with Thomas Sumter at Fishing Creek, or Catawba Fords, but was not equally successful when he encountered the same general at Blackstock Hill in November 1780; then in January 1781, in spite of much personal valour, he was defeated with heavy loss at Cowpens. Having been successful in a skirmish at Tarrants House, and having taken part in the battle of Guilford in March 1781, he marched with Cornwallis into Virginia, and after affording much assistance to his commander-in-chief he was instructed to hold Gloucester. This post, however, was surrendered to the Americans with Yorktown in October 1781, and Tarleton returned to England on parole. In 1790 he entered parliament as member for Liverpool, and with the exception of a single year he remained in the House of Commons until 1812. In 1794 he became a major-general; in 1812 a general; and he held a military command in Ireland and another in England. In 1815 he was made a baronet. He died without issue at Leintwardine in Shropshire on the 25th of January 1833.

For some time Tarleton lived with the actress Mary Robinson (Perdita), and his portrait was painted both by Reynolds and by Gainsborough. Sir Banastre wrote a *History of the Campaigns of 1780 and 1781 in the Southern Provinces of North America* (London, 1781), which, although of some value, is marred by the author's vanity and by his attacks on Cornwallis. It was criticized by Colonel Roderick Mackenzie in his *Strictures on Lieutenant-Colonel Tarleton's History* (1781) and in the *Cornwallis Correspondence*.

TARLTON, RICHARD (d. 1588), English actor, was probably at one time an inn-keeper, but in 1583, when he is mentioned as one of the original company of queen's players, was already an experienced actor. He was Elizabeth's favourite clown, and his talent for impromptu doggerel on subjects suggested by his audience has given his name to that form of verse. To obtain the advantage of his popularity a great number of songs and witticisms of the day were attributed to him, and after his death *Tarlton's Jests*, many of them older than he, made several volumes. Other books, and several ballads, coupled his name with their titles. He is said to have been the Yorick of Hamlet's soliloquy.

TARN, a river of southern France, tributary to the Garonne, watering the departments of Lozère, Aveyron, Tarn, Haute-Garonne and Tarn-et-Garonne. Length, 234 m. Area of basin, 5733 sq. m. Rising on the southern slope of Mt. Lozère at a height of 5249 ft., the Tarn flows westward and, having received the Tarnon, enters the gorge, famed for its beauty, which separates the Causse de Sauveterre from the Causse Méjan. Emerging from this cañon after a course of 37 m. it receives the Jonte on the left and, still flowing through gorges, passes between the Causse Noir, the Larzac plateau and the Causse de St Affrique (at the foot of which it receives the Dourdou de Vabre) on the left and the Lévezou range and the Plateau of Ségala on the right. In this part of its course the most important town is Millau, where it receives the Dourbie. At the cascade of Sabo, above Albi, the river enters the plains and, flowing in a deep bed, passes Albi and Gaillac, some distance below which, at the confluence of the Agoût, it exchanges a west-south-westerly for a north-westerly course. At Montauban the Tarn receives the Tescou and 6 m. farther on unites with the Aveyron. It then reaches Moissac, 2½ m. below which it flows into the Garonne.

TARN, a department of south-western France, formed in 1790 of the three dioceses of Albi, Castres and Lavaur, belonging to the province of Languedoc. Pop. (1906) 330,533. Area, 2231 sq. m. Tarn is bounded N. and E. by Aveyron, S.E. by Hérault, S. by Aude, S.W. and W. by Haute-Garonne, N.W. by Tarn-et-Garonne. The slope of the department is from east to west, and its general character is mountainous or hilly; its three principal ranges, the Mountains of Lacaune, the Sidobre, and the Montagne Noire, belonging to the Cevennes, lie on the south-east. The stony and wind-blown slopes of the first-named are used for pasturage. The highest point of the range and of the department is the Pic de Montalet (about 4150 ft.); several other summits are not much short of this. The granite-strewn plateaus of the Sidobre, from 1600 to 2000 ft. high, separate the valley of the Agoût from that of its left-hand affluent the Thoré. The Montagne Noire, on the southern border of the department, derives its name from the forests on its northern slope, and some of its peaks are from 3000 to 3500 ft. high. The limestone and sandstone foot-hills are clothed with vines and fruit trees, and are broken by deep alluvial valleys of extraordinary fertility. With the exception of a small portion of the Montagne Noire, which drains into the Aude, the whole department belongs to the basin of the Garonne. The eastern portion of the department has the climate of Auvergne, the severest in France, but that of the plain is Girondin. At Albi the mean temperature is 55°. The rainfall, 29 or 30 ins. at that place, exceeds 40 ins. on the Lacaune and Montagne Noire.

The most noteworthy places in the department are Albi, the capital, Castres, Gaillac, Lavaur, Mazamet and Cordes, which are separately treated. Other places of interest are Burlats, which has ruins of an old church and château; Lisle d'Albi, a *bastide* with a church of the 14th century; and Penne, which has ruins of a fine medieval château.

TARN (O. Eng. *tarne*, Scand. *tjarn*, *tjärn*, *tjörn*, &c.), a name applied in England (especially in the Lake District) and in Scotland to small lakes or pools in mountainous districts, especially to such as have no visible affluent streams. The term is sometimes used also of a marsh or bog.

TARN-ET-GARONNE, a department of south-western France, formed in 1808 of districts formerly belonging to Guienne and Gascony (Quercy, Lomagne, Armagnac, Rouergue, Agenais), with the addition of a small piece of Languedoc. From 1790 to 1808 its territory was divided between the departments of Lot, Haute-Garonne, Tarn, Aveyron, Gers and Lot-et-Garonne. It is bounded N. by Lot, E. by Aveyron, S. by Tarn and Haute-Garonne, and W. by Gers and Lot-et-Garonne. Area, 1440 sq. m. Pop. (1906) 188,553. The department is watered by three rivers, the Garonne, the Tarn, which joins the Garonne below Moissac, and the Aveyron, which flows into the Tarn between Moissac and Montauban, dividing it into three distinct regions of hills. Those to the south-west of the Garonne are a continuation of the plateau of Lannemezan; ramifications of the Cevennes extend between the Garonne and the Tarn, and between the Tarn and the Aveyron; the region to the north of the continuous valley formed by the courses of the three rivers belongs to the Central Plateau. The *causse* or limestone plateau of Quercy occupies the north-east corner of the department and includes its highest point (1634 ft.). The lowest point (164 ft.) is at the exit of the Garonne. The climate is mild and agreeable; the mean annual temperature being about 56° F. Rain falls seldom, but heavily, especially in spring, the annual rainfall being 28 or 30 ins.

The wide alluvial valleys of the three large rivers are most productive. Cereals, especially wheat, maize and oats, occupy more than two-thirds of the arable land of the department. The vine is everywhere cultivated and large quantities of grapes are exported as table fruit. Potatoes are also grown. Plums and apricots are abundant. The breeding of horses, especially for cavalry purposes, is actively carried on; and the rearing of horned cattle, both for draught and for fattening, is also important. Sheep, pigs, poultry and, in a minor degree, silk-worms, are also sources of profit. The manufacturing industry is represented by flour-mills, metal-foundries, tanneries, various kinds of silk-mills, and manufactories of linen, wool and paper. The principal exports are fruit, wine, flour, truffles from the Rouergue, poultry, phosphates and lithographic stone. Imports include raw materials for textile industries, timber, iron, wood-pulp, coal and agricultural produce. The canal of the Garonne traverses the department for 48 m. and the Garonne and the Tarn furnish 82 m. of navigable waterway. The department is served by the Orleans and the Southern railways. The department forms the diocese of Montauban, and belongs to the jurisdiction of the Toulouse court of appeal, to the *académie* (educational division) of Toulouse, and to the district of the XVII. corps d'armée (Toulouse). It has 3 arrondissements (Montauban, Moissac and Castelsarrasin), 24 cantons and 195 communes.

Montauban, Moissac and Castelsarrasin are the principal places. Other towns of interest are St Antonin, which has tanneries and manufactures of rough fabrics and is archaeologically important for its possession of a massive hôtel de ville of the 12th century, the oldest in France; Bruniquel, which is splendidly situated overlooking the valleys of the Aveyron and the Vère, and is dominated by a medieval castle with a donjon of the 11th century; Beaumont-de-Lomagne, a curious *bastide* of the 13th century with a fortified church of the 14th century; Montpezat-de-Quercy, which has a church of the same period, containing many precious antiquities; Varen, an ancient town of narrow streets and old houses with a remarkable Romanesque church and the ruins of a castle of the 14th and 15th centuries; and Ginals, where remains of the Cistercian abbey of Beaulieu, founded in 1141, are still to be seen.

TARNOPOL, a town in Galicia, Austria, 87 m. E.S.E. of Lemberg by rail. Pop. (1900) 30,368, half of which are Jews. Industry consists chiefly in corn-milling and the preparation of wax and honey. The principal trade is in horses, corn and other agricultural produce, and spirits. Tarnopol was formerly a fortress, and rendered valuable services to Polish kings, who in their turn conferred upon it important privileges.

TARNOW, a town in Galicia, Austria, 164 m. W.N.W. of Lemberg by rail. Pop. (1900) 31,691, about 40 per cent. Jews. It is situated on the river Biala, not far from its junction with the Dunajec, and is the seat of a Roman Catholic bishop. It possesses a cathedral in Gothic style, built in the 15th century, with monuments of the Tarnowski and Ostrogski families, to which the town formerly belonged, and another church built in 1454. On the Martinsberg, an eminence near the town, stands the ruins of the old castle of the Tarnowski family, and a small church over 800 years old. Worth mentioning also is the town hall, an old and interesting building. Agricultural implements, glass and chicory are manufactured.

TARNOWSKI, JAN [called MAGNUS] (1488–1561), Polish general. After a careful education beneath the eye of an excellent mother and subsequently at the palace of Matthew Drzewicki, bishop of Przemysl, he occupied a conspicuous position at court in the reigns of John Albert, Alexander and Sigismund I. As early as 1509 Tarnowski brilliantly distinguished himself in Moldavia, and took a leading part in the great victories of Wisniowiec (1512) and Orsza (1514), where he commanded the flower of the Polish chivalry. To complete his education he then travelled in Palestine, Syria, Arabia, Egypt, and northern and western Europe. While in Portugal he received from King Emanuel the chief command in the war against the Moors, and Charles V. rewarded his services in the Christian cause with the dignity of a count of the Empire. Indeed, the emperor had such a high regard for Tarnowski that he offered him the leadership of all the forces of Europe in a grand expedition against the Turks. On the death of Nicholas Firlej in 1526 Tarnowski became grand hetman of the crown, or Polish commander-in-chief, and in that capacity won his greatest victory at Obertyn (22nd August 1531) over the Moldavians, Turks and Tatars, for which he received a handsome subsidy and an ovation similar to that of an ancient Roman triumphator. Heartily attached to King Sigismund I. and his son Sigismund Augustus, Tarnowski took the royal side during the so-called *Kokosza wojna*, or *Poultry War*, of 1537;

and also in 1548 when the turbulent *szlachta* tried to annul by force the marriage of Sigismund Augustus with Barbara Radziwill. In 1553, however, we find him in opposition to the court and thwarting as much as possible the designs of the young king. Nevertheless Tarnowski was emphatically an aristocrat and an oligarch, proud of his ancient lineage and intensely opposed to the democratic tendencies of the *szlachta*. A firm alliance between the king and the magnates was his ideal of government. On the other hand, though a devout Catholic, he was opposed to the exclusive jurisdiction of the bishops and would even have limited the authority of Rome in Poland. As a soldier Tarnowski invented a new system of tactics which greatly increased the mobility and the security of the armed camps within which the Poles had so often to encounter the Tatars. He also improved discipline by adding to the authority of the commanders. His principles are set forth in his *Consilium Rationis Bellicae* (best edition, Posen, 1879), which was long regarded as authoritative. As an administrator he did much to populate the vast south-eastern steppes of Poland.

See Stanislaw Orzechowski, *Life and Death of Jan Tarnowski* (Pol.) (Cracow, 1855). (R. N. B.)

TAROK, a game of cards very popular in Austria and Germany, and played to a limited extent in some parts of France. Special cards are used, and the rules are complicated. The name *Tarot* was originally given by the Italians to a certain card in the pack as early as the 13th century, but was afterwards applied to the game itself.

TAROM, a district of Persia, situated on the borders of Gilan, north-west of Kazvin. It is divided into upper and lower Tarom; the former, on the right bank of the Kizil Uzain (Sefid Rud) river, is a crown domain; the latter, on the left bank, forms part of the province of Kazvin. It produces much cotton and fruit, and derives a considerable revenue from its alum mines at Zajkanin. Most of the alum is exported to Russia. It also has a few olive groves. The inhabitants are Turks.

TARPAULIN, or Tarpauling (as if *tarpalling*, from *tar*, and *palling*, a covering, Lat. *palla*, a mantle), a heavy, well-made, double warp plain fabric, of various materials, used chiefly in the manufacture of covers for railway and other waggons and for protecting goods on wharves, quays, &c. To make it proof against rain and other atmospheric influences it is generally treated with tar, though various compositions of different kinds are also employed, especially for the finer fabrics such as are used for covering motor-cars. These covers are generally made of flax, hemp and cotton, and are very similar to canvas—indeed, large quantities of canvas are made waterproof, and then called tarpaulin. A very large quantity of tarpaulin is made entirely of jute. The chief seats of manufacture are Dundee, Arbroath and Kirkcaldy. Formerly the word was used as a sort of nickname for a sailor, the modern "tar" in the same sense being an abbreviation of it.

TARPEIA, in Roman legend, daughter of the commander of the Capitol during the war with the Sabines caused by the rape of the Sabine women. According to the common story, she offered to betray the citadel, if the Sabines would give her what they wore on their left arms, meaning their bracelets; instead of this, keeping to the letter of their promise, they threw their shields upon her and crushed her to death. Simylus, a Greek elegiac poet, makes Tarpeia betray the Capitol to a king of the Gauls. The story may be an attempt to account for the Tarpeian rock being chosen as the place of execution of traitors. According to S. Reinach, however, in *Revue archéologique*, xi. (1908), the story had its origin in a rite—the taboo of military spoils, which led to their being heaped up on consecrated ground that they might not be touched. Tarpeia herself is a local divinity, the manner of whose death was suggested by the tumulus or shields on the spot devoted to her cult, a crime being invented to account for the supposed punishment.

Authorities.—Sir George C. Lewis, *Credibility of early Roman History*; A. Schwegler, *Römische Geschichte*, bk. ix. 10; Livy, i. 11; Dion. Halic., ii. 38–40; Plutarch, *Romulus*, 17; Propertius, iv. 4; Ovid, *Fasti*, i. 261; C. W. Müller, *Frag. Hist. Graec.*, iv. p. 367.

TARQUINII (mod. *Corneto Tarquinia, q.v.*), an ancient city of Etruria, Italy, situated on a hill overlooking the S.W. coast of Italy, about 5 m. N.W. of it. The site of the Roman town is now deserted, its last remains having been destroyed by the inhabitants of Corneto in 1307. Scanty remains of walling and of buildings of the Roman period exist above ground; traces of a large rectangular platform were found in 1876, and part of the thermae in 1829; it occupied the summit of a hill defended by ravines, called Piano di Civita. It seems probable, however, that the original settlement occupied the site of the medieval town of Corneto, to the W.S.W., on the further side of a deep valley. Some authorities indeed consider, and very likely with good reason, that this was the site of the Etruscan city, and that the Piano di Civita, which lies further inland and commands but little view of the sea, was only occupied in Roman times. The case would be parallel to others in Etruria, *e.g.* Civita Castellana (anc. *Falerii*) which also occupies the site of the Etruscan city, while the Roman site, some distance away, is now abandoned. The importance of Tarquinii to archaeologists lies mainly in its necropolis, situated to the S.E. of the medieval town, on the hill which, from the tumuli raised above the tombs, bears the name of Monterozzi. The tombs themselves are of various kinds. The oldest are *tombe a pozzo*, or shaft graves, containing the ashes of the dead in an urn, of the Villanova period, the oldest of them probably pre-Etruscan; in some of these tombs hut urns, like those of Latium, are found. Next come the various kinds of inhumation graves, the most important of which are rock-hewn chambers, many of which contain well-preserved paintings of various periods; some show close kinship to archaic Greek art, while others are more recent, and one, the Grotta del Tifone (so called from the typhons, or winged genii of death, represented) in which Latin as well as Etruscan inscriptions appear, belongs perhaps to the middle of the 4th century B.C. Fine sarcophagi from these tombs, some showing traces of painting, are preserved in the municipal museum, and also numerous fine Greek vases, bronzes and other objects.

Tarquinii is said to have been already a flourishing city when Demaratus of Corinth brought in Greek workmen. It was the chief of the twelve cities of Etruria, and appears in the earliest history of Rome as the home of two of its kings, Tarquinius Priscus and Tarquinius Superbus. From it many of the religious rites and ceremonies of Rome are said to have been derived, and even in imperial times a *collegium* of sixty haruspices continued to exist there. The people of Tarquinii and Veii attempted to restore Tarquinius Superbus to the throne after his expulsion. In 358 B.C. the citizens of Tarquinii captured and put to death 307 Roman soldiers; the resulting war ended in 351 with a forty years' truce, renewed for a similar period in 308. When Tarquinii came under Roman domination is uncertain, as is also the date at which it became a municipality; in 181 B.C. its port, Graviscae (mod. Porto Clementino), in an unhealthy position on the low coast, became a Roman colony. It exported wine and carried on coral fisheries. Nor do we hear much of it in Roman times; it lay on the hills above the coast road. The flax and forests of its extensive territory are mentioned by classical authors, and we find Tarquinii offering to furnish Scipio with sailcloth in 195 B.C. A bishop of Tarquinii is mentioned in A.D. 456.

See L. Dasti, *Notizie Storiche archeologiche di Tarquinia e Corneto* (Rome, 1878); G. Dennis, *Cities and Cemeteries of Etruria* (London, 1883), i. 301 sqq.; *Notizie degli Scavi, passim*, especially 1885, 513 sqq.; E. Bormann in *Corp. Inscr. Lat.*, xi. (Berlin, 1888), p. 510 sqq.; G. Körte, *s.v.* "Etrusker" in Pauly-Wissowa, *Realencyklopädie*, vi. 730 sqq. (T. As.)

TARQUINIUS PRISCUS, LUCIUS, fifth legendary king of Rome (616–578 B.C.). He is represented as the son of a Greek refugee, who removed from Tarquinii in Etruria to Rome, by the advice of his wife, the prophetess Tanaquil. Appointed guardian to the sons of Ancus Marcius, he succeeded in supplanting them on the throne on their father's death. He laid out the Circus Maximus, instituted the "great" games, built the great sewers (*cloacae*), and began the construction of the temple of Jupiter on the Capitol. He carried on war successfully against the Sabines and subjugated Latium. He is said to have raised the number of the senators to 300, and to have doubled the number of the knights (see NAVIUS, ATTUS). The introduction of many of the insignia both of war and of civil office is assigned to his reign, and he was the first to celebrate a Roman triumph, after the Etruscan fashion, in a robe of purple and gold, and borne on a chariot drawn by four horses. He was assassinated at the instigation of the sons of Ancus Marcius.

The legend of Tarquinius Priscus is in the main a reproduction of those of Romulus and Tullus Hostilius. His Corinthian descent, invented by the Greeks to establish a close connexion with Rome, is impossible for chronological reasons; further, according to the genuine Roman tradition, the Tarquinii were of Etruscan, not Greek, origin. There seems to have been originally only one Tarquinius; later, when a connected story of the legendary period was constructed, two (distinguished as the "Elder" and the "Proud") were introduced, separated by the reign of Servius Tullius, and the name of both was connected with the same events. Thus, certain public works were said to have been begun by the earlier and finished by the later king; both instituted games, acquired the Sibylline books, and reorganized the army.

For the constitutional reforms attributed to Tarquinius, see ROME: *Ancient History*; for a critical examination of the story, Schwegler, *Römische Geschichte*, bk. xv.; Sir George Cornewall Lewis, *Credibility of early Roman History*, ch. 11; W. Ihne, *History of Rome*, i.; E. Pais, *Storia di Roma*, i. (1898), who identifies Tarquinius with Tarpeius, the eponymus of the Tarpeian rock, subsequently developed into the wicked king Tarquinius Superbus. Ancient authorities:—Livy i. 34–41; Dion. Hal. iii. 46–73; Cic. *de Repub.*, ii. 200.

TARQUINIUS SUPERBUS, LUCIUS, son of Lucius Tarquinius Priscus and son-in-law of Servius Tullius, the seventh and last legendary king of Rome (534–510 B.C.). On his accession he proceeded at once to repeal the recent reforms in the constitution, and attempted to set up a pure despotism. Many senators were put to death, and their places remained unfilled; the lower classes were deprived of their arms and employed in erecting splendid monuments, while the army was recruited from the king's own retainers and from the forces of foreign allies. The completion of the fortress-temple on the Capitoline confirmed his authority over the city, and a fortunate marriage of his son to the daughter of Octavius Mamilius of Tusculum secured him powerful assistance in the field. His reign was characterized by bloodshed and violence; the outrage of his son Sextus upon Lucretia (*q.v.*) precipitated a revolt, which led to the expulsion of the entire family. All Tarquinius's efforts to force his way back to the throne were vain (see PORSENA), and he died in exile at Cumae.

In the story certain Greek elements, probably later additions, may easily be distinguished. Tarquinius appears as a Greek "tyrant" of the ordinary kind, who surrounds himself with a bodyguard and erects magnificent buildings to keep the people employed; on the other hand, an older tradition represents him as more like Romulus. This twofold aspect of his character perhaps accounts for the making of two Tarquinii out of one (see TARQUINIUS PRISCUS). The stratagem by which Tarquinius obtained possession of the town of Gabii is a mere fiction, derived from Greek and Oriental sources. According to arrangement, his son Sextus requested the protection of the inhabitants against his father. Having obtained their confidence, he sent a messenger to Tarquinius to inquire the next step. His father made no reply to the messenger, but walked up and down his garden, striking off the heads of the tallest poppies. Sextus thereupon put to death all the chief men of the town, and thus obtained the mastery. The stratagem of Sextus is that practised by Zopyrus is the case of Babylon, while the episode of the poppy-heads is borrowed from the advice given by Thrasybulus to Periander (Herodotus iii. 154, v. 92). On the other hand, the existence in the time of Dionysius of Halicarnassus of a treaty concluded between Tarquinius and the inhabitants of Gabii, shows that the town came under his dominion by formal agreement, not, as the tradition states, by treachery and violence. The embassy to Delphi (see BRUTUS, LUCIUS JUNIUS) cannot be historical, since at the time there was no communication between Rome and the mainland of Greece. The well-known story of Tarquinius's repeated refusal and final consent to purchase the Sibylline books has its origin in the fact that the building of the temple of Jupiter Capitolinus, in which they were kept, was ascribed to him. The traditional account of his expulsion can hardly be historical. A constitutional revolution, involving such far-reaching changes, is not likely to have been carried out in primitive times with so little disturbance by a simple resolution of the people, and it probably points to a rising of Romans and Sabines against the dominion of an Etruscan family (Tarquinii, Tarchna) at that time established at Rome.

For a critical examination of the story see Schwegler, *Römische Geschichte*, bk. xviii.; Sir G. Cornewall Lewis, *Credibility of early Roman History*, ch. 11; E. Pais, *Storia di Roma*, i. (1898); and, for the political character of his reign, ROME: *Ancient History*. Ancient authorities:—Livy i. 21; Dion. Hal. v. 1–vi. 21.

TARRAGONA, a maritime province in the north-east of Spain, formed in 1833 from the southern part of the province of Catalonia, and bounded on the S.E. by the Mediterranean, N.E. by Barcelona, N. by Lerida, W. by Saragossa and Teruel, and S.W. by Castellon de la Plana. Pop. (1900) 337,964; area, 2505 sq. m. The Ebro flows through the southern portion of the province, and the other chief streams are the Gaya and the Francoli. These three rivers flow south into the Mediterranean. Below Tortosa, the Ebro forms a conspicuous marshy delta jutting out into the sea, but elsewhere the even south-westward curve of the coast-line is unbroken by any noteworthy headland or indentation. The province, although mountainous, is naturally fertile. The hills are clothed with vineyards, which produce excellent wines, and in the valleys are cultivated all kinds of grain, vegetables, rice, hemp, flax and silk. Olive, orange, filbert and almond trees reach great perfection, and the mountains yield rich pastures and timber trees of various kinds. The climate is temperate on the coast and in the centre, cold in the highlands, very warm and damp in the valleys and on the banks of the rivers as they near the sea. Manufactures are well advanced, and comprise silk, cotton, linen and woollen fabrics, velvet, felt, soap, leather and spirits. There are also many potteries and cooperages, and flour, paper and oil mills. Silver, copper, lead and other minerals have been found, and quarries of marble and jasper are worked in the hills. The fisheries produce more than £20,000 yearly. There are upwards of 250 m. of railways, which link together all the large towns, and include the important main lines along the coast and up the Ebro valley. The cities of Tarragona (pop., 1900, 23,423) and Tortosa (24,452), which are the principal seaports, and the towns of Reus (26,681) and Valls (12,625) are described in separate articles. Montblanch (5243) is the only other town with a population exceeding 5000. The people of Tarragona are, like almost all the inhabitants of Catalonia (*q.v.*), hardy, enterprising and industrious. Although the birth-rate considerably exceeds the death-rate, the population tends to decrease slightly, as many families emigrate.

TARRAGONA (anc. *Tarraco*), the capital of the Spanish province of Tarragona, a flourishing seaport, and the seat of an archbishop; at the mouth of the river Francoli, 63 m. by rail W.S.W. of Barcelona, in 41° 10′ N. and 0° 20′ E. Pop. (1900) 23,423. Tarragona is on the coast railway from Barcelona to Valencia, and is connected with the Ebro Valley Railway by a branch line to Reus. The picturesque old town, with its dark and steep alleys, occupies a rugged hill which rises abruptly from the sea to an altitude of about 550 ft. Its highest point, where the ancient citadel stood, is crowned by the cathedral, the seminary for priests, and the palace of the archbishop, who shares the title primate of Spain with the archbishop of Toledo. Many of the houses in this quarter are very old, and are built partly of Roman masonry; one such fragment, immured in the palace wall, is inscribed with the epitaph of a charioteer (*auriga*) who, it says, would rather have died in the circus than of fever. Massive ruined walls encircle the old town. Their lowest course is "Cyclopean," consisting of unhewn blocks about 12 ft. long and 6 ft. wide; Roman masonry of the Augustan age is superimposed. The six gates and the square towers are also, to a great extent, "Cyclopean." The palace, itself a building of the early 19th century, has an old fortified tower, and there are barracks and forts in the city; but Tarragona can no longer be regarded as a fortress capable of withstanding modern artillery, although it is officially classed as such.

The new town, divided from the old by one broad and shady avenue, the Rambla de San Carlos, and intersected by another, the more modern Rambla de San Juan, extends to the west and south along a low promontory which juts out into the Mediterranean. Its outlying districts merge into the Camp de Tarragona, a plain planted with vines and walnut, almond and olive groves. Tarragona cathedral is one of the noblest examples of early Spanish art. It is 320 ft. long and 103 ft. broad, and consisted originally of a nave, aisles, transepts with an octagonal lantern at the crossing, and an apsidal chancel. Several exterior chapels were added in later times, and on the south-east stands a 14th-century steeple raised on a Romanesque tower. The east end was probably begun in 1131 on the ruins of an earlier church, but the main body of the building dates from the end of the 12th century and the first half of the 13th, and is of transitional character,—the exuberant richness of the sculptured capitals being admirably kept in subordination by the Romanesque simplicity of the general design. Considerable changes were introduced at a later date; and the present west end of the nave cannot have been completed till late in the 14th century. On the north-east side is a cloister contemporary with the church, with which it communicates by a very fine doorway. The cloister contains much remarkable work, and the tracery of the windows bears interesting marks of Moorish influence. Two other noteworthy churches in the city are San Pablo and Santa Tecla la Vieja, both of the 12th century. There is a fine Roman aqueduct; the Roman amphitheatre was dismantled in 1491 to furnish stone for the eastern mole, though a few rows of seats are left near the sea-shore; and the museum contains a large collection of Roman antiquities. The Torreón de Pilatos is said to have been the palace of the Emperor Augustus; it was partly destroyed by the French in 1811 and now serves as a prison. Its name is connected with an old tradition that Pontius Pilate was a native of the city. Tarragona has also many public buildings, including the law courts, several hospitals, a provincial institute, training schools for teachers, and offices of the provincial and municipal governments. When the monks of the Grande Chartreuse were compelled to leave France, they settled at Tarragona in 1903, and established a liqueur factory; 20,000 cases of liqueur were exported in 1904 and 39,000 in 1905. A characteristic feature of Tarragona is the number of its underground storehouses for wine (bodegas); wine is exported in large quantities. There is a British steel file factory; chocolate, soap, flour, ironware, paper, pipes and salted fish are also manufactured. The harbour is at the extreme south-west of the new town. It was originally protected by a Roman breakwater, which was destroyed in the 19th century. The eastern mole, founded in 1491 and frequently enlarged, terminates in a lighthouse. Its length was 1400 yards in 1904, when the construction of a new section was begun. In each of the five years 1901–5 about 870 ships of 580,000 tons entered the port. Wine, oil, nuts, almonds and small quantities of lead and pig iron are exported; the imports include coal from Great Britain, grain from the Black Sea, staves and petroleum from the United States, dried codfish from Norway and Iceland, guano and phosphates. Close to the harbour and at the mouth of the Francoli is the fishermen's quarter (*barrio de pescadores*), in which most of the houses are coloured pale blue.

History.—Tarraco, the capital of the Iberian Cessetani, many of whose coins are extant, was one of the earliest Roman strongholds in Spain. It was captured in 218 B.C. by Gnaeus and Publius Cornelius Scipio, who improved its harbours and enlarged its walls. A Roman monument on a hill 3 m. E. is known as the Sepulcro de los Escipiones, and locally believed to be the tomb of the Scipios, who were defeated and slain by the Carthaginians under Hasdrubal Barca in 212 B.C. The battle took place at Antiorgis, the modern Alcañiz in the province of Teruel; there is no good reason to believe that the bodies of the Scipios were conveyed to Tarragona for burial, nor is the monument older than the 1st century A.D. As the Colonia Triumphalis, so called to commemorate the victories of Julius Caesar, Tarraco was made the seat of one of the four assize courts (*conventus juridici*) established in Hispania Citerior. Augustus spent the winter of 26 B.C. here, and made Tarraco the capital of the whole province, which received the name of Hispania Tarraconensis. A temple was built in his honour. It was afterwards restored by Hadrian (A.D. 117–138), and the city became the Spanish headquarters of the worship of the goddess Roma and the deified emperors. Its flax trade and other industries made it one of the richest seaports of the empire; Martial and Pliny celebrated its climate and its wines, and the fragmentary remains of temples, baths, amphitheatre and other Roman buildings bear witness to its prosperity. It became an archbishopric in the 5th century.

To the Romans the Visigoths under Euric succeeded in 467, but on their expulsion by the Moors in 711 the city was plundered and burned. It was long before the ruins were again inhabited, but by 1089, when the Moors were driven out by Raymond IV. of Barcelona, there must have been a certain revival of prosperity, for the primacy, which had been removed to Vich, was in that year restored to Tarragona. In 1118 a grant of the fief was made to the Norman Robert Burdet, who converted the town into a frontier fortress against the Moors. In 1705 the city was taken and burned by the British; in 1811, after being partly fortified, it was captured and sacked by the French.

TARRASA, a town of north-eastern Spain, in the province of Barcelona, 6 m. W.N.W. of Sabadell on the Barcelona-Lérida railway, and in the midst of a narrow plain surrounded by mountains. Pop. (1900) 15,956. Tarrasa was a Roman municipality, and a bishopric from the 5th century to the Moorish invasion in the 8th. It was razed by the Moors and rebuilt later by the Christians. There are three ancient Romanesque churches, in one of which, San Miguel, some Roman pillars are incorporated. Tarrasa is now mostly a modern industrial town, with fine public buildings, including the royal college, built in 1864 for 450 students besides day scholars, the school of arts and handicrafts, the industrial institute, chamber of commerce, hospitals, town hall, clubs, theatres and many large textile factories. Grain, wine, oil and fruit are produced in the district, and there is a municipal farm, founded in 1885, for experiments in viticulture.

TARRING AND FEATHERING, a method of punishment at least as old as the Crusades. The head of the culprit was shaved and hot tar poured over it, a bag of feathers being afterwards shaken over him. The earliest mention of the punishment occurs in the orders of Richard Cœur de Lion, issued to his navy on starting for the Holy Land in 1191. "Concerning the lawes and ordinances appointed by King Richard for his navie the forme thereof was this . . . item, a thiefe or felon that hath stolen, being lawfully convicted, shal have his head shorne, and boyling pitch poured upon his head, and feathers or downe strawed upon the same whereby he may be knowen, and so at the first landing-place they shall come to, there to be cast up" (trans. of original statute in *Hakluyt's Voyages*, ii. 21). A later instance of this penalty being inflicted is given in *Notes and Queries* (series 4, vol. v.), which quotes one James Howell writing from Madrid, in 1623, of the "boisterous Bishop of Halverstadt," who, "having taken a place where there were two monasteries of nuns and friars, he caused divers feather beds to be ripped, and all the feathers thrown into a great hall, whither the nuns and friars were thrust naked with their bodies oiled and pitched and to tumble among these feathers, which makes them here (Madrid) presage him an ill-death." In 1696 a London bailiff, who attempted to serve process on a debtor who had taken refuge within the precincts of the Savoy, was tarred and feathered and taken in a wheelbarrow to the Strand, where he was tied to the Maypole which stood by what is now Somerset House. It is probable that the punishment was never regarded as legalized, but was always a type of mob vengeance.

TARRYTOWN, a village of Westchester county, New York, on the E. bank of the Hudson river, opposite Nyack, with which it is connected by ferry, and about 25 m. N. of New York City. Pop. (1890) 3562; (1900) 4770, of whom 984 were foreign-born and 191 were negroes; (1910, U.S. census) 5600. Tarrytown is served by the New York Central and Hudson River railway, and by interurban electric lines connecting it, via White Plains, with New York City. It is situated on a sloping hill that rises to a considerable height above Tappan Zee, a large expansion of the Hudson river, and is built principally along either side of a broad and winding country highway (laid out in 1723) from New York to Albany, called the King's Highway until the War of Independence, then called the Albany Post Road, and now known (in Tarrytown) as Broadway. South of the village is "Lyndhurst," the estate of Miss Helen Miller Gould, and to the N.E. is Kaakout (originally "Kijkuit," that is, "lookout," the name of a high promontory), the estate of John D. Rockefeller. In the village are the Hackley School (1899), Irving School (1837), Repton School and the "Castle" School for girls; a Young Men's Lyceum (1899), with a public library (8000 volumes in 1910) and the Tarrytown Hospital (1892). In the vicinity there are large nurseries and market-gardens, and automobiles are manufactured in the village. Tarrytown stands on the site of a Wecquaesgeek Indian village, Alipconk (the place of elms), burned by the Dutch in 1644. The first settlement of whites was made about 1645. There were perhaps a dozen Dutch families here in 1680, when Frederick Philipse (formerly known as Vredryk Flypse) acquired title to several thousand acres in Westchester county, called Philipse Manor. He built, partly of brick brought from Holland, a manor-house (on a point of land now known as Kingsland's Point, a short distance above the present village), a mill and a church, at the mouth of Sleepy Hollow, some three-quarters of a mile above the village; Dr Hamilton Wright Mabie has written: "There is probably no other locality in America, taking into account history, tradition, the old church, the manor-house and the mill, which so entirely conserves the form and spirit of Dutch civilization in the New World." During the War of Independence Tarrytown was the centre of the "Neutral Territory" between the lines of the British and Continental forces, and was the scene of numerous conflicts between the "cowboys" and "skinners," bands of unorganized partisans, the former acting in the name of the colonies, and the latter in that of the king. On the post road, on the 24th of September 1780, Major John André was captured by three Continentals, John Paulding, David Williams and Isaac Van Wert; to commemorate the capture a marble shaft surmounted by a bronze statue of a Continental soldier has been erected on the spot. Tarrytown is described in the *Sketch Book* of Washington Irving, who lived and died at "Sunnyside," within the limits of Tarrytown, was long warden of old Christ Church, and is buried in the Old Sleepy Hollow burying-ground, which adjoins the Dutch Church, and in which Carl Schurz also is buried. Tarrytown was incorporated as a village in 1870. Its name is probably a corrupt form of the Dutch "Tarwen dorp" (wheat town).

See H. B. Dawson, *Westchester County in the American Revolution* (New York, 1886); and an article by H. W. Mabie in L. P. Powell's *Historic Towns of the Middle States* (New York, 1899).

TARSIER, the Anglicized form of the scientific name of a small and aberrant lemur-like animal, *Tarsius spectrum*, inhabiting the Malay Peninsula and islands, and typifying a family. The name tarsier refers to the great elongation of two of the bones of the tarsus, or ankle, and *spectrum* to the huge goggle-like eyes and attenuated form which constitute two of the most distinctive features of this weird little creature. In organization the tarsier departs markedly from other lemurs as regards several particulars, and thereby approximates to monkeys and apes. Rather smaller than a squirrel, with dusky brown fur, the tarsier has immense eyes, large ears, a long thin tail, tufted at the end, a greatly elongated tarsal portion of the foot, and disk-like adhesive surfaces on the fingers, which doubtless assist the animal in maintaining its position on the boughs. Four species of the genus are now recognized, whose range includes the Malay Peninsula, Java, Sumatra, Borneo, Celebes and some of the Philippines. The tarsier feeds chiefly on insects and lizards, sleeps during the day, but is tolerably active at night, moving chiefly by jumping from place to place; an action for which the structure of its hind-legs seems particularly well adapted. It is rare, not more than two being generally found together, and only brings forth one young at a time. (See PRIMATES.) (R. L.*)

TARSUS (mod. *Tersous*), an ancient city in the fertile plain of Cilicia. The small river Cydnus flowed through the centre of the town, and its cool swift waters were the boast of the city (though visitors like Dion Chrysostom thought it far inferior to the rivers of many Greek cities). The harbour, Rhegma, below the city, was originally a lagoon, though it is said also to be supplied by springs of its own. The Cydnus flowed into the lake (where were the arsenals) and thence into the sea, about 10 m. from Tarsus. The city is first mentioned on the Black Obelisk, as captured by the Assyrians along with the rest of Cilicia about 850 B.C. It was probably an old Ionian colony, settled (like Mallus) under the direction of Clarian Apollo. Its importance was due (1) to its excellent and safe harbour, (2) to its possession of a fertile territory, and (3) to its command of the first waggon-road made across Mount Taurus, which was cut through the Cilician Gates, a narrow gorge 100 yards in length, originally only wide enough to carry the waters of a small affluent of the Cydnus. The greatness of Tarsus rested therefore mainly on the two great engineering works, the harbour and the road. That the latter was due to Greek influence is shown by the village Mopsucrene on the southern approach to the Gates: Mopsus was the prophet of Clarian Apollo. Few mountain passes have been so important in history as this road (seventy miles in length) over Taurus. Many armies have marched over it; those of Cyrus the Younger, Alexander the Great, Cicero, Septimius Severus and the First Crusade may specially be mentioned.

Tarsus is most accessible from the sea or from the east. Even after the "Cilician Gates" were cut, the crossing of Taurus was a difficult operation for an invading army (as Xenophon and Arrian show). Hence Tarsian history (where not determined by Greek maritime relations) has been strongly affected by Semitic influence, and Dion Chrysostom, about A.D. 112, says it was more like a Phoenician than a Hellenic city (which it claimed to be). After the Assyrian power decayed, princes, several of whom bore the name or title Syennesis, ruled Tarsus before and under Persian power. Persian satraps governed it in the 4th century B.C.; and struck coins with Aramaic legends there. The Seleucid kings of Syria for a time kept it in a state of servitude; but it was made an autonomous city with additional citizens (probably Argive Greeks and Jews) by Antiochus IV. Epiphanes in 171 B.C.; and then it began to strike its own coins. It became one of the richest and greatest cities of the East under the Romans after 104 B.C., and was favoured by both Antony and Augustus: the reception there by the former of Cleopatra, who sailed up to the city in a magnificent vessel, was a striking historic event. In spite of its oriental character, it maintained a university where Greek philosophy was taught by a series of famous Tarsians, who influenced Roman history. Chief among them was Athenodorus Cananites (*q.v.*), teacher and friend of Augustus for many years, a man of courage and power, who remodelled the Tarsian constitution (making it timocratic and oligarchic). The picture which Philostratus, in his biography of Apollonius Tyanensis, draws of the Tarsians as vain, luxurious and illiterate, represents the general Graeco-Roman conception of the city. The legend which was believed to be graven on the statue of Sardanapalus at Anchiale (12 m. S.W. from Tarsus) might have been the motto of most Tarsians: "Eat, drink, play, for nothing else is worth this (gesture)" (referred to by St Paul, 1 Cor. xv. 32). The statue was probably an archaic work, with Hittite or cuneiform inscription, representing a figure with right hand raised: the letters and the attitude were misunderstood; the figure was supposed to be snapping the fingers and uttering this expression of effeminate and weary sensualism.

Tarsus depended for its greatness on commerce, peace and orderly government. It was not a strong fortress, and could not be defended during the decay of the empire against barbarian invasion. The Arabs captured the whole of Cilicia shortly after A.D. 660; and Tarsus seems to have been a ruin for more than a century after the conquest. But Harun al-Rashid rebuilt its walls in 787, and made it the north-western capital of the Arab power in the long wars against the Byzantine empire. All the raids, which were made in Asia Minor regularly, year by year, sometimes twice in one year, through the Cilician Gates and past the fortress Loulon, issued through the north gate of Tarsus, which was called the "Gate of the Holy War." The western gate is still standing, and is misnamed "St Paul's Gate." The caliph Mamun died on such a foray in A.D. 833, having caught a chill at a great spring north of the Cilician Gates beside Ak-Keupreu. He was brought to Tarsus where (like the emperor Tacitus) he died, and (like the emperor Julian) was buried. His illness recalls the fever which Alexander the Great contracted from bathing in the Cydnus. Nicephorus Phocas reconquered Tarsus and all Cilicia for the empire in A.D. 965. In the First Crusade Baldwin and Tancred captured Tarsus A.D. 1099, and there the two leaders had a serious quarrel. It formed part of the kingdom of Lesser Armenia for great part of the three centuries after A.D. 1180, and it was fortified by Leo II. and Hethoum I. But Turkoman and Egyptian invaders disputed its possession with the Greek emperors and Armenian kings and with one another. Finally it passed into Ottoman hands about the beginning of the 16th century.

Most of the successive masters of Tarsus had their own legends about its origin, usually with a religious character justifying and explaining their possession of the city. The Assyrian Sardanapalus, the native god Sandan, the Greek hero Perseus, the Greek god Heracles, are all called founder of Tarsus. Iapetus, *i.e.* Japhet, father of Javan "the Ionian," was called the grandfather of Cydnus, who gave name to the river. A curious ceremony was practised in honour of Sandan (identified with the Greek Heracles): a pyre was periodically erected and the god was burned on it. It is said that the original name of the city was Parthenia, which suggests that a virgin goddess was worshipped here as in so many shrines of Asia Minor and Syria: the virgin goddess Athena appears on Tarsian coins. The Baal of Tarsus is named in Aramaic letters on many of its coins in the Persian period.

The ruins of the ancient city are very extensive, but they are deeply buried, and make little or no appearance above the surface except in the Dunuk Tash (popularly identified as the "Tomb of Sardanapalus," a monument which, however, was at Anchiale, not at Tarsus). This shapeless mass of concrete was probably the substructure of a Graeco-Roman temple, from which the marble coating has been removed. The modern town has considerable bazaars and trade; but the climate is very oppressive, owing to the proximity of vast marshes which occupy the site of the harbour and the lower part of the original Cyndus course. The river was diverted from its former course by Justinian in the 6th century. The emperor's intention was only to carry off the surplus waters in time of flood and prevent inundations in the city, not to deprive Tarsus of what was its chief pride and boast; but gradually the neglect of subsequent centuries allowed the channel in the city to become blocked by accumulation of soil, and now the whole body of water flows in the new channel east of the city, except what is drawn off by an artificial irrigation course to water the gardens on the western side of the city. The population is about 25,000, including, besides Turks and Syrian Moslems, alsc Armenians, Greeks, Syrian Christians, Persians, Afghans, Ansaria (mostly gardeners) and even Hindus. There is a large American mission school called St Paul's Institute, giving a very comprehensive education to Armenians and Greeks drawn from an extensive district.

The literature regarding Tarsus is scanty, and few ancient inscriptions have been published. See W. B. Barker, *Lares and Penates*; G. F. Hill in the British Museum Catalogue of Coins; Six in *Numismatic Chronicle*, 1884, pp. 152 ff., 1894, pp. 329 ff.; E. Babelon in the Catalogue Bibl. Nat., "Perses Achéménides"; the numismatic works of B. V. Head, F. Imhoof Blumer, &c.; Waddington in *Bulletin de Corr. Hell.*, vii. pp. 282 ff.; Ramsay, *Cities of St Paul* (1907), pp. 85–245, and "Cilicia, Tarsus and the Great Taurus Pass" in *Geographical Journal* (1903), pp. 357–410; R. Heberdey and A. Wilhelm, "Reisen in Kilikien" (in the *Denkschriften d. kais. Akademie Wien*, 1896, xliv.), with works of other travellers, especially V. Langlois and Macdonald Kinneir. Callander in *Journal of Hellenic Studies*, 1904, pp. 58 ff., studied Dion Chrysostom's two *Tarsian Orations*. (W. M. RA.)

TART, a dish of baked pastry containing fruit, a fruit pie; also a small open piece of baked pastry with jam placed upon it. The word was adapted from the O.Fr. *tarte*; the older form must have been *torte*, as is seen in the mod. Fr. *tourte* and the diminutive *tortel* or *torteau*; the origin is the Lat. *torta*, twisted (*torquere*, to twist), used of a cake in Med. Lat., the paste or dough of cakes or tarts being rolled or twisted. The alteration of the vowel is also seen in Ital. *tartera*. In English there is some confusion with "tart," sharp, acid, bitter, which comes from O.E. *teart*, sharp, severe, properly "tearing," from *teran*, to tear; cf. "bitter," from "to bite."

TARTAGLIA, or TARTALEA, **NICCOLÒ** (*c.* 1506–1559), Italian mathematician, was born at Brescia. His childhood was passed in dire poverty. During the sack of Brescia in 1512, he was horribly mutilated by some French soldiers. From these injuries he slowly recovered, but he long continued to stammer in his speech, whence the nickname, adopted by himself, of "Tartaglia." Save for the barest rudiments of reading and writing, he tells us that he had no master; yet we find him at Verona in 1521 an esteemed teacher of mathematics. In 1534 he went to Venice. For Tartaglia's discovery of the solution of cubic equations, and his contests with Antonio Marie Floridas, see ALGEBRA (*History*). In 1548 Tartaglia accepted a situation as professor of Euclid at Brescia, but returned to Venice at the end of eighteen months. He died at Venice in 1559.

Tartaglia's first printed work, entitled *Nuova scienzia* (Venice, 1537), dealt with the theory and practice of gunnery. He found the elevation giving the greatest range to be 45°, but failed to demonstrate the correctness of his intuition. Indeed, he never shook off the erroneous ideas of his time regarding the paths of projectiles, further than to see that no part of them could be a straight line. He nevertheless inaugurated the scientific treatment of the subject. His *Quesiti et invenzioni diverse*, a collection of the author's replies to questions addressed to him by persons of the most varied conditions, was published in 1546, with a dedication to Henry VIII. of England. Problems in artillery occupy two out of nine books; the sixth treats of fortification; the ninth gives several examples of the solution of cubic equations. He published in 1551 *Regola generale per sollevare ogni affondata nave, intitolata la Travagliata Invenzione* (an allusion to his personal troubles at Brescia), setting forth a method for raising sunken ships, and describing the diving-bell, then little known in western Europe. He pursued the subject in *Ragionamenti sopra la Travagliata Invenzione* (May 1551). His largest work, *Trattato generale di numeri e misure*, is a comprehensive mathematical treatise, including arithmetic, geometry, mensuration, and algebra as far as quadratic equations (Venice, 1556, 1560). He published the first Italian translation of Euclid (1543), and the earliest version from the Greek of some of the principal works of Archimedes (1543). These included the tract *De insidentibus aquae*, of which his Latin now holds the place of the lost Greek text. Tartaglia claimed the invention of the gunner's quadrant.

Tartaglia's own account of his early life is contained in his *Quesiti*, lib. vi. p. 74. See also Buoncompagni, *Intorno ad un testamento inedito di N. Tartaglia* (Milan, 1881); Rossi, *Elogi di Bresciana illustri*, p. 386. Tartaglia's writings on gunnery were translated into English by Lucar in 1588, and into French by Rieffel in 1845.

TARTAN (from F. *tiretaine*, "linsie-wolsie," Sp. *tiritaña*, a kind of woollen cloth, perhaps so called from its thinness and lightness, cf. Sp. *tiritar*, to tremble with cold), a worsted cloth woven with alternate stripes or bands of coloured warp and weft, so as to form a chequered pattern in which the colours alternate in "sets" of definite width and sequence. The weaving of particoloured and striped cloth cannot be claimed as peculiar to any special race or country, for indeed such checks are the simplest ornamental form into which dyed yarns can be combined in the loom. But the term tartan is specially applied to the variegated cloth used for the principal portions of the distinctive costume of the Highlanders of Scotland. For this costume, and the tartan of which it is composed, great antiquity is claimed, and it is asserted that the numerous clans into which the Highland population were divided had each from time to time a special tartan by which it was distinguished. After the rebellion of 1745 various acts of parliament were passed for disarming the Scottish Highlanders and for prohibiting the use of the Highland dress in Scotland, under severe penalties. These acts remained nominally in force till 1782, when they were formally repealed, and since that time clan tartan has, with varying fluctuations of fashion, been a popular article of dress, by no means confined in its use to Scotland alone; and many new and imaginary "sets" have been invented by manufacturers, with the result of introducing confusion in the heraldry of tartans, and of throwing doubt on the reality of the distinctive "sets" which at one time undoubtedly were more or less recognized as the badge of various clans.

Undoubtedly the term tartan was known, and the material was woven, "of one or two colours for the poor and more varied for the rich," as early as the middle of the 15th century. In the accounts of John, bishop of Glasgow, treasurer to King James III., in 1471, there occurs, with other mention of the material, the following:—"Ane elne and ane halve of blue Tartane to lyne his gowne of cloth of Gold." It is here obvious that the term is not restricted to particoloured chequered textures. In 1538 accounts were incurred for a Highland dress for King James V. on the occasion of a hunting excursion in the Highlands, in which there are charges for "variant cullorit velvet," for "ane schort Heland coit," and for "Heland tartane to be hose to the kinge's grace." Bishop John Lesley, in his *De origine, moribus, et rebus gestis Scotorum*, published in 1578, says of the ancient and still-used dress of the Highlanders and Islanders, "all, both noble and common people, wore mantles of one sort (except that the nobles preferred those of several colours)." George Buchanan, in his *Rerum Scoticarum historia* (1582), as translated by Monypenny (1612), says of the Highlanders, "They delight in marled clothes, specially that have any long stripes of sundry colours; they love chiefly purple and blue. Their predecessors used short mantles or plaids of divers colours sundry ways divided; and amongst some the same custom is observed to this day." A hint of clan tartan distinctions is given by Martin Martin in his *Western Isles of Scotland* (1703), which work also contains a minute description of the dress of the Highlanders and the manufacture of tartan. "Every isle," he observes, "differs from each other in their fancy of making plaids, as to the stripes in breadth and colours. This humour is as different through the mainland of the Highlands, in so far that they who have seen those places are able at the first view of a man's plaid to guess the place of his residence."

The following lines give a brief description of the colours of the tartans of the principal clans. The kilt-tartan colour is given in each case; the plaid-tartans vary in slight particulars.

Campbell of Breadalbane, light green, crossed with darker green, the stripes broad with narrow edging of yellow. *Campbell of Argyll*, light green crossed with dark green, narrow independent cross lines of white. *Cameron*, brick-red with broad chequered cross of same colour, edged white and with broad centre of ground colour, two independent cross lines of green. *Forbes*, yellow green, crossed with broad dark-green lines, centred black, independent cross lines yellow. *Fraser*, red ground, main cross lines red with deeper red centre edged with blue, independent cross lines blue. *Gordon*, dark blue-green ground, with broad cross lines of lighter green, narrow centre line yellow. *Graeme*, light green ground, crossed with darker green in small chequer, independent cross lines dark green. *Grant*, scarlet, with broad black-edged scarlet crossings, black independent cross lines. *Macdonald of Glengarry and Keppoch*, red, with open broad blue cross lines, and two independent blue crossings. *Macdonald of Glencoe*, green with broad dark-green crossing, the whole covered with fine red lines. *Macdonald of Clanranald*, light green with broad dark-green crossing, covered with fine red lines. *Macgregor*, scarlet, with narrow scarlet cross lines, edged and centred blue, widely spaced. *Mackintosh*, red with blue-edged and centred crossings of red, and independent blue cross lines. *Mackenzie*, blue-green, broad crossing of same colour with darker edges, independent cross lines, alternately red and white, over the main crossings. *Macleod*, green, with dark-green crossings, over crossings, every other square, a red line. *Macpherson*, pale grey, four darker grey bars at crossings, the whole covered with red double independent lines. *Munro*, red with broad green stripe and narrow lines forming a check of black and yellow. *Murray*, green, close crossings of darker green, independent lines red. *Stewart*, scarlet, deep coloured crossings with scarlet centre, fine widely spaced dark independent lines.

See W. and A. Smith, *Tartans of the Clans of Scotland* (1850); J. Sobieski Stuart, *Vestiarium Scoticum* (1842); R. R. M'Ian, *Clans of the Scottish Highlands* (1845–46); J. Grant, *Tartans of the Clans of Scotland* (Edinburgh, 1885).

TARTAR, the name commonly applied to crude acid potassium tartrate or "bitartrate of potash." $HK(C_4H_4O_6)$. During the process of fermentation wines deposit a crystalline crust of argol; this, after being roughly purified by recrystallization, is known as tartar, and when further purified and freed from colouring matters becomes "cream of tartar," also called technically "cream." With the iatrochemists tartar was a generic term which included both this *tartarus vini* and various substances obtained from it, and even salts, such as salt of sorrel (potassium oxalate), that resembled it. Thus *sal fixum tartari* was potassium carbonate, which on exposure to the air deliquesces to *oleum tartari per deliquium*; neutral potassium tartrate was called *tartarus tartarisatus*, because it was prepared by neutralizing ordinary tartar with the sal fixum; *tartarus chalybeatus* was a preparation with iron; and *spiritus tartari*, used by Paracelsus, was prepared by dry distillation of tartar. Paracelsus also used the term in a still wider sense to signify abnormal precipitates or sediments deposited from animal secretions; the same idea is apparent in the popular application of the word to the salivary calculus which forms on the teeth.

Cream of tartar is prepared by dissolving granulated argol in boiling water and allowing the solution to stand. The clear liquid is then drawn off and crystallized. The slightly coloured crystals thus obtained are redissolved in hot water, the colouring matters got rid of by means of pipeclay or egg-albumen, and the solution filtered and crystallized, the name "crean of tartar" being originally applied to the crust of minute crystals that form on its surface as it cools. The salt crystallizes in masses of small, hard, colourless, transparent, rhombic prisms. It is precipitated when an excess of a potassium salt is added to a solution of tartaric acid, but it dissolves in mineral acids, and in alkalis and alkaline carbonates. Solutions of boric acid or borax dissolve it freely, forming soluble cream of tartar, which is a white powder permanent in the air when made with the acid, but deliquescent when borax is employed. Its slight solubility in alcohol explains why it is deposited by wines as they mature. One part by weight of the salt dissolves in 15 parts of boiling water, but at lower temperatures the solubility is greatly diminished, and at 0° C. about 416 parts of water are required. When heated it is decomposed with formation of potassium carbonate and carbon, inflammable gases having an odour of burnt bread being evolved. The salt is used for the manufacture of tartaric acid; it is also employed in the mordant bath for wool-dyeing, with powdered chalk and alum for cleaning silver, and for the preparation of effervescing drinks and baking-powder. In medicine as *potassii tartras acidus* it is of some slight importance as a diuretic and purgative. The more soluble normal salt, $K_2(C_4H_4O_6)$, is used for the same purposes; it is formed by dissolving powdered cream of tartar in a hot solution of potassium carbonate. If sodium carbonate is substituted the result is $KNa(C_4H_4O_6)$, or Rochelle salt.

Tartar emetic (potassium antimonyl tartrate) $K\cdot(SbO)C_4H_4O_6\cdot\frac{1}{2}H_2O$. This substance has been known for a long period, being mentioned by Basil Valentine. It may be prepared by warming 3 parts of antimonious oxide with 4 parts of cream of tartar, in the presence of water, replacing the water as it evaporates; after digestion is complete, the solution is filtered hot. Powder of algaroth (*q.v.*) may be used in place of the antimony oxide. Tartar emetic crystallizes in small octahedra, which lose their water of crystallization gradually on exposure to air, and become opaque. It is soluble in 14·5 parts of cold water and 1·9 parts of hot, the solution showing an acid reaction to litmus. It possesses a nauseous metallic taste and produces vomiting when taken internally, whilst in large doses it is poisonous. It is used medicinally, and also as a mordant in dyeing and calico-printing.

TARTARIC ACID (dihydroxy-succinic acid), $C_4H_6O_6$, or $HO_2C\cdot CH(OH)\cdot CH(OH)\cdot CO_2H$. Four acids of this composition are known, namely dextro- and laevo-tartaric acids, racemic acid and mesotartaric acid, the two last being optically inactive (see STEREO-ISOMERISM). Their constitution follows from their formation from dibromosuccinic acid and from their synthesis from glyoxal cyanhydrin, these two methods producing the inactive racemic form which may then be split into the active components. Dextro-tartaric acid occurs in the free state or as the potassium or calcium salt in grape juice and in various unripe fruits. During the alcoholic fermentation of grape juice it is deposited in the form of an impure acid potassium tartrate which is known as argól, and when purified as cream of tartar. For the preparation of the acid the crude argol is boiled with hydrochloric acid and afterwards precipitated as calcium tartrate by boiling with milk of lime, the calcium salt being afterwards decomposed by sulphuric acid. It may also be obtained (together with racemic acid) by oxidizing milk sugar, saccharic acid, &c., with nitric acid, and by the reduction of oxalic ester with sodium amalgam (H. Debus, *Ann.*, 1873, 166, p. 109). It crystallizes from water in large prisms which melt at 168–170° C., and on further heating gives an anhydride and finally chars, emitting a characteristic odour and forming pyroracemic and pyrotartaric acids. It behaves as a reducing agent. Chromic acid and potassium permanganate oxidize it to formic and carbonic acids, whilst hydrogen peroxide in the presence of ferrous salts gives dihydroxymaleic acid (H. J. H. Fenton, *Jour. Chem. Soc.*, 1894, p. 899; 1895, pp. 48, 774; 1896, p. 546). Hydriodic acid and phosphorus reduce it to malic acid and finally to succinic acid. Calcium chloride gives a white precipitate of calcium tartrate in neutral solutions, the precipitate being soluble in cold solutions of caustic potash but re-precipitated on boiling. It prevents the precipitation of many metallic hydroxides by caustic alkalis. It carbonizes when heated with strong sulphuric acid, giving, among other products, carbon monoxide and carbon dioxide. A small crystal of oxalic acid added to concentrated sulphuric acid containing about 1 per cent. of resorcin gives a characteristic violet red coloration.

Laevo-tartaric acid is identical in its chemical and in most of its physical properties with the dextro-acid, differing chiefly in its action on polarized light, the plane of polarization being rotated to the left. By mixing equal quantities of the two forms in aqueous solution heat is evolved and racemic acid, $(C_4H_6O_6)_2\cdot 2H_2O$, is obtained. This variety is also formed by the hydrolysis of glyoxal cyanhydrin (F. Pollak, *Monats.*, 1894, 15, p. 469); by heating a solution of desoxalic acid; by the oxidation of fumaric acid with potassium permanganate; by the action of silver oxide on dibromosuccinic acid, and by the oxidation of mannite, dulcite, inulin, &c., with nitric acid. In the anhydrous state it melts at 205–206° C. Mesotartaric acid is formed when cinchonine tartrate is heated for some time at 170° C. (L. Pasteur, *Ann.*, 1853, 88, p. 212); by heating tartaric or racemic acid for some time with water to 165° C.; by the oxidation of laevulose; and by the oxidation of phenol or maleic acid with an alkaline solution of potassium permanganate (O. Doebner, *Ber.*, 1891, 24, p. 1755; A. Kekulé and R. Anschutz, *ibid.*, 1881, 14, p. 714). It crystallizes in prisms, and in the anhydrous state melts at 140° C. On prolonged boiling with aqueous hydrochloric acid it yields racemic acid. The sodium ammonium salt is not capable of decomposition into its optical antipodes, as is sodium ammonium racemate.

Tartaric acid as used in medicine is derived from potassium acid tartrate. Its impurities are lead, oxalic acid, lime and potassium tartrate. It is incompatible with potassium, calcium, mercury and vegetable astringents. Tartaric acid is rarely used alone, but is contained in *pilula quininae sulphatis* and in Seidlitz powder (see SODIUM), and is a constituent of many proprietary granular effervescent preparations. If taken in overdose or in a concentrated form tartaric acid produces severe gastro-enteritis. In these cases lime-water, alkalis and magnesia should be used as antidotes, and opium may be required.

TARTARUS, in Greek mythology, the son of Aether and Gaea, father of Typhoeus and the giants. In the *Iliad* the word denotes an underground prison, as far below Hades as earth is below heaven, in which those who rebelled against the will of Zeus were confined. In later writers Tartarus is the place of punishment of the wicked after death, and is used for the underworld generally. Cf. ABYSS.

TARTINI, GIUSEPPE (1692–1770), Italian violinist, composer and musical theorist, was born at Tirano in Istria on the 12th of April 1692. In early life he studied, with equal want of success, for the church, the law courts, and the profession of arms. As a young man he was wild and irregular, and he crowned his improprieties by clandestinely marrying the niece of Cardinal Cornaro, archbishop of Padua. The cardinal resented the marriage as a disgraceful mésalliance, and denounced it so violently that the unhappy bridegroom, thinking his life in danger, fled for safety to a monastery at Assisi, where his character underwent a complete change. He studied the theory of music under Padre Boemo, the organist of the monastery, and, without any assistance whatever, taught himself to play the violin in so masterly a style that his performances in the church became the wonder of the neighbourhood. For more than two years his identity remained undiscovered, but one day the wind blew aside a curtain behind which he was playing, and one of his hearers recognized him and betrayed his retreat to the cardinal, who, hearing of his changed character, readmitted him to favour and restored him to his wife.

Tartini next removed to Venice, where the fine violin-playing of Veracini excited his admiration and prompted him to repair, by the aid of good instruction, the shortcomings of his own self-taught method. He left his wife with relations and returned to Ancona, where he studied for a time. In 1721 he returned to Padua, where he was appointed solo violinist at the church of San Antonio. From 1723 to 1725 he acted as conductor of Count Kinsky's private band in Prague. In 1728 he founded a school for violin in Padua. The date of his presence in Rome does not seem to be clearly established, but he was in Bologna in 1739. Afterwards he returned to his old post in Padua, where he died on the 16th of February 1770.

Tartini's compositions are very numerous, and faithfully illustrate his passionate and masterly style of execution, which surpassed in brilliancy and refined taste that of all his contemporaries. He frequently headed his pieces with an explanatory poetical motto, such as "Ombra cara," or "Volgete il riso in pianto o mie pupille." Concerning that known as *Il Trillo del Diavolo*, or *The Devil's Sonata*, he told a curious story to Lalande, in 1766. He dreamed that the devil had become his slave, and that he one day asked him if he could play the violin. The devil replied that he believed he could pick out a tune, and thereupon he played a sonata so exquisite that Tartini thought he had never heard any music to equal it. On awaking he tried to note down the composition, but succeeded very imperfectly, though the *Devil's Sonata* is one of his best productions.

Tartini is historically important as having contributed to the science of acoustics as well as to musical art by his discovery (independently of Sorge, 1740, to whom the primary credit is now given) of what are still called "Tartini's tones" (see SOUND and HEARING), or differential tones.

The phenomenon is this:—when any two notes are produced steadily and with great intensity, a third note is heard, whose vibration number is the difference of those of the two primary notes. It follows from this that any two consecutive members of a harmonic series have the fundamental of that series for their difference tone —thus, $\frac{E}{C}$, the fourth and fifth harmonic, produce C, the prime or generator, at the interval of two octaves under the lower of those two notes; $\frac{E}{G}$, the third and fifth harmonic, produce C, the second harmonic, at the interval of a 5th under the lower of those two notes. The discoverer was wont to tell his pupils that their double-stopping was not in tune unless they could hear the third note; and Henry Blagrove (1811–1872) gave the same admonition. The phenomenon has other than technical significance; an experiment by Sir F. A. G. Ouseley showed that two pipes, tuned by measurement to so acute a pitch as to render the notes of both inaudible by human ears, when blown together produce the difference of tone of the inaudible primaries, and this verifies the fact of the infinite upward range of sound which transcends the perceptive power of human organs. The obverse of this fact is that of any sound being deepened by an 8th if the length of the string or pipe which produces it be doubled. The law is without exception throughout the compass in which our ears can distinguish pitch, and so, of necessity, a string of twice the length of that whose vibrations induce the deepest perceivable sound must stir the air at such a rate as to cause a tone at an 8th below that lowest audible note. It is hence manifest that, however limited our sense of the range of musical sound, this range extends upward and downward to infinity. Tartini made his observations the basis of a theoretical system which he set forth in his *Trattato di Musica, secondo la vera scienzia dell'Armonia* (Padua, 1754) and *Dei Principij dell' Armonia Musicale* (Padua, 1767). He also wrote a *Trattato delle Appogiature*, posthumously printed in French, and an unpublished work, *Delle Ragioni e delle Proporzioni*, the MS. of which has been lost.

TAS-DE-CHARGE, a French term in architecture, for which there is no equivalent in English, given to the lower courses of a Gothic vault, which are laid in horizontal courses and bonded into the wall, forming a solid mass; they generally rise about one-third of the height of the vault, and as they project forwards they lessen the span to be vaulted over.

TASHKENT, or TASHKEND, one of the largest and most important cities of Russian Central Asia, and capital of Russian Turkestan, situated in the valley of the Chirchik, some 50 m. above its confluence with the Syr-darya, in 40° 20′ N., 69° 18′ E. It is connected by rail with Krasnovodsk (1085 m.) on the Caspian, and since 1905 with Orenburg (1150 m.). The city, formerly enclosed by walls (now ruinous), is surrounded by luxuriant gardens, and its houses are buried among the fruit and other trees which grow alongside of the irrigation canals. The buildings, which are of stone and sun-dried bricks, are mostly low, on account of the earthquakes which frequently disturb the region. The native city in 1871 had 78,130 inhabitants, and in 1897 156,414, mostly Sarts, with Uzbegs, Kirghiz, Jews, Russians and Germans. The Russian city, to the south-east, dating from 1865, has clean, broad streets lined with poplars, and canals, the low, pleasant-looking houses being surrounded by gardens. In 1875 its population, exclusive of the military, was 4860, mostly Russians, and in 1900 about 25,000. Tashkent has a public library containing a valuable collection of works on Central Asia, an astronomical observatory and a museum.

TASHKURGHAN, or KHULM, a khanate and town of Afghan Turkestan. The khanate lies between Kunduz and Balkh. The ancient town of Khulm stood in the Oxus plain, surrounded by orchards of famous productiveness; but it was destroyed by Ahmad Shah Abdali, who founded Tashkurghan in the middle of the 18th century, and took all the inhabitants away from Khulm to populate it. Ancient Khulm is now only a mass of ruins; but Tashkurghan, lying two or three miles to the south of it, has become the great trade-mart of Afghan Turkestan and second only in importance to Mazar-i-Sharif, the military centre of the province; while it is much larger and more prosperous than the latter place. At Tashkurghan the caravans from India and Bokhara meet, and from here the merchandise is distributed all over the country. A hill fortress dominates the town and overlooks the debouchment of the road from Haibak and Kabul into the plains of the Oxus.

TASMAN, ABEL JANSZOON (*c.* 1603–1659), the greatest of Dutch navigators, the discoverer of Tasmania, New Zealand, the Tonga and the Fiji Islands, and the first circumnavigator of Australia, was born at Lutjegast in Groningen, about 1603. In 1634 we first meet with him in the East Indies, sailing from Batavia (Feb. 18) to Amboyna. On the 30th of December 1636 he sailed from Batavia for home; reached Holland August 1, 1637; started on his return to the East April 15, 1638; and reappeared at Batavia October 11, 1638. On the 2nd of June 1639 Tasman, along with Matthew (Matthijs Hendricxsen) Quast, was despatched by Antony Van Diemen, governor-general of the Dutch East Indies (1636–45), on a voyage to the north-western Pacific, in quest of certain "islands of gold and silver," supposed to lie in the ocean east of Japan. On this voyage Tasman and Quast visited the Philippines and improved Dutch knowledge of the east coast of Luzon; they also discovered and mapped various islands to the north, apparently the Bonin archipelago. Sailing on to N. and E. in search of the isles of precious metals, they ranged about fruitlessly in the northern Pacific, at one time believing themselves to be 600 Dutch miles east of Japan. After this the voyage was continued almost constantly westward, but in varying latitudes, reaching as high as 42° N., always without success. On the 15th of October the navigators decided to return, and, after touching at Japan, anchored at the Dutch fortress-station of Zeelandia in Formosa on the 24th of November 1639. After this Tasman was engaged in operations in the Indian seas (sailing to Formosa, Japan, Cambodia, Palembang, &c., as a merchant captain in the service of the Dutch East India Company) until 1642, when he set out on his first great "South Land" expedition. This was planned and organized by Governor Van Diemen, who cherished great schemes for the extension of the Dutch colonial empire. Several Dutch navigators had already discovered various portions of the north and west coasts of Australia (as in 1605–06, 1616, 1618–19, 1622, 1627–28, &c.), but Tasman now first showed that this great South Land did not stretch away to the southern pole, but was entirely encircled by sea within comparatively moderate limits. Sailing from Batavia on the 14th of August 1642 with two vessels, the "Heemskerk" and "Zeehaen," and calling at Mauritius (September 5 to October 8), Tasman sailed first S., then E., almost seven weeks, and on the 24th of November sighted (in 42° 25′ S., as he made it) the land which he named *Anthoonij van Diemen's landt* after Van Diemen, now called Tasmania. He doubled the land, which he evidently did not perceive was an island, coasting its southern shores, and, running up Storm Bay, anchored on the 1st of December in Frederick Henry's Bay, on the east coast of Tasmania (in 43° 10′ S., according to his reckoning)—so named after Prince Frederick Henry of Nassau, then the head of the Dutch republic. There he set up a post on which he hoisted the Dutch flag. Quitting Van Diemen's Land on the 5th of December, Tasman steered E. for the Solomon Islands, and on the 13th of December discovered (in 42° 10′ S., as he reckoned) a "high mountainous country," which he called *Staten landt* ("Land of the States," *i.e.*, of Holland, now New Zealand). Tasman and his company believed the newly discovered land to form part of the same great antarctic continent as the other *Staten landt* which Schouten and Lemaire had sighted and named to the east of Tierra del Fuego. Cruising up N.E. along the west coast of the South Island, he anchored on the 18th of December in 40° 50′ S., at the entrance of a "wide opening," which he took to be a "fine bay" (Cook's Strait). He gave the name of *Moordenaars* (*Murderers*, now softened to *Massacre*) *Bay* to this spot, where several of his men were killed by the natives (December 19). From Murderers' Bay Tasman sailed S.E. along the south shore of Cook's Strait, apparently getting into Blind or Tasman Bay, but not discovering the full extent of the strait here dividing New Zealand into two main islands. Returning westward he then coasted the west side of the North Island, till, on the 4th of January 1643, he came to the northern extremity of New Zealand, in 34° 35′ S. (in his reckoning). Thence he bore away to N.N.E., at first intending to keep that course for 30° of longitude from North Cape, New Zealand. On the 19th to 25th of January, in 22° 35′, 21° 20′, and 20° 15′ S. (Tasman's reckonings), he discovered various islands of the Tonga or Friendly group, especially Amsterdam (Tongatabu), Middelburg (Eva), and Rotterdam. Here the ships took in water and provisions, which they had not done since leaving Mauritius, and the crews went on shore for the first time since leaving Van Diemen's Land. Rotterdam Island they explored with some care. Thence Tasman steered N. and W., reaching on the 6th of February the eastern part of the Fiji archipelago (in 17° 29′ S., by his reckoning), which he called Prince William's Islands and Heemskerk's Shoals; on the 22nd of March he sighted the islands of Ontong Java (in 5° 2′ S., according to Tasman, and in 159° 30′ E., Greenwich). On the 1st of April he was near the north-eastern extremity of New Ireland (Neu Mecklenburg), mistaken by him for a part of New Guinea, in 40° 30′ S., off a point known to the Spaniards as *Cabo S. Maria.* Thence he passed westward along the north of New Ireland, New Hanover, New Britain (Neu Pommern) and New Guinea. He reached the western extremity of New Guinea on the 18th of May; Schouten's Islands were noted to the south of the vessels' course on the 12th of May. Tasman's track, lying between New Guinea and Halmahera (Gilolo), then brought him south to Ceram; he passed through the narrow strait between Celebes and Buton on the 27th of May, and arrived at Batavia on the 15th of June 1643 after a ten months' voyage. The materials for an account of Tasman's important second voyage in 1644 are scanty, but we know he was instructed to obtain a thorough knowledge of Staten Land and Van Diemen's Land, and to find out "whether New Guinea is a continent with the great Zuidland, or separated by channels and islands," and also "whether the new Van Diemen's Land is the same continent with these two great countries or with one of them." In this voyage Tasman had three ships under his command, the "Limmen," "Zeemeeuw" (or "Meeuw"), and "Brak" (or "Bracq"). His course lay along the south-west coast of New Guinea; he mistook the western opening of Torres Straits for a bay, but explored (and perhaps named) the Gulf of Carpentaria: for the first time the coast-line of this great bay was mapped with fair accuracy. Though preceded by Jansz (1606) and Carstensz (1623) on the east shore of the gulf as far as 17° S., Tasman first made known the south, and most of the west, coast. Beyond this he explored the north and west coasts of Australia as far as 22° S., and established the absolute continuity of all this shore-line of the "Great Known South Continent"; his chart gives soundings for the whole of this coast. Tasman's achievements were coldly received by the Dutch colonial authorities; but on the 4th of October 1644 they rewarded him with the rank of commander (he had frequently enjoyed the use of the title already). On the 2nd of November 1644 he was also made a member of the Council of Justice of Batavia. He was a member of the committee appointed on the 18th of April 1645 to declare a truce between the Dutch East India Company and the viceroy of Portuguese India. In 1647 he commanded a trading fleet to Siam, and in 1648 a war-fleet sent against the Spaniards of the Philippines (May 15, 1648, to January 1649). By 1653 he had quitted the company's service, but still lived, apparently as one of its wealthiest citizens, in and near Batavia. His will, made the 10th of April 1657, seems to have but slightly preceded his death, which probably happened before October 22, 1659, and certainly before February 5, 1661.

See Siebold's paper in *Le Moniteur des Indes-Orientales et Occidentales*, 1848–49, pt. i. p. 390; the paper on Tasman by C. M. Dozy in *Bijdragen tot de Taal-, Land-, en Volkenkunde van Nederlandsch-Indie*, 5th series, vol. ii. p. 308; R. H. Major, *Early Voyages to . . . Australia* (London, Hakluyt Society, 1859), especially pp. xciii.–ciii., 43–58 (here are printed the instructions for Tasman and his colleagues on the voyage of 1644); G. Collingridge, *Discovery of Australia* (Sydney, 1895), especially pp. 238–40, 279–80; and, above all, J. E. Heeres and others, *Tasman's Journal . . . facsimiles of the original MS. . . . . with . . . life . . . . of . . . . Tasman*, &c. (Amsterdam, 1898)—here the *Life of Tasman*, with its appendices, is separately paged (163 pp.). See also *Aandeel der Nederlanders in de Ontdekking van Australië*, 1606–1765 (in Dutch and English, Leiden and London, 1899), especially pp. vi., viii., xii.–xv., 72; the valuable summary of the voyage of 1642–43 in the anonymous *Account of several late Voyages and Discoveries* (beginning with Sir John Narborough's), London, 1711, with subtitle, *Relation of a Voyage . . . of Captain Abel Jansen Tasman* (originally extracted from his journals by Dirk Rembrantse in Dutch, published in English in Dr Hook's collections); also *The Discovery of Van Diemen's Land in 1642*, by James Backhouse Walker (Hobart, 1891). A draft journal of the voyage of 1642–43, probably made by a sailor on the expedition, is in the state archives at The Hague. There are also several copies made from Tasman's official journal; the best of these (the original fair copy) is reproduced in Heeres' *Tasman's Journal*, 1898, noticed above.

An original chart of Tasman's, made after the voyage of 1644, has been discovered and is in the possession of Prince Roland Bonaparte. Before this discovery reliance was placed on an excellent copy, probably made about 1687, by Captain Thomas Bowrey (art. 12 in the miscell. MS. collection marked 5222 in the British Museum, London). This gives the tracks of both the voyages 1642–43 and 1644, and the soundings of the latter. Burgomaster Witsen, of *Noord en Oost Tartarye* fame (1705), preserved a brief record of certain observations made in Tasman's voyage of 1644, between 13° 8′ and 19° 35′ S. (and approximately between 129° 30′ and 120° E., Greenwich). This was translated by A. Dalrymple in his *Papua* (reprinted in R. H. Major, *Early Voyages to . . . Australia*, xcviii.–xcix.). Basil Thomson, *Diversions of a Prime Minister* (Edinburgh, 1894), p. 311, &c., records that the remembrance of Tasman's visit to the Tonga Islands still remains "fresh to the smallest details" among the natives. (C. R. B.)

TASMANIA, a British colonial state, forming part of the Australian Commonwealth. It is composed of the island of Tasmania and its adjoining islands, and is separated from the Australian continent on the south-east by Bass Strait. The

island of Tasmania is triangular in shape, area 24,331 sq. m. (with the other islands 26,215 sq. m.), 200 m. from N. to S., and 245 m. from E. to W.

Coastal Features.—The southern portion of the eastern shore of Tasmania is remarkable for its picturesque inlets and bold headlands. The principal inlet is Storm Bay, which has three well-defined arms. The most easterly is Norfolk Bay, enclosed between Forestier's Peninsula and Tasman Peninsula. The middle arm is Frederick Henry Bay, and the western the estuary of the Derwent. It is on this estuary that Hobart, the capital of the island, is situated. Besides the main entrance to Storm Bay, between Cape Raoul and Tasman Head, there is D'Entrecasteaux Channel, which divides North and South Bruni Island from the mainland. This channel has two branches, the easterly forming the entrance into Storm Bay, and the western being the estuary of the Huon river. On the east coast lies the peculiarly-shaped Maria Island, almost severed by deep indentations on the east and west. Above this island is Oyster Bay, formed by the projection, Freycinet Peninsula. On the south are some very prominent headlands. In the south-west lies the fine harbour of Port Davey, which receives several small rivers. Proceeding northward along the west coast the most conspicuous headlands are Rocky Point, Point Hibbs and Cape Sorell, which stands at the entrance of Macquarie Harbour, the deep inlet receiving the waters of the river Gordon and several smaller streams. North of this there are several prominent headlands. The west coast terminates at Cape Grim, opposite which are the group known by the name of Hunter's Islands. Going eastward along the north coast Circular Head is met with, a narrow peninsula running out for six miles and terminating in a rocky bluff 400 ft. high. Further east are Emu Bay, Port Frederick, Port Sorell and Port Dalrymple, into which flows the Tamar river, on which Launceston is situated. In Bass Strait are several large islands belonging to Tasmania; King's, Flinders, Cape Barren and Clarke Islands are the largest. Flinders Island has an area of 513,000 acres. Among the rivers flowing northward to Bass Strait are the Tamar, Inglis, Cam, Emu, Blyth, Forth, Don, Mersey, Piper and Ringarooma. The Macquarie, receiving the Elizabeth and Lake, falls into the South Esk, which unites with the North Esk to form the Tamar at Launceston. Westward, falling into the ocean, are the Hellyer, Arthur and Pieman. The King and Gordon gain Macquarie Harbour; the Davey and Spring, Port Davey. The central and southern districts are drained by the Derwent from Lake St Clair—its tributaries being the Nive, Dee, Clyde, Ouse and Jordan. The Huon falls into D'Entrecasteaux Channel. The main axis of the Great Cordillera—so termed originally by Sir Roderick Murchison—bordering the eastern coast-line of Australia, may be traced across Bass Strait in the chain of islands forming the Furneaux and Kent group, which almost continually link Tasmania with Wilson's Promontory, the nearest and most southerly part of the Australian mainland. Tasmania is wholly occupied by the ramifications of this chain, and in itself may be said to embrace one and all of its characteristic features.

Taking a stand near Lake Fergus, to the east of Lake St Clair, the observer will find himself nearly in the centre of an extensive plateau, with an elevation, especially on the northern side, of between three and five thousand feet above the sea-level. This elevated plateau extends from Dry's Bluff in the north to the Denison Range in the south-west, and although often receding at points adjacent to the sources of the principal rivers, invariably presents a bold crested front to the north, west and east. At its greatest elevation it is comparatively level, and contains many extensive freshwater basins, such as Lake Augusta, Lake St Clair, Lake Sorell, Lake Echo, Lake Crescent, Arthur's Lake and the Great Lake. The marginal crests of this mountain tableland, together with its upper surface, are known locally as "Tiers," and have a very commanding aspect in the neighbourhood of Longford, Westbury, Deloraine and Chudleigh. The extent of the principal elevated plateau is best appreciated when we consider that it maintains its general altitude in a westerly direction from Dry's Bluff (4257 feet) on the north to Cradle Mountain (5069 feet) in the north-west, a distance of nearly 50 miles; from Dry's Bluff in a south-westerly direction to Denison Range, a distance of over 60 miles; and from Dry's Bluff to Table Mountain in a southerly direction, a distance of above 43 miles. This plateau itself again rests upon a more extended tableland, stretching westwards, and, with the Middlesex Plains, the Hampshire Hills and the Emu Plains, maintaining an altitude of 1200 to 2000 feet. Its limits follow the coast-line more or less closely, the space between it and the sea often broadening out into low-lying tracts not much raised above the sea-level. Here and there, rising abruptly from its surface, are to be seen isolated peaks, the most characteristic of which are Valentine's Peak (3637 feet) and Mount Pearse. Ridges and plateaus of a similar character, but more or less isolated, such as Ben Lomond (5010 feet) and Mount Wellington (4166 feet), are to be found in the north-east and south-west of the island. Towards the extreme west and south, anticlinal and synclinal ridges trend north and south, the most characteristic being the Huxley, Owen, Sedgwick, Franklin and Arthur Ranges. Settlement of population has taken place principally among the plains and lower levels of the north-western, midland and south-eastern parts of the island, following in the main the rocks of Tertiary and Mesozoic age. In the Recent Tertiary period the soils of these plains and valleys have been greatly enriched by extensive outbursts of basalt with accompanying tuffs. These basalts produce a very rich chocolate soil, and were it not for their influence, the greater part of what is now the most fertile part of the island would have been comparatively poor or altogether sterile.

The appearance of the island throughout is wonderfully beautiful, with its open plains, bordered by far-extending precipitous mountain tiers, its isolated shaggy peaks and wooded ranges, and its many noble rivers and lakes. Its coasts for the most part, especially towards the south, are bold, and frequently indented with splendid bays and harbours, affording ample shelter and safe anchorage for ships. On the western side one is reminded of scenes in the highlands of Ross-shire and Inverness-shire in Scotland, from the picturesque character of the blue, white, and pinkish crystalline peaks and the fantastic outlines of the mountain ranges which rise abruptly to a height of from 2000 to nearly 3000 feet above the Button Grass Plains. (T. A. C.)

Geology.—Tasmania is, geologically, an outlier of the Australian continent. It is most intimately connected with Victoria, from which it was only separated by the foundering of Bass's Strait in late Pliocene or early Pleistocene times. The precise date of the separation is fixed as later than the Miocene, since the fringe of the marine Miocene deposits along the southern coast of Victoria is broken, from Flinders to Alberton; and this gap was no doubt due to the subsidence of the land, of which the islands in the Bass Strait are remnants, which then connected Tasmania with the continent. The latest date for the existence of this connexion is given by the absence from Tasmania of the dingo, the lyre-bird and the giant marsupials; so that the isolation of Tasmania was earlier than the arrival of those animals in south-eastern Australia. That it was not much earlier is shown by the fact that some still living species of mammals, such as the thylacine, existed before the separation.

The geological sequence in Tasmania is full, and the island contains a better series of Carboniferous rocks than is found in Victoria. The nucleus of the island is a block of Archean rocks, which are not, so far as is known, extensively exposed. The most certain representatives of the Archean are the gneiss and schists of the Dove river and the upper Forth, and the hornblende-schists, which are exposed in the river valleys on the margins of the central plateau. The Mount Lyell schists which underlie the West Coast Range, and the quartzites of Port Davey on the western coast, have also been regarded as Archean. The Lower Palaeozoic systems begin with the Cambrian, which are found in northern Tasmania near Latrobe, and contain Cambrian fossils as *Dikelocephalus Tasmanicus* and *Conocephalites stephensi*. The Ordovician system has not been certainly identified; but probably many of the slates and quartzites in north-western Tasmania and of the mining field of Beaconsfield on the estuary of the Tamar, are Ordovician. The Silurian system, however, is well developed in north-western Tasmania, and is represented by slates, limestones and sandstones yielding a distinctively Silurian fauna. The rocks are best known by the limestones in the lead mining field at Zeehan, and the slates, including the tin mine of Mount Bischoff.

The Devonian system is best represented by the massive conglomerates and quartzites, which form the West Coast Range extending from Mount Lyell on Macquarie Harbour, through Mounts Jukes, Owen, Lyell, Murchison and Geikie, to Mount Black. These mountains consist of detached remnants of a sheet of quartz conglomerates, interbedded with sandstones, containing crinoid stems and obscure brachiopods. They rest unconformably on the Silurian rocks on the King river and to the west are faulted against the schists by a powerful overthrust fault, traversing the Mount Lyell copper field. A northern extension of these conglomerates forms the Dial Range near Burnie. The Devonian period, as in Victoria, was marked by a series of granitic intrusions, which altered the older beds on the contact, while the quartz-porphyry dikes, which are intrusive in the Silurian rocks at the Mount Bischoff tin mine, doubtless belong to this period. The Carboniferous system begins with a series of marine limestones, shales and grits, including a rich Lower Carboniferous fauna. The Carboniferous rocks occupy the whole of the south-eastern corner of Tasmania; and one outlier occurs on the northern coast in the Mersey Valley. This formation helps to build up the central plateau, and a band outcrops around its edge. The Upper Carboniferous includes beds of shale and coal; but though the coal is good, the seams are thin and have not been much worked. The Coal Measures are covered by marine shales with numerous bryozoa; and, on the horizon of the Greta Coal Measures of New South Wales, is a bed of Carboniferous glacial deposits.

The Mesozoic system is not well developed. It is usually regarded as beginning with a fresh-water series containing the remains of fish and labyrinthodonts; but as it also contains *Vertebraria* it is probably Palaeozoic; and this series is covered by sandstones and shales which are probably of Triassic age. The most conspicuous member of the Mesozoic group is the sheet of diabase and dolerite, made up of laccolites and sills, which covers most of the central plateau of Tasmania. These rocks form the prominent scarps, known as the Tiers, on the edge of the plateau, and its outliers, such at Mount Wellington near Hobart, and the Eldon Range. This sheet of diabase has been regarded as Carboniferous; but, according to W. H. Twelvetrees, it is probably Cretaceous. The Cainozoic system includes at Table Cape an outcrop of marine beds probably of Oligocene age. Lower Cainozoic lacustrine beds with fossil plants, of the same age as those which underlie the older basalts of Victoria, occur in the valleys of northern Tasmania. The Cainozoic series includes many igneous rocks. The tinguaites and sölvsbergites of Port Cygnet, south of Hobart, may be of this age; they are intrusive in Carboniferous rocks, and there is no evidence of their precise date; but their resemblance to the rocks associated with the geburite-dacite of Victoria suggests that they may belong to the beginning of the Cainozoic volcanic period of south-eastern Australia. North-western Tasmania in Pleistocene times had an extensive series of glaciers, of which the lower moraines were deposited only about 400 feet above sea level.

The information as to the geology of Tasmania up to 1888 is collected in R. M. Johnston's *Systematic Account of the Geology of Tasmania*, which gives a bibliography up to that date. A later sketch of the island is by W. H. Twelvetrees, "Outlines of the Geology of Tasmania," *Proc. R. Soc. Tasmania*, 1900–1901, pp. 58–74. The mining literature is given in the reports of the Mines Department, and special reports issued in the Parliamentary Papers; and the economic and general geology are described in reports issued periodically by the Geological Survey, under W. H. Twelvetrees, and in papers published in the *Proceedings of the Royal Society of Tasmania*. The Mount Lyell mining field is described, with some account of the neighbouring districts of Western Tasmania, in J. W. Gregory, *The Mount Lyell Mining Field* (Melbourne, 1904). The glacial geology, with a summary of the literature thereon, is described by the same writer in the *Quarterly Journal of the Geological Society*, 1904, vol. lx., pp. 7–8, 37–53. (J. W. G.)

Climate.—Tasmania possesses a very temperate and healthy climate. The mean temperature of the year, as estimated from observations extending back to 1841, is about 50·10°. The mean at Hobart was 54·4°, at Launceston 56·6° and at Oatlands, which is in the centre of the island and 1400 ft. above sea-level, 51·76°. Snow is rarely seen except in the mountains. The average temperature at Hobart of January, the hottest month, is 63°, and of July, which is mid-winter, 45°. The western prevailing winds—particularly the north-western—carry the rain-bearing clouds. The elevation-divide between the western and eastern parts of the island rises generally to a height of between 3000 and 5000 ft., and consequently the parts to the east of such heights receive much less precipitation than those to the westward. The general average for the eastern district over a period of years was 22·07 inches; for the western, 37·55 inches; and for Tasmania 26·69 inches.

Flora.—The vegetation which prevails among the older schistose rocks of the west and extreme south presents a totally different appearance to that which occurs in the more settled districts of the east. The western vegetation, as compared with that of the east, presents as marked a contrast as do the prevailing rocks upon which it flourishes. The characteristic trees and shrubs of the west include the following genera, viz.: *Fagus*, *Cenarrhenes*, *Anodopetalum*, *Eucryphia*, *Bauera*, *Boronia*, *Agastachys*, *Richea*, *Telopea*, *Grevillea*, *Orites*, *Athrotaxis*, *Dacrydium*, *Phyllocladus*. On the eastern side the plains and rocky ridges, where not artificially cleared, are occupied by shaggy and often sombre forests mainly composed of the following genera: *Eucalyptus* (gum tree), *Casuarina*, *Bursaria*, *Acacia*, *Leptospermum*, *Drimys*, *Melaleuca*, *Dodonaea*, *Notolea*, *Exocarpus*, *Hakea*, *Epacris*, *Xanthorrhoea*, *Frenela*. The mountain slopes and ravines of the east have a well-marked vegetation. In character it is more akin to, and in many cases identical with, that of the west. The tree fern (*Dicksonia antarctica*) in the mountain ravines is especially remarkable. The following genera are also found in such positions in great luxuriance, viz.: *Fagus*, *Anopterus*, *Phebalium*, *Eucalyptus*, *Richea*, *Cyathodes*, *Pomaderris*, *Prostanthera*, *Boronia*, *Gaultheria*, *Correa*, *Bedfordia*, *Aster*, *Archeria*, *Atherosperma*, &c. In the extreme west the trees and larger shrubs do not appear to ascend the schistose rocky mountain slopes of the central and eastern parts.

Fauna.—Animal life in Tasmania is similar to that in Australia. The dingo or dog of the latter is wanting; and the Tasmanian devil and tiger, or wolf, are peculiar to the island. The Marsupials include the *Macropus* or kangaroo; the opossums, *Phalangista vulpina* and *P. Cookii*; the opossum-mouse, *Dromicia nana*; *Perameles* or bandicoot; *Hypsiprymnus* or kangaroo rat; *Phascolomys* or wombat; while of *Monotremata* there are the *Echidna* or porcupine ant-eater and the duck-billed platypus. The marsupial tiger or Tasmanian wolf (*Thylacinus cynocephalus*), 5 ft. long, is yellowish brown, with several stripes across the back, having short stiff hair and very short legs. Very few of these nocturnal carnivores are now alive to trouble flocks. The tiger-cat of the colonists, with weasel legs, white spots and nocturnal habits, is a large species of the untameable native cats. The devil (*Dasyurus* or *Sarcophilus ursinus*) is black, with white bands on neck and haunches. The covering of this savage but cowardly little night-prowler is a sort of short hair, not fur. The tail is thick, and the bull-dog mouth is formidable. Among the birds of the island are the eagle, hawk, petrel, owl, finch, peewit, diamond bird, fire-tail, robin, emu-wren, crow, swallow, magpie, blackcap, goatsucker, quail, ground dove, parrot, lark, mountain thrush, cuckoo, wattlebird, whistling duck, honeybird, Cape Barren goose, penguin duck, waterhen, snipe, albatross and laughing jackass. Snakes are pretty plentiful in scrubs; the lizards are harmless. Insects, though similar to Australian ones, are far less troublesome; many are to be admired for their great beauty.

Population.—At the beginning of 1905, the state contained 181,100 people, giving a density of 6·9 persons per square mile. The population in 1870 was 100,765. The discovery of Mount Bischoff one year later, though it greatly stimulated speculation and induced a large influx of immigrants, did not put a stop to the outflow, for in 1880 the population was still below 115,000. During the next two decades there was a substantial advance; in 1890 it had reached 145,200, and in 1900, 172,980. Like all the Australian states, Tasmania shows a decline in the birth-rate; in 1905 the births were 5256—36 less than in 1904—which gives a rate of 29·32 per 1000 of mean population.

The climate is probably more healthy than that of any of the Australian states, although, owing to the large number of old people in the colony, the death-rate would appear to put Tasmania on a par with New South Wales and South Australia. The death-rate per 1000 of population, which was 16·52 in the period 1876–80, had fallen to 11·01 in the period 1901–5. There has therefore been a gradual and substantial improvement in the health conditions of the state. The annual marriage-rate was for many years considerably below the average of Australia generally, a condition sufficiently accounted for by the continued emigration of men unmarried and of marriageable ages; this emigration had ceased in 1900, and the marriage-rate may be taken as 7·8 per thousand. The chief towns are Hobart (pop. 35,000) and Launceston (pop. 22,500).

Administration.—As one of the states of Australia, Tasmania returns six senators and five representatives to the federal parliament. The local constitution resembles that of the other Australian states inasmuch as the executive government of four ministers is responsible to the legislature, which consists of a legislative council and a house of assembly. The former is composed of eighteen members elected for six years. Electors of the council must be natural-born or naturalized subjects of the king, twenty-one years of age, resident in Tasmania for twelve months, and possessing a freehold of the annual value of £10 or a leasehold of the annual value of £30 within the electoral district; the property qualification being waived in the case of persons with university degrees or belonging to certain professions. Members of the council must be not less than thirty years of age. The house of assembly consists of 35 members elected for three years. Every resident of Tasmania for a period of twelve months who is twenty-one years of age, natural-born or naturalized, is entitled to have his name placed on the electoral roll, and to vote for the district in which he resides. The franchise has been conferred on women.

Education.—Half the population are adherents of the Church of England, and about 18 per cent. Roman Catholics; Wesleyans number nearly 16 per cent., and Presbyterians about 6½ per cent. Instruction is compulsory upon children over seven years of age and under thirteen years in the towns of Hobart and Launceston, but not in the rural districts. Special religious instruction is allowed to be given after school hours by teachers duly authorized by the various religious denominations, and this privilege is somewhat extensively used by the Church of England. The schools are not free, as small fees are charged; but these are not enforced where parents can reasonably plead poverty. In 1905 there were 343 state schools, with 19,000 pupils on the roll, and administered by 600 teachers; there were also 180 private schools, with 310 teachers and 9000 scholars. The net expenditure averages £3, 15s. 2d. per child in average attendance, inclusive of what is spent in the upkeep of school buildings and on new schools. The university of Tasmania has an endowment of £4000 and a revenue from other sources (chiefly fees) of from £1100 to £2000. The students attending lectures in 1904 were 62, of whom 51 matriculated, and the number of degrees conferred to the close of that year was 180, the great majority of these degrees being granted *ad eundem gradum*.

Finance.—The revenue is chiefly obtained through the custom-house, but the federal tariff has had the effect of considerably reducing the receipts from this source. In 1905 the state raised £852,681 on account of the public revenue, which is equal to £4, 13s. 3d. per inhabitant; of this sum £259,099 was the excess of Commonwealth collections over expenditure, and £216,953 from other taxation; the railways returned £245,049, while from public lands was obtained £63,088, and from other sources £43,504. The expenditure was £840,185, thus distributed: railway working expenses, £171,619; public instruction, £67,403; interest and charges upon debt, including sinking funds, £349,090; and other services £252,075. The interest and other debt charges come to £1, 18s. 9d. per inhabitant, and represent 41·55 per cent. of the expenditure of the state. The public debt in the year 1906 stood at £9,471,971, of which £7,830,250 was held in London; this represents £52, 6s. per inhabitant. In 1871 it was £1,315,200, in 1881 £2,003,000, and in 1891 £7,110,290, representing respectively £12, 18s., £16, 16s. 10d., and £46, 11s. 10d. per inhabitant, the great increase in recent years being due to the rapid extension of railway and other public works. The expenditure upon works may be divided into that on revenue-yielding works, viz. railways, £4,122,589, and telegraphs, £142,410; and that on works not yielding revenue, £4,970,018. For local government purposes Tasmania is divided into municipalities, town boards, and road trusts. The rates are assessed on an assumed annual value, which in 1900 was £1,417,547, corresponding to a capital value of upwards of £28,000,000. The bulk of the revenue of the local government bodies is obtained from rates. The sources of revenue in 1905 were: government endowment, £5355; local rates, £71,920; and other sources, £83,187. The outstanding loans of municipalities amount to £697,133, of which the greater portion is represented by the indebtedness of the two chief cities, Hobart and Launceston.

Defence.—Tasmania being a portion of the Commonwealth of Australia, its defence is undertaken by the federal government. The strength of the local forces is about 1500 officers and men.

Mining.—Mining is now the foremost industry, the gross production in 1905 being valued at £1,858,218 as compared with £1,500,000, the value of agricultural production, which is next in importance. Tasmania produces gold, tin, silver, copper and coal, and in 1905 the production of these minerals was valued at: gold, £312,380; silver and silver-lead, £465,094; copper, £672,010; tin, £346,092; and coal, £44,194. Beaconsfield is the chief goldfield, 26 miles north-west of Launceston. There are about 1500 persons employed mining for gold on the various fields. The Mount Zeehan and Dundas districts produce almost the whole of the silver at the present time, and most of the ore is sold to agents of the Australian and German smelting works. Tasmania is the largest producer of tin in Australasia, and a very large proportion of the tin hitherto produced has been obtained from alluvial deposits, the lodes, except at Mount Bischoff, having, comparatively speaking, been neglected. The Mount Bischoff mine, which is worked as an open quarry, is the largest producer of tin, and (with an original capital of £30,000) has paid over two millions sterling in dividends. The number of tin miners in the state is about 1170. Tasmania also takes the lead amongst the states in copper production: in 1896 there was a small production of £1659; in 1897 it grew to £317,437, in 1898 to £378,565, in 1899 to £761,880, and in 1900 to £901,660; and although the production has since been considerably reduced it is still a great industry. This expansion was chiefly due to the enterprise of the Mount Lyell Mining and Railway Company, whose mine is situated at Gormanston. Coal-mining is carried on in various districts of the island, but the principal mines are at Mount Nicholas and Cornwall, in the Mount Nicholas Range; the output of the field is increasing, but no export trade is at present possible, the mines being situated too far from the seaboard. The number of men employed in coal-mining is 150, and the output about 52,000 tons per annum.

Manufactures are on a small scale, the number of establishments being about 440, and the hands employed 9000.

Agriculture.—After being much neglected, agriculture received renewed attention in 1892 and the following years up to 1904, when the area under crop reached a total of 259,611 acres; since the year named there has been no increase, and the area cultivated may be placed at about 250,000 acres. The area under crop, at intervals of ten years, was as follows: 1861, 163,385 acres; 1871, 155,046 acres; 1887, 148,494 acres; 1891, 168,121 acres; and 1901, 224,352 acres. Wheat is the principal crop, and the yield is larger per acre and less variable than that of the Australian states: for the fifteen years ending with 1905 the average yield was 18·9 bushels per acre, ranging between 15 bushels in 1894 and 27 bushels in 1899. The oat crop is also much above the Australian average, and may be set down at 30 bushels an acre, but an average of 5 bushels higher is not infrequent. Tasmania is renowned for its fruit crops, and now that this fruit has found an opening in the British market, renewed attention is being devoted to the industry. In 1905 there were 12,683 acres of apples, 2098 acres of pears, 1111 acres of apricots, 1123 acres of plums, 426 acres of cherries, 498 acres of peaches, 2000 acres of strawberries, gooseberries and raspberries, and 1107 acres of currants. The crop for the same year included 1,100,000 bushels of apples, 75,000 bushels of pears, and nearly 170,000 bushels of other fruit. Tasmania finds its best markets for fruits in New South Wales and in Great Britain. The total value of the produce of Tasmanian farms now exceeds £1,250,000, which is equivalent to £4, 17s. 5d. per acre cultivated.

Tasmania shows a decline in sheep-breeding, yet the state is singularly well adapted for sheep-raising, and its stud flocks are well known and annually drawn upon to improve the breed in the other states. Nor have the other branches of the pastoral industry shown much expansion, as the following table will show:—

Year.	Sheep.	Horned Cattle.	Horses.	Swine.
1861	1,714,498	87,114	22,118	40,841
1871	1,305,489	101,540	23,054	52,863
1881	1,847,479	130,526	25,607	49,660
1891	1,662,801	167,666	31,262	73,520
1901	1,683,956	165,516	31,607	68,291
1905	1,583,561	206,211	37,101	72,810

Commerce.—The shipping increased considerably after 1896. Hobart is now a place of call for several of the European steamship lines, and the state is becoming increasingly popular as a summer resort for the residents of Melbourne and Sydney. The growth of the shipping trade will be seen in the following table, which also gives the imports and exports at ten-yearly intervals:—

Year.	Shipping entered.	Imports.	Exports.
	Tons.	£	£
1861	113,610	954,517	905,463
1871	107,271	778,087	740,638
1881	192,024	1,431,144	1,555,576
1891	514,706	2,051,964	1,440,818
1900	618,963	2,073,657	2,610,617
1905	1,056,256	2,651,754	3,711,616

Tasmania does a large trade with Victoria and New South Wales as well as with Great Britain. The principal exports in 1905 and their values were: wool, £401,958; gold, £187,873; tin and ore, £257,256; silver and ore, £318,971; copper, £569,052; farm, fruit and vegetable products, £477,866; timber, £78,380. The imports represent £14, 15s. 10d. and the exports £20, 14s. per inhabitant. The chief ports of the state are Hobart, where the shipping entered in 1905 amounted to 645,000 tons, and Launceston, 223,000 tons; Strahan on the west coast has also a considerable trade.

Railways.—The railways open for traffic in 1905 had a length of 619 miles, of which 463 were government and 156 private lines. The progress of railway construction will be seen from the following figures: open for traffic, 1871, 45 miles; 1881, 168 miles; 1891, 425 miles; and 1905, 619 miles. The railways, both state and private, are of 3 ft. 6 in. gauge. The capital expended on government lines up to 1905 was £3,920,500; the gross earnings in that year were £243,566, and the working expenses £171,630; leaving £71,936 as the net earnings. This last-mentioned sum is equal to 1·83 per cent. on the capital expenditure; and as the average interest upon outstanding loans is 3·73 per cent., the railways are carried on at a loss of 1·9 per cent. The private railways show somewhat better returns; the Emu Bay and Mount Bischoff line, 103 miles in length, constructed at a cost of £565,365, returned in 1904 about 3·22 per cent., and the Mount Lyell Company's railway, 22 miles long, costing £220,333, returned nearly 6 per cent.

The roads maintained by the road trusts and boards of the colony extend over 7695 miles, of which 4146 were macadamized; the annual expenditure thereon is over £35,768.

Posts and Telegraphs.—There were 379 post offices and receiving offices in 1905, and 327 telegraphic stations; 12,616,000 postcards and letters, 2,800,000 packets, and 7,200,000 newspapers were received and despatched. The postal revenue amounted to £116,132, and the expenditure to £109,389; these sums include telegraph and telephone business. The telegraph messages sent numbered 496,000. The telephone system is being rapidly extended, and at the beginning of 1906, 1371 miles of line were being worked.

Banking.—There are four banks of issue, of which two are local institutions; their united assets average £3,576,700. The note circulation is about £150,000, and the deposits £3,520,000, about half bearing interest.

History.—Tasmania, or, as it was originally called, Van Diemen's Land, was discovered in 1642 by the Dutch navigator Tasman (*q.v.*) who named the territory after his patron, Van Diemen. The island was subsequently visited in 1772 by a French naval officer, Captain Marion du Fresne; in 1773 by Captain Furneaux, of the British man-of-war "Adventure"; in 1777 by the great circumnavigator Captain Cook; by Bligh in 1788, and again in 1792, when he planted fruit trees. In the same year the French navigator D'Entrecasteaux visited the south portion of the island and surveyed the coast. In 1798 Bass sailed through the strait which now bears his name, and discovered Van Diemen's Land was an island. In 1800 the French explorer Baudin, in command of the ships "Géographe" and "Naturaliste," surveyed the south of the island, and reports of his proceedings having reached the British officials at Sydney, they determined to forestall the French and take possession of Van Diemen's Land.

In 1802 the "Cumberland," a small schooner, landed at King's Island in Bass Strait, and in 1803 Lieutenant Bowen was sent by Governor King of New South Wales to form a settlement on the south coast of Van Diemen's Land. He had aboard his two ships, the "Lady Nelson" of 60 tons and the whaler "Albion" of 306 tons, three officials, a lance-corporal and seven privates of the New South Wales Corps, six free men and twenty-five convicts, together with an adequate supply of live stock, and landed at Risdon, near Hobart, where he was joined shortly afterwards by fifteen soldiers and forty-two convicts. In 1807, Colonel Paterson occupied Port Dalrymple on the north side of the island. During the same year Colonel Collins, who had failed in an attempt to colonize the shores of Port Phillip, transferred his soldiers, convicts and officials to the neighbourhood of Hobart, and was appointed commandant of the infant settlement. Provisions were scarce and dear, communication with the rest of the world was infrequent, and in 1807 the community was threatened with starvation, and flour was sold at £200 per ton. The difficulties of the settlers were increased by the hostility of the blacks. The first collision took place at Risdon, a few days after the landing of Lieutenant Bowen's expedition, and for this the white settlers were entirely responsible. Hostilities between the races were incessant from 1802 till 1830. An attempt was made in the year 1830 to drive the natives to one corner of the island, but without success. In the following year, however, Mr George Robinson induced the remnant of the blacks to leave the mainland and take refuge, first in South Bruni and subsequently in Flinders Island, their numbers having then diminished from 5000, the original estimate of the aboriginal population, to 203. In 1842 there were only 44, in 1854 they had diminished to 16, and the last pure-blooded Tasmanian died in 1876, at the age of seventy-six. There are, however, a few persons possessing more or less aboriginal blood in some of the islands of the Bass Strait.

Some persons who had settled at Norfolk Island when that island became a penal depot were transferred to Van Diemen's Land in 1805. But the growth of population was extremely slow, and in 1808 a census showed that there were only 3240 people on the island, including officials, military and convicts, and whatever measure of prosperity was enjoyed by the free inhabitants arose from the expenditure by the imperial government upon the convict settlement. In the year named settlers began to arrive. To every free immigrant was given a tract of land in proportion to the amount of capital brought by him to the colony—the possession of £500 entitling the holder to 640 acres, and so in proportion, a very liberal view being taken as to what constituted capital. To every free settler was assigned, if desired, the services of a number of convicts proportionate to the size of his holding. These were fed and clothed by the settler in return for their labour, and the government was relieved of the expense of their support and supervision. The assignment system was eventually abandoned in consequence of its moral and economic evils, but it cannot be denied that while it lasted the colony made substantial progress. In 1821 the population had grown to 7400; the sheep numbered 128,468; the cattle, 34,790; horses, 550; and 14,940 acres of land were under crops. As the number of free settlers in the colony increased an agitation arose for more political freedom and improved administration; especially was there a demand for a free press and for trial by jury. These requests were gradually granted. Courts of justice were substituted in 1822 for courts-martial; and in 1825 the colony was made independent of New South Wales, Colonel Arthur being appointed governor. In 1828 the Van Diemen's Land Company commenced sheep-farming on a large scale in the north-west district of the island under a charter granted three years before, and in 1829 the Van Diemen's Land Establishment obtained a grant of 40,000 acres at Norfolk Plains for agriculture and grazing. In 1834 Portland Bay, on the mainland of Australia, was occupied by settlers from Van Diemen's Land, and in 1835 there was a migration, large when compared with the population of the island, to the shores of Port Phillip, now Victoria. At that date the population was 40,172, a large proportion being convicts, for in four years 15,000 prisoners had been landed. The colony was prosperous, but the free settlers were not at all satisfied with the system of government, and an agitation commenced in Van Diemen's Land, as well as in New South Wales, for the introduction of representative institutions and the abolition of transportation. This system was abolished in New South Wales in 1840, after which date the island was the receptacle for all convicts not only from the United Kingdom, but from India and the colonies, and it was not until 1853 that transportation to Van Diemen's Land finally ceased; in the same year representative institutions were introduced, the name of the colony was changed to Tasmania, and three years later the colony was granted responsible government.

The discovery of gold in Victoria produced a very remarkable effect upon Tasmania. All kinds of produce brought fabulous prices, and were exported to Victoria in such quantities that the exports rose from a value of £665,790 in 1851 to £1,509,883 in 1852, and £1,756,316 in 1853, while the population diminished in almost equal ratio. It was estimated that in 1842 there were 38,000 adult males in the colony, but in 1854 their numbers had diminished to 22,261. For many years the island was inhabited by greybeards and children; the young men and women of all classes, so soon as they had reached manhood and womanhood, crossed Bass Strait, and entered upon the wider life and the more brilliant prospects which first Victoria, and subsequently New South Wales and Queensland, afforded them. It was not till the sixties that Tasmania embarked upon a new period of prosperity. In the early days little was known about the western half of the island. Its mineral wealth was not suspected, although as far back as 1850 coal of fair quality had been found between the Dee and the Mersey rivers, and gold had been discovered in two or three localities during 1852. In 1860 two expeditions were equipped by the government for a search for gold and other minerals, and although it was some years before there was any important result, the discoveries of these explorers directed attention to the mineral wealth of the island.

The political history of the colony after the inauguration of responsible government, until it became in 1901 one of the states of Federated Australasia, was not important. State aid to religion, which was given to any denomination which would receive it, was abolished; local self-government was extended to the rural as well as to the urban districts; a policy of semi-protection was introduced; the island was connected by a submarine cable to the mainland of Australia, and thence to the rest of the civilized world; and the population, which was only 99,328 in 1870, was nearly doubled. Like her neighbours, Tasmania organized a defence force, and was able to send a contingent to South Africa in 1900. (T. A. C.)

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TASSIE, JAMES (1735–1799), Scottish gem-engraver and modeller, was born of humble parentage at Pollokshaws, near Glasgow, in 1735. During his earlier years he worked as a stonemason, but, having seen the collection of paintings brought together in Glasgow by Robert and Andrew Foulis, the printers, he removed to Glasgow, attended the academy which had been established there by the brothers Foulis, and became one of the most distinguished pupils of the school. Subsequently he visited Dublin in search of commissions, and there became acquainted with Dr Quin, who had been experimenting, as an amateur, in imitating antique engraved gems in coloured pastes. He engaged Tassie as an assistant, and together they perfected the discovery of an "enamel," admirably adapted by its hardness and beauty of texture for the formation of gems and medallions. Dr Quin encouraged his assistant to try his fortune in London, and thither he repaired in 1766. At first he had a hard struggle to make his way. But he worked on steadily with the greatest care and accuracy, scrupulously destroying all impressions of his gems which were in the slightest degree inferior or defective. Gradually the beauty and artistic character of his productions came to be known. He received a commission from the empress of Russia for a collection of about 15,000 examples; all the richest cabinets in Europe were thrown open to him for purposes of study and reproduction; and his copies were frequently sold by fraudulent dealers as the original gems. He exhibited in the Royal Academy from 1769 to 1791. In 1775 he published the first catalogue of his works, a thin pamphlet detailing 2856 items. This was followed in 1791 by a large catalogue, in two volumes quarto, with illustrations etched by David Allan, and descriptive text in English and French by Rudolph Eric Raspe, enumerating nearly 16,000 pieces.

In addition to his impressions from antique gems, Tassie executed many large profile medallion portraits of his contemporaries, and these form the most original and definitely artistic class of his works. They were modelled in wax from the life or from drawings done from the life, and—when this was impossible—from other authentic sources. They were then cast in white enamel paste, the whole medallion being sometimes executed in this material; while in other cases the head only appears in enamel, relieved against a background of ground-glass tinted of a subdued colour by paper placed behind. His first large enamel portrait was that of John Dolbon, son of Sir William Dolbon, Bart., modelled in 1793 or 1794; and the series possesses great historic interest, as well as artistic value, including as it does portraits of Adam Smith, Sir Henry Raeburn, Drs James Beattie, Blair, Black and Cullen, and many other celebrated men of the latter half of the 18th century. At the time of his death, in 1799, the collection of Tassie's works numbered about 20,000 pieces.

His nephew, WILLIAM TASSIE (1777–1860), also a gem-engraver and modeller, succeeded to James Tassie's business and added largely to his collection of casts and medallions. His portrait of Pitt, in particular, was very popular, and circulated widely. When the Shakespeare Gallery, formed by Alderman Boydell, was disposed of by lottery in 1805, William Tassie was the winner of the prize, and in the same year he sold the pictures by auction for a sum of over £6000. He bequeathed to the Board of Manufactures, Edinburgh, an extensive and valuable collection of casts and medallions by his uncle and himself, along with portraits of James Tassie and his wife by David Allan, and a series of water-colour studies by George Sanders from pictures of the Dutch and Flemish schools.

(J. M. G.)

TASSO, TORQUATO (1544–1595), Italian poet, was the son of Bernardo Tasso (1493–1569), a nobleman of Bergamo, and his wife Porzia de' Rossi. He was born at Sorrento on the 11th of March 1544. His father had for many years been secretary in the service of the prince of Salerno, and his mother was closely connected with the most illustrious Neapolitan families. The prince of Salerno came into collision with the Spanish government of Naples, was outlawed, and was deprived of his hereditary fiefs. In this disaster of his patron Tasso's father shared. He was proclaimed a rebel to the state, together with his son Torquato, and his patrimony was sequestered. These things happened during the boy's childhood. In 1552 he was living with his mother and his only sister Cornelia at Naples, pursuing his education under the Jesuits, who had recently opened a school there. The precocity of intellect and the religious fervour of the boy attracted general admiration. At the age of eight he was already famous. Soon after this date he joined his father, who then resided in great indigence, an exile and without occupation, in Rome. News reached them in 1556 that Porzia Tasso had died suddenly and mysteriously at Naples. Her husband was firmly convinced that she had been poisoned by her brother with the object of getting control over her property. As it subsequently happened, Porzia's estate never descended to her son; and the daughter Cornelia married below her birth, at the instigation of her maternal relatives. Tasso's father was a poet by predilection and a professional courtier. When, therefore, an opening at the court of Urbino offered in 1557, Bernardo Tasso gladly accepted it. The young Torquato, a handsome and brilliant lad, became the companion in sports and studies of Francesco Maria della Rovere, heir to the dukedom of Urbino. At Urbino a society of cultivated men pursued the aesthetical and literary studies which were then in vogue. Bernardo Tasso read cantos of his *Amadigi* to the duchess and her ladies, or discussed the merits of Homer and Virgil, Trissino and Ariosto, with the duke's librarians and secretaries. Torquato grew up in an atmosphere of refined luxury and somewhat pedantic criticism, both of which gave a permanent tone to his character. At Venice, whither his father went to superintend the printing of the *Amadigi* (1560), these influences continued. He found himself the pet and prodigy of a distinguished literary circle. But Bernardo had suffered in his own career so seriously from addiction to the Muses and a prince that he now determined on a lucrative profession for his son. Torquato was sent to study law at Padua. Instead of applying himself to law, the young man bestowed all his attention upon philosophy and poetry. Before the end of 1562 he had produced a narrative poem called *Rinaldo*, which was meant to combine the regularity of the Virgilian with the attractions of the romantic epic. In the attainment of this object, and in all the minor qualities of style and handling, *Rinaldo* showed such marked originality that its author was proclaimed the most promising poet of his time. The flattered father allowed it to be printed; and, after a short period of study at Bologna, he consented to his son's entering the service of Cardinal Luigi d'Este. In 1565, then, Torquato for the first time set foot in that castle at Ferrara which was destined for him to be the scene of so many glories, and such cruel sufferings. After the publication of *Rinaldo* he had expressed his views upon the epic in some *Discourses on the Art of Poetry*, which committed him to a distinct theory and gained for him the additional celebrity of a philosophical critic. The age was nothing if not critical; but it may be esteemed a misfortune for the future author of the *Gerusalemme* that he should have started with pronounced opinions upon art. Essentially a poet of impulse and instinct, he was hampered in production by his own rules.

The five years between 1565 and 1570 seem to have been the happiest of Tasso's life, although his father's death in 1569 caused his affectionate nature profound pain. Young, handsome, accomplished in all the exercises of a well-bred gentleman, accustomed to the society of the great and learned, illustrious by his published works in verse and prose, he became the idol of the most brilliant court in Italy. The princesses Lucrezia and Leonora d'Este, both unmarried, both his seniors by about ten years, took him under their protection. He was admitted to their familiarity, and there is some reason to think that neither of them was indifferent to him personally. Of the celebrated story of his love for Leonora this is not the place to speak. It is enough at present to observe that he owed much to the constant kindness of both sisters. In 1570 he travelled to Paris with the cardinal. Frankness of speech and a certain habitual want of tact caused a disagreement with his worldly patron. He left France next year, and took service under Duke Alfonso II. of Ferrara. The most important events in Tasso's biography during the following four years are the publication of the *Aminta* in 1573 and the completion of the *Gerusalemme Liberata* in 1574. The *Aminta* is a pastoral drama of very simple plot, but of exquisite lyrical charm. It appeared at the critical moment when modern music, under Palestrina's impulse, was becoming the main art of Italy. The honeyed melodies and sensuous melancholy of *Aminta* exactly suited and interpreted the spirit of its age. We may regard it as the most decisively important of Tasso's compositions, for its influence, in opera and cantata, was felt through two successive centuries. The *Gerusalemme Liberata* occupies a larger space in the history of European literature, and is a more considerable work. Yet the commanding qualities of this epic poem, those which revealed Tasso's individuality, and which made it immediately pass into the rank of classics, beloved by the people no less than by persons of culture, are akin to the lyrical graces of *Aminta*. It was finished in Tasso's thirty-first year; and when the MS. lay before him the best part of his life was over, his best work had been already accomplished. Troubles immediately began to gather round him. Instead of having the courage to obey his own instinct, and to publish the *Gerusalemme* as he had conceived it, he yielded to the critical scrupulosity which formed a secondary feature of his character. The poem was sent in manuscript to several literary men of eminence, Tasso expressing his willingness to hear their strictures and to adopt their suggestions unless he could convert them to his own views. The result was that each of these candid friends, while expressing in general high admiration for the epic, took some exception to its plot, its title, its moral tone, its episodes or its diction, in detail. One wished it to be more regularly classical; another wanted more romance. One hinted that the Inquisition would not tolerate its supernatural machinery; another demanded the excision of its most charming passages—the loves of Armida, Clorinda and Erminia. Tasso had to defend himself against all these ineptitudes and pedantries, and to accommodate his practice to the theories he had rashly expressed. As in the *Rinaldo*, so also in the *Jerusalem Delivered*, he aimed at ennobling the Italian epic style by preserving strict unity of plot and heightening poetic diction. He chose Virgil for his model, took the first crusade for subject, infused the fervour of religion into his conception of the hero Godfrey. But his own natural bias was for romance. In spite of the poet's ingenuity and industry the stately main theme evinced less spontaneity of genius than the romantic episodes with which, as also in *Rinaldo*, he adorned it. Godfrey, a mixture of pious Aeneas and Tridentine Catholicism, is not the real hero of the *Gerusalemme*. Fiery and passionate Rinaldo, Ruggiero, melancholy impulsive Tancredi, and the chivalrous Saracens with whom they clash in love and war, divide our interest and divert it from Goffredo. On Armida, beautiful witch, sent forth by the infernal senate to sow discord in the Christian camp, turns the action of the epic. She is converted to the true faith by her adoration for a crusading knight, and quits the scene with a phrase of the Virgin Mary on her lips. Brave Clorinda, donning armour like Marfisa, fighting in duel with her devoted lover, and receiving baptism from his hands in her pathetic death; Erminia seeking refuge in the shepherd's hut—these lovely pagan women, so touching in their sorrows, so romantic in their adventures, so tender in their emotions, rivet our attention, while we skip the battles, religious ceremonies, conclaves and stratagems of the campaign. The truth is that Tasso's great invention as an artist was the poetry of sentiment. Sentiment, not sentimentality, gives value to what is immortal in the *Gerusalemme*. It was a new thing in the 16th century, something concordant with a growing feeling for woman and with the ascendant art of music. This sentiment, refined, noble, natural, steeped in melancholy, exquisitely graceful, pathetically touching, breathes throughout the episodes of the *Gerusalemme*, finds metrical expression in the languishing cadence of its mellifluous verse, and sustains the ideal life of those seductive heroines whose names were familiar as household words to all Europe in the 17th and 18th centuries.

Tasso's self-chosen critics were not men to admit what the public has since accepted as incontrovertible. They vaguely felt that a great and beautiful romantic poem was imbedded in a dull and not very correct epic. In their uneasiness they suggested every course but the right one, which was to publish the *Gerusalemme* without further dispute. Tasso, already overworked by his precocious studies, by exciting court-life and exhausting literary industry, now grew almost mad with worry. His health began to fail him. He complained of headache, suffered from malarious fevers, and wished to leave Ferrara. The *Gerusalemme* was laid in manuscript upon a shelf. He opened negotiations with the court of Florence for an exchange of service. This irritated the duke of Ferrara. Alfonso hated nothing more than his courtiers leaving him for a rival duchy. He thought, moreover, that, if Tasso were allowed to go, the Medici would get the coveted dedication of that already famous epic. Therefore he bore with the poet's humours, and so contrived that the latter should have no excuse for quitting Ferrara. Meanwhile, through the years 1575, 1576, 1577, Tasso's health grew worse. Jealousy inspired the courtiers to calumniate and insult him. His irritable and suspicious temper, vain and sensitive to slights, rendered him only too easy a prey to their malevolence. He became the subject of delusions,—thought that his servants betrayed his confidence, fancied he had been denounced to the Inquisition, expected daily to be poisoned. In the autumn of 1576 he quarrelled with a Ferrarese gentleman, Maddalo, who had talked too freely about some love affair; in the summer of 1577 he drew his knife upon a servant in the presence of Lucrezia d'Este, duchess of Urbino. For this excess he was arrested; but the duke released him, and took him for change of air to his country seat of Belriguardo. What happened there is not known. Some biographers have surmised that a compromising *liaison* with Leonora d'Este came to light, and that Tasso agreed to feign madness in order to cover her honour. But of this there is no proof. It is only certain that from Belriguardo he returned to a Franciscan convent at Ferrara, for the express purpose of attending to his health. There the dread of being murdered by the duke took firm hold on his mind. He escaped at the end of July, disguised himself as a peasant, and went on foot to his sister at Sorrento.

The truth seems to be that Tasso, after the beginning of 1575, became the victim of a mental malady, which, without amounting to actual insanity, rendered him fantastical and insupportable, a misery to himself and a cause of anxiety to his patrons. There is no evidence whatsoever that this state of things was due to an overwhelming passion for Leonora. The duke, instead of acting like a tyrant, showed considerable forbearance. He was a rigid and not sympathetic man, as egotistical as a princeling of that age was wont to be. But to Tasso he was never cruel—hard and unintelligent perhaps, but far from being that monster of ferocity which has been painted. The subsequent history of his connexion with the poet, over which we may pass rapidly, will corroborate this view. While at Sorrento, Tasso hankered after Ferrara. The court-made man could not breathe freely outside its charmed circle. He wrote humbly requesting to be taken back. Alfonso consented, provided Tasso would agree to undergo a medical course of treatment for his melancholy. When he returned, which he did with alacrity under those conditions, he was well received by the ducal family. All might have gone well if his old maladies had not revived. Scene followed scene of irritability, moodiness, suspicion, wounded vanity and violent outbursts. In the summer of 1578 he ran away again; travelled through Mantua, Padua, Venice, Urbino, Lombardy. In September he reached the gates of Turin on foot, and was courteously entertained by the duke of Savoy. Wherever he went, "wandering like the world's rejected guest," he met with the honour due to his illustrious name. Great folk opened their houses to him gladly, partly in compassion, partly in admiration of his genius. But he soon wearied of their society, and wore their kindness out by his querulous peevishness. It seemed, moreover, that life was intolerable to him outside Ferrara. Accordingly he once more opened negotiations with the duke; and in February 1579 he again set foot in the castle. Alfonso was about to contract his third marriage, this time with a princess of the house of Mantua. He had no children; and, unless he got an heir, there was a probability that his state would fall, as it did subsequently, to the Holy See. The nuptial festivals, on the eve of which Tasso arrived, were not therefore the occasion of great rejoicing to the elderly bridegroom. As a forlorn hope he had to wed a third wife; but his heart was not engaged and his expectations were far from sanguine. Tasso, preoccupied as always with his own sorrows and his own sense of dignity, made no allowance for the troubles of his master. Rooms below his rank, he thought, had been assigned him.

The princesses did not want to see him. The duke was engaged. Without exercising common patience, or giving his old friends the benefit of a doubt, he broke into terms of open abuse, behaved like a lunatic, and was sent off without ceremony to the madhouse of St Anna. This happened in March 1579; and there he remained until July 1586. Duke Alfonso's long-sufferance at last had given way. He firmly believed that Tasso was insane, and he felt that if he were so St Anna was the safest place for him. Tasso had put himself in the wrong by his intemperate conduct, but far more by that incomprehensible yearning after the Ferrarese court which made him return to it again and yet again. It would be pleasant to assume that an unconquerable love for Leonora led him back. Unfortunately, there is no proof of this. His relations to her sister Lucrezia were not less intimate and affectionate than to Leonora. The lyrics he addressed to numerous ladies are not less respectful and less passionate than those which bear her name. Had he compromised her honour, the duke would certainly have had him murdered. Custom demanded this retaliation, and society approved of it. If therefore Tasso really cherished a secret lifelong devotion to Leonora, it remains buried in impenetrable mystery. He did certainly not behave like a loyal lover, for both when he returned to Ferrara in 1578 and in 1579 he showed no capacity for curbing his peevish humours in the hope of access to her society.

It was no doubt very irksome for a man of Tasso's pleasure-loving, restless and self-conscious spirit to be kept for more than seven years in confinement. Yet we must weigh the facts of the case rather than the fancies which have been indulged regarding them. After the first few months of his incarceration he obtained spacious apartments, received the visits of friends, went abroad attended by responsible persons of his acquaintance, and corresponded freely with whomsoever he chose to address. The letters written from St Anna to the princes and cities of Italy, to warm well-wishers, and to men of the highest reputation in the world of art and learning, form our most valuable source of information, not only on his then condition, but also on his temperament at large. It is singular that he spoke always respectfully, even affectionately, of the duke. Some critics have attempted to make it appear that he was hypocritically kissing the hand which had chastised him, with the view of being released from prison. But no one who has impartially considered the whole tone and tenor of his epistles will adopt this opinion. What emerges clearly from them is that he laboured under a serious mental disease, and that he was conscious of it.

Meanwhile he occupied his uneasy leisure with copious compositions. The mass of his prose dialogues on philosophical and ethical themes, which is very considerable, we owe to the years of imprisonment in St Anna. Except for occasional odes or sonnets—some written at request and only rhetorically interesting, a few inspired by his keen sense of suffering and therefore poignant—he neglected poetry. But everything which fell from his pen during this period was carefully preserved by the Italians, who, while they regarded him as a lunatic, somewhat illogically scrambled for the very offscourings of his wit. Nor can it be said that society was wrong. Tasso had proved himself an impracticable human being; but he remained a man of genius, the most interesting personality in Italy. Long ago his papers had been sequestered. Now, in the year 1580, he heard that part of the *Gerusalemme* was being published without his permission and without his corrections. Next year the whole poem was given to the world, and in the following six months seven editions issued from the press. The prisoner of St Anna had no control over his editors; and from the masterpiece which placed him on the level of Petrarch and Ariosto he never derived one penny of pecuniary profit. A rival poet at the court of Ferrara undertook to revise and re-edit his lyrics in 1582. This was Battista Guarini; and Tasso, in his cell, had to allow odes and sonnets, poems of personal feeling, occasional pieces of compliment, to be collected and emended, without lifting a voice in the matter. A few years later, in 1585, two Florentine pedants of the Della Crusca academy declared war against the *Gerusalemme.* They loaded it with insults, which seem to those who read their pamphlets now mere parodies of criticism. Yet Tasso felt bound to reply; and he did so with a moderation and urbanity which prove him to have been not only in full possession of his reasoning faculties, but a gentleman of noble manners also. Certainly the history of Tasso's incarceration at St Anna is one to make us pause and wonder. The man, like Hamlet, was distraught through ill-accommodation to his circumstances and his age; brain-sick he was undoubtedly; and this is the duke of Ferrara's justification for the treatment he endured. In the prison he bore himself pathetically, peevishly, but never ignobly. He showed a singular indifference to the fate of his great poem, a rare magnanimity in dealing with its detractors. His own personal distress, that terrible *malaise* of imperfect insanity, absorbed him. What remained over, untouched by the malady, unoppressed by his consciousness thereof, displayed a sweet and gravely-toned humanity. The oddest thing about his life in prison is that he was always trying to place his two nephews, the sons of his sister Cornelia, in court-service. One of them he attached to the duke of Mantua, the other to the duke of Parma. After all his father's and his own lessons of life, he had not learned that the court was to be shunned like Circe by an honest man. In estimating Duke Alfonso's share of blame, this wilful idealization of the court by Tasso must be taken into account. That man is not a tyrant's victim who moves heaven and earth to place his sister's sons with tyrants.

In 1586 Tasso left St Anna at the solicitation of Vincenzo Gonzaga, prince of Mantua. He followed his young deliverer to the city by the Mincio, basked awhile in liberty and courtly pleasures, enjoyed a splendid reception from his paternal town of Bergamo, and produced a meritorious tragedy called *Torrismondo.* But only a few months had passed when he grew discontented. Vincenzo Gonzaga, succeeding to his father's dukedom of Mantua, had scanty leisure to bestow upon the poet. Tasso felt neglected. In the autumn of 1587 we find him journeying through Bologna and Loreto to Rome, and taking up his quarters there with an old friend, Scipione Gonzaga, now patriarch of Jerusalem. Next year he wandered off to Naples, where he wrote a dull poem on *Monte Oliveto.* In 1589 he returned to Rome, and took up his quarters again with the patriarch of Jerusalem. The servants found him insufferable, and turned him out of doors. He fell ill, and went to a hospital. The patriarch in 1590 again received him. But Tasso's restless spirit drove him forth to Florence. The Florentines said, "Actum est de eo." Rome once more, then Mantua, then Florence, then Rome, then Naples, then Rome, then Naples—such is the weary record of the years 1590–94. We have to study a veritable Odyssey of malady, indigence and misfortune. To Tasso everything came amiss. He had the palaces of princes, cardinals, patriarchs, nay popes, always open to him. Yet he could rest in none. Gradually, in spite of all veneration for the *sacer vates*, he made himself the laughing-stock and bore of Italy.

His health grew ever feebler and his genius dimmer. In 1592 he gave to the public a revised version of the *Gerusalemme.* It was called the *Gerusalemme Conquistata.* All that made the poem of his early manhood charming he rigidly erased. The versification was degraded; the heavier elements of the plot underwent a dull rhetorical development. During the same year a prosaic composition in Italian blank verse, called *Le Sette Giornate*, saw the light. Nobody reads it now. We only mention it as one of Tasso's dotages—a dreary amplification of the first chapter of Genesis.

It is singular that just in these years, when mental disorder, physical weakness, and decay of inspiration seemed dooming Tasso to oblivion, his old age was cheered with brighter rays of hope. Clement VIII. ascended the papal chair in 1592. He and his nephew, Cardinal Aldobrandini of St Giorgio, determined to befriend our poet. In 1594 they invited him to Rome. There he was to assume the crown of bays, as Petrarch had assumed it, on the Capitol. Worn out with illness, Tasso reached Rome in November. The ceremony of his coronation was deferred because Cardinal Aldobrandini had fallen ill. But the pope assigned him a pension; and, under the pressure of pontifical remonstrance, Prince Avellino, who held Tasso's maternal estate, agreed to discharge a portion of his claims by payment of a yearly rent-charge. At no time since Tasso left St Anna had the heavens apparently so smiled upon him. Capitolian honours and money were now at his disposal. Yet fortune came too late. Before the crown was worn or the pensions paid he ascended to the convent of St Onofrio, on a stormy 1st of April in 1595. Seeing a cardinal's coach toil up the steep Trasteverine Hill, the monks came to the door to greet it. From the carriage stepped Tasso, the Odysseus of many wanderings and miseries, the singer of sweetest strains still vocal, and told the prior he was come to die with him.

In St Onofrio he died, on the 25th of April 1595. He was just past fifty-one; and the last twenty years of his existence had been practically and artistically ineffectual. At the age of thirty-one the *Gerusalemme*, as we have it, was accomplished. The world too was already ringing with the music of *Aminta*. More than this Tasso had not to give to literature. But those succeeding years of derangement, exile, imprisonment, poverty and hope deferred endear the man to us. Elegiac and querulous as he must always appear, we yet love Tasso better because he suffered through nearly a quarter of a century of slow decline and unexplained misfortune. (J. A. S.)

Taken altogether, the best complete edition of Tasso's writings is that of Rosini (Pisa), in 33 vols. The prose works (in 2 vols., Florence, Le Monnier, 1875) and the letters (in 5 vols., same publisher, 1853) were admirably edited by Cesare Guasti. This edition of Tasso's *Letters* forms by far the most valuable source for his biography. No student can, however, omit to use the romantic memoir attributed to Tasso's friend, Marchese Manso (printed in Rosini's edition of Tasso's works above cited), and the important *Vita di Torquato Tasso* by Serassi (Bergamo, 1790). See also Solerti's *Life* (1895), his editions of the *Opere Minori in versi* (1891 et seq.), and *Gerusalemme* (1895), and his bibliography, in the *Rivista biblioteche e archivi* (1895), on the occasion of the celebration of the tercentenary of Tasso's death.

TASSONI, ALESSANDRO (1565–1635), Italian poet, was a native of Modena, where he was born and died. From 1599 till 1608 he was secretary to Cardinal Ascanio Colonna, and in this capacity saw some diplomatic service; he was afterwards employed for some time in similar occupations by Charles Emmanuel, duke of Savoy. His best-known literary work is a burlesque epic entitled *La Secchia Rapita*, or "The Rape of the Bucket" (1622), the reference being to a raid of the Modenese upon the people of Bologna in 1325, when a bucket was carried off as a trophy. As in Butler's *Hudibras*, many of the personal and local allusions in this poem are now very obscure, and are apt to seem somewhat pointless to the general reader, but, in spite of Voltaire's contempt, it cannot be neglected by any systematic student of Italian literature (see Carducci's edition, 1861). Other characteristic works of Tassoni are his *Pensieri Diversi* (1612), in which he treats philosophical, literary, historical and scientific questions with unusual freedom, and his *Considerazioni sopra il Petrarcha* (1609), a piece of criticism showing great independence of traditional views.

TASTE (from Lat. *taxare*, to touch sharply; *tangere*, to touch), in physiology, the sensation referred to the mouth when certain soluble substances are brought into contact with the mucous membrane of that cavity. By analogy, the word "taste" is used also of aesthetic appreciation (see AESTHETICS) and a sense of beauty—commonly with the qualifications "good taste" and "bad taste."

The physiological sense is located almost entirely in the tongue. Three distinct sensations are referable to the tongue—(1) taste, (2) touch, and (3) temperature. The posterior part of its surface, where there is a Λ-shaped group of large papillae, called circumvallate papillae, supplied by the glosso-pharyngeal nerve, and the tip and margins of the tongue, covered with filiform (touch) papillae and fungiform papillae, are the chief localities where taste is manifested, but it also exists in the glosso-palatine arch and the lateral part of the soft palate. The middle of the tongue and the surface of the hard palate are devoid of taste. The terminal organs of taste consist of peculiar bodies named taste-bulbs or taste-goblets, discovered by Schwalbe and S. L. Lovèn in 1867. They can be most easily demonstrated in the *papillae foliatae*, large oval prominences found on each side near the base of the tongue in the rabbit. Each papilla consists of a series of laminae or folds, in the sides of which the taste-bodies are readily displayed in a transverse section. Taste-bodies are also found on the lateral aspects of the circumvallate papillae (see Fig. 1), in the fungiform papillae,

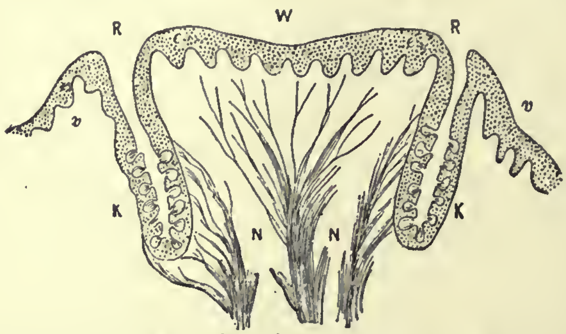


FIG. 1.—Transverse section of a circumvallate papilla: W, the papilla; *v*, *v*, the wall in section; R, R, the circular slit or fossa; K, K, the taste-bulbs in position; N, N, the nerves.

in the papillae of the soft palate and uvula, the under surface of the epiglottis, the upper part of the posterior surface of the epiglottis, the inner sides of the arytenoid cartilages, and even in the vocal cords.

The taste-bulbs are minute oval bodies, somewhat like an old-fashioned Florence flask, about $\frac{1}{300}$ inch in length by $\frac{1}{800}$ in breadth. Each consists of two sets of cells—an *outer* set, nucleated, fusiform, bent like the staves of a barrel, and arranged side by side so as to leave a small opening at the apex (the mouth of the barrel), called the gustatory pore; and an *inner* set, five to ten in number, lying in the centre, pointed at the end next the gustatory pore, and branched at the other extremity. The branched ends are continuous with non-medullated nerve fibres from the gustatory nerve. These taste-bodies are found in immense numbers: as many as 1760 have been counted on one circumvallate papilla in the ox. The proofs that these are the terminal organs of taste rest on careful observations which have shown (1) that taste is only experienced when the sapid substance is allowed to come into contact with the taste-body, and that the sense is absent or much weakened in those areas of mucous membrane where these are deficient; (2) that they are most abundant where the sense is most acute; and (3) that section of the glosso-pharyngeal nerve which is known to be distributed to the areas of mucous membrane where taste is present is followed by degeneration of the taste-bodies. At the same time it cannot be asserted that they are absolutely essential to taste, as we can hardly suppose that those animals which have no special taste-bodies are devoid of the sense.

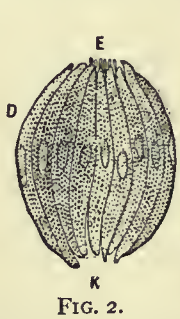


FIG. 2.

FIG. 3.

FIG. 2.—Isolated taste-bulb: D, supporting or protective cells; K, under end; E, free end, open, with the projecting apices of the taste-cells.

FIG. 3.—*d*, Isolated protective cell; *e*, taste-cell.

Evidence is accumulating that taste depends on nervous impulses excited by chemical change. Substances that have taste must be soluble. Chemical changes are in all probability set up in the taste-cells, or in the processes connected with them. Some progress has been made in the attempt to establish a connexion between the chemical composition of sapid substances and the different kinds of taste to which they may give rise. Thus acids are usually sour; alkaloids have a peculiar soapy taste; salts may be sweet, like sugar of lead, or bitter, like sulphate of magnesia; soluble alkaloids, such as quinine or strychnine, are usually bitter; and the higher alcohols are more or less sweet. Substances which taste sweet or bitter often contain definite groups in the molecule, especially in the hydroxyl (HO) and amido (NH_2) groups. By altering the chemical composition of a substance having a characteristic taste (changing the position or relations of the radicles), the substance may become tasteless or intensely bitter. The sensation of taste may also be excited mechanically, as by smartly tapping the tongue, or by the stimulus of a continuous current. In the latter case electrolytic change may be the exciting cause; but that the sense organs may be stimulated electrically is proved by the fact that rapidly interrupted induced currents, which produce little or no electrolysis, may also excite taste. Sensations of taste are heightened by increasing the area of the tongue affected, and by mechanical stimulation, as when the tongue is pressed against the lips, cheeks or palate. A temperature of about 40° C. is most favourable, either extreme heat or cold apparently benumbing the sense for a time. Gustatory sensations affect each other: that is to say, a strong taste will affect the taste of another body taken immediately after it. Thus sweetness will modify bitterness, and sourness will modify both. Moreover, the application of a sapid substance to the tongue will affect taste in other parts. If the same taste is excited on each side of the tongue, although there are two sets of gustatory nerves, one for each lateral half, the sensations are blended into one; while if two different substances, say one sweet and the other bitter, are simultaneously applied, one to each side, the observer can distinctly differentiate the one from the other.

Tastes have been variously classified. One of the most useful classifications is into sweet, bitter, acid and saline tastes. Insoluble substances, when brought into contact with the tongue, give rise to feelings of touch or of temperature, but excite no taste. If solutions of various substances are gradually diluted with water until no taste is experienced, G. G. Valentin found that the sensations of taste disappeared in the following order—syrup, sugar, common salt, aloes, quinine, sulphuric acid; and Camerer found that the taste of quinine still continued although diluted with twenty times more water than common salt. The time required to excite taste after the sapid substance was placed on the tongue varies. Thus saline matters are tasted most rapidly (·17 second), then sweet, acid and bitter (·258 second). There are many curious examples of substances of very different chemical constitutions having similar tastes. For example, sugar, acetate of lead and the vapour of chloroform have all a sweetish taste. A temperature of from 50° to 90° F. is the most favourable to the sense, water above or below this temperature either masking or temporarily paralysing it.

As a general rule, bitter tastes are most acute at the back of the tongue, near the circumvallate papillae, and sweet tastes at the tip, but there are considerable individual variations. Some persons taste both bitter and sweet substances best at the back, while others taste bitter things at the tip. Many experience salt tastes best at the tip, and acid tastes at the sides of the tongue. When we consider that there are three kinds of papillae on the surface of the tongue, one would expect to meet with different degrees of sensitiveness to different tastes, even while we admit that the papillae may also have to do with sensations of touch and of temperature. By experimenting with fine capillary tubes containing sapid substances, observations have been made with individual papillae. Some are found to be sensitive to many tastes, others to two or three, others to only one, while others are insensitive to taste altogether. Again, it has been found that a mixture of sapid substances, say of quinine and sugar, may taste sweet when applied to one papilla and bitter when applied to another. The inference must be that there are special terminal organs for different tastes. Assuming that there are different kinds of taste-cells, it might be possible to paralyse some without affecting others, and thus different sensations of taste might be discriminated. This has been done by the use of the leaves of a common Indian plant, *Gymnema sylvestre*. If some of these be chewed, it has been found that bitters and sweets are paralysed (neither quinine nor sugar giving rise to sensation), while acids and salines are unaffected. Again, certain strengths of decoctions of the leaves appear to paralyse sweets sooner than bitters. These observations show the existence of different taste-cells for sweets, bitters, acids and salines; and it is clear that the region of the tongue most richly supplied with taste-cells sensitive to sweets will respond best to sweet substances, while another region, supplied by taste-cells sensitive to bitters, will respond best to bitter substances. In like manner the argument may be applied to other tastes. Suppose, again, a set of taste-cells sensitive to bitter substances: it is conceivable that in whatever way these were irritated, a bitter taste would result. If so, a substance which, applied to one part of the tongue, would cause a sweet sensation, might cause a bitter if applied to a part of the tongue richly supplied with taste-cells sensitive to bitters. This may explain why sulphate of magnesia excites at the root of the tongue a bitter taste, while applied to the tip it causes a sweet or an acid taste. Saccharine, a peculiar toluene derivative, in like manner is sweet to the tip and bitter to the back of the tongue. It has also been found that if the sweet and bitter taste-cells are paralysed by *Gymnema*, electrical irritation of the tip by a weak interrupted current does not give rise to an acid taste mixed with sweet, as it usually does, but to sensations somewhat different, which may be described as metallic or salt or acid. This experiment indicates that the action of the interrupted current on the terminal organ is analogous to the action of sweet or bitter substances (Shore). No direct observations of importance have yet been made on single circumvallate papillae. Further experiments with capillary tubes show that fungiform papillae destitute of taste buds, and areas of the surface of the tongue having neither papillae nor taste buds, may still, when stimulated by sapid substances, give rise to tastes. Taste is often associated with smell (*q.v.*), giving rise to a sensation of *flavour*, and we are frequently in the habit of confounding the one sensation with the other. Chloroform excites taste alone, whilst garlic, asafoetida and vanilla excite only smell. This is illustrated by the familiar experiment of blindfolding a person and touching the tongue successively with slices of an apple and of an onion. In these circumstances the one cannot be distinguished from the other when the nose is firmly closed. Taste may be educated to a remarkable extent; and careful observation—along with the practice of avoiding all substances having a very pronounced taste or having an irritating effect—enables tea-tasters and wine-tasters to detect slight differences of taste, more especially when combined with odour so as to produce flavour, which would be quite inappreciable to an ordinary palate. As to the action of electrical currents on taste, observers have arrived at uncertain results. So long ago as 1752 J. G. Sulzer stated that a constant current caused, more especially at the moments of opening and of closing the current, a sensation of acidity at the anode (+ pole) and of alkalinity at the katode (−pole). This is in all probability due to electrolysis, the decomposition products exciting the taste-bodies. Rapidly interrupted currents fail to excite the sense.

Disease of the tongue causing unnatural dryness may interfere with taste. Substances circulating in the blood may give rise to subjective sensations of taste. Thus santonine, morphia and biliary products (as in jaundice) usually cause a bitter sensation, whilst the sufferer from diabetes is distressed by a persistent sweetish taste. The insane frequently have subjective tastes, which are real to the patient, and frequently cause much distress. In such cases, the sensation is excited by changes in the taste-centres of the brain. Increase in the sense of taste is called *hypergeusia*, diminution of it *hypogeusia*, and its entire loss *ageusia.* Rare cases occur where there is a subjective taste not associated with insanity nor with the circulation of any known sweetish matters in the blood, possibly caused by irritation of the gustatory nerves or by changes in the nerve centres.

For the anatomy of the organs of taste, see the articles MOUTH and TONGUE. (J. G. M.)

TATA, JAMSETJI NASARWANJI (1839–1904), Parsee merchant and philanthropist, was born at Nosari, in the state of Baroda, in 1839, and went as a boy to Bombay, where he was educated at the Elphinstone College. In 1858 he entered his father's office, and began a commercial career of the highest eminence, beginning with cotton mills at Bombay and also at Nagpur, and ending with the formation of a company to work the iron ores of the Central Provinces on modern principles. One of his best-known achievements was the lowering of the freights on Indian goods to China and Japan, as the result of a long struggle with the Nippon Yusen Kaisha Co. He also introduced a silk industry after Japanese methods into Mysore, and built the Taj Mahal hotel in Bombay. But his greatest benefaction is the endowment of a research institute at Bangalore. He died at Nauheim, in Germany, on the 19th of May 1904.

TATAR PAZARJIK, or TATAR BAZARDJIK, a town of Bulgaria in Eastern Rumelia; on the river Maritza, and on the Sofia-Constantinople railway, 74 m. E.S.E. of Sofia and 23 m. W. of Philippopolis. Pop. (1906) 17,549. Situated at the junction of several roads, Tatar Pazarjik began to acquire commercial importance in the 15th century. Rice, millet and tobacco are largely cultivated in the surrounding lowlands, and there is some trade in cocoons and wool.

TATARS (the common form Tartars is less correct), a name given to nearly three million inhabitants of the Russian empire, chiefly Moslem and of Turkish origin. The majority—in European Russia—are remnants of the Mongol invasion of the 13th century (see MONGOLS), while those who inhabit Siberia are survivals of the once much more numerous Turkish population of the Ural-Altaic region, mixed to some extent with Finnish and Samoyedic stems, as also with Mongols. The name is derived from that of the Ta-ta Mongols, who in the 5th century inhabited the north-eastern Gobi, and, after subjugation in the 9th century by the Khitans, migrated southward, there founding the Mongol empire under JENGHIZ KHAN (*q.v.*). Under the leadership of his grandson (Batu) they moved westwards, driving with them many stems of the Turkish Ural-Altaians towards the plains of Russia. The ethnographical features of the present Tatar inhabitants of European Russia, as well as their language, show that they contain no admixture (or very little) of Mongolian blood, but belong to the Turkish branch of the Ural-Altaic stock, necessitating the conclusion that only Batu, his warriors, and a limited number of his followers were Mongols, while the great bulk of the 13th century invaders were Turks. On the Volga they mingled with remnants of the old Bulgarian empire, and elsewhere with Finnish stems, as well as with remnants of the ancient Italian and Greek colonies in Crimea and Caucasians in Caucasus. The name of Tatars, or Tartars, given to the invaders, was afterwards extended so as to include different stems of the same Turkish branch in Siberia, and even the bulk of the inhabitants of the high plateau of Asia and its N.W. slopes, described under the general name of Tartary. This last name has almost disappeared from geographical literature, but the name Tatars, in the above limited sense, remains in full use.

The present Tatar inhabitants of the Russian empire form three large groups—those of European Russia and Poland, those of Caucasus, and those of Siberia. The discrimination of the separate stems included under the name is still far from completion. The following subdivisions, however, may be regarded as established. (1) The Kazañ Tatars, descendants of the Kipchaks settled on the Volga in the 13th century, where they mingled with survivors of the old Bulgarians and partly with Finnish stems. They number about half a million in the government of Kazañ, about 100,000 in each of the governments of Ufa, Samara and Simbirsk, and about 300,000 in Vyatka, Saratov, Tambov, Penza, Nizhniy-Novgorod, Perm and Orenburg; some 15,000 belonging to the same stem have migrated to Ryazañ, or have been settled as prisoners in the 16th and 17th centuries in Lithuania (Vilna, Grodno and Podolia); and there are some 2000 in St Petersburg, where they pursue the callings of coachmen and waiters in restaurants. In Poland they constitute 1 per cent. of the population of the district of Plock. The Kazañ Tatars speak a pure Turkish dialect; they are middle-sized, broad-shouldered and strong, and mostly have black eyes, a straight nose and salient cheek bones. They are Mahommedans; polygamy is practised only by the wealthier classes and is a waning institution. Excellent agriculturists and gardeners, very laborious, and having a good reputation for honesty, they live on the best terms with their Russian peasant neighbours. The Bashkirs who live between the Kama, Ural and Volga are possibly of Finnish origin, but now speak a Tatar language and have become Mahommedans. (2) The Astrakhan Tatars (about 10,000) are, with the Mongol Kalmucks, all that now remains of the once so powerful Astrakhan empire. They also are agriculturists and gardeners; while some 12,000 Kundrovsk Tatars still continue the nomadic life of their ancestors. (3) The Crimean Tatars, who occupied the Crimea in the 13th century, have preserved the name of their leader, Nogai. During the 15th, 16th and 17th centuries they constituted a rich empire, which prospered until it fell under Turkish rule, when it had to suffer much from the wars fought between Turkey and Russia for the possession of the peninsula. The war of 1853 and the laws of 1860–63 and 1874 caused an exodus of the Crimean Tatars; they abandoned their admirably irrigated fields and gardens and moved to Turkey, so that now their number falls below 100,000. Those of the south coast, mixed with Greeks and Italians, are well known for their skill in gardening, their honesty and their laborious habits, as well as for their fine features, presenting the Tatar type at its best. The mountain Tatars closely resemble those of Caucasus, while those of the steppes—the Nogais—are decidedly of a mixed origin from Turks and Mongols.

The Tatars of Caucasia, who inhabit the upper Kubañ, the steppes of the lower Kuma and the Kura, and the Aras, number about 1,350,000. Of these (4) the Nogais on the Kuma show traces of an intimate mixture with Kalmucks. They are nomads, supporting themselves by cattle-breeding and fishing; few are agriculturists. (5) The Karachais (18,500) in the upper valleys about Elburz live by agriculture. (6) The mountain Tatars (about 850,000), divided into many tribes and of an origin still undetermined, are scattered throughout the provinces of Baku, Erivan, Tiflis, Kutais, Daghestan, and partly also of Batum. They are certainly of a mixed origin, and present a variety of ethnological types, all the more so as all who are neither Armenians nor Russians, nor belong to any distinct Caucasian tribe, are often called Tatars. As a rule they are well built and little behind their Caucasian brethren. They are celebrated for their excellence as gardeners, agriculturists, cattle-tenders and artisans. Although most fervent Shi'ites, they are on very good terms both with their Sunnite and with their Russian neighbours. Polygamy is rare with them, and their women go to work unveiled.

The Siberian Tatars are estimated (1895) at 80,000 of Turki stock and about 40,000 of mixed Finnic stock. They occupy three distinct regions—a strip running west to east from Tobolsk to Tomsk, the Altai and its spurs, and South Yeniseisk. They originated in the agglomerations of Turkish stems which in the region north of the Altai reached some degree of culture between the 4th and the 8th centuries, but were subdued and enslaved by the Mongols. They are difficult to classify, for they are the result of somewhat recent minglings of races and customs, and they are all more or less in process of being assimilated by the Russians, but the following subdivisions may be accepted provisionally. (7) The Baraba Tatars, who take their name from one of their stems (Barama), number about 50,000 in the government of Tobolsk and about 5000 in Tomsk. After a strenuous resistance to Russian conquest, and much suffering at a later period from Kirghiz and Kalmuck raids, they now live by agriculture, either in separate villages or along with Russians. (8) The Cholym or Chulym Tatars on the Cholym and both the rivers Yus speak a Turkish language with many Mongol and Yakut words, and are more like Mongols than Turks. In last century they paid a tribute for 2550 arbaletes, but they now are rapidly becoming fused with Russians. (9) The Abakan or Minusinsk Tatars occupied the steppes on the Abakan and Yus in the 17th century, after the withdrawal of the Kirghizes, and represent a mixture with Kaibals (whom Castrén considers as partly of Ostiak and partly Samoyedic origin) and Beltirs—also of Finnish origin. Their language is also mixed. They are known under the name of Sagais, who numbered 11,720 in 1864, and are the purer Turkish stem of the Minusinsk Tatars, Kaibals, and Kizil or Red Tatars. Formerly Shamanists, they now are, nominally at least, adherents of the Greek Orthodox Church, and support themselves mostly by cattle-breeding. Agriculture is spreading but slowly among them; they still prefer to plunder the stores of bulbs of *Lilium Martagon*, *Paeonia*, and *Erythronium Dens canis* laid up by the steppe mouse (*Mus socialis*). The Soyotes, or Soyons, of the Sayan mountains (estimated at 8000), who are Finns mixed with Turks the Uryankhes of north-west Mongolia, who are of Turkish origin but follow Buddhism, and the Karagasses, also of Turkish origin and much like the Kirghizes, but reduced now to a few hundreds, are akin to the above. (10) The Tatars of the northern slopes of the Altai (nearly 20,000 in number) are of Finnish origin. They comprise some hundreds of Kumandintses, the Lebed Tatars, the Chernevyie or Black-Forest Tatars and the Shors (11,000), descendants of the Kuznetsk or Iron-Smith Tatars. They are chiefly hunters, passionately loving their *taiga*, or wild forests, and have maintained their Shaman religion and tribal organization into *suoks*. They live partly also on cedar-nuts and honey collected in the forests. Their dress is that of their former rulers, the Kalmucks, and their language contains many Mongol words. (11) The Altai Tatars, or "Altaians," comprise—(*a*) the Mountain Kalmucks (12,000), to whom this name has been given by mistake, and who have nothing in common with the Kalmucks except their dress and mode of life, while they speak a Turkish dialect, and (*b*) the Teleutes, or Telenghites (5800), a remainder of a formerly numerous and warlike nation who have migrated from the mountains to the lowlands, where they now live along with Russian peasants. Although Turkestan and Central Asia were formerly known as Independent Tartary, it is not now usual to call the Sarts, Kirghiz and other inhabitants of those countries Tatars, nor is the name usually given to the Yakuts of Eastern Siberia.

It is evident from the above that the name Tatars was originally applied to both the Turkish and Mongol stems which invaded Europe six centuries ago, and gradually extended to the Turkish stems mixed with Mongol or Finnish blood in Siberia. It is used at present in two senses: (*a*) Quite loosely to designate any of the Ural-Altaic tribes, except perhaps Osmanlis, Finns and Magyars, to whom it is not generally applied. Thus some writers talk of the Manchu Tatars. (*b*) In a more restricted sense to designate Mahommedan Turkish-speaking tribes, especially in Russia, who never formed part of the Seljuk or Ottoman Empire, but made independent settlements and remained more or less cut off from the politics and civilization of the rest of the Mahommedan world.

AUTHORITIES.—The literature of the subject is very extensive, and bibliographical indexes may be found in the *Geographical Dictionary* of P. Semenov, appended to the articles devoted respectively to the names given above, as also in the yearly *Indexes* by M. Mezhov and the *Oriental Bibliography* of Lucian Scherman. Besides the well-known works of Castrén, which are a very rich source of information on the subject, Schiefner (St Petersburg academy of science), Donner, Ahlqvist and other explorers of the Ural-Altaians, as also those of the Russian historians Soloviev, Kostomarov, Bestuzhev-Ryumin, Schapov, and Ilovaiskiy, the following containing valuable information may be mentioned: the publications of the Russian Geographical Society and its branches; the Russian *Etnographicheskiy Sbornik;* the *Izvestia* of the Moscow society of the amateurs of natural science; the works of the Russian ethnographical congresses; Kostrov's researches on the Siberian Tatars in the memoirs of the Siberian branch of the geographical society; Radlov's *Reise durch den Altai, Aus Sibirien*; "Picturesque Russia" (*Zhivopisnaya Rossiya*); Semenov's and Potanin's "Supplements" to Ritter's *Asien;* Harkavi's report to the congress at Kazañ; Hartakhai's "Hist. of Crimean Tatars," in *Vyestnik Evropy*, 1866 and 1867; "Katchinsk Tatars," in *Izvestia Russ. Geogr. Soc.*, xx., 1884. Various scattered articles on Tatars will be found in the *Revue orientale pour les Études Oural-Altaïques*, and in the publications of the university of Kazañ. See also E. H. Parker, *A Thousand Years of the Tartars*, 1895 (chiefly a summary of Chinese accounts of the early Turkish and Tatar tribes), and Skrine and Ross, *Heart of Asia* (1899). (P. A. K.; C. El.)

TATE, SIR HENRY, Bart. (1819–1899), English merchant and founder of the National Gallery of British Art, was born at Chorley, Lancashire, in 1819. His father, a minister of religion, put him into business in Liverpool. He became a prosperous sugar-broker, and about 1874 removed to London, where he greatly increased the operations of his firm and made "Tate's Cube Sugar" known all over the world. He had early in his career begun to devote large sums of money to philanthropic and educational purposes. He gave £42,000 to the Liverpool University College, founded in 1881; and a still larger sum to the Liverpool hospitals. Then, when he came to London, he presented four free public libraries to the parish of Lambeth. His interest in art came with later years. He was at first merely a regular buyer of pictures, for which he built a large private gallery in his house at Streatham. Gradually his gallery came to contain one of the best private collections of modern pictures in England, and the owner naturally began to consider what should be done with it after his death. It had always been his intention to leave it to the nation, but in the way of carrying out this generous desire there stood several obstacles. The National Gallery could not have accepted more than a selection from Tate's pictures, which were not all up to the standard of Trafalgar Square; and even when he offered to build a new gallery for them, it was found difficult to secure a suitable site. What Tate offered was to spend £80,000 upon a building if the government would provide the ground; and in 1892 this offer was accepted. A new gallery, controlled by the Trustees of the National Gallery, was built on the site of Millbank Prison. The gallery was opened on 21st July 1897, and a large addition to it was completed just before the donor died. It contained sixty-five pictures presented by him; nearly all the English pictures from the National Gallery painted within the previous eighty years; the pictures purchased by the Royal Academy under the Chantrey Bequest, which had previously hung in South Kensington Museum; and seventeen large works given to the nation by Mr G. F. Watts, R.A. Mr Tate was created a baronet in the year after the Tate Gallery had been opened. He died at Streatham on the 5th of December 1899.

TATE, JAMES (1771–1843), English classical scholar and schoolmaster, was born at Richmond in Yorkshire on the 11th of June 1771. He was educated at Richmond school and Sidney Sussex College, Cambridge (fellow, 1795). From 1796 to 1833 he held the headmastership of his old school, being then appointed canon of St Paul's and vicar of Edmonton. He died on the 2nd of September 1843. The work by which he is chiefly known is his *Horatius Restitutus* (1832).

TATE, NAHUM (1652–1715), English poet laureate and playwright, was born in Dublin in 1652. He was the son of Faithful Teate (as the name was spelt), who wrote a quaint poem on the Trinity entitled *Ter Tria*. Nahum Tate was educated at Trinity College, Dublin, graduating B.A. in 1672. He published a volume of poems in London in 1677, and became a regular writer for the stage. *Brutus of Alba, or The Enchanted Lovers* (1678), a tragedy dealing with Dido and Aeneas, and *The Loyal General* (1680), were followed by a series of adaptations from Elizabethan dramas. In Shakespeare's *Richard II.* he altered the names of the personages, and changed the text so that every scene, to use his own words, was "full of respect to Majesty and the dignity of courts"; but in spite of these precautions *The Sicilian Usurper* (1681) was suppressed on the third representation on account of a possible political interpretation. *King Lear* (1687) was fitted with a happy ending in a marriage between Cordelia and Edgar; and *Coriolanus* became the *Ingratitude of a Commonwealth* (1682). From John Fletcher he adapted *The Island Princess* (1687); from Chapman and Marston's *Eastward Ho* he derived the *Cuckold's Haven* (1685); from John Webster's *White Devil* he took *Injured Love, or The Cruel Husband* (pr. 1707); and Sir Aston Cockayne's *Trappolin suppos'd a Prince* he imitated in *Duke and no Duke* (1685). Tate's name is chiefly connected with these mangled versions of other men's plays and with the famous *New Version of the Psalms of David* (1696), in which he collaborated with Nicholas Brady. A supplement was licensed in 1703. Some of these hymns, notably "While Shepherds watched," and "As pants the hart," rise above the general dull level, and are said to be Tate's work.

Tate was commissioned by Dryden to write the Second Part of *Absalom and Achitophel*. The portraits of Elkanah Settle and Thomas Shadwell, however, are attributed to Dryden, who probably also put the finishing touches to the poem. Of his numerous poems the most original is *Panacea, a poem on Tea* (1700). In spite of his consistent Toryism, he succeeded Shadwell as poet laureate in 1692. He died within the precincts of the Mint, Southwark, where he had taken refuge from his creditors, on the 12th of August 1715.

TATE, RALPH (1840–1901), British geologist, was born at Alnwick in Northumberland in 1840. He was a nephew of George Tate (1805–1871), naturalist and archaeologist, an active member of the Berwickshire Naturalists' Club. He was educated at the Cheltenham Training College and at the Royal School of Mines, and in 1861 he was appointed teacher of natural science at the Philosophical Institution in Belfast. He there studied botany, and published his *Flora Belfastinesis* (1863); and he also investigated the Cretaceous and Liassic rocks of Antrim, bringing his results before the Geological Society of London. In 1864 he was appointed assistant in the museum of that society. In 1867 he went on an exploring expedition to Nicaragua and Venezuela. In 1871 he was appointed to the mining school established by the Cleveland ironmasters first at Darlington and then at Redcar. Here he made a special study of the Lias and its fossils, in conjunction with the Rev. J. F. Blake, and the results were published in an important work, *The Yorkshire Lias* (1876), in which the life-history of the strata was first worked out in detail. In 1875 Tate was appointed professor of natural science in the university of Adelaide, South Australia. He now gave especial attention to the recent and tertiary mollusca of Australia. He was the chief founder of the Royal Society of South Australia, and was in 1893 president of the Australian Association for the Advancement of Science. He died at Adelaide on the 20th of September 1901.

TATI, a district of British South Africa forming, geographically, the S.W. corner of Matabeleland, but attached administratively to the Bechuanaland Protectorate. Area about 2500 sq. m. The railway from Cape Town to Bulawayo crosses the territory with a station at Francistown, the principal settlement. Francistown stands 3254 ft. above the sea and is 126 m. S.W. of Bulawayo by rail. The town of Tati, on the river of that name, is 18 m. S.E. of Shashi river railway station.

Tati owes its importance to the presence of gold, first discovered by the German traveller, Karl Mauch, in 1864. Mining began in 1868, but it was not until 1895 that work on a large scale was undertaken, and it has been frequently interrupted since that date. The chief mine is the Monarch, situated by the railway. A concession to work the gold-mines, and for other purposes, was obtained in 1887 by Mr S. H. Edwards from Lobengula, the Matabele chief, and the mining rights are vested in a company, thereafter formed, called the Tati Concessions Company. (See BECHUANALAND and RHODESIA.)

TATIAN (2nd cent. A.D.), Christian apologist, missionary and heretic. Such knowledge as we have of his life is derived from (1) his own *Oratio ad Graecos* (see § 3); (2) Irenaeus, *Adv. Haereses*, i. 28, i.; (3) Rhodon, quoted in Eusebius's *Hist. Eccl.* v. 13, 1; (4) Clement of Alexandria, *Strom.* i. 1, 11; (5) Eusebius, *Chronicon anno* A.D. 171; (6) Epiphanius, *Panarion*, i. 3, 46. Convenient collections of these passages may be found in E. Schwartz's *Tatiani Oratio ad Graecos, Texte und Untersuchungen*, iv. 1, pp. 51–55; and in A. Harnack's *Geschichte der altchristlichen Litteratur*, i. pp. 485–96. From these data the following outline of his life can be reconstructed. He was a Syrian[1] (Clem. Alex. and Epiphanius) born in Mesopotamia (*Or.* 42) and educated in Greek learning, in which he became proficient (*Or.* i. and 42). He was initiated into the Mysteries, though into which is not stated (*Or.* 29), but after this became acquainted with the Old Testament, and was converted to Christianity. He then went to Rome, where he was a hearer of Justin, and together with the latter incurred the enmity of a certain philosopher Crescens. As this fact is mentioned both in Justin's *Apology* and in Tatian's *Oratio ad Graecos*, and the *Apology* can be dated with fair security about A.D. 152 (see JUSTIN MARTYR), the conversion of Tatian must have been before this date. After the death of Justin he became a heretic—according to Eusebius's *Chronicon* in 173. Among his pupils were Rhodon, and perhaps Apelles (see Victorinus Reat. schol. 44, in *Ep. Hieronymi ad Avitum*, ep. 124) and Clement of Alexandria (*Storm.* i. 1, 11). He made a missionary journey to the East and worked in Cilicia and Pisidia, using the Syrian Antioch as the centre of his efforts (Epiphan.).

According to Epiphanius, Tatian went to the East after the death of Justin (*c.* 165), and then became heretical, and Eusebius states that he was recognized as heretical in 173. Zahn (*Forschungen zur Geschichte des Kanons*, i.) and most writers accept this as in the main correct; it is generally thought that his heresy was recognized in Rome, and it is suggested that this was the reason why he returned to the East. The statement in Epiphanius is capable of being interpreted in this sense, and whereas Tatian was always regarded as heretical in the West, he seems to have been unsuspected in the East. This fact, however, does more than support the suggestion that Tatian's heresy was recognized before he left Rome: it throws some doubt on the theory that after being turned out of the Church in Rome he worked as a missionary in the East without being suspected. Harnack (*Texte und Untersuchungen*, i. 1, pp. 196 ff.) once suggested that the missionary work in the East belongs to an earlier period, and that Tatian left Rome and returned to it between his first arrival and the death of Justin Martyr. But in his *Chronologie*, i. pp. 284 ff., he has withdrawn this, and it is probably too hypothetical; it is, however, the only serious effort to deal with the difficulty, which if not insoluble is at least unsolved.

The Heresy of Tatian.—As in the case of most heresies, we have only the partisan statements of opponents. Everything is therefore open to some doubt, but the following points seem fairly certain. The heresy which Tatian either founded or adopted was that of the Encratites. Their main doctrines were the evil nature of matter, an absolute forbidding of marriage, abstinence from wine and perhaps from meat. It would also seem that Tatian believed in the existence of aeons, one of whom was the Demiurge of the world. He denied the salvation of Adam. It is also stated that in his celebration of the Mysteries (*i.e.* the Eucharist) he used only water (see Tertullian, *De Jejun.* 15; Hippolytus, *Philos.*, 8, 4, 16 and 10, 18; Jerome in *Amos* ii. 12 and Iren., *Adv. Haer.*, i. 28, iii. 23).

Writings.—According to Eusebius, Tatian wrote many books (*Hist. Eccl.*, iv. 29); of these the names of the following have survived:—(1) Περὶ ζῴων (mentioned in *Or.*, 15); (2) Περὶ δαιμόνων (mentioned in *Or.*, 16); (3) Λόγος πρὸς τοὺς Ἕλληνας; (4) Προβλημάτων βιβλίον (Eus., v. 13, 1—a quotation from Rhodon) an attempt to deal with the contradictions to be found in the Bible; (? 5) Πρὸς ἀποφηναμένους τὰ πρὸς θεοῦ (mentioned in *Or.*, 40 as a book which Tatian intended to write, but there is no evidence that he carried his plan into effect; (6) Περὶ τοῦ κατὰ τὸν Σωτῆρα καταρτισμοῦ (Clem. Alex., *Strom.*, iii. 12, 80); (7) The *Diatessaron;* (? 8) a recension of the Pauline epistles (Eus., *Hist. Eccl.*, iv. 29) says that he was accused of producing a μετάφρασις of the epistles so as to smooth the grammar, and in Jerome's preface to St Paul's Epistle to Titus it is stated that he rejected some of the epistles, but not that to Titus. Of these books only two—the *Diatessaron* and the πρὸς τοὺς Ἕλληνας are still extant.

The Λόγος πρὸς τοὺς Ἕλληνας (*Oratio ad Graecos*) belongs to Tatian's Catholic period. He has the double purpose in view of exposing the weakness of the pagan view of the universe and of commending the Christian explanation. For the former purpose he seems to have made use of an already existent book, perhaps the Γοήτων φορά of Oenomaus of Gadara, a Syrian who wrote in the time of Hadrian. The same source seems to have been used by Minucius Felix and Tertullian, and Eusebius in his *Praep. Evan.*, v. 19, quotes some other fragments of the work of Oenomaus. The main argument employed is an exposition of the contradictions, absurdities and immoralities of Greek mythology. A special attack is made on the doctrine of Fate or Necessity. Tatian insists that man is a free agent: that his sins and the consequent evils in the world are the result of free choice, and that the same free choice can remedy the evil.

His positive explanation of the universe is rather difficult to follow. He lays great stress on the Logos doctrine; all good is to be found in union with the Logos; all evil is in matter or in "spirits of a material nature"; the origin of evil in the world seems to be the choice of the latter rather than of the former; and redemption consists in the reverse process. But the choice of evil was not made only by man but by angels, who by their evil choice became the demons, that is, the gods of the heathen world. Both men and angels will be judged at the end of the world, when the good will receive again the immortality which was lost through sin, and the wicked will receive death through punishment with immortality (θάνατον διὰ τιμωρίαν ἐν ἀθανασίᾳ). Tatian does not deny the stories of the Greek mythology—indeed he protests against any attempt to allegorize it—but he insists that these stories are the record of the deeds of demons and have no religious value. The truth of his views he rests, rather strangely, on the argument that Moses, the writer of the Pentateuch, lived long before Homer, whom he regards as the earliest Greek religious writer, and to prove this he quotes a series of synchronisms, which were made use of by

[1] Tatian describes himself as an "Assyrian," and though the terms "Assyrian" and "Syrian" are used very loosely by ancient writers, it is probable that he was born E. of the Tigris, *i.e.* not in Syria as we understand it. Epiphanius, in another passage, calls him an Assyrian.

many subsequent chronologers, including probably Julius Africanus, who in turn was used by Eusebius.

The omissions in the *Oratio* are even more remarkable than its statements. There is at the most not more than an allusion to Christ, who is never mentioned by name, and though there are frequent allusions to the regaining of life, which is accomplished by union with the Logos, there is no reference to the doctrines of the incarnation or of the atonement.

The date of the writing of the *Oratio* cannot be fixed more accurately than that it was before 165 and probably about A.D. 150. On the hypothesis that Tatian remained in Rome until the death of Justin it must have been written there: but on internal evidence Harnack thinks, probably correctly, that it was written in Greece, perhaps in Athens, and Tatian made at least one journey outside Rome before Justin's death (cf. *Texte und Untersuchungen, l.c.*, and *Gesch. d. altchr. Litt., l.c.*). (K. L.)

TATRA MOUNTAINS (Hungarian *Tarczal*) or the High Tatra, the highest group in the central Carpathians, and the central group of the whole Carpathian system. They extend between the rivers Waag, Arva, Dunajec and Poprad, and form a sharply defined and isolated group, rising abruptly like a gigantic wall to an altitude of over 8400 ft. in the midst of a high plateau situated 2600 ft. above sea-level. The Tatra Mountains extend through the Hungarian counties of Liptó and Szepes, and with their northern extremities also through the Austrian crownland of Galicia, and have a length of 40 m. and a width varying between 9 and 15 m. The mean altitude is between 6000 and 7500 ft. The principal peaks are:—the Franz-Josef or Gerlsford (Hung. *Gerlachfalvi-Csúcs*, 8737 ft.), the highest in the Carpathian system; the Lomnitz (*Lomniczi-Csúcs*, 8642 ft.); the Eisthal (*Jégvölgyi-Csúcs*, 8630 ft.); the Tatraspitze or Hohe Visoka (8415 ft.); the Kesmark (8226 ft.); the Meeraugenspitze (*Tengerszem-Csúcs*, 8210 ft.); the Schlagendorf (*Szalóki-Csúcs*, 8050 ft.); and the Kriván (8190 ft.). The principal valleys, which lie at an altitude of 2600 to 3250 ft. above sea-level, and present some of the wildest scenery, are:—the Kohlbach Valley, the Felka Valley, the Valley of Mengsdorf, the Javorina Valley, the Kotlina Valley, in which is the stalactite cavern of Béla, and the Bielka Valley. One of the characteristics of the Tatra are the numerous mountain lakes (112 in number), called by the people "eyes of the sea." The largest of them are the Lake of Csorba, in the southern part of the group, which has an area of 50 acres; the Grosser Fischsee in the Bielka Valley; and the Wielki Staw, with an area of 85 acres, the largest of the Five Polish Lakes, which lie in the Roztoka Valley.

There are many summer resorts in the Tatra Mountains, the most frequented being Tatrafüred (German, *Schmecks*), three small villages situated at an altitude of 3250 ft., at the foot of the Schlagendorf peak; and the environs of the Lake of Csorba, which is called the "Pearl of the Tatra."

TATTA, or THATO, an ancient town of British India, in the Sind province of Bombay, 7 m. from the right bank of the main channel of the Indus and 13 m. from a station on the North-Western railway: pop. (1901) 10,783. Tatta was the capital of the Samma dynasty in Lower Sind in the 16th century, and long continued to be the centre of trade in the country, to which it sometimes gave its name in early European travels. An English factory was established here in 1758, but withdrawn after a few years. There are two old mosques, decorated with the coloured tiles characteristic of Sind.

TATTERSALL'S, the London horse auction mart, founded in 1766 by Richard Tattersall (1724–1795), who had been stud groom to the second duke of Kingston. The first premises occupied were near Hyde Park Corner, in what was then the outskirts of London. Two "Subscription rooms" were reserved for members of the Jockey Club, and they became the rendezvous for sporting and betting men. Among the famous dispersal sales conducted by "Old Tatt" were those of the duke of Kingston's stud in 1774 and of the stud of the Prince of Wales (afterwards George IV.) in 1786. The prince often visited Richard Tattersall, and was joint proprietor with him of the *Morning Post* for several years. He was succeeded by his son, Edmund Tattersall (1758–1810), who extended the business of the firm to France. The third of the dynasty, Richard Tattersall (1785–1859), the eldest of Edmund's three sons, became head of the firm at his father's death. He had his grandfather's ability and tact, and was the intimate of the best sporting men of his time. Another Richard Tattersall (1812–1870), son of the last, then took command of the business. His great-grandfather's 99-year lease having expired, he moved the business to Knightsbridge. Richard was followed by his cousin, Edmund Tattersall (1816–1898), and he by his eldest son, Edmund Somerville Tattersall (b. 1863).

A son of the second Richard Tattersall, George Tattersall (1817–1849), was a well-known sporting artist. In 1836 he compiled a guide to *The Lakes of England* illustrated with forty-three charming line drawings, and he showed skill as an architect by building the Tattersall stud stables at Willesden. His experience in this and similar undertakings led him to publish *Sporting Architecture* (1841). In the same year, under the pseudonym "Wildrake," he published *Cracks of the Day*, describing and illustrating sixty-five race-horses. He also contributed illustrations to the *Hunting Reminiscences* of Nimrod (Charles J. Apperley), the *Book of Sports* (1843), and the *New Sporting Almanack*.

TATTNALL, JOSIAH (1795–1871), American naval officer, was born near Savannah, and was educated in England. He entered the United States navy in 1812, and was actively employed till the beginning of the Civil War. He may be said to have gained a world-wide reputation by his use of the phrase "blood is thicker than water" to justify his intervention on behalf of the British squadron engaged in the operations against the Peiho Forts. Tattnall's flagship the *Toeywan* had grounded shortly before, and had been helped off by the British squadron. He was in the Peiho river when the unsuccessful attack of the 25th of June 1859 was made. Tattnall not only brought the *Toeywan* under fire, but lent the aid of his boats to land detachments to turn the Chinese defences. When the Civil War began he took the side of the Confederacy. He was put in command of its naval forces when Franklin Buchanan resigned after he was wounded in the action with the Federal squadron in Hampton Roads. The Confederate States were never able to form a sea-going squadron, and Tattnall had no chance to do more than make a struggle with insufficient resources on its rivers. He died on the 14th of June 1871.

TATTOO, a signal given by beat of drum and call of bugle at nightfall for soldiers to go to quarters when in garrison or to tents when in the field. The earlier word is *taptoo* or *taptow*, and was borrowed from Du. *taptoe;* the phrase *de taptoe slaan*, to close the taps, and the parallel Ger. *Zapfenstreich*, literally "tap-stroke" (*Zapf*, a tap of a cask), show that it meant originally a signal that the "taps" or public-houses were closed for the night.

TATTOOING (Tahitian, *tatu*, from *ta*, mark), the practice of decorating the skin, by cutting or puncturing, with various patterns into which a colouring matter is introduced. Though the word is Polynesian, the custom appears to have been almost universal, but tends to disappear before the spread of civilization. The prohibition to the Jews (Lev. xix. 28) under the Mosaic Law to "print any marks" upon themselves is believed to have reference to tattooing, which is still common in Arabia. The North and South American Indians, the Chinese, Japanese, Burmese, all tattoo. The origin of the custom is disputed. It was probably at first for purely ornamental purposes and with the idea of attracting the opposite sex. The discovery in the caves of Western Europe of hollowed stones which had been apparently used for grinding up ochre and other coloured clays is thought evidence that prehistoric man painted himself, and tattooing for decorative reasons may easily date back to the cave-dwellers. The modern savage paints himself as a protection against cold, against the bites of insects or the sun's rays, and most of all to give himself a ferocious appearance in battle, as Caesar relates of the ancient Britons. Any of these motives may have shared in originating tattooing. Subsequently the practice assumed religious and social significance, varying with the country and according to the age at which it was performed. Thus in Polynesia it is begun in or about the twelfth year, and becomes thus a mark of puberty; while among the Arabs and the Kabyles of Algeria infants are tattooed by their mothers for simple ornament or as a means of recognizing them. The American Indians bore from their initiation at puberty the mark of the personal or tribal *totem*, which at once represented the religious side of their life, and served the practical purpose of enabling them to be known by friendly tribes. Among the Australians tattooing served as a mark of adoption into the family or tribe, the distinctive emblem or *kobong* being scarred on the thighs.

Tattooing is regarded, too, as a mark of courage. A Kaffir who has been a successful warrior has the privilege of making a long incision in his thigh, which is rubbed with cinders until sufficiently discoloured. Elsewhere tattooing is a sign of mourning, deep and numerous cuts being made on face, breast and limbs. Among the Fijians and Eskimos the untattooed were regarded as risking their happiness in the future world. Some of the most remarkable examples of tattooing are those to be found among the Laos, whose stomachs, thighs, legs and breasts are often completely covered with fantastic animal figures like those on Buddhistic monuments.

The rudest form of tattooing is that practised specially by the Australians and some tribes of negroes. It consists in cutting gashes, arranged in patterns, on the skin and filling the wounds with clay so as to form raised scars. This tattooing by scarring as compared with the more common mode of pricking is, as a general rule, confined to the black races. Light-skinned races tattoo, while dark practise scarring. In Polynesia the art of tattooing reached its highest perfection. In the Marquesas group of islands, for example, the men were tattooed all over, even to the fingers and toes and crown of the head, and as each operation took from three to six months, beginning at virility, a man must have been nearly thirty before his body was completely covered. In New Zealand the face was the part most tattooed, and Maori heads so decorated were at one time in much request for European museums, but they are no longer obtainable in the colony. In Japan, where it became a high art, tattooing was neither ceremonial nor symbolical. It was in lieu of clothing, and only on those parts of the body usually covered in civilized countries, and in the case of those only who, like the jinrikisha-men, work half naked. The colours used are black, which appears blue, made from Indian ink, and different tints of red obtained from cinnabar. Fine sewing-needles, eight, twelve, twenty or more, fixed together in a piece of wood, are used. A clever tattooer can cover the stomach or back in a day. As soon as the picture is complete, the patient is bathed in hot water. The Ainus, on the other hand, tattoo only the exposed parts of the body, the women, unlike the Japanese, being frequently patients. The tattooing instruments used in Polynesia consisted of pieces of sharpened bone fastened into a handle, with their edges cut into teeth. These were dipped into a solution of charcoal and then driven into the skin by smart blows with a mallet. During the operation, assistants, usually female relatives, drowned the cries of the sufferer with songs and the beating of drums.

Under the influence of civilization tattooing is losing its ethnological character, and has become, in Europe at least, an eccentricity of soldiers and sailors and of many among the lower and often criminal classes of the great cities. Among eight hundred convicted French soldiers Lacassagne found 40 per cent. tattooed. In the British army till 1879 the letters D. and B. C. for *Deserter* and *Bad Character* were tattooed with needles and Indian ink; and tattooing has often been used to identify criminals and slaves.

See Lacassagne, *Les Tatouages* (Paris, 1881); General Robley, *Moko or Maori Tattooing* (1896).

TAUCHNITZ, the name of a family of German printers and publishers. Karl Christoph Traugott Tauchnitz (1761–1836), born at Grossbardau near Grimma, Saxony, established a printing business in Leipzig in 1796 and a publishing house in 1798. He specialized on the publication of dictionaries, Bibles and stereotyped editions of the Greek and Roman classics. The business was carried on by his son, Karl Christian Phillipp Tauchnitz (1798–1884), until 1865, when the business was sold to O. Holtze. He left large sums to the city of Leipzig for philanthropic purposes. Christian Bernhard, Freiherr von Tauchnitz (1816–1895), the founder of the existing firm of Bernhard Tauchnitz, was the nephew of the first-mentioned. His printing and publishing firm was started at Leipzig in 1837. The Library of British and American Authors, so familiar to travellers on the continent of Europe, was begun in 1841. In 1908 the collection numbered over 4000 volumes. In 1868 he began the Collection of German Authors, followed in 1886 by the Students' Tauchnitz editions. In 1860 he was ennobled with the title of *Freiherr* (Baron), and in 1877 was made a life member of the Saxon Upper Chamber. From 1866 to 1895 he was British Consul-General for the kingdom and duchies of Saxony. He was succeeded in the business by his son, Christian Karl Bernhard, Freiherr von Tauchnitz.

TAULANTII, in ancient geography, an Illyrian people in the neighbourhood of Epidamnus (Thuc. i. 24). They were originally powerful and independent, under their own kings. One of these was Glaucias, who fought against Alexander the Great, and placed Pyrrhus, the infant king of Epirus, whom he had refused to surrender to Cassander, upon the throne (Plutarch, *Pyrrhus*, 3). Later the Taulantii fell under the sway of the kings of Illyria, and when the Romans were carrying on war against the Illyrian queen, Teuta, they were unimportant.

TAULER, JOHANN (*c.* 1300–1361), German mystic, was born about the year 1300 in Strassburg, and was educated at the Dominican convent in that city, where Meister Eckhart, who greatly influenced him, was professor of theology (1312–1320) in the monastery school. From Strassburg he went to the Dominican college of Cologne, and perhaps to St James's College, Paris, ultimately returning to Strassburg. In 1324 Strassburg with other cities was placed under a papal interdict. Legend says that Tauler nevertheless continued to perform religious services for the people, but though there may be a germ of historical truth in this story, it is probably due to the desire of the 16th-century Reformers to enroll the famous preachers of the middle ages among their forerunners. In 1338–1339 Tauler was in Basel, then the headquarters of the "Friends of God" (see MYSTICISM), and was brought into intimate relations with the members of that pious mystical fellowship. Strassburg, however, remained his headquarters. The Black Death came to that city in 1348, and it is said that, when the city was deserted by all who could leave it, Tauler remained at his post, encouraging by sermons and personal visitations his terror-stricken fellow-citizens. His correspondence with distinguished members of the *Gottesfreunde*, especially with Margaretha Ebner, and the fame of his preaching and other work in Strassburg, had made him known throughout a wide circle. He died on the 16th of June 1361.

The well-known story of Tauler's conversion and discipline by "the Friend of God from the Oberland" (see NICHOLAS OF BASEL) cannot be regarded as historical. Tauler's sermons are among the noblest in the German language. They are not so emotional as Suso's, nor so speculative as Eckhart's, but they are intensely practical, and touch on all sides the deeper problems of the moral and spiritual life.

Tauler's sermons were printed first at Leipzig in 1498, and reprinted with additions from Eckhart and others at Basel (1522) and at Cologne (1543). There is a modern edition by Julius Hamberger (Frankfort, 1864), and R. H. Hutton published Tauler's Sermons for Festivals under the title of *The Inner Way*. See Denifle, *Das Buch von geistlicher Armuth* (Strassburg, 1877); Carl Schmidt, *Johann Tauler von Strassburg* (Hamburg, 1841); S. Winkworth, *Tauler's Life and Sermons* (London, 1857); R. A. Vaughan, *Hours with the Mystics*, 3rd ed., vol. i. pp. 214–307; Preger's *Gesch. der deutschen Mystik im Mittelalter*, vol. iii.; W. R. Inge, *Christian Mysticism*; R. M. Jones, *Studies in Mystical Religion* (1909).

TAUNG-GYI, the headquarters of the superintendent and political officer, southern Shan States, Burma. It is situated in 96° 58′ E. and 20° 47′ N., at an altitude of about 5000 ft., in a depressed plateau on the crest of the Sintaung hills. It is in the state of Yawnghwe, 105 m. from Thazi railway station on the Rangoon-Mandalay railway, with which it is connected by a cart-road. The civil station dates from 1894, when there were only a few Taungthu huts on the site. There were in 1906 upwards of a thousand houses, many of them substantially built of brick. Since 1906 the southern Shan States have been garrisoned by military police, whose headquarters are in Taunggyi. The station is to a considerable extent a commercial depôt for the country behind, and there are many universal supply shops of most nationalities (except British)—Austrian, Chinese and Indian. The five-day bazaar is the trading place of the natives of the country. A special quarter contains the temporary residences of the chiefs when they visit headquarters, and there is a school for their sons. An orchard for experimental cultivation has met with considerable success. The average shade maximum temperature is 84°; the minimum 39°.

TAUNTON, HENRY LABOUCHERE, Baron (1798–1869), English politician, came of a French Huguenot family, which, on leaving France, settled in Holland. His father, Peter Caesar Labouchere, merchant, was a partner in the wealthy Amsterdam banking firm of Hope & Company;[1] he went to live in England, and married a daughter of Sir Francis Baring. Henry was his elder son, while a younger son, John, was the father of the later well-known Radical member of parliament and proprietor of *Truth*, Henry Labouchere (b. 1831). He was educated at Winchester and Christ Church, Oxford, and entered the House of Commons as a Whig in 1826. From 1830 to 1858 he sat for Taunton, Somerset. After filling various minor offices, he became president of the Board of Trade in 1839–41; and in 1846 he was chief secretary for Ireland. In 1847–52 he was again president of the Board of Trade, and from 1855 to 1858 secretary of state for the colonies. In 1859 he was created Baron Taunton, but on his death, on the 13th of July 1869, the title became extinct.

TAUNTON, a municipal and parliamentary borough and market town of Somersetshire, England, on the river Tone, 163 m. W. by S. of London by the Great Western railway. Pop. (1901) 21,087. Standing in the beautiful valley of Taunton Dene, the town is chiefly built on the south side of the river. Its three main streets, broad and regular, converge upon a triangular space called the Parade, where there is a market cross. The parish church of St Mary Magdalene is one of the finest and largest Perpendicular churches in England. Remnants of Norman work are preserved in the chancel arch, and of Early English work in the north aisles and transepts. The tower, noteworthy for its union of elaborate ornament and lightness of effect, exceeds 150 ft. in height. There are double aisles on each side of the nave, and the whole interior is admirable in its harmony of design and colour. Little is left of an Austin priory established in the reign of Henry I. by William Giffard, bishop of Winchester, who also built the castle, now a museum for prehistoric, Roman and medieval antiquities. Taunton castle, though largely rebuilt in 1496, embodies the remains of a very early fortress, while its walls and keep date from the 12th century, its towers and gatehouses from the 13th or 14th. At the Restoration it was dismantled and its moat filled in. Among the schools is a grammar school founded in 1522 by Richard Fox, bishop of Winchester. There are also public gardens, assembly rooms, almshouses, a town hall, market hall, a hospital founded in 1819 to commemorate the jubilee of George III., and a shire hall containing a series of marble busts representing, among other Somerset worthies, Admiral Blake, John Locke the philosopher, the Puritan leader Pym, Bishop Ken, and Speke the African explorer. The local industries are silk, linen and glove manufactures, iron and brass founding, coachbuilding, cabinetmaking, malting and brewing; while Taunton Dene is famous as a rich agricultural district.

[1] The Amsterdam Hopes were descended from Henry Hope, son of a Scottish merchant, and younger brother of Sir Thomas Hope (d. 1646), the famous Scottish lord-advocate, ancestor of the earls of Hopetoun (marquess of Linlithgow, *q.v.*). Among his descendants was Thomas Hope (1770–1831), father of A. J. B. Beresford-Hope (1820–1887), politician and author.

The parliamentary borough of Taunton returns one member. The town is governed by a mayor, six aldermen and eighteen councillors. Area, 1393 acres.

There was perhaps a Romano-British village near the suburb of Holway, and Taunton (Tantun, Tantone, Tauntone) was a place of considerable importance in Saxon times. King Ine threw up an earthen castle here about 700, and a monastery was founded before 904. The bishops of Winchester owned the manor, and obtained the first charter for their "men of Taunton" from King Edward in 904, freeing them from all royal and county tribute. At some time before the Domesday Survey Taunton had become a borough with very considerable privileges, governed by a portreeve appointed by the bishops. It did not obtain a charter of incorporation until that of 1627, which was renewed in 1677. The corporation existed until 1792, when the charter lapsed owing to vacancies in the number of the corporate body, and Taunton was not reincorporated until 1877. Parliamentary representation began in 1299, and two members were returned until 1885. A fair on the 7th of July was held under a charter of 1256, and there are now two fairs yearly, on the 17th of June and the 7th of July. The Saturday market for the sale of corn, cattle and provisions dates from before the Conquest. There is also a smaller market on Wednesdays. The medieval fairs and markets of Taunton were celebrated for the sale of woollen cloth called "Tauntons" made in the town. On the decline of the west of England woollen industry, silk-weaving was introduced at the end of the 18th century.

See *Victoria County History, Somerset*; Toulmen's *History of Taunton*, edited by James Savage (1830).

TAUNTON, a city and one of the county-seats of Bristol county, Massachusetts, U.S.A., at the head of ocean navigation on the Taunton river, 17 m. above its mouth, about 35 m. S. of Boston, and about 14 m. N. of Fall River. Pop. (1890) 25,448; (1900) 31,036, of whom 9140 were foreign-born, 2844 being Irish, 2366 French-Canadians, 1144 English, and 801 English-Canadians; (1910, U.S. census) 34,259. Taunton is served by the New York, New Haven & Hartford railroad (Old Colony Branch) and by interurban electric railways connecting with Fall River, New Bedford, Providence and Boston. The channel of the Taunton river has been deepened and widened by the Federal government, and in 1910 vessels of 11 ft. draft could reach the city at high water (mean range of tide at Taunton, 3·4 ft.). Within the corporate limits of the city, which has a land area of 44·25 sq. m., there are six villages—Hopewell, Britanniaville, Oakland, Whittenton, East Taunton and the Weir. Taunton Green, a rectangular stretch of land fringed with lofty elms, the "common" of the New England town, about which is the business portion of the modern city, is 1 m. from the Weir, the port of the city.

The city contains interesting specimens of colonial or early 19th-century architecture. Among the modern public buildings are the handsome granite County Court House (1895), facing the Green, the Public Library building (given by Andrew Carnegie), the registry building, the county gaol, the city hall, the post office, an old ladies' home, an emergency hospital, the Morton Hospital, occupying the fine old residence of Governor Marcus Morton, and the Y.M.C.A. building. The Bristol County Law Library and Old Colony Historical Society (incorporated in 1853 and organized in 1854) possess valuable collections of books, and the latter has a collection of portraits and antiquities. Bristol Academy (1792; non-sectarian) is a well-known preparatory school, and there is also a commercial school—the Bristol County Business College. At Norton (pop. in 1910, 2544), directly N. of Taunton, and formerly within its boundaries, is Wheaton Seminary (1834) for girls. Among social clubs are the Winthrop Club, the Bristol Club, the Taunton Boat Club, the Yacht Club, and the Country Club. A good water-supply, owned by the city, is obtained from neighbouring lakes and ponds, along the shores of which are many summer cottages. Taunton was one of the first cities in the United States to own and operate its own electric lighting plant, which it acquired from a private corporation in 1897. Its industrial importance began with the establishment of ironworks in 1656; the plant then opened continued in active operation for about 225 years. Brick-making and shipbuilding were two of the early industries; the latter, formerly very important, has now been abandoned. The manufactures to-day are extensive and varied. The aggregate value of the factory product in 1905 was $13,644,586, an increase of 18·2 per cent. over that of 1900. Of this amount the value of the cotton manufactured was $6,141,598, or 45 per cent. of the whole. Herring fisheries give occupation during a part of the year to a considerable number of workers. Taunton has a prosperous jobbing trade, and large shipping interests, the coastwise trade being particularly important.

Taunton was founded in 1638, when the territory was purchased from Massasoit by settlers from the Massachusetts Bay Colony, and became the frontier town of Plymouth Colony. Myles Standish was engaged on the original survey. But there had been earlier settlers in the region—at "Tecticutt" (Titicut), which later became part of Taunton. The settlement at Taunton was at first known as Cohannet, but the present name—from Taunton, Somerset, England, the home of many of the settlers—was soon adopted. The town was incorporated in 1639. In 1671 it was the scene of a meeting between Gov. Thomas Prince and King Philip, at which a treaty was drawn up. During King Philip's War, Taunton was a base of operations for Plymouth Colony troops under Gov. Josiah Winslow. In 1686 Taunton was one of the towns which refused to comply with Sir Edmund Andros's demands for a tax levy. For some years Thomas Coram, the philanthropist and founder of the London Foundling Hospital, was engaged in the shipbuilding industry here. In 1774, after the passage of the Boston Port Bill, the people of Taunton showed their sympathy for Boston by raising on the Green a red flag on which were inscribed the words "Liberty and Union." The leader of the patriotic party at this time was Robert Treat Paine, to whose memory a bronze statue has been erected. During Shays's rebellion the Taunton court-house was twice besieged by insurgents, who were each time dispersed through the resolute action and firmness of Gen. David Cobb, one of the judges. The event is commemorated by a tablet on Taunton Green. In Berkley, which until 1735 was a part of Dighton (Taunton South Purchase, separated from Taunton in 1712), is the famous Dighton Rock, with inscriptions long erroneously supposed to have been made by Norse discoverers of America, but now known to be the work of Indians. Taunton was chartered as a city in 1864. In 1909 a new city charter was adopted, under which the mayor and nine councilmen (elected at large) were the only city officers elected at any city election; candidates for these offices are nominated by petition; the mayor appoints, subject to the approval of the council, a chief of police and a city solicitor.

See S. H. Emery, *History of Taunton from its Settlement to the Present Time* (Syracuse, N.Y., 1893); D. H. Hurd, *History of Bristol County* (Philadelphia, 1883); *Quarter Millennial Celebration* (Taunton, 1889).

TAUNUS, a wooded mountain range of Germany in the Prussian province of Hesse-Nassau and the grand-duchy of Hesse-Darmstadt. It lies between the Rhine and the Main on the S. and the Lahn on the N., and stretches some 55 m. E. and W. Its southern slopes stand 5 to 10 m. back from the Main, but leave only a very narrow strip of low ground alongside the Rhine, and from Bingen downwards they overhang it with precipitous crags, many of which are crowned with picturesque ruins. It has an average elevation of 1500 ft. The loftiest peaks occur in the east, where the imposing cluster of Grosser Feldberg (2887 ft.), Kleiner Feldberg (2714 ft.) and Altkönig (2618 ft.) dominate the Wetterau and the valley of the Main. Above the Rheingau, or the slopes which stretch down to the Rhine between Biebrich and Bingen, the altitude averages 1500 to 1700 ft. The geological core of the system consists of primitive argillaceous schists, capped by quartzite and broken through in places by basalt. On the northern side, which sinks on the whole gently towards the Lahn, the greywacke formation attains a considerable development. The hills are almost everywhere well wooded, the predominant trees being firs and beeches. The lower slopes are, wherever possible, planted with vineyards, orchards and chestnut and almond groves. The vineyards of the Rheingau are specially famous, and yield brands of wine—*e.g.* Johannisberger, Steinberger, Rüdesheimer, Marcobrunner, Hochheimer, Rauenthaler, Assmannshäuser, and others—which enjoy the highest reputation amongst the vintages of Germany. The Taunus is also famous for the number and efficacy of its mineral springs, which annually attract thousands of visitors to the celebrated spas of Wiesbaden, Homburg, Ems, Schlangenbad, Schwalbach, Soden and Nauheim, while the waters of Selters and other springs are exported in large quantity. The sheltered position and warm climate have led also to the establishment of the health resorts of Falkenstein (1875) and Schmitten, and of tourist centres at Königstein, Cronberg and Ober Ursel.

Above Falkenstein stand the ruins of the ancestral castle of Kuno, the powerful archbishop of Trier; above Königstein are the remains of a fortress of like name, formerly belonging to the electors of Mainz, and destroyed by the French in 1796; on Altkönig are two concentric lines of pre-Roman fortifications, 4557 and 2982 ft. in circumference. Interest also attaches to the once celebrated Cistercian abbey of Eberbach, founded in 1116; to Eltville, a favourite residence of the archbishops of Mainz in the 14th and 15th centuries; and to the family seats of Eppstein, Katzenelnbogen and Scharfenstein.

The chief historical monument of this region is the Saalburg, an ancient Roman fort serving as a centre of communications along the *limes* or fortified frontier-line drawn from Rhine to Main by Domitian (see Limes Germanicus). The excavations, which were begun in 1868, have revealed four different encampments, the earliest of which perhaps dates back to the time of the earliest Roman conquest. The remains now visible are an excellent type of the solidly constructed permanent camps of the middle imperial period (about A.D. 200). Elaborate restorations have been undertaken, and the minor remains have been housed since 1904 in the reconstructed *praetorium* or headquarters. An electric tram connects the Saalburg with Homburg (distance 4 m.).

Forty miles to the west of the Saalburg there is a modern national monument, the colossal figure of Germania, which stands on a bold spur of the Taunus 740 ft. above the Rhine. It was erected in 1883 to commemorate the War of 1870–71 and the re-creation of the German empire in the latter year. The steep crags of the western end of the Taunus, where they abut upon the Rhine, are rich in the romantic associations of the great river. Here are the rock of the siren Lurlei or Lorelei; the old castles of Stahleck and Pfalz, which belonged to the Counts Palatine of the Rhine; and the quaint medieval towns of Caub and St Goarshausen. Schloss Friedrichshof, at the foot of the Feldberg and Altkönig, immediately north of Kronberg, was built in 1889–97 by the widowed empress Frederick, and is the place where she died in 1901. The railway from Frankfort-on-Main to Oberlahnstein skirts the south and west foot of the range, that from Frankfort to Cassel the eastern side, while the line from Wiesbaden and Höchst to Limburg intersects it from south to north.

See *Die Heilquellen des Taunus* (published by Grossmann, Wiesbaden, 1887); Sievers, *Zur Kenntnis des Taunus* (Stuttgart, 1891), and the *Taunus Club's Guide* (4th ed. Frankfort-on-Main, 1905). For the Saalburg see L. Jacobi, *Das Römerkastell Saalburg* (2 vols., Homburg, 1897); also a small guide by the same author (3rd ed. Homburg, 1907).

TAUPO, a township of East Taupo county, New Zealand, in the south-west of the Hot Spring district of North Island. It attracts many visitors both as a health resort and on account of the magnificent scenery and remarkable volcanic phenomena of the surrounding district. It lies on the north-east shore of lake Taupo, the largest lake in the island, having an extreme length of 26 m. and a shore-line, not counting minor indentations, of about 100 m., and lying 1200 ft. above sea-level. The river Waikato, which reaches the west coast not far from Manukau Harbour near Auckland, here leaves the lake. The district abounds in geysers, springs, mud volcanoes and other phenomena; some of the waters have petrifying powers, and some of the springs are vividly coloured. On the road running N.E. to Rotorua (56 m.) are the resorts of Weirakei (7 m.) and Ateamuri (31 m.). Lake Taupo is finely situated, hills rising over 2000 ft. immediately from the shores, while the mountains of Tongariro, Ngauruhoe, an active volcano, and Ruapehu, a snow-clad peak, back the view to the south and mark the limit of the great volcanic line which extends 160 m. north-westward to White Island in the Bay of Plenty. The upper Waikato enters the lake from the south near Tokaano, where there is another collection of springs, &c. The river forms several fine falls and rapids below the lake.

TAURELLUS, NICOLAUS (1547–1606), German philosopher and theologian, was born at Mömpelgard. He read theology at Tübingen and medicine at Basel, where he lectured on physical science. He subsequently became professor of medicine at Altdorf, where he died in 1606. He attacked the dominant Aristotelianism of the time, and endeavoured to construct a philosophy which should harmonize faith and knowledge, and bridge over the chasm made by the first Renaissance writers who followed Pomponazzi. Scholasticism he condemned on account of its unquestioning submission to Aristotle. Taurellus maintained the necessity of going back to Christianity itself, as at once the superstructure and the justification of philosophy.

His chief works were *Philosophiae Triumphus* (1573); *Synopsis Metaphysicae Aristotelis* (1596); *De Rerum Aeternitate* (1604); and a treatise written in criticism of Caesalpinus entitled *Caesae Alpes* (1597). See Schmid-Schwarzenburg, *Nicolaus Taurellus* (1860 and 1864).

TAURI, the earliest known inhabitants of the mountainous south coast of the Crimea (Herodotus iv. 103). Nothing is certain as to their affinities. They probably represent an old population perhaps connected with some Caucasus stock; in spite of the resemblance of the name Taurisci they are not likely to be Celts. They were famous in the ancient world for their maiden goddess, identified by the Greeks with Artemis Tauropolos or Iphigeneia, whom the goddess was said to have brought to her shrine at the moment when she was to have been sacrificed at Aulis. Orestes sought his sister, and almost fell a victim to the Tauric custom of sacrificing to the maiden shipwrecked strangers, a real custom which was the ground of the whole myth. His adventures were the subject of plays by Euripides and Goethe. Towards the end of the 2nd century B.C. we find the Tauri dependent allies of the Scythian king Scilurus, who from their harbour of Symbolon Portus or Palacium (Balaclava) harassed Chersonese (*q.v.*). Their later history is unknown. (E. H. M.)

TAURIDA, a government of southern Russia, including the peninsula of Crimea and a tract of mainland situated between the lower Dnieper and the coasts of the Black Sea and the Sea of Azov. It is bounded by these two seas on the S., while it has on the N. the governments of Kherson and Ekaterinoslav. The area is 24,532 sq. m., of which 9704 sq. m. belong to the Crimea. The continental part consists of a gently undulating steppe (from sea-level up to 400 ft. in the north-east) of black earth, with only a few patches of saline clay on the shores of the Sivash or Putrid Sea, and sand along the lower Dnieper. The government is drained by the Dnieper, which flows along the frontier for 180 m., and by two minor streams, the Molochnaya and Berda. Many small lakes and ponds occur in the north, as well as on the Kinburn peninsula, at the mouth of the Dnieper, where salt is made. There are no forests. The climate is continental, and resembles that of central Crimea and Kherson. The population in 1906 was estimated at 1,634,700. The continental portion, although less mixed than that of the peninsula, consists of Great and Little Russians, who constitute 83 per cent. of the whole, Germans (5·4 per cent.), Bulgarians (2·8 per cent.), Jews (3·8 per cent.), and Armenians. The chief occupation of the people is agriculture, and every available patch of land has been brought under the plough. In 1900 no less than 43 per cent. of its area was under cereal crops alone. The principal crops are rye, wheat, oats, barley and potatoes. Tobacco is also grown, and over 32,000 acres are under vineyards, while gardens extend to some 15,500 acres in Crimea. Live-stock breeding is extensively engaged in. Salt is the only mineral raised, but the iron industry, and especially the manufacture of agricultural machinery (*e.g.* at Berdyansk), has greatly developed. The export trade is considerable, the chief ports being Sevastopol, Eupatoria, Theodosia, and Yalta on the Black Sea, and Azov and Berdyansk on the Sea of Azov. The fisheries along the coast are active. Manufactures are insignificant, but there is a brisk export trade in grain, salt, fish, wool and tallow. The government is divided into eight districts, the chief towns of which are Simferopol, capital of the government, Eupatoria and Theodosia, in Crimea, and Aleshki, Berdyansk, Melitopol, Perekop and Yalta on the continent.

TAURINI, an ancient Ligurian people, although the name may be of Celtic origin, who occupied the upper valley of the Padus (Po) in the centre of the modern Piedmont. In 218 B.C. they were attacked by Hannibal, with whose friends the Insubres they had a long-standing feud, and their chief town (Taurasia) was captured after a three days' siege (Polybius iii. 60, 8). As a people they are rarely mentioned in history. It is not known when they definitely became subject to the Romans, nor when the colony of (Julia) Augusta Taurinorum (Torino, Turin) was founded in their territory (probably by Augustus after the battle of Actium). Both Livy (v. 34) and Strabo (iv. p. 209) speak of the country of the Taurini as including one of the passes of the Alps, which points to a wider use of the name in earlier times.

See H. Nissen, *Italische Landeskunde*, ii. (1902), p. 163; and ancient authorities quoted in A. Holder, *Altceltischer Sprachschatz*, ii. (1904).

TAUROBOLIUM, the sacrifice of a bull, usually in connexion with the worship of the Great Mother of the Gods, though not limited to it. Of oriental origin, its first known performance in Italy occurred in A.D. 134, at Puteoli, in honour of Venus Caelestis. Prudentius describes it in *Peristephanon* (x., 1066 ff.): the priest of the Mother, clad in a toga worn *cinctû Gabino*, with golden crown and fillets on his head, takes his place in a trench covered by a platform of planks pierced with fine holes, on which a bull, magnificent with flowers and gold, is slain. The blood rains through the platform on to the priest below, who receives it on his face, and even on his tongue and palate, and after the baptism presents himself before his fellow-worshippers purified and regenerated, and receives their salutations and reverence.

The taurobolium in the 2nd and 3rd centuries was usually performed as a measure for the welfare of the Emperor, Empire, or community, its date frequently being the 24th of March, the *Dies Sanguinis* of the annual festival of the Great Mother and Attis. In the late 3rd and the 4th centuries its usual motive was the purification or regeneration of an individual, who was spoken of as *renatus in aeternum*, reborn for eternity, in consequence of the ceremony (*Corp. Insc. Lat.* vi. 510–512). When its efficacy was not eternal, its effect was considered to endure for twenty years. It was also performed as the fulfilment of a vow, or by command of the goddess herself, and the privilege was limited to no sex nor class. The place of its performance at Rome was near the site of St Peter's, in the excavations of which several altars and inscriptions commemorative of taurobolia were discovered.

The taurobolium was probably a sacred drama symbolizing the relations of the Mother and Attis (*q.v.*). The descent of the priest into the sacrificial foss symbolized the death of Attis, the withering of the vegetation of Mother Earth; his bath of blood and emergence the restoration of Attis, the rebirth of vegetation. The ceremony may be the spiritualized descent of the primitive oriental practice of drinking or being baptized in the blood of an animal, based upon a belief that the strength of brute creation could be acquired by consumption of its substance or contact with its blood. In spite of the phrase *renatus in aeternum*, there is no reason to suppose that the ceremony was in any way borrowed from Christianity.

See Esperandieu, *Inscriptions de Lectoure* (1892), pp. 94 ff.; Zippel, *Festschrift zum Doctorjubilaeum*, Ludwig Friedländer, 1895, p. 489 f.; Showerman, *The Great Mother of the Gods, Bulletin of the University of Wisconsin*, No. 43, pp. 280–84 (Madison, 1901); Hepding, *Attis, Seine Mythen und Sein Kult* (Giessen, 1903), pp. 168 ff., 201; Cumont, *Le Taurobole et le Culte de Bellone, Revue d'histoire et de littérature religieuses*, vi., No. 2, 1901. (G. SN.)

TAURUS ("the Bull"), in astronomy, the second sign of the zodiac (*q.v.*), denoted by the symbol ♉. It is also a constellation of very great antiquity, the Pleiades and Hyades, two star clusters, being possibly referred to in the Old Testament; Aldebaran, a star, is mentioned by Hesiod and Homer. Ptolemy catalogued 44 stars, Tycho Brahe 43, Hevelius 51. The Greeks fabled this constellation to be the bull which bore Europa across the seas to Crete, and was afterwards raised to the heavens by Jupiter. *α Tauri*, or Aldebaran, is a brilliant star of a reddish colour and magnitude 1·2; this star is the principal object of the group named the Hyades, named after the seven daughters of Atlas and Aethra—Ambrosia, Coronis, Eudora, Pasithoë, Plexaris, Pytho and Tycho—fabled by the Greeks to have been transformed into stars by Jupiter for bewailing the death of their brother Hyas. Another star group in this constellation is the Pleiades. *λ Tauri* is an "Algol" variable, varying in magnitude from 3·4 to 4·2. Nebula *M*.1 *Tauri* is a famous "crab" nebula, so named by Lord Rosse from its clawlike protuberances; it is the first of the series of nebula on the enumeration of Messier.

TAUSEN, HANS (1494–1561), the protagonist of the Danish Reformation, was born at Birkende in Funen in 1494. The quick-witted peasant lad ran away from the plough at an early age, finally settling down as a friar in the Johannite cloister of Antvorskov near Slagelse. After studying at Rostock and teaching there for a time and also at Copenhagen, he was again sent abroad by his prior, visiting, among other places, the newly founded university of Leyden and making the acquaintance of the Dutch humanists. He was already a good linguist, understanding both Latin and Hebrew. Subsequently he translated the books of Moses from the original. In May 1523 Tausen went to Wittenberg, where he studied for a year and a half, when he was recalled to Antvorskov. In consequence of his professed attachment to the doctrines of Luther he was first imprisoned in the dungeons of Antvorskov and thence transferred, in the spring of 1525, to the Grey Friars' cloister at Viborg in Jutland, where he preached from his prison to the people assembled outside, till his prior, whom he won over to his views, permitted him to use the pulpit of the priory church. At Viborg the seed sown by Tausen fell upon good soil. Several young men in the town had studied at Wittenberg, and the burghers, in their Lutheran zeal, had already expelled their youthful Bishop Jörgen Friis. Tausen's preaching was so revolutionary that he no longer felt safe among the Franciscans, so he boldly discarded his monastic habit and placed himself under the protection of the burgesses of Viborg. At first he preached in the parish church of St John, but this soon growing too small for him he addressed the people in the market-place from the church tower. When the Franciscans refused to allow him to preach in their large church, the mob broke in by force. A compromise was at last arranged, whereby the friars were to preach in the forenoon and Tausen in the afternoon. The bishop, very naturally averse to these high-handed proceedings, sent armed men to the church to arrest Tausen, but the burghers, who had brought their weapons with them, drove back "the bishop's swains." In October 1526 King Frederick I., during his visit to Aalborg, took Hans Tausen under his protection, appointed him one of his chaplains, and charged him to continue for a time "to preach the holy Gospel" to the citizens of Viborg, who were to be responsible for his safety, thus identifying himself with the new doctrines in direct contravention of the plain letter of his coronation oath. Tausen found a diligent fellow-worker in Jörgen Viberg, better known as Sadolin, whose sister, Dorothea, he married, to the great scandal of the Catholics. He was indeed the first Danish priest who took unto himself a wife. He was also the first of the reformers who used Danish instead of Latin in the church services, the "Even song" he introduced at Viborg being of great beauty. Tausen was certainly the most practically gifted of all the new native teachers. But he was stronger as a preacher and an agitator than as a writer, the pamphlets which he now issued from the press of his colleague the ex-priest Hans Vingaard, who settled down at Viborg as a printer, being little more than adaptations of Luther's *opuscula*. He continued to preach in the Grey Friars' church, while Sadolin, whom he had "consecrated" a priest, officiated at the church of the Dominicans, who had already fled from the town. The stouter-hearted Franciscans only yielded to violence persistently applied by the soldiers whom their opponents quartered upon them. In 1529 Tausen's "mission" at Viborg came to an end. King Frederick now recommended him to Copenhagen to preach heresy at the church of St Nicholas, but here he found an able and intrepid opponent in Bishop Rönne. Serious disturbances thereupon ensued; and the Protestants, getting the worst of the argument, silenced their gainsayers by insulting the bishops and priests in the streets and profaning and devastating the Catholic churches. A *Herredag*, or Assembly of Nobles, was held at Copenhagen on the 2nd of July 1530, ostensibly to mediate between the two conflicting confessions, but the king, from policy, and the nobility, from covetousness of the estates of the prelates, made no attempt to prevent the excesses of the Protestant rabble, openly encouraged by Tausen. On the other hand, the preachers failed to obtain the repeal of the Odense recess of 1527 which had subjected them to the spiritual jurisdiction of the prelates. On the death of King Frederick, Tausen, at the instance of Rönne, was, at the *Herredag* of 1533, convicted of blasphemy and condemned to expulsion from the diocese of Sjaelland, whereupon the mob rose in arms against the bishop, who would have been murdered but for the courageous intervention of Tausen, who conducted him home in safety. The noble-minded Rönne thereupon, from gratitude, permitted Tausen to preach in all his churches on condition that he moderated his tone. On the final triumph of the Reformation Tausen was appointed bishop of Ribe (1542), an office he held with great zeal and fidelity for twenty years.

See Suhr, *Tausens Levnet* (Ribe, 1836); *Danmarks Riges Historie*, vol. iii. (Copenhagen, 1897–1905). (R. N. B.)

TAUSSIG, FRANK WILLIAM (1859–), American economist, was born at St Louis, Missouri, on the 28th of December 1859. He was educated in his native city and at Harvard University, where he became professor of political economy in 1892. He has made a particular study of finance, and has written *Tariff History of the United States* (1888); *The Silver Situation in the United States* (1892); *Wages and Capital* (1896). He was for some time editor of the *American Quarterly Journal of Economics*.

TAUTPHOEUS, JEMIMA, Baroness von (1807–1893), British novelist, was born at Seaview, Co. Donegal, on the 23rd of October 1807, her maiden name being Montgomery. In 1838 she married the Baron von Tautphoeus of Marquartstein (1805–1885), chamberlain to the king of Bavaria, and in Bavaria she passed most of the rest of her life. She was the author of several novels, written in English, describing South German life, manners and history. *The Initials* (1850), *Quits* (1857), and *At Odds* (1863) are the best known of these. She died on the 12th of November 1893.

TAVASTEHUS, a province of Finland, bounded by the provinces of Nyland, Viborg, Vasa and St Michel. Pop. (1904) 317,326. The province is largely unproductive, much of the surface being composed of hills and lakes, but in favourable districts agriculture is sucessfully pursued, and there is a school of agriculture and an institute of forestry.

TAVERN, the old name for an inn, a public house where liquor is sold and food is supplied to travellers. It is, however, now usually applied to a small ale-house where liquor only is supplied. The word comes through Fr. from Lat. *taberna*, a booth, shop, inn. It is usually connected with the root seen in "tabula," board, whence Eng. "table;" and thus meant originally a hut or booth made of planks or boards of wood.

TAVERNIER, JEAN BAPTISTE (1605–1689), French traveller and pioneer of trade with India, was born in 1605 at Paris, where his father Gabriel and uncle Melchior, Protestants from Antwerp, pursued the profession of geographers and engravers. The conversations he heard in his father's house inspired Tavernier with an early desire to travel, and in his sixteenth year he had already visited England, the Low Countries and Germany, and seen something of war with the imperialist Colonel Hans Brenner, whom he met at Nuremberg. Four and a half years in the household of Brenner's uncle, the viceroy of Hungary (1624–29), and a briefer connexion in 1629 with the duke of Rethel and his father the duke of Nevers, prince of Mantua, gave him the habit of courts, which was invaluable to him in later years; and at the defence of Mantua in 1629, and in Germany in the following year with Colonel Walter Butler (afterwards notorious through the death of Wallenstein), he gained some military experience. When he left Butler to view the diet of Ratisbon in 1630, he had seen Italy, Switzerland, Germany, Poland and Hungary, as well as France, England and the Low Countries, and spoke the principal languages of these countries. He was now eager to visit the East; and at Ratisbon he found the opportunity to join two French fathers, M. de Chapes and M. de St Liebau, who had received a mission to the Levant. In their company he reached Constantinople early in 1631, where he spent eleven months, and then proceeded by Tokat, Erzerum and Erivan to Persia. His farthest point in this first journey was Ispahan; he returned by Bagdad, Aleppo, Alexandretta, Malta and Italy, and was again in Paris in 1633. Of the next five years of his life nothing is known with certainty, but it was probably during this period that he became controller of the household of the duke of Orleans. In September 1638 he began a second journey (1638–43) by Aleppo to Persia, and thence to India as far as Agra and Golconda. His visit to the court of the Great Mogul and to the diamond mines was connected with the plans realized more fully in his later voyages, in which Tavernier travelled as a merchant of the highest rank, trading in costly jewels and other precious wares, and finding his chief customers among the greatest princes of the East. The second journey was followed by four others. In his third (1643–49) he went as far as Java and returned by the Cape; but his relations with the Dutch proved not wholly satisfactory, and a long lawsuit on his return yielded but imperfect redress. In his last three journeys (1651–55, 1657–62, 1664–68) he did not proceed beyond India. The details of these voyages are often obscure; but they completed an extraordinary knowledge of the routes of overland Eastern trade, and brought the now famous merchant into close and friendly communication with the greatest Oriental potentates. They also secured for him a large fortune and great reputation at home. He was presented to Louis XIV., "in whose service he had travelled sixty thousand leagues by land," received letters of nobility (on the 16th of February 1669), and in the following year purchased the barony of Aubonne, near Geneva. In 1662 he had married Madeleine Goisse, daughter of a Parisian jeweller.

Thus settled in ease and affluence, Tavernier occupied himself, as it would seem at the desire of the king, in publishing the account of his journeys. He had neither the equipment nor the tastes of a scientific traveller, but in all that referred to commerce his knowledge was vast and could not fail to be of much public service. He set to work therefore with the aid of Samuel Chappuzeau, a French Protestant littérateur, and produced a *Nouvelle Relation de l'Intérieur du Sérail du Grand Seigneur* (4to, Paris, 1675), based on two visits to Constantinople in his first and sixth journeys. This was followed by *Le Six Voyages de J. B. Tavernier* (2 vols. 4to, Paris, 1676) and by a supplementary *Recueil de Plusieurs Relations* (4to, Paris, 1679), in which he was assisted by a certain La Chapelle. This last contains an account of Japan, gathered from merchants and others, and one of Tongking, derived from the observations of his brother Daniel, who had shared his second voyage and settled at Batavia; it contained also a violent attack on the agents of the Dutch East India Company, at whose hands Tavernier had suffered more than one wrong. This attack was elaborately answered in Dutch by H. van Quellenburgh (*Vindiciæ Batavicæ*, Amst., 1684), but made more noise because Arnauld drew from it some material unfavourable to Protestantism for his *Apologie pour les Catholiques* (1681), and so brought on the traveller a ferocious onslaught in Jurieu's *Esprit de M. Arnauld* (1684). Tavernier made no reply to Jurieu; he was in fact engaged in weightier matters, for in 1684 he travelled to Berlin at the invitation of the Great Elector, who commissioned him to organize an Eastern trading company—a project never realized. The closing years of Tavernier's life are obscure; the time was not favourable for a Protestant, and it has even been supposed that he passed some time in the Bastille. What is certain is that he left Paris for Switzerland in 1687, that in 1689 he passed through Copenhagen on his way to Persia through Muscovy, and that in the same year he died at Moscow. It appears that he had still business relations in the East, and that the neglect of these by his nephew, to whom they were intrusted, had determined the indefatigable old man to a fresh journey.

Tavernier's travels, though often reprinted and translated, have two defects: the author uses other men's material without distinguishing it from his own observations; and the narrative is much confused by his plan of often deserting the chronological order and giving instead notes from various journeys about certain routes. The latter defect, it is true, while it embarrasses the biographer, is hardly a blemish in view of the object of the writer, who sought mainly to furnish a guide to other merchants. A careful attempt to disentangle the thread of a life still in many parts obscure has been made by Charles Joret, *Jean Baptiste Tavernier d'après des Documents Nouveaux*, 8vo, Paris, 1886, where the literature of the subject is fully given.

See also an English translation of Tavernier's account of his travels so far as relating to India, by V. Ball, 2 vols. (1889).

TAVIRA, a seaport of southern Portugal, in the district of Faro (formerly the province of Algarve); at the mouth of the river Seca, 21 m. E.N.E. of Faro. Pop. (1900) 12,175. The harbour is protected by two forts, and the public buildings include a Moorish citadel, a Renaissance church, and a ruined nunnery founded by King Emanuel (1495–1521). Tavira has sardine and tunny fisheries, and carries on a considerable coasting trade. Excellent fruit is grown in the neighbourhood.

TAVISTOCK, a market town in the Tavistock parliamentary division of Devonshire, England, in the valley of the Tavy, on the western border of Dartmoor; 16½ m. N. of Plymouth, on the Great Western and the London and South Western railways. Pop. of urban district (1901), 4728. There are some remains (including a portion in the square, now used as a public library established in 1799) of the magnificent abbey of St Mary and St Rumon, founded in 961 by Orgar, earl of Devon. After destruction by the Danes in 997 it was restored, and among its famous abbots were Lyfing, friend of Canute, and Aldred, who crowned Harold II. and William, and died archbishop of York. The abbey church was rebuilt in 1285, and the greater part of the abbey in 1457–58. The church of St Eustachius dates from 1318, and possesses a lofty tower supported on four open arches. Within are monuments to the Glanville and Bourchier families, besides some good stained glass, one window being the work of William Morris. Kelly College, near the town, was founded by Admiral Benedictus Marwood Kelly, and opened in 1877 for the education of his descendants and the orphan sons of naval officers. Mines of copper, manganese, lead, silver and tin are in the neighbourhood, and the town possesses a considerable trade in cattle and corn, and industries in brewing and iron-founding. The mining industry generally has declined, but there is a trade in arsenic, extracted from the copper ore.

The early history of Tavistock (*Tavistoke*) centres round the abbey of St Rumon. Both town and abbey were sacked by the Danes in 997, but were shortly afterwards rebuilt, and the latter at the time of the Conquest ranked as the wealthiest house in Devon, including the hundred and manor of Tavistock among its possessions. Tavistock was governed from before the Conquest by a portreeve, who in the 14th century was assisted by a select council of burgesses, styled in 1660 "the Masters of the Toune and Parish of Tavistock." It returned two members to parliament as a borough from 1295 until deprived of one member by the act of 1867, and finally disfranchised by that of 1885, but no charter of corporation was granted until 1683, when Charles II. instituted a governing body of a mayor, twelve aldermen and twelve assistants; with a recorder, deputy recorder, common clerk and two sergeants-at-mace. A market on Friday and a three days' fair at the feast of St Rumon were granted by Henry I. to the monks of Tavistock; and in 1552 two fairs on April 23 and November 28 were granted by Edward VI. to the earl of Bedford, then lord of the manor. In the 17th century great quantities of cloth were sold at the Friday market, and four fairs were held at the feasts of St Michael, the Epiphany, St Mark, and the Decollation of St John the Baptist. The charter of Charles II. instituted a Tuesday market and fairs on the Thursday after Whitsunday and at the feast of St Swithin. In 1822 the old fairs were abolished in favour of six fairs on the second Wednesdays in May, July, September, October, November and December. The Friday market is still held. Tavistock was one of the four stannary towns appointed by charter of Edward I., at which tin was stamped and weighed, and monthly courts were held for the regulation of mining affairs. It was also the site of one of the earliest printing-presses, and copies of the stannary laws and of a translation of Boethius issued from the Tavistock press in the reign of Henry VIII. are preserved in Exeter College library. The decay of the woollen industry at Tavistock was attributed by the inhabitants in 1641 to the dread of the Turks at sea and of popish plots at home. The trade is now extinct. The copper-mining industry has much declined. The Royalist troops were quartered here in 1643 after the defeat of the Parliamentary forces at Bradock Down.

See *Victoria County History, Devonshire*; A. J. Kempe, *Notices of Tavistock and its Abbey* (London, 1830); R. N. Worth, *Calendar of Tavistock Parish Records* (Plymouth, 1887).

TAVOY, a town and district in the Tenasserim division of Lower Burma. The town is on the left bank of the river of the same name, 30 m. from the sea. Pop. (1901) 22,371. It carries on a considerable coasting trade with other ports of Burma, and with the Straits Settlements. The chief industry is silk-weaving, but there are also rice and timber mills.

The district has an area of 5308 sq. m. It lies between Siam and the Bay of Bengal, enclosed by mountains on three sides, viz., the main chain of the Bilauktaung on the east, rising in places to 5000 feet, which, with its densely wooded spurs, forms an almost impassable barrier between British and Siamese territory; the Nwahlabo in the centre, which takes its name from its loftiest peak (5000 ft.); and a third range, under the name of Thinmaw, between the Nwahlabo and the sea-coast. The chief rivers are the Tenasserim and Tavoy, the former being formed by the junction of two streams which unite near Met-ta; for the greater part of its course it is dangerous to navigation. The Tavoy is navigable for vessels of any burden. It is interspersed with many islands, and with its numerous smaller tributaries affords easy and rapid communication. The climate is on the whole pleasant. The annual rainfall averages 228 inches. Pop. (1901) 109,979, showing an increase of 16 per cent. in the decade. The staple crop is rice. Forests cover an area of nearly 5000 sq. m., of which 960 sq. m. are "reserved."

Tavoy, with the rest of Tenasserim, was handed over to the British at the end of the first Burmese war in 1824. A revolt broke out in 1829, headed by the former governor, which was at once quelled, and since then the district has remained undisturbed.

TAWDRY, an adjective used to characterize cheap finery, and especially things which imitate in a cheap way that which is rich or costly, or adornments of which the freshness and elegance have worn off. The word is first used in combination in the phrase "tawdry lace," a shortened form or corruption of St Audrey's or St Awdrey's lace. St Audrey was St Etheldreda, who founded Ely cathedral, and it is generally accepted that tawdry-laces or tawdries were necklaces bought at St Audrey's Fair on the 17th of October. Nares (*Glossary to the Works of English Authors*, 1859) gives as an alternative the story that the saint died of a swelling in the throat, which she took as a judgment for having worn fine necklaces in her youth.

TAXATION (from "tax," derived, through the French, from Lat. *taxare*, to appraise, which again is connected with the same root as *tangere*, to touch), that part of the revenue of a state which is obtained by compulsory dues and charges upon its subjects. The state may have revenue from property of its own. In past times one of the principal sources of the revenue of the sovereign was in fact property of some sort, of which the crown lands in Great Britain, still administered by the government, are a remnant. In other countries, even at the present time, there is a large public domain yielding revenue. Local authorities also largely own property from which a revenue is obtained. But as a rule, and in spite of what has often been the practice in the past, and of exceptions which may still exist in some countries, a government obtains the money required for its expenses by means of taxation. Some of the apparent exceptions, moreover, appear to be only exceptions in name. It is contended, for instance, that the revenue from land obtained by the government of India is in reality of the nature of a land rent—a species of property owned by the government. But the fact of a government levying so general a charge may be held *ipso facto* to convert the charge into a tax, having much the same economic effects and consequences as a tax. When, moreover, a state receives a revenue from property, some of the economic consequences may be the same as if it received the money by means of a tax. In both cases there is absorption and administration by the state of so much of the income of the community, and it may be a question whether the private ownership of the property would not be more expedient both for the state and its subjects than state ownership is, in spite of the apparent advantage to all concerned in the state getting so much of its income without the compulsion of a tax.

The Different Kinds of Taxes.—In the economic development of states taxes have come to be grouped in different ways, according to variations in the method of levying them or the means of enforcing compulsion or other differences. One of the most usual divisions is into *direct* and *indirect* taxes. Taxes are distinguished as direct, because they are charged directly upon the tax-payer from whose income they are supposed to be taken. Indirect taxes are those where it is recognized from the beginning that the individual who pays in the first instance usually passes on the charge to some one else, who may again pass it on until it finally reaches the subject who bears the burden. The income tax, a direct charge upon all incomes above a certain limit, is the principal type in the United Kingdom of a direct tax. In France there is a group of taxes known by that name—a land tax, a personal and furniture tax, a door and window tax, and a trade licence tax. In the United States there are mainly assessments of the capital value of property, always for state and local purposes only, and not for the central government. Among the indirect taxes the most important are excise and customs duties upon articles of general consumption, the principal articles almost everywhere being spirits, beer and tobacco. Sugar, tea, coffee and cocoa are also among the articles commonly selected. In essential character there is no difference between excise and customs duties, except that excise duties are levied upon articles of home production, and customs upon articles imported from abroad, or brought into one part of a country or empire from another part; but excise duties on the whole are considered more likely to interfere with trade, in consequence of the necessity of supervising the production of the articles affected. Next in importance to excise and customs we have duties levied by means of *stamps* upon documents or by charges at the time of registering deeds to which registration is necessary for the purpose of being valid. The charge in one case upon the article at a certain stage of its production, and in the other upon a transaction, is supposed to be passed on by the first payer to others. With these have been usually classed in the United Kingdom certain licence taxes upon traders, although such licences in France are reckoned direct taxes.

This division into direct and indirect is, however, far from logical. To take first the direct taxes. The income tax itself is not, in all cases, really paid to the state directly by the person out of whose income it comes. It is paid, in the first instance, in the case of land or houses, by the occupier, and where the occupier is a tenant it is recovered by him from the owner. In the case of joint-stock companies the company pays the state, and deducts the amount from the individual owners of stocks and shares out of whose incomes the amount comes. The ultimate payer in these cases is no doubt reached without delay or many steps, but the process is not quite direct. It is the same with rates. A householder is assessed as occupier, but he may be "compounded for," and really know nothing of the payment, though it is supposed to come out of his income. In the case, again, of a long-established land tax or rate many questions may arise as to whether the person who is considered to bear the burden in the first instance really bears it in the end. It is contended by some that the tax becomes in the nature of a rent-charge upon the property affected, and that the state really acts as landowner in levying the charge just as it does in receiving the rent of crown lands, and with similar economic incidents and consequences. Thus the direct taxes so called may frequently be no more direct than any others.

As regards indirect taxes, again, there appear to be some cases at least where it is by no means certain that the charge is passed on; stamp duties, for instance, especially where moderate in amount, may have the effect of diminishing *pro tanto* the profits in business of the person paying them, or the income which he enjoys. Where they are heavy, as, for instance, with the French registration duties on the transfer of property, there appears to be little doubt that they constitute a deduction from the price which a seller receives, and thus they are direct enough. Sometimes also, when a charge upon a commodity is not of such a figure as to be easily divisible among the ordinary units of retail consumption, so that it can be passed on to a consumer of the articles in the form of an increased price, it may remain fixed upon those who first pay it, at least for a time. This is supposed to have actually happened with the increase of the beer duty in the British budget of 1894 by 6d. per *barrel*—a sum which would not when divided by the pints in a barrel amount to the smallest coin of the realm. When the multure tax, a tax upon milling grain, was imposed in Italy many years ago, it was found that no corresponding increase took place in the price of flour and bread. The trade fell into the hands of the millers on a large scale, who paid the tax out of their increased profits from larger business, while the smaller millers were crushed out; so that this was manifestly the case of a tax, so called indirect, where the whole burden really fell on those who paid the charge in the first instance, and who in theory were supposed to pass it on to others. Even in the case of indirect taxes, therefore, there are important exceptions to the rule that they are indirect.

The division of taxes into direct and indirect is thus based on no real intrinsic difference. It is a classification for convenience' sake, adopted upon a rough observation of conspicuous, or apparently conspicuous, differences in the mode of levying taxes, and nothing more. The division, nevertheless, cannot be passed over without mention, as it is not only a common one in economic writing, but it figures largely in budget statements, financial accounts, and finance ministers' speeches—especially in the United Kingdom and France. In the United Kingdom the distinction has been made familiar by free-trade discussions. Direct taxation in the shape of income tax was substituted for indirect taxation previously levied, in order to relieve trade from the shackles of duties and charges which had become all-embracing. In France the direct taxes above referred to are described officially as direct, having been originally, there is little doubt, the main sources of government income; and there is equally an official designation of certain heads of revenue as "*contributions et taxes indirectes*." Recently in budget debates in England there has been much comparison of the amounts yielded at different times by direct and indirect taxes respectively.

Other general classifications of taxes have also been attempted, as, for instance, taxes upon real property, and taxes upon personal property, and so on. Classification is indeed only too easy. Applying a characteristic common to some taxes, we can make a group of them, and set them against a group of all the other taxes lumped together. Such classifications are, however, uninstructive, and it has been found practically necessary in financial writing to take the principal taxes by name, or by such a general grouping as that of import or stamp duties, and then describe their nature, characteristics and incidence. In this way each country has a grouping of its own, though there is a common likeness, and the experience and practice of one country assist the financial study of another. As Adam Smith remarks, there is nothing in which governments have been so ready to learn of one another as in the matter of new taxes.

Descriptions of Taxes.—Following the practice of authors on finance, we may give a short account of the principal taxes in the United Kingdom, with references in passing to points of comparison or contrast with the taxes of other countries. See, however, also the article on ENGLISH FINANCE.

The income tax (*q.v.*) for many years has been the most prominent, and latterly it has been the most productive, single tax. Its technical name is the property and income tax, but it is essentially a charge upon all incomes or profits, whether arising from property, or from the remuneration of personal services, or from annuities, income being applied with the widest possible meaning. As originally instituted in April 1798, during the great war with France, under the name of a "triplicate assessment," it was rather a consolidation of various assessed taxes levied upon the luxuries of the rich and upon property, than a wholly new tax. In December of the same year this impost was repealed, and a true income tax of 10 per cent. established on all incomes over £60, with abatements between £60 and £200. It was intended as a temporary tax for war purposes only, and was repealed in 1802, but was re-imposed when the war recommenced in 1803, with the limit of abatement reduced to £150. So odious was it that parliament in 1815, when the war came to an end, ordered the destruction of the documents relating to it. Its efficiency as an instrument of producing revenue was, however, so great as to lead to its revival in 1842, when Sir Robert Peel inaugurated his great free-trade reform and swept away duties on exports, duties on imported raw material, and other imposts hampering the trade of the country. The intention again was that the tax should be temporary, but although the free-trade work was practically completed in the early 'sixties, and Mr Gladstone went so far as to dissolve parliament in 1874 with a promise that he would abolish the tax if his party were returned to power, it has become a permanent impost. The reasons are that with the tax at a low rate it has been found much less intolerable than during the Napoleonic War, when it was at the rate of 10 per cent., while the pressure of the tax has also been greatly mitigated by placing very high the minimum income subject to it, and giving abatements upon the lower taxable incomes. These expedients have since been carried much farther. The tax, if kept at a low rate, undoubtedly fulfils a useful function as a revenue reserve for emergencies, on account of the ease with which it can be put up and down without disturbing trade. But in recent years, by rising to the rate of 1s. 2d. per £, it has been felt more heavily, and at this height is decidedly less elastic. As regards this tax at least there is no question of its "directness" in a sense, as it is so contrived that it can hardly be passed on by those who are struck at, though they are not always the same as those who pay in the first instance, as has already been pointed out. There have been great complaints also of injustice by the possessors of temporary and precarious incomes, who have to pay the same rate of tax as the owners of permanent incomes from property, although these complaints have been diminished to some small extent by the raising of the minimum limit of the income assessed and the increase of the principle of abatements.

The varieties of income charged being very great, and special claims for consideration having been set up at different times, the result has been the formation of an income tax code, defining the methods and rules for assessing the different classes of profits and income, and prescribing the way in which abatements and exemptions are to be obtained. A leading peculiarity is the avoidance of special inquisition into the aggregate of individual incomes. Although it is called a direct tax, the method of levy, as far as property is concerned, is upon the profits at their source, and not as they are distributed among the receivers. The question of the amount of individual incomes only comes before the authorities when claims for exemption and abatement are made. The character of the tax is accordingly much less odious than it would be if an account of individual incomes were invariably demanded, as was the case in the United States during the Civil War, when an income tax existed for a short time.

Other taxes grouped with the income tax by the authorities are house duty and land tax, but they are unimportant by comparison. The house duty replaced a window tax and other charges which were formerly not unimportant, especially in the interval between 1815 and 1843, when there was no income tax. It is a charge upon the occupiers of houses, mainly dwelling-houses, according to the amount of rent, the rate upon dwelling-houses ranging from 3d. to 9d. in the £, and the yield being about £1,750,000 per annum. The incidence is probably much the same as that of the income tax itself, though there are curious questions as to the ultimate incidence as between owners and occupiers of houses. The land tax is quite unimportant, being an ancient tax upon an old assessment which has long become obsolete, and it interests economists most of all by the illustration it furnishes of what may be called a rent-charge tax—a tax, that is, which has been so long in existence and so fixed in its basis that it becomes in reality a charge upon the property, and not a direct burden upon the person who pays it, as the income tax is upon the person who pays it or for whom it is paid. In 1897 the basis of the tax was varied, but not in any way to affect the principle just stated.

The next great group of taxes is that of the excise (*q.v.*) and customs duties upon commodities. Excise duties are charges upon commodities produced at home on their way to the consumer, and customs duties in the United Kingdom are charges upon commodities brought into the country from abroad; and they are of essentially the same nature. Not only so, but excise duties and customs duties are in some cases supplementary to each other, like articles being produced at home and imported from abroad, so that for the sake of the revenue they have both to be taxed alike. Of this in the British system spirits are the best instance.

Export duties, it may be observed, are not important in systems of taxation generally, as there are few articles where the charge will not really fall on the wages of labour and profits of capital within the country imposing them; but opium grown in India is a well-known exception, and in the West Indies export duties on principal articles of production, in spite of their incidence, have been found a convenient source of revenue.

The list of commodities selected for taxation in the English fiscal system, under Free Trade, is very small. Few countries have so short a list of import duties, but this is in consequence of their design to give protection, which raises totally different questions from those of revenue.

The next large group of taxes is that of the stamp duties (*q.v.*). The principal items are those derived from a stamp of 1d. upon each cheque or receipt for money paid, and from a variety of charges on deeds and other instruments, and principally on the price paid for the transfer of real property and of stocks and shares, and on mortgages. Included are various charges on foreign bonds to bearer, to compensate for the advantage they have in escaping the transfer duty on deeds, through their passing on sale or mortgage from hand to hand. The essence of the compulsion in the case of stamp duties is the invalidity of the documents in courts of law unless the stamp is affixed, besides liability to penalties for not affixing the proper stamps. As things go in matters of taxation, English stamp duties are low. In France, besides the stamp duties, there are charges on the transfer of real property amounting to about 6 per cent. on the official registration of the transfer which is necessary to make it effective.

We come next, in dealing with taxation, to a group of charges about which the question has been raised as to whether they are, properly speaking, taxes or not. These are the post office charges, and the charges for telegraph service, including telephones. In the classification of the revenue in English budgets and in official returns these charges are deliberately separated from the above sources of the revenue described as taxes, and classed with "revenue derived from other sources." The correctness of this procedure is questionable. According to old usage, the post office was made a state monopoly for the express purpose of levying taxation by means of it. In France the postage on letters is still called the *taxe des lettres*. There is no doubt also, that when postage on letters is charged at the rate of 1d. each, where the cost of collection and delivery, as in the metropolis, is perhaps not more than a tenth of a penny, it is difficult to distinguish the levy from that of any other tax. The excuse, as a rule, may hold good, that the postal charge is only a reasonable one for service rendered, so that the net income of the post office really resembles the profit of a business, but the element of taxation appears undoubtedly to enter. The same remark would apply to the charges for passenger conveyance and goods freight made by governments which carry on railway business, as in Prussia, India and the Australian states. In strict theory, where the *government* makes a charge, it levies a tax. The reasonableness of the charge in a given case is to its credit, but the features of monopoly and compulsion on the tax-payer make the charges difficult to distinguish logically from other taxes. The facts are not in dispute, however they may be described. If the government derived a large income from post office and telegraph service in excess of the amount expended, the whole income would be generally, and not improperly, described as taxation; but consideration, of course, must be given to the difference made by the working of the service generally for the public advantage rather than for purposes of revenue.

Another source of revenue in British imperial finance is that from fees in courts of justice, patent stamps and the like, which is usually classified, like the income of the post office, as revenue derived from other sources than taxes. The amount is not large, though unfortunately it is not exactly known, owing to the fees being treated in many cases as extra receipts, and deducted from the expenditure of the departments by which they are received, so that this part of the national expenditure is not shown in the accounts at all. The proceeding appears to be quite incorrect, whatever excuse there may be for treating revenue like that of the post office as non-tax revenue. Fees levied on proceedings in courts of justice are not only taxes, but taxes of the worst sort. They received the special condemnation of Jeremy Bentham. It is a blot on British finance, therefore, that this part of the taxation is treated as if it were not taxation at all, and largely concealed from view in the way described.

Last of all, we have to notice among the imperial taxes the estate (*q.v.*) or death duties, as they are called—the charges made by government on the transfer of property from the dead to the living. These have been considerably increased in amount. Various interesting questions arise regarding them. Logically they are apparently taxes upon the dead, as they limit the area of bequest, but they are felt by the living who receive the estate as if the burden of taxation fell on them. Practically, when a stranger receives the estate of a deceased man, the proper way of viewing the tax would appear to be that it is a share of property claimed by the state against a stranger who has no right in the matter except that which the state gives him, so that it is hardly a tax at all, as the word is usually understood; but when the estate is received by the near relatives of the deceased who were subsisting upon it even before his death, it is undoubtedly felt as a tax by them, and operates as a tax. It is even at times a very burdensome tax, falling upon a family when its sources of income are otherwise diminished, while it has the demerit of striking a small number annually instead of being diffused equally. Death duties also raise the question as to their being taxes upon capital. They are of large amount, even at the lowest rates of 1 to 4 per cent. upon the capital charged, and they have to be paid at such times as to cause their being paid out of capital and not out of income, so that their tendency is to diminish the capital available for productive enterprises.

Local Taxation.—Besides the above revenue from taxation for imperial purposes, large amounts are raised for local purposes. The local authorities derive a large income from private property, and from monopolies such as water, gas, electric light, telephones and tramway service, which they carry on, and on which the same observations may be made as on the post office and telegraph services; but in addition there is a large amount of taxation. The principal portion of this taxation consists of rates, that is, a direct charge upon the income or rental of real property, such as lands, houses, railways and mines, but mainly lands and houses. Rates are even a more important factor in direct taxation than the income tax, and they have given rise to even greater complaints and discussion. In 1896 a special royal commission was appointed, under the chairmanship of Lord Balfour of Burleigh, to consider the problems of the rates; it made several elaborate reports, the final one appearing in 1901. The most important questions raised in a scientific view appear to be the misconception of the whole problem of local taxation by governments. Rates were originally imposed, there is little question, when the intention was to tax all local incomes equally, and this is still the intention in the local taxation of the United States as well as the United Kingdom. Rates were imposed, therefore, on all kinds of property and the income arising from them, just as they are imposed in the United States on the capital of the property itself. But it has been found in practice that for various reasons only real property, which is visibly local and cannot be moved away, can be assessed and made to pay. The owners of real property, however, continually urge that they are unfairly treated, and that other property should be rated. Next there has been misconception, arising from the same cause, in the constant attempt to charge the occupier of lands and houses with rates, although the real effect of the rates must be, as a rule, to diminish the value of the property affected like an old-established land tax, so that rates, properly speaking, do not fall upon either owner or occupier. It would be hard, however, to persuade the mass of occupiers in England that they do not pay the rates, so that the expedient of dividing the rates between owner and occupier, though it cannot affect their real incidence to a substantial extent, constantly finds favour. The confusion has been further increased of late years by attempts, as far as towns are concerned, to find a new subject of taxation in what are called *site values*, as if rates themselves were not in reality an appropriation by the state of a portion of the whole value of the property, subject to which all the other interests exist. It would be impossible here even to state all the questions that have arisen about rates; but the essential confusion caused by the neglect of practical men to study the natural history of taxation, as it may be called, must be obvious to every student. The frank recognition that local income taxes are impossible, and that taxation on property for local purposes can only be applied to real property, where it becomes, usually or frequently, in the nature of a rent-charge, would have saved the legislature and the public an infinity of laborious discussion.

Other taxes for local purposes comprise dues and tolls, such as harbour dues, where the money is required for such a definite purpose as a harbour, maintained at the expense of the traffic accommodated. Here again the question arises as to whether the tax is a mere compulsory charge or payment for a service rendered. Among these tolls may perhaps be included some charges in the nature of *octroi* dues, imposed on commodities entering a town, but not to a great extent. Such dues, in the nature of customs, are very common in continental cities, and yield large revenue to the local authorities, although they have been very generally, if not quite universally, abolished in the United Kingdom. They have been regarded with much dislike by most economists, and some dues of the kind which existed in London, viz., dues on coal and wine imported, and metage dues on grain, were much imposed until their final abolition in recent years. When of moderate account, however, dues of this sort appear no more objectionable than harbour dues already mentioned, or any other moderate charges on transactions. If of large amount and very numerous, they hamper trade, as all taxation tends to do, but that is no reason for condemning them specially when the choice lies between them and other forms of taxation.

In addition, we have to notice certain taxes which up to 1910–11 were levied by the British government and distributed to the local authorities, just as in France the government levies certain direct taxes, or *centimes additionnelles*, added to its own direct taxes for the benefit of the local authorities. These taxes were additional beer and spirit dues (customs and excise), excise licences, and share of probate and estate duty. The remarks already made on the corresponding taxes levied for imperial purposes of course apply to these. Exceptionally, it may be added, as regards the licence taxes, which occupy quite an inferior place in the British system of taxation for imperial purposes, that the question whether some of them are not really direct in their incidence on the first person charged may also be raised, although they are classed with indirect taxes. Many of the licences are those of brewers, distillers and publicans, and others in trade, and are paid out of the general profits of the business, so that they can hardly be passed on to the consumers, while other licences are for shooting, for employing carriages and men-servants, and for similar objects, where the charge on the payer is direct. This may be the place to mention that in other countries, as in France, the licence duties on traders are more general than in the United Kingdom, and are levied on an elaborate scale, according to the size of population of the town where the business is carried on, and the rent paid for the premises. They take the place, to some extent, of the income tax, and are usually classed with the direct taxes.

The peculiarity of taxes which are levied by the imperial authority and distributed among the local authorities for disbursement deserves notice. There must be a general cause for such an arrangement when we find it to have been in existence in France and other countries, and to have been introduced into the United Kingdom. And this cause no doubt is the need of the local authorities, and the difficulty of letting them have taxes of their own to levy which do not interfere with the imperial monopoly. The arrangement is obviously objectionable on the score of its conducing to local extravagance, as local authorities are not likely to be so economical with money that comes to them from the outside, as it were, as they would be with money directly taken from their own pockets. Local authorities receive other subventions and aids from the central government besides the proceeds of these taxes, so that their appropriation for local needs is related to a large question which belongs, however, to the general subject of local government, and not so much to the special subject of taxation.

Incidence of Taxation.—In describing the principal taxes which are employed in the United Kingdom to provide for the national expenditure, observations have necessarily been made upon the incidence, probable or assumed, upon the taxpayer, and on the question how far they may fall equally on the whole community without any special incidence being traceable. The incidence of taxation is, however, a special subject for discussion, and is connected with various large issues, such as that of Free Trade, which are of deep interest to economic students.

The starting-point of discussions as to incidence of taxation is a classical passage in Adam Smith's *Wealth of Nations* (book v. chap. ii.), where he lays down the following maxims with regard to taxes in general: 1. The subjects of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state. 2. The tax which each individual is bound to pay ought to be certain and not arbitrary. 3. Every tax ought to be levied at the time or in the manner in which it is most likely to be convenient for the contributor to pay it. [Adam Smith specially praises indirect taxes on commodities under this head, because the consumer "pays them by little and little as he buys the goods," and "it must be his own fault if he ever suffers any considerable inconveniency from such taxes."] 4. Every tax ought to be so contrived as both to take out and keep out of the pockets of the people as little as possible over and above what it brings into the public treasury of the state. [This last passage is specially directed against taxes which are expensive to collect, or discourage trade, or offer temptation to smuggling, or subject people to frequent visits of the tax-gatherer.] These maxims have commanded universal assent, as they are obviously the common sense of the subject.

It may be observed, however, that while general maxims are easy, the application presents difficulties, and since Adam Smith wrote, and especially in modern times, new questions of some interest have been raised. Adam Smith does not go minutely into the incidence of taxation. Taxes in his view must come out of rent, or profit, or the wages of labour; and he observes that every tax which falls finally upon one only of the three sorts of revenue "is necessarily unequal in so far as it does not affect the other two," and in examining different taxes he disregards as a rule this sort of inequality, and confines his observations "to that inequality which is occasioned by a particular tax falling unequally upon that particular sort of private revenue which is affected by it." Recent discussion, however, has gone rather to the point which Adam Smith neglected, that of inequality generally, not merely as between different sorts of income, but as between individuals and classes. The whole burden of taxation, it is maintained, should fall equally upon classes and individuals as far as possible, and, if necessary, taxes falling equally upon special sources of private revenue should be balanced against each other in order to obtain the desired result. Along with this view has arisen the question whether the burden of taxation should not be *progressive*—the proportion of the sum taken by the state from the tax-payers increasing with the wealth of the individual; because ability to pay taxes is assumed to be not in proportion to, but to increase with the size of, the income.

What opinion should be held regarding this modern view as to equality in taxation, which differs so widely from anything countenanced by Adam Smith, though his language is echoed in it? The answer must be that, however sound, the view is for the most part far too ambitious. One difficulty is caused by the large proportion of the taxes in almost every system of taxation, and at any rate in the British system, where the exact incidence is in no way traceable, or where there is no sort of general agreement as to the incidence. The whole of the British revenue from post office and telegraph service, and the whole of the stamp revenue, are derived from charges whose exact incidence cannot be traced. We have seen, indeed, that doubt is even felt as to whether post office and telegraph charges can be treated as taxes at all. Again, the death duties are in a distinct category, these duties falling each year not on a particular class of the community, or a particular kind of property, but on a few individuals only, who are in some cases treated severely, while others may have no cause of complaint. In the course of fifty years, it may be said, the balance will be rectified, and the whole class to which the individuals belong, and the property they own, will be visited in turn, so that this taxation should be credited to them in an account of the incidence of taxes generally; but fifty years is altogether too long a period for such adjustments to be made. Thus a very large proportion of the total revenue cannot be made available for an account showing the incidence of taxation. There remain principally the income tax and one or two minor "direct" taxes, and the customs and excise duties. These, it is said, can be distributed among different classes of tax-payers, because the income tax falls on the owners of incomes of all kinds of property subject to the duty, if their incomes are above a certain limit, while the incidence of customs and excise duties can be ascertained by inquiries as to the consumption of dutiable articles by different classes. Even here, however, formidable difficulties are presented. The payers of income tax, unfortunately, are not one class but many, and although the rate of duty is the same, the definition of income seems imperfect, so that many pay on a much larger assessment of income than seems fair in comparison with other incomes of nominally the same amount, but really of much greater value when all deductions from the gross sum are fairly reckoned. If all who pay income tax are lumped together and contrasted with those who do not pay, then there is a false division to begin with, and there is so far no means of establishing equality or inequality. As regards indirect taxes, again, there appears no small difficulty in ascertaining the relative consumption of different classes, for the simple reason that in the same class so called the habits of consumption differ widely. It is only by a wide extension of the term "working man," for instance, that a class which includes a steady mechanic earning 30s. to £2 a week, who is frequently a total abstainer, and a labourer of inferior capacity and character earning 15s. to 20s. a week, and who is *not* a total abstainer, can be spoken of as one, and credit given to the *one* class for so much taxation on spirits, beer, tobacco, wine, tea and sugar. There are also geographical differences of a serious kind. On the other hand, the consumption by the income tax paying classes of customs and excise articles must vary indefinitely amongst themselves, according to personal habits, size of families, and even their geographical distribution. A further difficulty is furnished by a question as to whether the employer of domestic servants who gives them their board does or does not bear the burden of the duties on the articles which they consume, and which he buys for their use. Theoretically the burden falls on them as consumers. They would have more real wages, it is said, if the price of the articles they consume was not raised by taxation. But practically most employers are convinced that they pay the taxes for their servants. To establish, therefore, any fair account of the incidence of indirect taxes on different classes of the community, real classes being distinguished, and not a mere rough grouping into so-called classes of units who are altogether heterogeneous, is probably beyond the skill of man.

All this is evident on a view of imperial taxation alone. In studying equality, moreover, local taxation must be brought into view, with even more impracticable differences of opinion as to the real incidence of the taxation. The moment rates are brought into question it is seen at once how impossible it would be to establish equality among tax-payers, when owners on one side and occupiers on the other claim that they each bear the burden of the same taxes, and economists favour the opinion that much of the burden is in the nature of a rent-charge on the property, and in any case is equally diffused over the whole community.

Adam Smith was thus not altogether badly advised in not carrying his investigations into the equality of taxation farther than he did. There was another reason for his so doing in the heaviness of the burden of taxation at the time he wrote, governments exacting as much as they could, and being only desirous of finding the easiest means of doing so. It is the very lightness of taxation in recent years which has suggested the possibility of comparing the relative burdens of different classes, which would have seemed quite hopeless with a high taxation and an immense variety of high taxes. The conclusion that with good taxes long established the burden of taxation tends to become equal over the whole community was certainly not ill founded in the circumstances of former times, and may be accepted as true even in the present day.

As to progressive taxation based on the assumption that equality requires a larger proportionate charge upon a big income than on one of a smaller amount, the practical application of the principle, if true, would be impossible. A great deal more would need to be known than is now known as to the effect of taxes on different classes, and the aggregate amount of different incomes, before such a task could be undertaken. If there is a greater proportionate charge already on the larger incomes, nothing more need be done, and we cannot know that there is not. As to the justice of such a progressive tax, there is a common opinion in its favour among economists, at least to the extent of exempting a certain minimum of subsistence from taxation; but the present writer, after accepting this view in early life on the authority of Mill, must now express the greatest doubt. The ideal is equality, and no measure of a minimum of subsistence can really be devised.

Of course there may be single taxes which are progressive in form, such as the licence tax in France, or the income tax in Great Britain, where progression is established by abatements, or the death duties, where progression by scale is very common. But such progression may arise in a different way and on different principles from those proposed in defence of a general system of progressive taxation. It may be expedient for balancing taxation and roughly redressing palpable inequalities, and may be adopted for that purpose and no other.

Statistical inquiries as to the incidence of taxation or of particular taxes, though ideal or even approximate equality of a palpable arithmetical kind is practically unattainable by governments, are not altogether to be put aside. The information thus obtainable may be useful as far as it goes, indicating the directions in which the burden of taxation may press, and forming a guide of some utility when changes of taxation are contemplated. Calculations, for instance, as to what people at the lower levels of the income tax must pay because they happen to be struck by every sort of tax as no other class is, and calculations as to the freedom from taxation of large numbers of other classes whose habits of consumption and living enable them to escape the tax-gatherer as the class to which they belong cannot generally do, may help a finance minister in the selection of taxes to be repealed or reduced or to be newly imposed. With every effort after equality he must fail to satisfy all, but friction may be diminished and the work of carrying on government quietly and steadily facilitated.

Taxes and Free Trade.—Taxation ought not to interfere with trade if possible, and the object of Adam Smith's maxims, as we have seen, was largely to erect sign-posts warning finance ministers against the kind of taxes likely to harass traders. There has been much discussion, however, on free trade since Adam Smith's time, and the far-reaching nature of his warnings is not even yet generally understood. There will probably be general agreement as to the wisdom of avoiding taxes which are uncertain and arbitrary, or which involve frequent visits of the tax-gatherer; but so far from there being a general assent in all countries to his maxims as to the expediency of avoiding taxation, which takes more from the tax-payer than what comes into the hands of the government, this is the very characteristic of duties deliberately imposed by most governments for the purpose of interfering with trade, and frequently called for even in the United Kingdom with a similar object. In a question of taxation. however, for the purpose of meeting the expenses of the government, all such duties must be ruled out. Taxes, as instruments for advancing the prosperity of a country, are things unknown to the study of "taxation" in the proper sense of the word. The only proper object of taxation is to meet the expenses of the state, and when taxes are used primarily or mainly for some other object they can only be justified by political and economic reasons of a different order from anything that has been under discussion.

On this ground, in an account of taxation proper, one might avoid discussing altogether the question of irregular or illegitimate taxation. But the subject is of too much popular interest, perhaps, to be passed over altogether. Generally, then, it may be affirmed that taxation in its essential nature cannot be thought of as a good instrument for promoting trade and the advancement of a country. So far as it operates at all, it operates by diverting trade from the channels in which it would naturally flow into other channels, and this diversion of industry, so far as it goes, must involve loss. People are induced to do things they would otherwise leave alone, or to leave alone what they would otherwise do, because money is given to them out of the pockets of the tax-payers to make it worth their while to do so; but there is palpably loss and not profit in the proceeding. It is urged that in time industries are set up that would not otherwise have existed, and population thereby attracted, this being especially the argument for protective duties in new countries; but even so, there is loss to set against the final gain, if any, and we have not yet had an account in which a balance of loss and gain is attempted. The presumption is that on balance there is loss. In new countries especially the diversion of industry from its natural development cannot but be mischievous, wrong manufactures and industries being set up at the expense of the whole community, instead of those manufactures and industries which would be most profitable.

There is more to be said for the political argument which induced Adam Smith to favour navigation laws, giving a preference to national shipping in national waters, and for a similar political argument in favour of duties on agricultural produce imported into the country, on the ground, as regards navigation, that the prosperity of the shipping industry in particular was essential to the safety of the country, and on the ground, as regards duties on agricultural produce, that the maintenance of a larger rural population and of a larger agricultural production than would exist under natural conditions of perfect free trade was essential to the welfare of the state and even to its very existence in the possible event of a temporary defeat at sea and a partial blockade of the coasts. This is not the place to discuss such political problems, but there is no question of free trade theory involved if the cost to the community of any such taxation is frankly acknowledged.

Sir John A. Macdonald, the great protectionist prime minister of Canada, in a conversation with the present writer in 1882, avowed without hesitation that protectionist taxation in Canada was indefensible on economic grounds, and he defended it exclusively for political reasons. Politically one might differ from him, but economists as such must either be silent when political reasons are alleged for taxes that are against fundamental maxims, or must be content to point out the cost of the taxes in order that the communities concerned may decide whether the object in view is obtainable by means of the taxation, and is worth the price.

A great deal has been said as to taxes termed "countervailing duties," which are called for in order to defend free trade itself against the protectionist bounties of foreign governments. Such duties are obviously taxes outside the limits to be considered in a question of taxation proper. They are to be imposed for other purposes than revenue. As to the claim for them that they will restore free trade conditions by nullifying the foreign bounties which have caused a disturbance of trade, this is really in the nature of a political reason. A country which is so devoted to free trade that it not only practises free trade itself but endeavours to convert others by nullifying their protectionist measures as far as it can, even with immediate loss to itself, departs from the guidance of self-interest so far; but its political action may be justifiable in the long run by other considerations. It seems right to point out, however, that countervailing duties, which are really differential duties of a special kind, are not the good expedient they are supposed to be for nullifying foreign bounties; that experience of differential duties in former times is altogether against them; and that they cannot be enforced without certificates of origin and other causes of harassment and confusion in the conduct of trade.

The extent of the interference with trade, in regard to particular taxes, is also a matter of importance. A particular tax is not necessarily to be condemned because it takes a little more out of the pockets of the people than what the government receives. Such a defect is a ground for consideration in weighing a particular tax against others, but it is only one inconvenience among many incidental to all taxes.

Some English applications of free trade theory in recent times in the matter of import duties have been pedantic—the abolition of the shilling corn duty in 1869 by Robert Lowe (Lord Sherbrooke) being typical of this pedantry, though it is not the only instance. No doubt, in theory, this duty, being levied on the import only and not on the home production of corn, took from the tax-payer a shilling on every quarter of grain produced at home which did not go into the exchequer. *Per contra* the tax was wholly unfelt, a shilling a quarter only affecting an average family of four persons to the extent of three shillings per annum, or about three farthings a week, while it was paid little by little, as Adam Smith explains with regard to indirect taxes in general. The amount yielded, moreover, was considerable, being equal to a penny on the income tax, which it is desirable to maintain as a reserve of taxation. When we balance advantages and disadvantages, therefore, the repeal of the corn duty and similar measures would appear to have been sacrifices of revenue without adequate reason.

Rates of Taxation.—Apart from the merits or demerits of particular taxes or groups of taxes, and the questions as to inequality, injury to trade, and the like already discussed, the aggregate of taxation, or rather revenue, of a state may be considered in the most general way, having regard to the proportion appropriated by the state of the total income of the community, and the return made by the state therefor. Here there are the greatest variations. At one time, for instance, during the great wars at the beginning of the 19th century, it was calculated that the British government expenditure, and the corresponding revenue, mostly raised by taxation, were each equal to about one-third of the aggregate of individual incomes—that is, as £90,000,000 to about £270,000,000. Proportions even higher have not been unknown in history, and it is probable that in Russia, India, Egypt, and in other countries at this moment, in time of peace, the proportion may amount to one-fourth or one-fifth. On the other hand, some years ago in the United Kingdom, before the high expenditure on army and navy began, and before the South African war of 1899–1902, it is probable that with an outlay of less than £100,000,000 by the central government, the proportion of this outlay to the aggregate income of the people was not higher than *one-fourteenth.* At the beginning of 1902, when the South African war was closing, the normal peace expenditure, even reckoned at £160,000,000, did not exceed *one-tenth*, while even peace and war expenditure together in 1901, taking them as close on £200,000,000, did not exceed *one-eighth.* These varying proportions, however, mean different things economically, and it is of obvious interest that, besides questions as to particular taxes, the broad effect of the whole burden of taxation should also be discussed.

The important points in this connexion appear to be: (1) Very large appropriations can be made by the state from the revenue of its subjects without *permanent* injury. The community thereby suffers, but the land and fixed capital remain, and when the high government expenditure ceases individuals at once have the benefit, subject to possible disturbance at the moment of transition, when many persons employed by the state return to private employment. (2) A state which in ordinary times appropriates one-tenth or some less proportion of aggregate individual incomes is much stronger relatively than a state absorbing one-fourth, one-third, or even a higher proportion. It has much larger resources, which would be available if time were given to develop them. (3) When the proportion becomes one-tenth or less it is doubtful whether the state can do best for its subjects by making the proportion still lower, that is, by abandoning one tax after another, or whether equal or greater advantage would not be gained by using the revenue for wise purposes under the direction of the state, such as great works of sanitation, or water supply, or public defence. In other words, when taxes are very moderate and the revenue appropriated by the state is a small part only of the aggregate of individual incomes, it seems possible that individuals in a rich country may waste individually resources which the state could apply to very profitable purposes. The state, for instance, could perhaps more usefully engage in some great works, such as establishing reservoirs of water for the use of town populations on a systematic plan, or making a tunnel under one of the channels between Ireland and Great Britain, or a sea-canal across Scotland between the Clyde and the Forth, or purchasing land from Irish landlords and transferring it to tenants, than allow money to fructify or not fructify, as the case may be, in the pockets of individuals. Probably there are no works more beneficial to a community in the long run than those like a tunnel between Ireland and Great Britain, which open an entirely new means of communication of strategical as well as commercial value, but are not likely to pay the individual *entrepreneur* within a short period of time.

AUTHORITIES.—See also, for taxation and taxes in different countries, the separate articles on the finance under the heading of each country; and the articles on FREE TRADE, PROTECTION and TARIFFS. The following short list of authors may be useful to the student:—Adam Smith, *Wealth of Nations*; Ricardo-M'Culloch, *Principles of Taxation*; Mill, *Principles of Political Economy*; Bastable, *Public Finance*; E. R. A. Seligman, *Shifting and Incidence of Taxation* (2nd ed., 1899); Garnier, *Traité de Finances*; Cohn, *System der National-Ökonomie*; Wagner, *Finanzwissenschaft*; Roscher, *System der Finanzwissenschaft.* (R. GN.)

TAXIDERMY, the art of preserving the integument, together with the scales, feathers or fur, of animals. Little is known of the beginnings of the practice of the "stuffing" or "setting up" of animals for ornament or for scientific purposes; and it is highly probable, from what we gather from old works of travel or natural history, that the art is not more than some three hundred years old. It was practised in England towards the end of the 17th century, as is proved by the Sloane collection, which in 1725 formed the nucleus of the collection of natural history now lodged in the galleries at South Kensington.

It was not until the middle of last century that any treatise devoted to the principles of the then little understood art was published in France, R. A. F. Réaumur's treatise (1749) being probably the first. This was followed at intervals by others in France and Germany, until the beginning of the 19th century, when the English began to move in the matter, and several works were published, notably those by E. Donovan,[1] W. Swainson,[2] Capt. Thomas Brown[3] and others. These works, however, are long since inadequate; and at the Great Exhibition of 1851, the Germans and French taught British taxidermists the rudiments of scientific treatment of natural objects. The demands of sportsmen for the due preservation of their trophies, and the requirements of the great museums in every civilized country, have rapidly transformed a crude handicraft into an elaborate art, and the finest modern results, as produced by a private firm like Rowland Ward in England, or the expert staff of the American Museum of Natural History in New York, leave almost nothing to be desired. The rapidly recurring editions of Rowland Ward's handbook[4] supply a guide to the amateur specially useful as indicating what may be done in the field; John Rowley's little manual[5] supplies

[1] *Instructions for Collecting and Preserving Various Subjects of Natural History* (London, 1794).
[2] *The Naturalist's Guide for Collecting and Preserving Subjects of Natural History and Botany* (London, 1822).
[3] *Taxidermist's Manual* (Glasgow, 1833).
[4] *The Sportsman's Handbook to Practical Collecting, Preserving and Artistic Setting up of Trophies and Specimens* (London, many editions).
[5] *The Art of Taxidermy* (New York, 1898).

more detail as to what may be done in the workshop; Montague Browne's elaborate treatise[1] remains a standard work, whilst William T. Hornaday[2] has supplied a very full account of the excellent American methods which he has done so much to develop.

The first principle governing the art is that, after the specimen has been procured, in as fresh and clean a state as may be, it should have the skin stripped from the body in such a manner as not to disturb the scales if a fish or a reptile, the feathers if a bird, or the fur or hair if a mammal. To do this correctly requires a small stock of tools, as well as a great amount of patience and perseverance. The appliances comprise several sharp knives (some pointed and some obtuse), a pair of scissors, a pair of pliers, a pair of nippers or "cutting-pliers," some tow, wadding, needles and thread, also a "stuffing-iron," some crooked awls, a pair of fine long flat-nosed pliers, and a camel-hair brush. The preservative compound is often the original (Bécoeur's) "arsenical soap," made by cutting up and boiling 2 ℔ of white soap, to which 12 oz. of salt of tartar and 4 oz. of powdered lime (or whiting) are added when dissolved; to this mixture, when nearly cold, 2 ℔ of powdered arsenic and 5 oz. of camphor (the latter previously triturated in a mortar with spirits of wine) are added. The mixture is put away in small jars or pots for use. Like all arsenical preparations, this is exceedingly dangerous in the hands of unskilled persons, often causing shortness of breath, sores, brittleness of the nails and other symptoms; and, as arsenic is really no protection against the attacks of insects, an efficient substitute has been invented by Browne, composed of 1 ℔ of white curd soap and 3 ℔ of whiting boiled together, to which is added, whilst hot, 1½ oz. of chloride of lime, and, when cold, 1 oz. of tincture of musk. This mixture is perfectly safe to use when cold (although when hot the fumes should not be inhaled, owing to the chlorine given off), and is spoken of as doing its work efficiently. Solutions of corrosive sublimate, often recommended, are, even if efficient, dangerous in the extreme. Powders consisting of tannin, pepper, camphor, and burnt alum are sometimes used for "making skins," but they dry them too rapidly for the purposes of "mounting." Mammals are best preserved by a mixture of 1 ℔ of burnt alum to ¼ ℔ of saltpetre; this, when intimately mixed, should be well rubbed into the skin. Fishes and reptiles, when not cast and modelled, are best preserved in rectified spirits of wine; but this, when economy is desired, can be replaced by "Müller's solution" (bichromate of potash 2 oz., sulphate of soda 1 oz., distilled water 3 pints) or by a nearly saturated solution of chloride of zinc. The cleaning of feathers and furs is performed by rubbing them lightly with wadding soaked in benzoline, afterwards dusting on plaster of Paris, which is beaten out, when dry, with a bunch of feathers.

The preparation and mounting of bird specimens, the objects most usually selected by the amateur, are performed in the following manner. The specimen to be operated upon should have its nostrils and throat closed by plugs of cotton-wool or tow; both wing-bones should be broken close to the body, and the bird laid upon a table on its back; and, as birds—especially white-breasted ones—should seldom, if ever, be opened on the breast, an incision should be made in the skin under the wing on the side most damaged, from which the thigh protrudes when pushed up slightly; this is cut through at its junction with the body, when the knife is gently used to separate the skin from this, until the wing-bone is seen on the open side. This is then cut through by scissors, and by careful manipulation the skin is further freed from the back and breast until the neck can be cut off. The other side now remains to be dealt with; from this the wing is cut by travelling downwards, the remaining leg is cut away, and very careful skinning over the stomach and upon the lower back brings the operator to the tail, which is cut off, leaving a small portion of the bone (the coccyx) in the skin. The body now falls off, and nothing remains in the skin but the neck and head. To skin these out properly without unduly stretching the integument, is a task trying to the patience, but it can be accomplished by gradually working the skin away from the back of the head forward, taking care to avoid cutting the eyes or the eyelids, but by cautious management, to cut the membranous skin over those parts, so that the eyes are easily extracted from the orbits without bursting. The skin should be freed down nearly to the beak, and then the back of the head, with neck attached, should be cut off, the brains extracted, all the flesh cleared from the skull and from the bones of the wings, legs and tail, the skin painted with the preservative, and ultimately turned into its proper position. When "skins" only are to be made for the cabinet, it is sufficient to fill the head and neck with chopped tow, the body with a false one made of tow, tightly packed or loose according to the genius of the preparer, to sew up the skin of the stomach, and to place a band of paper lightly pinned around the body over the breast and wings, and allow it to remain in a warm position, free from dust, for several days or weeks, according to the size of the specimen. It should then be labelled with name, sex, locality and date, and put away with insect powder around it.

When, however, the specimen is to be "mounted," the operations should be carried up to the point of returning the skin, and then a false body of tightly wrapped tow is made upon a wire pointed at its upper end. This is inserted through the incision under the wing, the pointed end going up the neck and through the skull to the outside. When the imitation body rests within the skin, pointed wires are thrust through the soles of the feet, up the skin of the back of the legs, and are finally clenched in the body. Wires are also thrust into the butts of the wings, following the skin of the under surface, and also clenched through into the body. A stand or perch is provided, and the bird, being fixed upon this, is, after the eyes have been inserted, arranged in the most natural attitude which the skill of the taxidermist can give it.

Mammals are cut along the stomach from nearly the middle to the breast, and are skinned by working out the hind legs first, cutting them off under the skin at the junction of the femur with the tibia, and carefully stripping the skin off the lower back and front until the tail is reached, the flesh and bones of which are pulled out of the skin, leaving the operator free to follow on up the back and chest until the fore legs are reached, which are cut off in like manner. The neck and head are skinned out down to the inner edges of the lips and nose, great care being exercised not to cut the outer portions of the ears, the eyelids, the nose or the lips. The flesh being cleared off, and the brain and eyes extracted, the skull should adhere to the skin by the inner edges of the lips. All the flesh should be trimmed from the bones of the legs. The head, being shaped, where the flesh was removed, by tow and clay, is returned into the skin. A long wire of sufficient strength is tightly bound with tow, making a long, narrow body, through which wires are thrust by the skin of the soles of the feet. The leg wires and bones being wrapped with tow and clay into shape, the points of the wires are pushed through the tow body and clenched. They and the body are then bent into the desired position, and modelled up by the addition of more tow and clay, until the contours of the natural body are imitated, when the stomach is sewn up. A board is provided upon which to fix the specimen, artificial eyes are inserted, the lips, nose and eyelids fixed by means of pins or "needle-points," and the specimen is then placed in a warm situation to dry.

Reptiles, when small, have their skin removed by cutting away the attachment of the skull to the cervical vertebrae, and by turning the decapitated trunk out at the mouth by delicate manipulation. When large, they are cut along their median line, and treated in the same manner as mammals.

Fishes, after being covered on their best side with paper or muslin to protect the scales, are cut along the other side from the tail to the gills, and are skinned out by removing "cutlets," as large as is possible without cracking the skin, which, indeed, should be kept damp during work. After being cured with a preservative, they are filled with sawdust or dry plaster of Paris, sewn up, turned over on a board, the fins pinned out, and the mouth adjusted, and, when perfectly dry, the plaster may be shaken out.

The new school of taxidermists, with new methods, whose aim is to combine knowledge of anatomy and modelling with taxidermic technique, has now come to the front, all processes of "stuffing" have been discarded in favour of modelling. Within the limits of an article like the present it is impossible to do more than glance at the intricate processes involved in this. In the case of mammals, after the skin has been completely removed, even to the toes, a copy is made of the body, posed as in life, and from this an accurate representation of form, including delineation of muscles, &c., is built up in light materials, and known as the "manikin"; the model is then covered with skin, which is damped, and moulded to follow every depression and prominence, the manikin, before having the skin put on it, frequently being covered completely with a thin layer of clay; the study is then suffered to dry; and, models having been made, in the case of large animals, of the

[1] *Artistic and Scientific Taxidermy and Modelling* (London, 1896).
[2] *Taxidermy and Zoological Collecting* (London, seventh edition, 1901).

mucous membrane of the jaws, palate, tongue and lips, these are truthfully reproduced in a plastic material. The ordinary glass eyes are discarded, and hollow globes, specially made, are hand-painted from nature, and are fixed in the head so as to convey the exact expression which the pose of the body demands. Birds, if of any size, can be modelled in like manner, and fishes are treated by a nearly identical process, being finally coloured as in a "still life" painting.

To give a life-like representation, attention is also paid to artistic "mounting." By this is meant the surrounding of specimens with appropriate accessories, and it is well exemplified by the work shown in the natural history museum at South Kensington, where, for example, birds are arranged as in a state of nature.

The great American museums have extended a similar method to the mounting of even large mammals, whilst they have made bird groups naturally still more life-like by panoramic backgrounds and top and side lighting of the cases. (M. B.)

TAY, the longest river in Scotland. From its source in Ben Lui (3708 ft.), a mountain on the borders of Perthshire and Argyllshire, it pursues a mainly north-easterly direction to Logierait, where it curves to the south by east as far as Dunkeld; there its course turns to the south-east to the mouth of the Isla, where it bends towards the south by west to the vicinity of Scone. From this point it makes a sharp descent to the south by east beyond the county town, when it sweeps south-east to near Newburgh in Fifeshire, where it again faces the north-east as far as Broughty Ferry, whence it flows straight eastwards into the North Sea, off Buddon Ness in Forfarshire, after a total run of 117 miles. During the first 11 miles it is known as the Fillan and discharges into Loch Dochart. From the lake it emerges as the Dochart (13 m.), which enters Loch Tay at Killin. Flowing through the loch for 14½ m., it issues at Kenmore under its proper name of Tay. From hence to the sea its course measures 78½ m., from which we may deduct 25 m. as the length of the Firth of Tay (which begins at Cairniepier Ferry), leaving 53½ m. as the length of the stream between Kenmore and the mouth of the Earn. Its principal affluents on the right are the Bran, Almond and Earn, and on the left the Lyon, Tummel and Isla. Along with its tributaries, therefore, it drains all Perthshire and portions of Forfarshire and Argyllshire, having a catchment basin of 2400 sq. m. In many parts the current is impetuous, and in flood has occasionally wrought much havoc, certain of the inundations being historically important. Its mean discharge of water every minute is estimated to amount to 273,000 cubic ft., a larger outpour than that of any other stream in the United Kingdom. Vessels make Dundee at all stages of the tide, and the estuary is navigable to Newburgh by vessels of 500 tons, and as far as Perth by ships of 200 tons. The navigation, however, is seriously obstructed by shifting sandbanks. The estuary varies in width from ½ m. at Cairniepier Ferry to fully 3 m. at its mouth. The principal points on the river are Crianlarich on the Fillan (with stations on the West Highland and Callander to Oban railways), Luib and Killin on the Dochart, Kenmore, Aberfeldy, Dunkeld, Birnam, Stanley, Scone, Perth and, on the north shore of the firth, Errol, Dundee, Broughty Ferry and Monifieth, and, on the south shore, Newburgh, Newport and Tayport. It is bridged at Kenmore, Aberfeldy, Logierait, Dunkeld, Caputh and Perth (3). The first railway viaduct across the firth at Dundee was nearly two miles long and had been in use for some eighteen months from the date of its opening in 1877. During the night of the 28th of December 1879, however, while a great gale was at the height of its fury, the passing of a train over the central section gave purchase to the tempest and that portion of the structure was blown down along with the train and the unfortunate travellers. Some 75 to 90 persons are supposed to have perished. The second bridges of somewhat lower height, 2 m. and 73 yds. in length, was erected 60 ft. higher up stream and opened in 1887. The Tay is famous for salmon, the annual catch in the river and estuary being the most valuable in Scotland. There is a hatchery at Hormontfield, close to Luncarty station, 4 m. N. of Perth, for the artificial breeding of salmon, the fish being liberated from the ponds about the age of three years. In respect of riparian scenery the Tay as a whole is the most beautiful river in Scotland, the stretch between Logierait and Cargill, particularly the reaches above and below Dunkeld, being universally admired.

TAY, LOCH, the largest lake in Perthshire, Scotland. It is situated about the middle of the county and has a flattened ogee form, with a general trend from N.E. to S.W. It is 14½ m. long from Killin at the head to Kenmore at the foot, from ½ m. to fully 1 m. wide. The maximum depth is 508 ft., the mean depth 200 ft. The lake lies 355 ft. above the sea, covers an area of 6550 acres, or over 10 sq. m., and has a drainage basin of 232 sq. m., including the overflow from Lochs Dochart and Tubhair. It receives at Killin the rivers Lochay and Dochart and discharges by the Tay at Kenmore. Ben Lawers (3984 ft.) rises near the left bank. There are piers at Killin, Ardeonaig, Lawers, Fernan and Kenmore, at which the steamers call during the tourist season; ferries at Ardeonaig and Lawers; and a coaching road on the left shore and a somewhat longer and more hilly road on the right. At the foot of the lake is an island containing the ruins of the priory which was founded in 1121 by Alexander I. in memory of his wife Sibylla, daughter of Henry I. She was buried here. Loch Tay enjoys great repute for its salmon-fishing.

TAYABAS, a town of the province of Tayabas, Luzon, Philippine Islands, 8 m. N. of Lucena, the capital. Pop. of the municipality (1903) 14,740. Tayabas is picturesquely situated on the slopes of the extinct volcano Banájao, and commands a magnificent view of the surrounding country, which is extremely fertile, and is planted in rice and coco-nuts. Its climate, although cool, is very unhealthy, malignant malarial fevers causing a high death-rate. It has a church and convent of large size and massive construction. During the revolt of 1896 a Spanish garrison occupying these buildings withstood a siege of fifty-eight days, at the end of which time it was forced to surrender by lack of food. Tagalog and Bicol are the languages spoken. Until 1901 Tayabas was the capital of the province.

TAYGETUS (*Ταΰγετος* or *Ταΰγετον*, mod. St Elias or Pentedaktylon), the highest mountain ridge in the Peloponnese, separating Laconia from Messenia. Height 7900 ft. The highest point is H. Elias; here horses are said to have been sacrificed to Helios.

TAYLOR, ANN (1782–1866), afterwards Mrs. Gilbert, and **TAYLOR, JANE** (1783–1824), English writers for children, daughters of Isaac Taylor (1759–1829), were born in London on the 30th of January 1782 and the 23rd of September 1783 respectively. In 1786 the Taylors went to live at Lavenham in Suffolk, and ten years later removed to Colchester. Jane was a lively and entertaining child, and composed plays and poems at a very early age. Their father and mother held advanced views on education, and under their guidance the girls were instructed not only in their father's art of engraving, but in the principles of fortification. Their poems were written in short intervals in the round of each day's occupations. Ann introduced herself to the publishers Darton and Harvey by a rhymed answer to a puzzle in the *Minor's Pocket Book* for 1799, and Jane made her first appearance in print in the same periodical with "The Beggar Boy." The publishers then wrote to Isaac Taylor asking for more verses for children from his family, and the result was *Original Poems for Infant Minds* (2 vols., 1804–5), by "several young persons," of whom Ann and Jane were the largest contributors. The book had an immediate and lasting success. It went through numerous editions, and was translated into German, Dutch and Russian. Ann and Jane Taylor wrote directly for children, and viewed events and morals from the nursery standpoint. They had many imitators, but few serious rivals in their own kind, except perhaps Mrs Elizabeth Turner. They followed up this success with *Rhymes for the Nursery* (1806), *Hymns for Infant Minds* (1808, 2nd ed. 1810), a less-known collection, *Signor Topsy*

Turvy's Wonderful Magic Lantern; or, The World Turned Upside Down (1810), and *Original Hymns for Sunday School* (1812). In 1813 Ann married a Congregational minister, the Rev. Josiah Gilbert, and Jane went to live at Ilfracombe with her brother Isaac. In 1816 Jane returned to Ongar, where the family had been settled for some years, and died there on the 13th of April 1824. Mrs Gilbert died at Nottingham on the 20th of December 1866. Both sisters wrote after their separation, but none of their later works had the same vogue. Jane showed more wit and vivacity than her sister, notably in the *Contributions of Q. Q.* (2 vols., 1824), and in *Display, a Tale for Young People* (1815); but, though she was generally supposed to be the chief writer of the two, some of the most famous pieces in their joint works, such as "I thank the goodness and the grace," "Meddlesome Matty," "The Notorious Glutton," &c., are by Ann.

The best edition of the *Poetical Works* of the sisters is that of 1877. There is an excellent edition (1903) of the *Original Poems and Others*, by Ann and Jane Taylor and Adelaide O'Keeffe, edited by E. V. Lucas, with illustrations by F. D. Bedford.

Abundant information about Ann and Jane Taylor is to be found in: *Autobiography and Other Memorials of Mrs Gilbert* (2 vols., 1874), edited by her son Josiah Gilbert; Isaac Taylor, *Memoirs . . . of Jane Taylor* (2 vols., 1825), and the collection by the same editor entitled *The Family Pen: Memorials . . . of the Taylor Family of Ongar*, vol. ii. (1867).

TAYLOR, BAYARD (1825–1878), American author, was born at Kennett Square in Chester county, Pennsylvania, on the 11th of January 1825. The son of a well-to-do farmer, he received his early instruction in an academy at West Chester, and later at Unionville. At the age of seventeen he was apprenticed to a printer in West Chester. A little volume, published at Philadelphia in 1844 under the title *Ximena, or the Battle of the Sierra Morena, and other Poems*, brought its author a little cash; and indirectly it did him better service as the means of his introduction to *The New York Tribune*. With the money thus obtained, and with an advance made to him on account of some journalistic work to be done in Europe, "J. B. Taylor" (as he had up to this time signed himself, though he bore no other Christian name than Bayard) set sail for the East. The young poet spent a happy time in roaming through certain districts of England, France, Germany and Italy; that he was a born traveller is evident from the fact that this pedestrian tour of almost two years cost him only £100. The graphic accounts which he sent from Europe to *The New York Tribune*, *The Saturday Evening Post*, and *The United States Gazette* were so highly appreciated that on Taylor's return to America he was advised to throw his articles into book form. In 1846, accordingly, appeared his *Views Afoot, or Europe seen with Knapsack and Staff* (2 vols., New York). This pleasant book had considerable popularity, and its author now found himself a recognized man of letters; moreover, Horace Greeley, then editor of the *Tribune*, placed Taylor on the *Tribune* staff (1848) thus securing him a certain if a moderate income. His next journey, made when the gold-fever was at its height, was to California, as correspondent for the *Tribune;* from this expedition he returned by way of Mexico, and, seeing his opportunity, published (2 vols., New York, 1850) a highly successful book of travels, entitled *El Dorado; or, Adventures in the Path of Empire*. Ten thousand copies were said to have been sold in America, and thirty thousand in Great Britain, within a fortnight from the date of issue. Bayard Taylor always considered himself native to the East, and it was with great delight that in 1851 he found himself on the banks of the Nile. He ascended as far as 12° 30′ N., and stored his memory with countless sights and delights, to many of which he afterwards gave expression in metrical form. From England, towards the end of 1852, he sailed for Calcutta, proceeding thence to China, where he joined the expedition of Commodore Perry to Japan. The results of these journeys (besides his poetical memorials) were *A Journey to Central Africa; or, Life and Landscapes from Egypt to the Negro Kingdoms of the White Nile* (New York, 1854); *The Lands of the Saracen; or, Pictures of Palestine, Asia Minor, Sicily and Spain* (1854); and *A Visit to India, China and Japan in the Year 1853* (1855). On his return (December 20, 1853) from these various journeyings he entered, with marked success, upon the career of a public lecturer, delivering addresses in every town of importance from Maine to Wisconsin. After two years' experience of this lucrative profession, he again started on his travels, on this occasion for northern Europe, his special object being the study of Swedish life, language and literature. The most noteworthy result was the long narrative poem *Lars*, but his "Swedish Letters" to the *Tribune* were also republished, under the title *Northern Travel: Summer and Winter Pictures* (London, 1857). His first wife, May Agnew, died (1850) within a year of her marriage, and in October 1857 he married Maria Hansen, the daughter of Peter Hansen, the German astronomer. The ensuing winter was spent in Greece. In 1859 Taylor once more traversed the whole extent of the western American gold region, the primary cause of the journey lying in an invitation to lecture at San Francisco. About three years later he entered the diplomatic service as secretary of legation at St Petersburg, and the following year (1863) became chargé d'affaires at the Russian capital. In 1864 he returned to the United States and resumed his active literary labours, and it was at this period that *Hannah Thurston* (New York, 1863), the first of his four novels, was published. This book had a moderate success, but neither in it nor in its successors did Bayard Taylor betray any special talent as a novelist. In 1874 he went to Iceland, to report for the *Tribune* the one thousandth anniversary of the first settlement there. In June 1878 he was accredited United States minister at Berlin. Notwithstanding the resistless passion for travel which had always possessed him, Bayard Taylor was (when not actually *en route*) sedentary in his habits, especially in the later years of his life. His death occurred on the 19th of December, only a few months after his arrival in Berlin.

Taylor's most ambitious productions in poetry—his *Masque of the Gods* (Boston, 1872), *Prince Deukalion; a lyrical drama* (Boston, 1878), *The Picture of St John* (Boston, 1866), *Lars; a Pastoral of Norway* (Boston, 1873), and *The Prophet; a tragedy* (Boston, 1874)—are marred by a ceaseless effort to overstrain his power. But he will be remembered by his poetic and excellent translation of *Faust* (2 vols., Boston, 1870–71) in the original metres. Taylor felt, in all truth, "the torment and the ecstasy of verse"; but, as a critical friend has written of him, "his nature was so ardent, so full-blooded, that slight and common sensations intoxicated him, and he estimated their effect, and his power to transmit it to others, beyond the true value." He had, from the earliest period at which he began to compose, a distinct lyrical faculty: so keen indeed was his ear that he became too insistently haunted by the music of others, pre-eminently of Tennyson. But he had often a true and fine note of his own. His best short poems are "The Metempsychosis of the Pine" and the well-known Bedouin love-song. In his critical essays Bayard Taylor had himself in no inconsiderable degree what he wrote of as "that pure poetic insight which is the vital spirit of criticism." The most valuable of these prose dissertations are the *Studies in German Literature* (New York, 1879). Collected editions of his *Poetical Works* and his *Dramatic Works* were published at Boston in 1888; his *Life and Letters* (Boston, 2 vols., 1884) were edited by his wife and Horace E. Scudder.

See also Albert H. Smyth, *Bayard Taylor* (Boston, 1896), in the "American Men of Letters" series; and W. D. Howells's *Literary Friends and Acquaintances* (1900).

TAYLOR, BROOK (1685–1731), English mathematician, was the son of John Taylor, of Bifrons House, Kent, by Olivia, daughter of Sir Nicholas Tempest, Bart., of Durham, and was born at Edmonton in Middlesex on the 18th of August 1685. He entered St John's College, Cambridge, as a fellow-commoner in 1701, and took degrees of LL.B. and LL.D. respectively in 1709 and 1714. Having studied mathematics under John Machin and John Keill, he obtained in 1708 a remarkable solution of the problem of the "centre of oscillation," which, however, remaining unpublished until May 1714 (*Phil. Trans.*, vol. xxviii. p. 11), his claim to priority was unjustly disputed by John Bernoulli. Taylor's *Methodus Incrementorum Directa et Inversa* (London, 1715) added a new branch to the higher mathematics, now designated the "calculus of finite differences." Among other ingenious applications, he used it to determine the form of movement of a vibrating string, by him first successfully reduced to mechanical principles. The same work contained the celebrated formula known as "Taylor's theorem" (see INFINITESIMAL CALCULUS), the importance of which remained unrecognized until 1772, when J. L. Lagrange realized its powers and termed it "*le principal fondement du calcul différentiel.*"

In his essay on *Linear Perspective* (London, 1715) Taylor set forth the true principles of the art in an original and more general form than any of his predecessors; but the work suffered from the brevity and obscurity which affected most of his writings, and needed the elucidation bestowed on it in the treatises of Joshua Kirby (1754) and Daniel Fournier (1761).

Taylor was elected a fellow of the Royal Society early in 1712, sat in the same year on the committee for adjudicating the claims of Sir Isaac Newton and Gottfried Wilhelm Leibnitz, and acted as secretary to the society from the 13th of January 1714 to the 21st of October 1718. From 1715 his studies took a philosophical and religious bent. He corresponded, in that year, with the Comte de Montmort on the subject of Nicolas Malebranche's tenets; and unfinished treatises, "On the Jewish Sacrifices" and "On the Lawfulness of Eating Blood," written on his return from Aix-la-Chapelle in 1719, were afterwards found among his papers. His marriage in 1721 with Miss Brydges of Wallington, Surrey, led to an estrangement from his father, a person of somewhat morose temper, which terminated in 1723 after the death of the lady in giving birth to a son. The ensuing two years were spent by him with his family at Bifrons, and in 1725 he married, with the paternal approbation, Sabetta, daughter of Mr Sawbridge of Olantigh, Kent, who, by a strange fatality, died also in childbed in 1730; in this case, however, the infant, a daughter, survived. Taylor's fragile health gave way; he fell into a decline, died on the 29th of December 1731, at Somerset House, and was buried at St Ann's, Soho. By his father's death in 1729 he had inherited the Bifrons estate. As a mathematician, he was the only Englishman after Sir Isaac Newton and Roger Cotes capable of holding his own with the Bernoullis; but a great part of the effect of his demonstrations was lost through his failure to express his ideas fully and clearly.

A posthumous work entitled *Contemplatio Philosophica* was printed for private circulation in 1793 by his grandson, Sir William Young, Bart., prefaced by a life of the author, and with an appendix containing letters addressed to him by Bolingbroke, Bossuet, &c. Several short papers by him were published in *Phil. Trans.*, vols. xxvii. to xxxii., including accounts of some interesting experiments in magnetism and capillary attraction. He issued in 1719 an improved version of his work on perspective, with the title *New Principles of Linear Perspective*, revised by Colson in 1749, and printed again, with portrait and life of the author, in 1811. A French translation appeared in 1753 at Lyons. Taylor gave (*Methodus Incrementorum*, p. 108) the first satisfactory investigation of astronomical refraction.

See Watt, *Bibliotheca Britannica*; Hutton, *Phil. and Math. Dictionary*; Fétis, *Biog. des Musiciens*; Th. Thomson, *Hist. of the R. Society*, p. 302; Grant, *Hist. Phys. Astronomy*, p. 377; Marie, *Hist. des Sciences*, vii. p. 231; M. Cantor, *Geschichte der Mathematik.*

TAYLOR, SIR HENRY (1800–1886), English poet and political official, was born on the 18th of October 1800, at Bishop-Middleham, Durham, where his ancestors had been small landowners for some generations. His mother died while he was yet an infant, and he was chiefly educated by his father, a man of studious tastes, who, finding him less quick than his two elder brothers, allowed him to enter the navy as a midshipman. Finding the life uncongenial, he only remained eight months at sea, and after obtaining his discharge was appointed to a clerkship in the storekeeper's office. He had scarcely entered upon his duties when he was attacked by typhus fever, which carried off both his brothers, then living with him in London. In three or four years more his office was abolished while he was on duty in the West Indies. On his return he found his father happily married to a lady whose interest and sympathy proved of priceless value to him. Through her he became acquainted with her cousin, Isabella Fenwick, the neighbour and intimate friend of Wordsworth, who introduced him to Wordsworth and Southey. Under these influences he lost his early admiration for Byron, whose school, whatever its merits, he at least was in no way calculated to adorn, and his intellectual powers developed rapidly. In October 1822 he published an article on Moore's *Irish Melodies* in the *Quarterly Review*. A year later he went to London to seek his fortune as a man of letters, and met with rapid success, though not precisely in this capacity. He became editor of the *London Magazine*, to which he had already contributed, and in January 1824 obtained, through the influence of Sir Henry Holland, a good appointment in the Colonial Office. He was immediately entrusted with the preparation of confidential state papers, and his opinion soon exercised an important influence on the decisions of the secretary of state. He visited Wordsworth and Southey, travelled on the Continent with the latter, and at the same time, mainly through his friend and official colleague, the Hon. Hyde Villiers, became intimate with a very different set, the younger followers of Bentham, without, however, adopting their opinions—"young men," he afterwards reminded Stuart Mill, "who every one said would be ruined by their independence, but who ended by obtaining all their hearts' desires, except one who fell by the way." The reference is to Hyde Villiers, who died prematurely. Taylor actively promoted the emancipation of the slaves in 1833, and became an intimate ally of Sir James Stephen, then counsel to the Colonial Office, afterwards under-secretary, by whom the Act of Emancipation was principally framed. His duties at the Colonial Office were soon afterwards lightened by the appointment of James Spedding, with whom he began a friendship that lasted till the end of his life.

His first drama, *Isaac Comnenus*, Elizabethan in tone, and giving a lively picture of the Byzantine court and people, was published anonymously in 1828. Though highly praised by Southey, it made little impression on the public. *Philip van Artevelde*, an elaborate poetic drama, the subject of which had been recommended to him by Southey, was begun in 1828, published in 1834, and, aided by a laudatory criticism from Lockhart's pen in the *Quarterly*, achieved extraordinary success. Its great superiority to Taylor's other works may be explained by its being to a great extent the vehicle of his own ideas and feelings. Artevelde's early love experiences reproduce and transfigure his own. *Edwin the Fair* (1842) was less warmly received; but his character of Dunstan, the ecclesiastical statesman, is a fine psychological study, and the play is full of historical interest. Meanwhile he had married (1839) Theodosia Spring-Rice, the daughter of his former chief Lord Monteagle, and, in conjunction with Sir James Stephen, had taken a leading part in the abolition of negro apprenticeship in the West Indies. *The Statesman*, a volume of essays suggested by his official position, had been published in 1836, and about the same time he had written in the *Quarterly* the friendly notices of Wordsworth and Southey which did much to dispel the conventional prejudices of the day, and which were published in 1849 under the somewhat misleading title of *Notes from Books*.

In 1847 he was offered the under-secretaryship of state for the colonies, which he declined. *Notes from Life* and *The Eve of the Conquest* appeared in this year; and an experiment in romantic comedy, *The Virgin Widow*, afterwards entitled *A Sicilian Summer*, was published in 1850. "The pleasantest play I had written," says the author; "and I never could tell why people would not be pleased with it." His last dramatic work was *St Clement's Eve*, published in 1862. In 1869 he was made K.C.M.G. He retired from the Colonial Office in 1872, though continuing to be consulted by government. His last days were spent at Bournemouth in the enjoyment of universal respect; and the public, to whom he had hitherto been an almost impersonal existence, became familiarized with the extreme picturesqueness of his appearance in old age, as represented in the photographs of his friend Julia Margaret Cameron. He died on the 27th of March 1886. His *Autobiography*, published a year before his death, while sinning a little by the egotism pardonable in a poet and the garrulity natural to a veteran, is in the main a pleasing and faithful picture of an aspiring youth, an active maturity, and a happy and honoured old age.

Taylor's *Artevelde* cannot fail to impress those who read it as the work of a poet of considerable distinction; but, perhaps for the very reason that he was so prominent as a state official, he has not been accepted by the world as more than a very accomplished man of letters. His lyrical work is in general laboriously artificial, but he produced two well-known songs—"Quoth tongue of neither maid nor wife" and "If I had the wings of a dove."

Taylor's *Autobiography* (2 vols. 1885) should be supplemented by his *Correspondence* (1888), edited by Edward Dowden. His *Works* were collected in five volumes in 1877–78.

TAYLOR, ISAAC (1787–1865), English author, son of Isaac Taylor (1759–1829), engraver and author, was born at Lavenham, Suffolk, on the 17th of August 1787. He was trained by his father to be an engraver, but early adopted literature as a profession. From 1824, the year of his marriage, he lived a busy but uneventful life at Stanford Rivers, near Ongar, Essex, where he died on the 28th of June 1865. His attention was drawn to the study of the fathers of the church through reading the works of Sulpicius Severus, which he had picked up at a bookstall. He published a *History of the Transmission of Ancient Books to Modern Times* (1827), a study in biblical criticism, and some other works, but he attracted little notice until, in 1829, he published anonymously a book bearing upon the religious and political problems of the day, entitled *The Natural History of Enthusiasm*, which speedily ran through eight or nine editions. *Fanaticism* (1833), *Spiritual Despotism* (1835), *Saturday Evening* (1832), and *The Physical Theory of Another Life* (1836), all commanded a large circulation. In his *Ancient Christianity* (1839–46), a series of dissertations in reply to the "Tracts for the Times," Taylor maintained that the Christian church of the 4th century should not be regarded as embodying the doctrine and practice of the apostles because it was then already corrupted by contact with pagan superstition. The book met with great opposition, but Taylor did not follow up the controversy.

Among his other works may be mentioned biographies of Ignatius Loyola (1849) and John Wesley (1851); a volume entitled *The Restoration of Belief* (1855); and a course of lectures on *The Spirit of Hebrew Poetry* (1861).

TAYLOR, ISAAC (1829–1901), English philologist, eldest son of the preceding, was born at Stanford Rivers, 2nd May 1829. He was educated at Trinity College, Cambridge, and took the mathematical tripos in 1853. His interests, however, were linguistic rather than mathematical, and his earliest publication was a translation from the German of W. A. Becker's *Charicles*. Though of Nonconformist stock, Isaac Taylor joined the Church of England, and in 1857 was ordained to a country curacy. In 1860 he published *The Liturgy of the Dissenters*, an appeal for the revision of the Book of Common Prayer "on Protestant lines," "as expedient for the material interests of the Church, and as an act of plain justice to the Dissenters." His studies in local etymology bore fruit in *Words and Places in Etymological Illustration of History, Ethnology and Geography* (1864). Between 1865 and 1869, when he was in charge of a Bethnal Green parish, his philological studies were laid aside, and he published only *The Burden of the Poor* and *The Family Pen*, a record of the literary work of his own family, the Taylors of Ongar. In 1869 he became incumbent of a church at Twickenham, and used his comparative leisure to produce his *Etruscan Researches* (1874), in which he contended for the Ugrian origin of the Etruscan language. In 1875 he was presented to the rectory of Settrington, Yorkshire, and began his systematic researches into the origin of the alphabet. His *Greeks and Goths; a Study on the Runes* (1879), in which he suggested that the runes were of Greek origin, led to a good deal of controversy. His most important work is *The Alphabet, an Account of the Origin and Development of Letters* (1883; new and revised edition 1899). Taylor points out that alphabetical changes are the result of evolution taking place in accordance with fixed laws. "Epigraphy and palaeography may claim, no less than philology or biology, to be ranked among the inductive sciences." He was largely indebted to the Egyptian researches of Rougé, which it has since become necessary to reconside in the light of discoveries in Crete. In 1885 Taylor became canon of York, and two years later dean. His paper on the *Origin of the Aryans*, read at the British Association in 1887, was afterwards expanded into a book. In the following winter he visited Egypt, and his letters from there, collected under the title *Leaves from an Egyptian Notebook*, aroused considerable controversy from the extremely favourable view he took of the Mahommedan religion. For the last few years of his life Dean Taylor suffered from ill health, and was laid aside from active work for some time before his death in October 1901.

TAYLOR, JEREMY (1613–1667), English divine and author, was baptized at Cambridge on the 15th of August 1613. His father, Nathaniel, though a barber, was a man of some education, for Jeremy was "solely grounded in grammar and mathematics" by him. The tradition that he was descended from Dr Rowland Taylor, Cranmer's chaplain, who suffered martyrdom under Mary, is grounded on the untrustworthy evidence of a certain Lady Wray, said to have been a granddaughter of Jeremy Taylor. She supplied Bishop Heber in 1732 with other biographical data of doubtful authenticity. Jeremy Taylor was a pupil of Thomas Lovering, at the newly founded Perse grammar school. Lovering is first mentioned as master in 1619, so that Taylor probably spent seven years at the school before he was entered at Gonville and Caius College as a sizar in 1626,[1] eighteen months after Milton had entered Christ's, and while George Herbert was public orator and Edmund Waller and Thomas Fuller were undergraduates of the university. He was elected a Perse scholar in 1628, and fellow of his college in 1633, but the best evidence of his diligence as a student is the enormous learning of which he showed so easy a command in after years. In 1633, although still below the canonical age, he took holy orders, and, accepting the invitation of Thomas Risden, a former fellow-student, to supply his place for a short time as lecturer in St Paul's, he at once attracted attention by his eloquence and by his handsome face. Archbishop Laud sent for Taylor to preach before him at Lambeth, and took the young man under his special protection. Taylor did not vacate his fellowship at Cambridge before 1636, but he spent, apparently, much of his time in London, for Laud desired that his "mighty parts should be afforded better opportunities of study and improvement than a course of constant preaching would allow of." In November 1635 he had been nominated by Laud to a fellowship at All Souls, Oxford, where, says Wood (*Athen. Oxon.*, Ed. Bliss, iii. 781), love and admiration still waited on him. He seems, however, to have spent little time there. He became chaplain to his patron the archbishop, and chaplain in ordinary to Charles I. At Oxford William Chillingworth was then busy with his great work, *The Religion of Protestants*, and it is possible that by intercourse with him Taylor's mind may have been turned towards the liberal movement of his age. After two years in Oxford, he was presented, in March 1638, by Juxon, bishop of London, to the rectory of Uppingham, in Rutlandshire. In the next year he married Phoebe Langsdale, by whom he had six children, the eldest of whom died at Uppingham in 1642. In the autumn of the same year he was appointed to preach in St Mary's on the anniversary of the Gunpowder Plot, and apparently used the occasion to clear himself of a suspicion, which, however, haunted him through life, of a secret leaning to the Romish communion. This suspicion seems to have arisen chiefly from his intimacy with Christopher Davenport, better known as Francis a Sancta Clara, a learned Franciscan friar who became chaplain to Queen

[1] An obviously erroneous entry in the Admission Book states that he had been at school under Mr. Lovering for ten years, and was in his fifteenth year. *Admissions to Gonville and Caius College* (ed. J. Venn, 1887).

Henrietta; but it may have been strengthened by his known connexion with Laud, as well as by his ascetic habits. More serious consequences followed his attachment to the Royalist cause. The author of *The Sacred Order and Offices of Episcopacy or Episcopacy Asserted against the Aerians and Acephali New and Old* (1642), could scarcely hope to retain his parish, which was not, however, sequestrated until 1644. Taylor probably accompanied the king to Oxford. In 1643 he was presented to the rectory of Overstone, Northamptonshire, by Charles I. There he would be in close connexion with his friend and patron Spencer Compton, 2nd earl of Northampton.

During the next fifteen years Taylor's movements are not easily traced. He seems to have been in London during the last weeks of Charles I., from whom he is said to have received his watch and some jewels which had ornamented the ebony case in which he kept his Bible. He had been taken prisoner with other Royalists while besieging Cardigan castle on the 4th of February 1645. In 1646 he is found in partnership with two other deprived clergymen, keeping a school at Newton Hall, in the parish of Llanvihangel-Aberbythych, Carmarthenshire. Here he became private chaplain to Richard Vaughan, 2nd earl of Carbery (1600–1686), whose hospitable mansion, Golden Grove, is immortalized in the title of Taylor's still popular manual of devotion, and whose first wife was a constant friend of Taylor. The second Lady Carbery was the original of the "Lady" in Milton's *Comus*. Mrs Taylor had died early in 1651. He second wife was Joanna Bridges, said on very doubtful authority to have been a natural daughter of Charles I. She owned a good estate, though probably impoverished by Parliamentarian exactions, at Mandinam, in Carmarthenshire.

From time to time Jeremy Taylor appears in London in the company of his friend Evelyn, in whose diary and correspondence his name repeatedly occurs. He was three times imprisoned: in 1654–5 for an injudicious preface to his *Golden Grove*; again in Chepstow castle, from May to October 1655, on what charge does not appear; and a third time in the Tower in 1657–8, on account of the indiscretion of his publisher, Richard Royston, who had adorned his "Collection of Offices" with a print representing Christ in the attitude of prayer.

Much of his best work was produced at Golden Grove. In 1646 appeared his famous plea for toleration, Θεολογία Ἐκλεκτική, *A Discourse of the Liberty of Prophesying*. In 1649 he published the complete edition of his *Apology for authorized and set forms of Liturgy against the Pretence of the Spirit*, as well as his *Great Exemplar . . . a History of . . . Jesus Christ*, a book which was inspired, its author tells us, by his earlier intercourse with the earl of Northampton. Then followed in rapid succession the *Twenty-seven Sermons* (1651), "for the summer half-year," and the *Twenty-five* (1653), "for the winter half-year," *The Rule and Exercises of Holy Living* (1650), *The Rule and Exercises of Holy Dying* (1651), a controversial treatise on *The Real Presence* . . . (1654), the *Golden Grove; or a Manuall of daily prayers and letanies* . . . (1655), and the *Unum Necessarium* (1655), which by its Pelagianism gave great offence.[1] *The Rule and Exercises of Holy Living* provided a manual of Christian practice, which has retained its place with devout readers. The scope of the work is described on the title-page. It deals with "the means and instruments of obtaining every virtue, and the remedies against every vice, and considerations serving to the resisting all temptations, together with prayers containing the whole Duty of a Christian." *Holy Dying* was perhaps even more popular. A very charming piece of work of a lighter kind was inspired by a question from his friend, Mrs Katherine Phillips (the "matchless Orinda"), asking "How far is a dear and perfect friendship authorized by the principles of Christianity?" In answer to this he dedicated to the "most ingenious and excellent Mrs Katherine Phillips" his *Discourse of the Nature, Offices and Measures of Friendship* (1657). His *Ductor Dubitantium, or the Rule of Conscience* . . . (1660) was intended to be the standard manual of casuistry and ethics for the Christian people.

He probably left Wales in 1657, and his immediate connexion with Golden Grove seems to have ceased two years earlier. In 1658, through the kind offices of his friend John Evelyn, Taylor was offered a lectureship in Lisburn, Ireland, by Edward Conway, second Viscount Conway. At first he declined a post in which the duty was to be shared with a Presbyterian, or, as he expressed it, "where a Presbyterian and myself shall be like Castor and Pollux, the one up and the other down," and to which also a very meagre salary was attached. He was, however, induced to take it, and found in his patron's mansion at Portmore, on Lough Neagh, a congenial retreat.

At the Restoration, instead of being recalled to England, as he probably expected and certainly desired, he was appointed to the see of Down and Connor, to which was shortly added the small adjacent diocese of Dromore. He was also made a member of the Irish privy council and vice-chancellor of the university of Dublin. None of these honours were sinecures. Of the university he writes, "I found all things in a perfect disorder . . . . a heap of men and boys, but no body of a collegé, no one member, either fellow or scholar, having any legal title to his place, but thrust in by tyranny or chance." Accordingly he set himself vigorously to the task of framing and enforcing regulations for the admission and conduct of members of the university, and also of establishing lectureships. His episcopal labours were still more arduous. There were, at the date of the Restoration, about seventy Presbyterian ministers in the north of Ireland, and most of these were from the west of Scotland, and were imbued with the dislike of Episcopacy which distinguished the Covenanting party. No wonder that Taylor, writing to the duke of Ormonde shortly after his consecration, should have said, "I perceive myself thrown into a place of torment.". His letters perhaps somewhat exaggerate the danger in which he lived, but there is no doubt that his authority was resisted and his overtures rejected. His writings also were ransacked for matter of accusation against him, "a committee of Scotch spiders being appointed to see if they can gather or make poison out of them." Here, then, was Taylor's opportunity for exemplifying the wise toleration he had in other days inculcated, but the new bishop had nothing to offer the Presbyterian clergy but the bare alternative—submission to episcopal ordination and jurisdiction or deprivation. Consequently, in his first visitation, he declared thirty-six churches vacant; and of these forcible possesssion was taken by his orders. At the same time many of the gentry were won by his undoubted sincerity and devotedness as well as by his eloquence. With the Roman Catholic element of the population he was less successful. Ignorant of the English language, and firmly attached to their ancestral forms of worship, they were yet compelled to attend a service they considered profane, conducted in a language they could not understand. As Heber says, "No part of the administration of Ireland by the English crown has been more extraordinary and more unfortunate than the system pursued for the introduction of the Reformed religion." At the instance of the Irish bishops Taylor undertook his last great work, the *Dissuasive from Popery* (in two parts, 1664 and 1667), but, as he himself seemed partly conscious, he might have more effectually gained his end by adopting the methods of Ussher and Bedell, and inducing his clergy to acquire the Irish tongue.

The troubles of his episcopate no doubt shortened his life. Nor were domestic sorrows wanting in these later years. In 1661 he buried, at Lisburn, Edward, the only surviving son of his second marriage. His eldest son, an officer in the army, was killed in a duel; and his second son, Charles, intended for the church, left Trinity College and became companion and secretary to the duke of Buckingham, at whose house he died. The day after his son's funeral Taylor caught fever from a patient whom he visited, and, after a ten days' illness, he died at Lisburn on the 13th of August 1667, in the fifty-fifth year of

[1] See an angry letter by Brian Duppa, bishop of Salisbury, on the subject (*Eden* i. xlii.).

his life and the seventh of his episcopate, and was buried in the cathedral of Dromore.

Taylor's fame has been maintained by the popularity of his sermons and devotional writings rather than by his influence as a theologian or his importance as an ecclesiastic. His mind was neither scientific nor speculative, and he was attracted rather to questions of casuistry than to the problems of pure theology. His wide reading and capacious memory enabled him to carry in his mind the materials of a sound historical theology, but these materials were unsifted by criticism. His immense learning served him rather as a storehouse of illustrations, or as an armoury out of which he could choose the fittest weapon for discomfiting on opponent, than as a quarry furnishing him with material for building up a completely designed and enduring edifice of systematized truth. Indeed, he had very limited faith in the human mind as an instrument of truth. "Theology," he says, "is rather a divine life than a divine knowledge." His great plea for toleration is based on the impossibility of erecting theology into a demonstrable science. "It is impossible all should be of one mind. And what is impossible to be done is not necessary it should be done." Differences of opinion there must be; but "heresy is not an error of the understanding but an error of the will." He would submit all minor questions to the reason of the individual member, but he set certain limits to toleration, excluding "whatsoever is against the foundation of faith, or contrary to good life and the laws of obedience, or destructive to human society, and the public and just interests of bodies politic." Peace, he thought, might be made "if men would not call all opinions by the name of religion, and superstructures by the name of fundamental articles." Of the propositions of sectarian theologians he said that confidence was the first, and the second, and the third part. Of a genuine poetic temperament, fervid and mobile in feeling, and of a prolific fancy, he had also the sense and wit that come of varied contact with men. All his gifts were made available for influencing other men by his easy command of a style rarely matched in dignity and colour. With all the majesty and stately elaboration and musical rhythm of Milton's finest prose, Taylor's style is relieved and brightened by an astonishing variety of felicitous illustrations, ranging from the most homely and terse to the most dignified and elaborate. His sermons especially abound in quotations and allusions, which have the air of spontaneously suggesting themselves, but which must sometimes have baffled his hearers. This seeming pedantry is, however, atoned for by the clear practical aim of his sermons, the noble ideal he keeps before his hearers, and the skill with which he handles spiritual experience and urges incentives to virtue.

The whole works of . . . Jeremy Taylor with a life of the author and a critical examination of his writings was published by Bishop Reginald Heber in 1822, reissued after careful revision by Charles Page Eden (1847–54). His most popular works, *The Liberty of Prophesying*, *Holy Living*, and *Holy Dying* have been often reprinted. *The Poems and Verse-translations of Jeremy Taylor* were edited by Dr. A. B. Grosart in vol. i. of the *Miscellanies of the Fuller Worthies Library* (1870). The first biographer of Jeremy Taylor was his friend and successor, George Rust, who preached a funeral sermon (in 1668) which remains a valuable document. His life has been written by John Wheeldon (1793), H. K. Bonney (1815), T. S. Hughes (1831), R. H. Willmott (1847), George L. Duyckinck (New York, 1860). The chief authority is still Eden's revision of Bishop Heber's memoir, which includes much valuable correspondence. See also E. W. Gosse's *Jeremy Taylor* (1904) in the *English Men of Letters* series. A bibliography of works dealing with the subject is included in the article by the Rev. Alexander Gordon in the *Dictionary of National Biography*. S. T. Coleridge was a diligent student and a warm admirer of Jeremy Taylor, whom he regarded as one of the great masters of English style. A series of comments by Coleridge are collected in his *Literary Remains* (1838, vol. iii. pp. 203-390).

TAYLOR, JOHN (1580–1653), English pamphleteer, commonly called the "Water-Poet," was born at Gloucester on the 24th of August 1580. After fulfilling his apprenticeship to a waterman, he served (1596) in Essex's fleet, and was present at Flores in 1597 and at the siege of Cadiz. On his return to England he became a Thames waterman, and was at one time collector of the perquisites exacted by the lieutenant of the Tower. He was an expert in the art of self-advertisement, and achieved notoriety by a series of eccentric journeys. With a companion as feather-brained as himself he journeyed from London to Queenborough in a paper boat, with two stockfish tied to canes for oars. *The Pennyles Pilgrimage, or the Moneylesse Perambulation of John Taylor . . . how he travailed on foot from London to Edenborough in Scotland* . . . 1618, contains the account of a journey perhaps suggested by Ben Jonson's celebrated undertaking, though Taylor emphatically denies any intention of burlesque. He went as far as Aberdeen. At Leith he met Jonson, who good-naturedly gave him twenty-two shillings to drink his health in England. Other travels undertaken for a wager were a journey to Prague, where he is said to have been entertained (1620) by the queen of Bohemia, and those described respectively in *A very merry, wherry ferry voyage, or Yorke for my money*, and *A New Discovery by sea with a Wherry from London to Salisbury* (1623). At the outbreak of the civil war Taylor began to keep a public-house at Oxford, but when his friends the Royalists were obliged to surrender the city he returned to London, where he set up a similar business at the sign of "The Crown" in Phoenix Alley, Long Acre. At the time of the king's execution he changed his sign to the Mourning Crown, but the authorities objected, and he substituted his own portrait. He was buried in the churchyard of St Martin's-in-the-Fields on the 5th of December 1653.

Taylor gave himself the title of "the king's water-poet and the queen's water-man." He was no poet, though he could string rhymes together on occasion. His gifts lay in a coarse, rough and ready wit, a talent for narrative, and a considerable command of repartee, which made him a dangerous enemy. Thomas Coryate, the author of the *Crudities*, was one of his favourite butts, and he roused Taylor's special anger because he persuaded the authorities to have burnt one of Taylor's pamphlets directed against him. This was *Laugh and be Fat* (1615?), a parody of the *Odcombian Banquet*.

Sixty-three of Taylor's "works" appeared in one volume in 1630. This was reprinted by the Spenser Society in 1868–9, being followed by other tracts not included in the collection (1870–8). Some of his more amusing productions were edited (1872) by Charles Hindley as *The Works of John Taylor*. They provide some very entertaining reading, but in spite of the legend on one of his title-pages, "Lastly that (which is Rare in a Travailer) all is true," it is permissible to exercise some mental reservations in accepting his statements. Mr Hindley edited other tracts of Taylor's in his *Miscellanea Antiqua Anglicana* (1873).

TAYLOR, JOHN (1704–1766), English classical scholar, was born at Shrewsbury on the 22nd of June 1704. His father was a barber, and, by the generosity of one of his customers, the son, having received his early education at the grammar school of his native town, was sent to St John's College, Cambridge. In 1732 he was appointed librarian, in 1734 registrar of the university. Somewhat late in life he took orders, became rector of Lawford in Essex in 1751, and canon of St Paul's in 1757. He died in London on the 4th of April 1766. Taylor is best known for his editions of some of the Greek orators, chiefly valuable for the notes on Attic law, *e.g.* Lysias (1739); Demosthenes *Contra Leptinem* (1741) and *Contra Midiam* (1743, with Lycurgus *Contra Leocratem*), intended as specimens of a proposed edition, in five volumes, of the orations of Demosthenes, Aeschines, Dinarchus and Demades, of which only vols. ii. and iii. were published. Taylor also published (under the title of *Marmor Sandvicense*) a commentary on the inscription on an ancient marble brought from Greece by Lord Sandwich, containing particulars of the receipts and expenditure of the Athenian magistrates appointed to celebrate the festival of Apollo at Delos in 374 B.C. His *Elements of Civil Law* (1755) also deserves notice. It was severely attacked by Warburton in his *Divine Legation*, professedly owing to a difference of opinion in regard to the persecution of the early Christians, in reality because Taylor had spoken disparagingly of his scholarship.

TAYLOR, JOSEPH (*c.* 1586–*c.* 1653), English actor, is mentioned in the folio Shakespeare of 1623 as one of the twenty-six who took principal parts in all of these plays. There is a legend that he was trained by Shakespeare to play Hamlet, and that he succeeded Burbage in this and other parts. Certain it is that in many of Beaumont and Fletcher's plays he had a leading rôle, and he is one of the ten actors who signed the dedication of the first folio of these dramatists (1647).

TAYLOR, MICHAEL ANGELO (1757–1834), English politician, was a son of Sir Robert Taylor (1714–1788), the architect, and was educated at Corpus Christi College, Oxford, becoming a barrister at Lincoln's Inn in 1774. He entered the House of Commons as member for Poole in 1784, and, with the exception of the short period from 1802 to 1806, remained a member of parliament until 1834, although not as the representative of the same constituency. In parliament Taylor showed himself anxious to curtail the delays in the Court of Chancery, and to improve the lighting and paving of the London streets; and he was largely instrumental in bringing about the abolition of the pillory. At first a supporter of the younger Pitt, he soon veered round to the side of Fox and the Whigs, favoured parliamentary reform, and was a personal friend of the regent, afterwards George IV. He was on the committee which managed the impeachment of Warren Hastings; was made a privy councillor in 1831; and died in London on the 16th of July 1834. Taylor is chiefly known in connexion with the Metropolitan Paving Act of 1817, which is still referred to as "Michael AngeloTaylor's Act." Often called "Chicken Taylor" because of his reference to himself as a "mere chicken in the law," he is described by Sir Spencer Walpole as "a pompous barrister, with a little body and a loud voice." Taylor's father, Sir Robert, was the founder of the Taylorian Institution at Oxford.

TAYLOR, NATHANIEL WILLIAM (1786–1858), American Congregational theologian, was born in New Milford, Connecticut, on the 23rd of June 1786, grandson of Nathaniel Taylor (1722–1800), pastor at New Milford. He graduated at Yale College in 1807, studied theology under Timothy Dwight, and in 1812 became pastor of the First Church of New Haven. From 1822 until his death in New Haven on the 10th of March 1858 he was Dwight professor of didactic theology at Yale. He was the last notable representative of the New England School, in which his predecessors were the younger Edwards, John Smalley (1734–1820) and Nathaniel Emmons. In the Yale Divinity School his influence was powerful, and in 1833 one of his foremost opponents, Bennet Tyler (1783–1858), founded in East Windsor a Theological Institute to offset Taylor's teaching at Yale.

Taylorism, sometimes called the "New Haven" theology, was an attempt to defend Calvinism from Arminian attacks, and the defence itself was accused of Arminianism and Pelagianism by A. A. Hodge of Princeton and Leonard Woods of Andover. Taylor's theology was distinctively infra-lapsarian; it disagreed with Samuel Hopkins and Emmons in rejecting the theory of "divine efficiency" and in arguing that man can choose the right "even if he won't" —distinguishing like Edwards between natural ability and moral inability; it distinguished sensibility or susceptibility as something different from will or understanding, without moral qualities, to which the appeal for right choice may be made; and it made self-love (a term borrowed from Dugald Stewart, connoting the innocent love of happiness and distinct from selfishness) the particular feeling appealed to by the influences of the law and gospel.

He wrote *Practical Sermons* (1858; edited by Noah Porter); *Lectures on the Moral Government of God* (2 vols., 1859), and *Essays and Lectures upon Select Topics in Revealed Theology* (1859), all published posthumously.

TAYLOR, PHILIP MEADOWS (1808–1876), Anglo-Indian administrator and novelist, was born at Liverpool on the 25th of September 1808. At the age of fifteen he was sent out to India to become a clerk to a Bombay merchant. On his arrival the house was in financial difficulties, and he was glad to accept in 1824 a commission in the service of his highness the nizam, to which service he remained devotedly attached throughout his long career. He was speedily transferred from military duty to a civil appointment, and in this capacity he acquired a knowledge of the languages and the people of Southern India which has seldom been equalled. He studied the laws, the geology, the antiquities of the country; he was alternately judge, engineer, artist and man of letters, for on his return to England in 1840 on furlough he published the first of his Indian novels, *Confesssions of a Thug*, in which he reproduced, with singular vivacity and truth, the scenes which he had heard described by the chief actors in them. This book was followed by a series of tales, *Tippoo Sultaun* (1840), *Tara* (1863), *Ralph Darnell* (1865), *Seeta* (1872), and *A Noble Queen* (1878), all illustrating periods of Indian history and society, and giving a prominent place to the native character, for which and the native institutions and traditions he had a great regard and respect. Returning to India he acted from 1840 to 1853 as correspondent for *The Times*. He also wrote a *Student's Manual of the History of India* (1870). About 1850, Meadows Taylor was appointed by the nizam's government to administer, during a long minority, the principality of the young raja of Shorapore. He succeeded without any European assistance in raising this small territory to a high degree of prosperity, and such was his influence with the natives that on the occurrence of the mutiny in Bengal he held his ground without military support. Colonel Taylor, whose merits were now recognized and acknowledged by the British government of India—although he had never been in the service of the Company—was subsequently appointed to the deputy commissionership of the Western ceded districts, where he succeeded in establishing a new assessment of revenues at once more equitable to the cultivators and more productive to the government. By indefatigable perseverance he had raised himself from the condition of a half-educated lad, without patronage, and without even the support of the Company, to the successful government of some of the most important provinces of India, 36,000 square miles in extent and with a population of more than five millions. On his retirement from service in 1860 he was made a C.S.I. and given a pension. Taylor died at Mentone on the 13th of May 1876.

See Meadows Taylor's *The Story of My Life* (1877).

TAYLOR, ROWLAND (d. 1555), English Protestant martyr, was born at Rothbury, Northumberland; he took minor orders at Norwich in 1528 and graduated LL.B. at Cambridge in 1530 and LL.D. in 1534. Adopting reformed views he was made chaplain by Cranmer in 1540 and presented to the living of Hadleigh, Suffolk, in 1544. In Whitsun week, 1547, he preached a "notable sermon" at St Paul's Cross, and was given the third stall in Rochester cathedral. In 1549 he was placed on a commission to examine Anabaptists, and in 1551 he was appointed chancellor to Bishop Ridley, select preacher at Canterbury, and a commissioner for the reform of the canon law; in 1552 Coverdale made him archdeacon of Exeter. Apparently he advocated the cause of Lady Jane Grey, for on the 25th of July 1553, only six days after Mary's proclamation as queen, he was committed to the custody of the sheriff of Essex. He was released not long afterwards, and with the support of his parishioners offered strenuous resistance to the restoration of the Mass. He was consequently imprisoned in the King's Bench prison on the 26th of March 1554. The sturdy protestantism of Taylor and his flock, who seem to have caused various commotions, marked him out for the special enmity of Mary's government; and he was one of the first to suffer when in January 1555 parliament had once more given the clerical courts liberty of jurisdiction. He was sentenced on the 22nd, excommunicated on the 29th, degraded by Bonner on the 4th of February, and burnt on the 9th at Aldham Common near Hadleigh. His blameless character had made a great impression on his age, and he was commemorated in many popular ballads. He was regarded as the ideal of a Protestant parish priest; he was married and had nine children. The alleged descent of Jeremy Taylor from him has not been proved.

See Thomas Quinton Stow's *Memoirs of Rowland Taylor* (1833); *Dict. of Nat. Biogr.* lv. 463–4, and authorities there cited.

(A. F. P.)

TAYLOR, THOMAS (1758–1835), English writer, generally called "the Platonist," was born in London on the 15th of May 1758, and lived there till his death on the 1st of November 1835. He was sent to St Paul's school, but was soon removed to Sheerness, where he spent several years with a relative who was engaged in the dockyard. He then began to study for the dissenting ministry, but an imprudent marriage and pecuniary difficulties compelled him to abandon the idea. He became a schoolmaster, a clerk in Lubbock's banking-house, and from 1798–1806 was assistant secretary to the society for the encouragement of arts, manufactures and commerce, which post he resigned to devote himself to the study of philosophy. He had the good fortune to obtain the patronage of the duke of Norfolk and of a Mr Meredith, a retired tradesman of literary tastes, who assisted him to publish several of his works. These mainly consisted of translations of the whole or part of the writings of Aristotle, Plato, Plotinus, Proclus, Pausanias, Porphyry, Ocellus Lucanus, and the Orphic hymns. His efforts were unfavourably—almost contemptuously—received, but, in spite of defects of scholarship and lack of critical faculty, due recognition must be awarded to the indomitable industry with which he overcame early difficulties. He figures as the "modern Pletho" in Isaac Disraeli's *Curiosities of Literature* and in his novel *Vaurien*, and as "England's gentile priest" in Mathias's *Pursuits of Literature*.

TAYLOR, TOM (1817–1880), English dramatist and editor of *Punch*, was born at Bishop Wearmouth, near Sunderland, on the 19th of October 1817. After attending school there, and studying for two sessions at Glasgow University, he in 1837 entered Trinity College, Cambridge, of which he became a fellow. Subsequently he held for two years the professorship of English literature at University College, London. He was called to the bar (Middle Temple) in November 1846, and went on the northern circuit until, in 1850, he became assistant secretary of the Board of Health. On the reconstruction of the Board in 1854 he was made secretary, and on its abolition his services were transferred to a department of the Home Office, retiring on a pension in 1876. In his very early years Tom Taylor had shown a predilection for the drama, and had been in the habit of performing dramatic pieces with a number of children in a loft over a brewer's stable. Four burlesques of his were produced at the Lyceum in 1844. He made his first hit with *To Parents and Guardians*, brought out at the Lyceum in 1845. He also wrote some burlesques in conjunction with Albert Smith and Charles Kenny, and collaborated with Charles Reade in *Masks and Faces* (1852). Before the close of his life his dramatic pieces numbered over 100, amongst the best known of which are *Our American Cousin* (1858), produced by Laura Keene in New York, in which Sothern created the part of Lord Dundreary; *Still Waters Run Deep* (1855); *Victims* (1857); the *Contested Election* (1859); the *Overland Route* (1860); the *Ticket of Leave Man* (1863); *Anne Boleyn* (1875); and *Joan of Arc* (1871). He was perhaps the most popular dramatist of his time; but, if his chief concern was the construction of a popular acting play, the characters in his dramas are clearly and consistently drawn, and the dialogue is natural, nervous and pointed. In his blank verse historical dramas, *Anne Boleyn* and *Joan of Arc*, he was not so successful.

Taylor had begun his career as a journalist when he first came to London. He very soon became connected with the *Morning Chronicle* and the *Daily News*, for which he wrote leaders. He was on the staff of *Punch* until 1874, when he succeeded Shirley Brooks as editor. He occasionally appeared with success in amateur theatricals, more especially in the character of Adam in *As You Like It* and of Jasper in *A Sheep in Wolf's Clothing*. He had some talent for painting, and for many years was art critic to *The Times* and the *Graphic*. He died at Lavender Sweep, Wandsworth, on the 12th of July 1880.

Apart from the drama, Tom Taylor's chief contributions to literature are his biographies of painters, viz., *Autobiography of B. R. Haydon* (1853); *Autobiography and Correspondence of C. R. Leslie, R.A.* (1860); and *Life and Times of Sir Joshua Reynolds* (1865), which had been left in a very incomplete state by Leslie. His *Historical Dramas* appeared in one volume in 1877. He also edited, with a memorial preface, *Pen Sketches from a Vanished Hand, selected from Papers of the late Mortimer Collins.*

TAYLOR, WILLIAM (1765–1836), English man of letters, son of a Norwich manufacturer, was born in that city on the 7th of November 1765. He belonged to the Unitarian community, and went to a school kept at Palgrave, Suffolk, by Rochemont Barbauld, husband of Anna Letitia Barbauld, where Frank Sayers (1763–1817) was among his schoolmates. He travelled on the Continent for some years to perfect himself in foreign languages. William Taylor and his father were both in sympathy with the French Revolution, and belonged to a "revolution society" at Norwich. In 1791 the disturbed condition of affairs induced the elder Taylor to wind up his business, and from this time William devoted himself to letters. He was an enthusiast for German poetry, and did great service to English literature by translations of Bürger's *Lenore* (1790, printed 1796), of Lessing's *Nathan the Wise* (1790, printed 1805), of Goethe's *Iphigenia in Tauris* (1790, printed 1793), and of four of Wieland's *Dialogues of the Gods* (1795). He was a prolific writer of review articles, in which his knowledge of foreign literature served as a useful standard of criticism. Much of this material was made use of in his most important work, his *Historic Survey of German Poetry* (3 vols., 1828–30). He also edited the works of his friend Sayers with a memoir (1823). He died at Norwich on the 5th of March 1836.

See a *Memoir of the Life and Writings of the late W. Taylor of Norwich*, by John Warden Robberds (2 vols., 1843); Georg Herzfeld, *William Taylor von Norwich* (1897). Taylor is well known to readers of George Borrow by the portrait of him as the "elder individual" in the 23rd chapter of *Lavengro.*

TAYLOR, ZACHARY (1784–1850), twelfth president of the United States, was born in Orange county, Virginia, on the 24th of September 1784. During the following year his father, Colonel Richard Taylor, a veteran of the War of Independence, migrated to Kentucky, settling near Louisville, and thereafter played an important part in the wars and politics of his adopted state. The boyhood and youth of Zachary Taylor were thus passed in the midst of the stirring frontier scenes of early Kentucky, and from this experience he acquired the hardihood and resoluteness that characterized his later life, although he inevitably lacked the advantages of a thorough education. In May 1808 Taylor received a commission as first lieutenant in the 7th United States Infantry, and for the next few years was employed in routine duties. Early in 1812 he was made captain, and during the ensuing hostilities with Great Britain distinguished himself by his gallant defence against the Indians of Fort Harrison, a stockade in central Indiana. For this he was breveted major, and in May 1814 received a regular major's commission, but being reduced at the conclusion of the war to the rank of captain, temporarily left the service. In May 1816 he was reinstated as major, and in 1819 was promoted to be a lieutenant-colonel; and in the routine discharge of his duties he was stationed at various posts on the western frontier. In 1832, as colonel, he took part in the Black Hawk War, and was the officer to whom Black Hawk surrendered; later he occasionally acted as Indian agent along the upper Mississippi.

In 1836 Taylor was ordered from Wisconsin to take command against the Seminoles in Florida. On the 25th of December 1837, after a difficult campaign, he inflicted a severe defeat upon the Indians at the battle of Okeechobee, and for this was breveted brigadier-general. Then followed four years of harassing service in the Florida Everglades, whence he passed to the command of the First Department of the army, with headquarters at Fort Jesup, Louisiana.

While at New Orleans in 1845, Taylor received orders from President Polk to march his troops into Texas, as soon as that state should accept the terms of annexation proposed by the Joint Resolution of Congress of March 2, 1845. Later in June Polk, who assumed that the Rio Grande rather than the Nueces was the south-western boundary of Texas, ordered him to take up a position at the mouth of the Sabine, or at some other point best suited for an advance to the former river. By the middle of August Taylor had selected a position at Corpus Christi, on the west bank of the Nueces and within the disputed territory, and here he remained until the following spring. Upon the definite refusal of the Mexican government under Paredes to resume with the United States the diplomatic relations broken off by the annexation of Texas, Taylor was ordered to advance to the Rio Grande for the purpose of anticipating any hostile incursion from Mexico. He himself favoured such a movement if the United States was to maintain its claim as regards the boundary. In obedience to his instructions he left Corpus Christi on the 12th of March 1846, fortified Point Isabel as a base of supplies, and took up his position on the disputed river, opposite the Mexican town of Matamoras. Here he began to construct Fort Texas, afterwards called Fort Brown, upon the present site of Brownsville. The commander of the Mexican Army of the North, Ampudia, immediately summoned him to retire behind the Nueces under the threat of interpreting his advance as an invasion of Mexican territory. Taylor not only disregarded this summons, but within the following week proceeded to blockade the Rio Grande. Hostilities were then unavoidable, and the first passage at arms occurred on the 24th of April 1846, when a large force of Mexicans on the east bank of the Rio Grande ambushed and captured a small party of American dragoons under Captain Seth B. Thornton (1814–1847). The news of this event led President Polk, on the 11th of May, to recommend a formal declaration of war on the ground that it existed "by the act of Mexico herself," for that power "has passed the boundary of the United States, has invaded our territory and shed American blood upon American soil." This statement was incorporated in the bill declaring war, and although severely criticized during the Senate debate, passed both houses of Congress by overwhelming majorities.

Meanwhile Taylor had strengthened his base of supplies at Point Isabel, where he was reinforced by militia from Texas and Louisiana, and during the return march from this post was fiercely attacked at Palo Alto (about 8 m. N.E. of Brownsville, Texas) on May 8th, by the Mexicans under Arista. The latter was easily driven from the field, but on the following day threatened Taylor's advance in a much stronger position, Resaca de la Palma (about 4 m. N. of Brownsville). A brilliant charge by the dragoons under Captain May decided this contest, which Taylor followed up by a pursuit of the Mexican general to the Rio Grande. After relieving Fort Brown, which had been besieged since the 3rd of May, Taylor himself crossed the river, and on the 18th of May occupied Matamoras, from which Arista had already retreated to Monterrey.

As it was the intention of the administration to wage war for the purpose merely of bringing Mexico to negotiate, Taylor did not immediately advance southward from the Rio Grande. When, however, Mexico persisted in her refusal to treat, Polk decided to conquer her northern provinces. Taylor formed a new base of operations at Camargo, farther up the river, and from this point, in August began an advance towards Monterrey, the capital of Nuevo Leon. After hard fighting he occupied this city in the latter part of September (see MONTERREY). The truce with which he followed up this success was unacceptable to the administration, and upon receiving notice to resume hostilities, he occupied Saltillo, the capital of Coahuila, and Victoria, the capital of Tamaulipas, thus completing the conquest of the north-eastern states of Mexico. By this time Taylor had been reinforced by some 3000 troops which had marched under Gen. John E. Wool from San Antonio directly towards Chihuahua, but which had been deflected at Monclova to join his "army of occupation." During the war he was breveted major-general (May 1846), and Congress thrice passed votes of thanks and ordered the presentation of commemorative gold medals. President Polk distrusted Taylor because of his supposed Whig views, and now began to express his dissatisfaction with the general's failure to take full advantage of his victories and his hesitancy to suggest a plan for the future conduct of the war. Taylor was unwilling to lead his own army farther into the desert interior of Mexico and remained non-committal upon the projected attempt from Vera Cruz. When Polk finally determined upon the latter campaign, he selected Gen. Winfield Scott, although the latter was personally unacceptable to himself, as its leader, and despite Taylor's vigorous protests detached most of his experienced troops to join Scott's command. Meanwhile through the connivance of the American authorities, Santa Anna returned from his Cuban exile, and, as the newly elected Mexican president, disregarding his pledges to aid Polk in bringing about a satisfactory peace, prepared to wage a more effective war against the American invaders. Learning of the weakened condition of Taylor's force he made a sudden advance to the northward, with some 20,000 troops, and on the 22nd of February 1847 encountered Taylor with one-fourth that number at Buena Vista, a few miles beyond Saltillo. The all-day battle in the narrow mountain pass was the most stubbornly contested of the whole war, and the brilliant victory of Taylor over such odds made "Old Rough and Ready," as he was called by his troops, the hero of the hour. With this encounter the serious work of his "army of occupation" ended, although he was later joined by Gen. Alexander W. Doniphan's troops, who had marched from New Mexico *via* Chihuahua. Taylor's brilliant victory, won when he was so greatly handicapped by Polk, emphasized the popular discontent which that president's policy had already aroused, and suggested him to the political leaders as a presidential possibility. The general, however, had passed his mature years wholly in military service and had never voted, much less strongly allied himself, with any political party. Nevertheless when Taylor meetings became the fashion and newspapers began to advocate his nomination, party lines threatened to disappear despite the frantic efforts of the old-time chiefs of the two leading organizations to stem the tide against the popular favourite. The Democratic party with its more efficient machinery prevented a stampede of its rank and file, but the Whigs were less successful. Within a month after his victory over Santa Anna a Whig convention in Iowa nominated him for the presidency, and public meetings in Kentucky, Ohio, Virginia, Pennsylvania and elsewhere quickly took similar action, in many cases without regard to party lines. Taylor first adopted a course of discouraging these suggestions and emphasized his non-partisan attitude, but later gave way to the pressure, and issued a statement that proved satisfactory to the majority of the Whig politicians. Yet it required four ballots in the national convention to overcome the reluctance of Webster's, Clay's and Scott's followers and secure the party nomination. The disaffection of these leaders was more than counterbalanced, however, by the split of the New York Democrats over the slavery question, which assured Taylor of the vote of that state. His residence in Louisiana, his ownership of a large plantation with its slaves, and his family connexion with Jefferson Davis (who had married his daughter), rendered him more acceptable to many of the Southern Democrats than their party candidate, Lewis Cass, an advocate of "squatter sovereignty" and the representative of the democracy of the free North-west. As a result Taylor carried eight slave states while his opponent secured seven, but in the free states the conditions were exactly reversed. He received a majority of electoral votes on each side of the Mason and Dixon line and was confirmed in his preconceived opinion that he was to be the president of the whole people. Both parties had attempted to avoid the burning slavery issue,—the Whigs by adopting no platform whatever and the Democrats by trusting to the well-known views of their candidate, but the political leaders in Congress could not escape the many definite questions presented by the possession of the territory newly acquired from Mexico. The Wilmot Proviso and the bill to organize the territory of Oregon had already aroused both sections and had given occasion for Webster and Calhoun to state their respective views upon the constitutional questions involved. The three weeks' contest over the election of a speaker in the House of Representatives, in December 1849, emphasized the sectional passions already engendered. Under the circumstances the first message from President Taylor was awaited with great interest. While advising Congress to "abstain from the introduction of those exciting topics of sectional character which have hitherto produced painful apprehensions in the public mind," he favoured the admission of California as a free state, and counselled the legislators to await the action of the people of New Mexico and Utah upon the slavery question. As he had already encouraged California to form the state government it desired, and later took a strong position against the efforts of Texas to possess itself of part of New Mexico, it was apparent that he was less inclined to favour the radical pro-slavery programme than his previous career had seemed to promise. This was still further emphasized by his marked friendship for William H. Seward and his contemptuous reference to the territorial portion of Clay's compromise measures as the "Omnibus Bill." This situation militated greatly against that leader's cherished policy, and led him to a bitter criticism of the president on the floor of the Senate. Such was the situation when the president, early in July 1850, was stricken by the disease to which he succumbed on the 9th. His remains were temporarily interred at Washington, but afterwards removed to the family cemetery near Louisville.

The only son that survived him, RICHARD TAYLOR (1826–1879), popularly known as "General Dick," graduated at Yale in 1845, entered the Confederate army at the beginning of the Civil War, was commanding officer in Louisiana, and under Kirby Smith helped to administer the western half of the Confederacy, after the fall of Vicksburg. He won the victory of Sabine Cross Roads over the Union expedition under Gen. N. P. Banks on the 8th of April 1864. He finally surrendered to Gen. E. R. S. Canby on the 4th of May 1865. He wrote *Destruction and Reconstruction* (1879).

H. Montgomery's *Life* (Auburn, 1850) and John Frost's *Life* (New York and Philadelphia, 1847) are almost wholly devoted to President Taylor's military career, and are excessively laudatory in character. A better biography is that (New York, 1892) by Maj.-Gen. O. O. Howard, in the "Great Commanders" series. There is much material about Taylor in the general histories of M'Master, Von Holst, and Rhodes. (I. J. C.)

TAYLOR, a town in Williamson county, Texas, U.S.A., about 35 m. N.E. of Austin. Pop. (1890) 2584; (1900) 4211 (1260 negroes); (1910) 5314. It is served by the International & Great Northern and the Missouri, Kansas & Texas railways. It is in a region especially devoted to the growing of cotton and grain and to poultry raising, and an annual county fair is held here. In the city are machine and car shops of the International & Great Northern railway, and cotton-compresses, and there are manufactures of cotton-seed oil, &c. Taylor, named in honour of Gen. Zachary Taylor, was founded in 1876, and was incorporated in 1882.

TAYPORT, a police burgh of Fifeshire, Scotland. Pop. (1901) 3325. It is situated on the Firth of Tay, here about 1 m. wide, opposite to Broughty Ferry, with which there is communication by means of a ferry, 5½ m. N. of Leuchars Junction by the North British railway. Its older alternative name of Ferry Port on Craig has reference both to its uses and its site. Its industries include manufactures of linen and jute, spinning mills, engineering works, timber-yard and salmon fishery. In other respects it is a residential quarter for Dundee. A mile S.W. is the estate of Scotscraig, which belonged to Archbishop Sharp (1613–1679), of whose mansion there are still some traces. Two miles and a half W. by S. is the police burgh of NEWPORT (pop. 2869), with stations at Easter and Wester Newport, on the North British Railway Company's loop line from Leuchars Junction to Wormit. It lies on the Firth of Tay opposite to Dundee, with which there is communication by means of a ferry, as well as by rail via the Tay Bridge. Even to a greater extent than has Tayport, it has practically become a suburb of Dundee. Its small harbour was designed by Telford. Two and a quarter miles S.W. of Wormit, the nearest railway station, close to the southern terminus of the Tay Bridge, is the village of BALMERINO (Gaelic, "Town on the seashore"). Its once considerable shipping trade has declined, but some fishery is still carried on. In 1227 Ermengarde, widow of William the Lion, and her son Alexander II. founded a Cistercian Abbey here, but in 1604 the Abbey estates were converted into a temporal lordship in favour of James Elphinstone, created Lord Balmerino.

TAYUG, a town of the province of Pangasinan, Luzon, Philippine Islands, near the Agno river, 33 m. E. of Lingayen, the capital. Pop. (1903) 10,400. The river furnishes water for irrigating the low fields in the vicinity. The town's inhabitants are farmers, and rice is the principal crop. Pangasinan and Ilocano are the languages spoken.

TAZZA (Ital., cf. Fr. *tasse*, Ger. *Tasse*, cup; all from Persian *tas*, goblet), a word generally adopted by archaeologists and connoisseurs for a type of drinking vessel. It is a shallow saucer-like dish either mounted on a stem and foot or on a foot alone.

TCHERNAIEV, MIKHAIL GREGORJOVICH (1828–1898), Russian general, a member of a noble family, was born on the 24th of October 1828. Educated at the Nicholas Staff College, he entered the army in 1847, and distinguished himself in the Crimean war and in the Caucasus. After serving as divisional chief of the staff in Poland, he went to Orenburg in 1858 as assistant to the commander of the line of the Syr-Darya, and the following year commanded an expedition to support the Kirghiz tribes on the borders of the Sea of Aral against the Khivans. He did duty on the staff of the army of the Caucasus for a time, and returned to Orenburg as chief of the staff. In 1864, having reached the rank of major-general, he made his famous march with 1000 men across the steppes of Turkestan to Chimkent in Khokand, to meet another Russian column from Semipalatinsk, in Siberia, in conjunction with which he successfully stormed Chimkent, and then unsuccessfully attacked Tashkent, 80 miles farther south. Wintering at Chimkent, he captured Tashkent the following year. This was contrary to his instructions, and although he was received in St Petersburg with enthusiasm, and presented with a sword of honour by the emperor, he was not again employed in the military service, and retired from it in July 1874. He bought, and edited with great success, the *Russkiy Mir* in Slavonic interests, devoting himself to the Panslavic idea. In the summer of 1876 he was appointed commander-in-chief of the Servian army, but on entering Turkey was driven back by Osman Pasha, who followed him into Servia, defeating him at Zayechar and Yavor in July, and the campaign in Servia proved disastrous. He rashly proclaimed Milan king of Servia in September, and in October Aleksinats and Deligrad were in the hands of the Turks, and the road open to Belgrade. An armistice was concluded, and Tchernaiev resigned his command. In 1877 he visited Austria in connexion with his propaganda, but was expelled, and lived for a time in France. In 1879 he organized a Bulgarian rising, but was arrested at Adrianople and sent back to Russia. He succeeded Kaufmann (*q.v.*) as governor of Turkestan in 1882, but his aggressive policy led to his recall two years later, when he was appointed a member of the council of war at St Petersburg. In 1886 his opposition to the Central Asian Military railway caused him to lose his seat in the council. He died on the 16th of August 1898, at his country seat in the province of Mogilev.

TCHIHATCHEFF, PIERRE ALEXANDROWITSCH DE (1812–1890), Russian naturalist and geologist, was born at Gatchina, near St Petersburg, in 1812. He entered the diplomatic service and was (1842–44) attached to the embassy at Constantinople; whence he visited Asia Minor, Syria and Egypt. In 1844, he was charged with a scientific mission to the Altai mountains. He died at Florence on the 13th of October 1890 (N.S.).

His publications include: *Voyage scientifique dans l'Altai oriental et les parties adjacentes de la frontière de Chine* (with atlas, 1845); *Asie Mineure; description physique, statistique et archéologique de cette contrée* (4 vols. with 3 atlases, 1853–69); *Le Bosphore et Constantinople* (1864, another ed. 1877); *Considérations géologiques sur les Îles Océaniques* (1878); and *Espagne, Algérie et Tunisie* (1880).

TEA (Chinese *cha*, Amoy dialect *tê*), the name given to the leaves of the tea bush (see below) prepared by decoction as a beverage The term is by analogy also used for an infusion or decoction of other leaves, *e g.* camomile tea; and similarly for the afternoon meal at which tea is served.

Historical.—The early history of tea as a beverage is mainly traditional. The lack of accurate knowledge regarding the past of the Chinese Empire may possibly some day be supplied, as European scholars become more able to explore the unstudied stores in the great Chinese libraries, or as Chinese students ransack the records of their country for the facts of earlier periods. It may then be learnt who made the first cup of tea, who planted the earliest bushes, and how the primitive methods of manufacture were evolved. In the meantime knowledge on the subject is mingled with much that is obviously mythical and with gleanings from the casual references of travellers and authors.

According to Chinese legend, the virtues of tea were discovered by the Emperor Chinnung, 2737 B.C., to whom all agricultural and medicinal knowledge is traced. It is doubtfully referred to in the book of ancient poems edited by Confucius, all of which are previous in date to 550 B.C. A tradition exists in China that a knowledge of tea travelled eastward to and in China, having been introduced 543 A.D. by Bodhidharma, an ascetic who came from India on a missionary expedition, but that legend is also mixed with supernatural details. But it is quite certain, from the historical narrative of Lo Yu, who lived in the Tang dynasty (618–906 A.D.), that tea was already used as a beverage in the 6th century, and that during the 8th century its use had become so common that a tax was levied on its consumption in the 14th year of Tih Tsung (793). The use of tea in China in the middle of the 9th century is known from Arab sources (Reinaud, *Relation des Voyages*, 1845, p. 40). From China a knowledge of tea was carried into Japan, and there the cultivation was established during the 9th century. Seed was brought from China by the priest Miyoye, and planted first in the south island, Kiushiu, whence the cultivation spread northwards till it reached the high limit of 39° N.

It is somewhat curious that although many of the products of China were known and used in Europe at much earlier times, no reference to tea has yet been traced in European literature prior to 1588. No mention of it is made by Marco Polo, and no knowledge of the substance appears to have reached Europe till after the establishment of intercourse between Portugal and China in 1517. The Portuguese, however, did little towards the introduction of it into Europe, and it was not till the Dutch established themselves at Bantam early in the 17th century that these adventurers learned from the Chinese the habit of tea drinking and brought it into Europe.

The earliest mention of tea by an Englishman is probably that contained in a letter from Mr Wickham, an agent of the East India Company, written from Firando in Japan, on the 27th June 1615, to Mr Eaton, another officer of the company, resident at Macao, and asking for "a pot of the best sort of *chaw*." How the commission was executed does not appear, but in Mr Eaton's subsequent accounts of expenditure occurs this item—"three silver porringers to drink chaw in."

It was not till the middle of the century that the English began to use tea, and they also received their supplies from Java till in 1686 they were driven out of the island by the Dutch. At first the price of tea in England ranged from £6 to £10 per lb. In the *Mercurius Politicus*, No. 435, of September 1658, the following advertisement occurs:— "That excellent and by all Physitians approved China Drink called by the Chineans *Tcha*, by other nations *Tay*, *alias Tee*, is sold at the Sultaness Head, a cophee-house in Sweetings Rents, by the Royal Exchange, London." Thomas Garway, the first English tea dealer, and founder of the well-known coffee-house, "Garraway's," in a curious broadsheet, *An Exact Description of the Growth, Quality and Virtues of the Leaf Tea*, issued in 1659 or 1660, writes, "in respect of its scarceness and dearness, it hath been only used as a regalia in high treatments and entertainments, and presents made thereof to princes and grandees." In that year he purchased a quantity of the rare and much-prized commodity, and offered it to the public, in the leaf, at fixed prices varying from 15s. to 50s. the lb, according to quality, and also in the infusion, "made according to the directions of the most knowing merchants and travellers into those eastern countries." In 1660 an Act of the first parliament of the Restoration imposed a tax on "every gallon of chocolate, sherbet and tea, made and sold, to be paid by the maker thereof, eightpence" (12 Car. II. c. 23).

Pepys's often-quoted mention of the fact that on the 25th September 1660, "I did send for a cup of tee, a China drink, of which I never had drunk before," proves the novelty of tea in England at that date. In 1664 we find that the East India Company presented the king with 2 lb and 2 oz. of "thea," which cost 40s. per lb, and two years afterwards with another parcel containing 22¾ lb, for which the directors paid 50s per lb. Both parcels appear to have been purchased on the Continent. Not until 1677 is the Company recorded to have taken any steps for the importation of tea. The order then given to their agents was for "teas of the best kind to the amount of 100 dollars." But their instructions were considerably exceeded, for the quantity imported in 1678 was 4713 lb, a quantity which seems to have glutted the market for several years. The annals of the Company record that, in February 1684, the directors wrote thus to Madras:— "In regard thea is grown to be a commodity here, and we have occasion to make presents therein to our great friends at court, we would have you to send us yearly five or six canisters of the very best and freshest thea." Until the Revolution no duty was laid on tea other than that levied on the infusion as sold in the coffee-houses. By 1 William and Mary, c. 6, a duty of 5s. per lb and 5 per cent. on the value was imposed. For several years the quantities imported were very small, and consisted exclusively of the finer sorts. The first direct purchase in China was made at Amoy, the teas previously obtained by the Company's factors having been purchased in Madras and Surat, whither it was brought by Chinese junks after the expulsion of the British from Java. During the closing years of the century the amount brought over seems to have been, on the average, about 20,000 lb a year. The instructions of 1700 directed the supercargoes to send home 300 tubs of the finer green teas and 80 tubs of bohea. In 1703 orders were given for "75,000 lb Singlo (green), 10,000 lb imperial, and 20,000 lb bohea." The average price of tea at this period was 16s. per lb.

As the 18th century progressed the use of tea in England rapidly increased, and by the close of the century the rate of consumption exceeded an average of 2 lb per person per annum, a rate in excess of that of to-day of all people except those of Mongol and Anglo-Saxon origin. The business being a monopoly of the East India Company, and a very profitable one, the company at an early stage of its development endeavoured to ascertain whether tea could not be grown within its own dominions. Difficulties with China doubtless showed the advisability of having an independent source of supply. In 1788 Sir Joseph Banks, at the request of the directors, drew up a memoir on the cultivation of economic plants in Bengal, in which he gave special prominence to tea, pointing out the regions most favourable for its cultivation. About the year 1820 Mr David Scott, the first commissioner of Assam, sent to Calcutta from Kuch Behar and Rangpur—the very districts indicated by Sir Joseph Banks as favourable for tea-growing—certain leaves, with a statement that they were said to belong to the wild tea-plant. The leaves were submitted to Dr Wallich, government botanist at Calcutta, who pronounced them to belong to a species of *Camellia*, and no result followed on Mr Scott's communication. These very leaves ultimately came into the herbarium of the Linnean Society of London, and have authoritatively been pronounced to belong to the indigenous Assam tea-plant. Dr Wallich's attribution of this and other specimens subsequently sent in to the genus *Camellia*, although scientifically defensible, unfortunately diverted attention from the significance of the discovery. It was not till 1834 that, overcome by the insistence of Captain Francis Jenkins, who maintained and proved that, called by the name *Camellia* or not, the leaves belonged to a tea-plant, Dr Wallich admitted "the fact of the genuine tea-plant being a native of our territories in Upper Assam as incontrovertibly proved." In the meantime a committee had been formed by Lord William Bentinck, the governor-general, for the introduction of tea culture into India, and an official had already been sent to the tea districts of China to procure seed and skilled Chinese workmen to conduct operations in the Himalayan regions. The discovery and reports of Captain Jenkins led to the investigation of the capacities of Assam as a tea-growing country by Lord William Bentinck's committee. Evidence of the abundant existence of the indigenous tea-tree was obtained; and the directors of the East India Company resolved to institute an experimental establishment in Assam for cultivating and manufacturing tea, leaving the industry to be developed by private enterprise should its practicability be demonstrated.

In 1834 the monopoly of the East India Company was abolished and an era of rapid progress in the new industry began. In 1836 there was sent to London 1 lb of tea made from indigenous leaves; in 1837 5 lb of Assam tea were sent; in 1838 the quantity sent was 12 small boxes, and 95 boxes reached London in 1839. In 1840 there were grown, and offered at public auction in Calcutta early the following year, 35 packages, chiefly green teas, stated to have been manufactured by a chief of the Singpho tribe aided by the government establishment. In the same auction catalogue were included 95 packages, "the produce of the Government Tea Plantation in Assam," many of which bore the Chubwa mark, one well known to this day. This auction is most interesting as being the first of British-grown tea, and it included about 6000 lb. It is of interest also for the reference to the Singpho tribe, who are even now in small numbers in the same district, where they still produce in a primitive manner tea plucked from the indigenous trees growing in their jungles.

In January 1840 the Assam Company was formed to take over the early tea garden of the East India Company, and this, the premier company, is still in existence, having produced up to 1907 no less than 117,000,000 lb of tea and paid in dividends £1,360,000 or 730 per cent. on capital. It is no longer the first company in extent of yield, as the Consolidated Tea and Lands Company produced in 1907 about 15,000,000 lb of tea, besides other products. The introduction of Chinese seed and Chinese methods was a mistake, and there seems little reason to doubt that, in clearing jungle for tea planting, fine indigenous tea was frequently destroyed unwittingly in order to plant the inferior China variety. The period of unlearning the Chinese methods, and replacing the Chinese plants, had to be lived through. Vicissitudes of over-production and inflation came to interfere with an even course of success, but the industry developed and has increased enormously. From its point of origin in Assam, it has gradually spread to other districts with varying commercial success. The aggregate total of capital of the tea-producing companies in India and Ceylon now amounts to about £25,000,000.

The Dutch were rather earlier than the English in attempting to establish tea growing in their eastern possessions. A beginning was made in Java in 1826, but probably because of the even more marked influence of Chinese methods and Chinese plant, the progress was slow and the results indifferent. Of late years, however, by the introduction of fine Assam seed and the adoption of methods similar to those in use in India, a marked improvement has taken place, and there seems little reason to doubt that, with the very rich soil and abundant cheap labour that the island of Java possesses, the relative progress there may be greater in future than in any other producing land.

Somewhere about 1860 the practical commercial growing of tea was introduced into the island of Formosa. The methods of cultivation and manufacture followed there differ in many ways from those of the other large producing countries, but the industry has been fairly successful throughout its history.

Attempts were repeatedly made to introduce tea culture in Ceylon, under both Dutch and British authority. No permanent success was attained till about 1876, when the disastrous effects of the coffee-leaf disease forced planters to give serious attention to tea. Since that period the tea industry has developed with marvellous rapidity, and now takes first rank in the commerce of the island.

Several plantations have been successfully put out both by the Russian government and private enterprise in the Caucasus, but it is doubtful whether they could exist long but for the high rate of duty on tea entering Russia from foreign countries. Natal has now about 5000 acres under tea giving a fairly large yield, but of quality not highly esteemed outside of South Africa, where it benefits to the extent of 4d. per pound of protection in the tariff. A small plantation exists in South Carolina under circumstances not conducive to financial success on a large scale of production. Attempts at tea growing have been made in the West Indies, Brazil, Australia, Nyassaland, Mauritius, the Straits Settlements, Johore, Fiji and at San Miguel in the Azores without marked success. In addition to favourable conditions of soil and climate, abundant cheap labour is an absolute necessity if satisfactory commercial results are to be obtained.

Botany.—The tea bush or tree is a member of the natural order Ternstroemiaceae and is closely allied to the well-known ornamental shrub the camellia. As cultivated in China it is an evergreen shrub growing to a height of from 3 to 5 ft. The stem is bushy, with numerous and very leafy branches; the leaves are alternate, leathery in texture, elliptical, obtusely serrated, strongly veined and placed on short channelled footstalks. The flowers are white, axillary and slightly fragrant,—often two or three together on separate pedicels. The calyx is small, smooth and divided into five obtuse sepals. The corolla has from five to nine petals, cohering at the base. The stamens are short, numerous and inserted at the base of the corolla; the anthers are large and yellow, and the long style ends in three branches. The fruit is a woody capsule of three cells, each containing one large nearly spherical seed, which consists mainly of two large hemispherical cotyledons.

As is commonly the case with plants which have been long under cultivation, there has been some doubt as to specific distinctions among the varieties of tea. The plant was originally described by Linnaeus as one species, *Thea sinensis*. Later Linnaeus established two species, viz. *Thea Bohea* and *Thea viridis*, and it was erroneously assumed that the former was the source of black teas, while *Thea viridis* was held to yield the green varieties. In 1843, however, Mr Robert Fortune found that, although the two varieties of the plant existed in different parts of China, black and green tea were produced from the leaves of the same plant by varying the manufacturing processes.

Sir George Watt (*Journal of the Royal Horticultural Society*, vol. xxxii.) describes with ample illustrations the recognized varieties, placing all of them under *Camellia Thea*, with the following subdivision:—

A. Variety Viridis:—races
1. Assam Indigenous.
2. Lushai.
3. Naga Hills.
4. Manipur.
5. Burma and Shan.
6. Yunnan and Chinese.

B. ,, Bohea.
C. ,, Stricta.
D. ,, Lasiocalyx.

Of the foregoing, the teas of commerce are derived almost entirely from the varieties Viridis and Bohea. The Assam Indigenous, in its two sub-races of Singlo and Bazalona, and the Manipur, originally found wild in the jungles of the native state of that name, have, with various intermixtures and crossings, been used to cover the greatest areas of all the more modern planting in India, Ceylon and Java. The great size of leaf when fully developed (4 to 9 ins. in length and 2 to $3\frac{1}{2}$ in breadth) has made them in demand because of the heavy yields. From the variety Bohea, or from hybrids of descent from it, came the China teas of former days and the earlier plantings in India grown from imported China stock. The

FIG. 1.—Bohea variety.

leaves of this variety are generally, roughly speaking, about half the size of those of the Assam Indigenous and Manipur sorts. The bush is in every way smaller than the Assam types. The latter is a tree attaining in its natural conditions, or where allowed to grow unpruned in a seed garden, a height of from 30 to 40 ft. and prospering in the midst of dense moist jungle and in shady sheltered situations.

FIG. 2.—Bohea Tea-leaf, full size.

The Bohea variety is hardy, and capable of thriving under many different conditions of climate and situation, while the indigenous plant is tender and difficult of cultivation, requiring for its success a close, hot, moist and equable climate. In minute structure it presents highly characteristic appearances.

The under side of the young leaf is densely covered with fine one-celled thick-walled hairs, about 1 mm. in length and ·015 mm. in thickness. These hairs entirely disappear with increasing age. The structure of the epidermis of the under side of the leaf, with its contorted cells, is represented (×160) in fig. 3.

A further characteristic feature of the cellular structure of the tea-leaf is the abundance, especially in grown leaves, of large, branching, thick-walled, smooth cells (idioblasts), which, although they occur in other leaves, are not found in such as are likely to be confounded with or substituted for tea. The minute structure of the leaf in section is illustrated in fig. 4.

Constant controversy has existed as to what is the actual original home of the tea-plant, and probably no one has given to the subject more careful study than Professor Andreas Krassnow, of Kharkoff University. By order of the Russian government, he visited each of the great tea-growing countries, and the results of his observations were published in a book entitled *On the Tea-producing Districts of Asia.* He holds the opinion that the tea-plant is indigenous, not to Assam only, but to the whole monsoon region of eastern Asia, where he found it growing wild as far north as the islands of southern Japan. He considers that the tea-plant had, from the remotest times, two distinct varieties, the Assam and Chinese, as he thinks that the period of known cultivation has been too short to produce the differences that exist between them.

Chemistry.—What may be termed the chemistry of production, viz., that relating to soils, manures, manufacturing processes, &c., has of recent years received great attention from the scientific

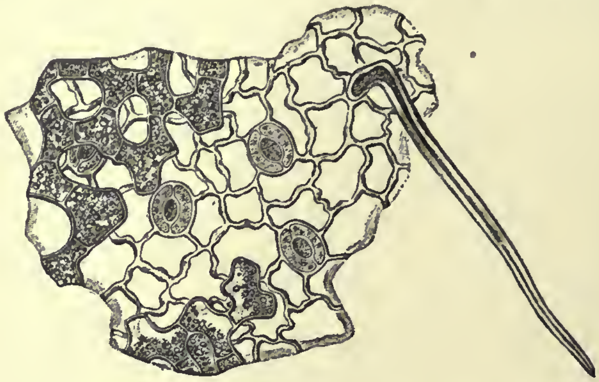


FIG. 3.—Epidermis of Tea-leaf (under side). ×160.

experts appointed in India and Ceylon to assist and guide the tea planters. The chemistry of the completed teas of commerce does not appear to have been subjected to adequate scientific study. There cannot be said to be any standard or recognized analysis. Many such have been made, and they may be found in chemical text-books of high authority, but they are defective because of the lack of commercial knowledge in association with the chemical skill. More attention seems to have been given to the matter in the United States of America and in Germany and Russia than in England, but the infinite variety of samples known to the commercial expert, and the impossibility of standardizing those in such a manner as to make readily recognizable what the chemist has treated, renders most of the recorded analyses of uncertain value. There seems to be no relationship between the commercial value and the analysis, the arbitrary personal methods of the expert tea-taster being controlled by factors that chemistry does not appear to deal with. One reason may be that analyses are generally made of tea liquors produced by distilled water, which is the very worst possible from the point of view of the commercial expert or in domestic usage.

FIG. 4.—Section through Tea-leaf.

The principal chemical constituents of tea of practical interest are: caffeine, tannin and essential oil, on which depend respectively the physiological effects, the strength and the flavour. The commercial value appears to depend on the essential oil and aroma, not on the amount of caffeine, tannin or extract.

The following is suggested as a typical analysis of an average sample of black tea:—

	Per cent.
Albuminous matters	24
Gummy matters	4
Cellulose	20
Chlorophyll and wax	2
Caffeine	3
Tannin	10
Essential oil	0·75
Resin	3
Mineral matter (ash)	6
Moisture	7
Extractive matter	20·25
	100

Also a trace (·1 to ·2 per cent.) of boheic acid, a vegetable acid peculiar to tea. The amount of tannin found in green teas appears to be about half as much again as in black, and the former always yield less moisture, doubtless because of the harder fibre produced by the method of manufacture and the frequent use of a facing medium. A large percentage of moisture found in any sample would indicate improper condition. At the stage of final firing, tea is supposed to be desiccated as completely as possible, and it is then sealed up to exclude air entirely. It is, however, most liable to absorb moisture upon subsequent exposure. Caffeine (formerly known as theine) is the alkaloid of tea, and is identical with that of coffee, guarana, mate and kola nut. It is closely allied to theobromine, the alkaloid of cocoa, and also to uric acid. In large quantities it is a poison, but in smaller quantities it acts as a stimulant. It exists in greater percentage in Indian and Ceylon teas than in those from Java, and is lowest in China and Japan teas. Tannin is a hardening and astringent substance, and in large quantities impairs digestion. Prolonged infusion increases the amount extracted. The essential oil of tea is of a citron yellow colour; it is lighter than water and possesses the distinctive odour of tea. Extract varies from 26 to 40 per cent., and is no guide to quality. Ash averages 5·7 per cent., about half of which is soluble in water. About 8 per cent. of ash is proof of adulteration.

Commercial.—There is probably no article of large consumption the commerce in which has been so revolutionized during a single generation. In 1877, except to the initiated, tea meant China tea. India and Java were producing a little, but practically for use only in Great Britain and Holland. Formosa and Japan were beginning to attract attention in America, but China supplied the world, and almost entirely through the medium of the London market. The days of sailing ships from China had not entirely passed, and the steamers of the period were built for rapidity of transit to London. The Australasian colonies got their supplies direct, and part of the Russian supplies went by the caravan routes.

By 1907, however, the greatly increased production in India and Ceylon, with the willingness of many nations to drink such teas, in preference to those of China, had left to her Russia as a customer for nearly half her export of the article, a proportion rapidly diminishing, as that country too turned in the direction of using the stronger varieties.

China and Japan have hitherto been regarded as the chief producers of tea, and the reputed large domestic consumption of those Mongolian peoples has led to assumptions of vast internal productions. There exist absolutely no data, and it is doubtful whether such can ever be gathered, for forming trustworthy estimates. In both of those countries tea is grown principally in a retail manner, and much of it simply for family consumption. The country cultivator has, as a rule, only a small area—perhaps a corner of his farm or garden—planted with tea, the produce of which is roughly sun-dried and cured in a primitive manner. Any surplus not needed for the family is sold in its sun-dried state to the collector, who takes it to the hong, where it is fired, blended and packed for exportation. Excluding therefore from any record the quantities produced for internal consumption in China and Japan (that from the former alone has been estimated at a total of 2,000,000,000 lb), the following are the acreage and production of the world as taken from the latest recorded statistics available in 1908:—

	Acreage under tea.	Production. lb	
China	...[1]	188,371,000	quantities exported only.
„ . . .	(Brick tea for Tibet)[1]	19,000,000	
Japan	121,202[2]	39,778,000	
Formosa . . .	79,858	20,300,000	
India	531,808	240,411,000	
„ (Burma) .	1,498[2]	3,249,000	
Shan States .	(mostly pickled tea)[1]	16,000,000	
Ceylon	390,000	170,527,000	
Java	45,000	26,215,000	
Natal	5,000	2,750,000	
		726,601,000	

The quantity from China includes about 16,000,000 lb imported from India, Ceylon and Java, and worked up with China teas into bricks and tablets.

China. The modern developments of production and consumption have rendered the subject of China tea one of subordinate interest, except to students of commercial evolution. In several of the earlier editions of this work very ample details are furnished regarding the same, with many interesting pictorial illustrations of the processes of production. The conservative tendencies of the Chinese people have prevented them adopting the modern methods of extensive cultivation based on scientific principles, and the manipulation of crops by machinery in place of hand labour. Consequently, their export trade has been for many years a diminishing one. Of the exported quantity referred to above, only 81,000,000 lb were the ordinary black tea known to the English consumer (collectively described in the United States of America and Canada as "English Breakfast

China black tea.

[1] Areas unascertained. [2] Official figure, but accuracy doubtful.

Tea"). Out of that total, Great Britain consumed only about 5,000,000 lb, against a consumption of 126,000,000 lb of China tea in 1879. Green tea is represented by 28,000,000 lb, and this went chiefly to the United States of America, to Central Asia and to North Africa. The remainder, 80,000,000 lb, is brick and tablet tea sent entirely to Asiatic and European Russia. The method of compressing tea into tablets or bricks is unfamiliar in western Europe. It doubtless arose from the necessity of reducing bulk to a minimum for conveyance by caravan across the great trade routes of Asia, and now that the railway and the steamship have supplemented more primitive methods of transit, the system is still continued to meet the wants of the consumer who would not recognize his tea in any other shape. The preparation of the tea in the requisite form has, however, largely left Chinese hands. The Russians have themselves established several important factories at Hankow, which is the chief seat of this industry, and to which place they import in large quantities tea-dust and small broken tea from India, Ceylon and Java. Those are freely used in the preparation of small tablets, compressed to such a condition of hardness as to resemble wood or stone, and commonly passed round as currency in certain districts of Russia. Of a somewhat different nature is the brick tea prepared chiefly at Ya-chou in the province of Ssu-chuan for overland transit to Tibet, to investigate the commerce in which Mr James Hutchison, M.A., was sent in 1906 as a special commissioner for the Indian Tea Cess Committee. This tea is mostly prepared from exceedingly rough leaf, including even bush prunings, which would not be plucked for manufacturing purposes in India or Ceylon. It is "panned," rolled, fermented and divided into various classes or qualities. It is then steamed and placed in a moulding frame of wood to compress it into the size and shape of brick wanted. The bricks are wrapped in paper bearing hong marks, or some writing in Tibetan. For transit they are packed twelve together in hides sewn up while moist, which contract to make a strong tight package of 60 to 70 lb weight. These bales are carried on the backs of coolies for great distances across very high passes into Tibet, and the trade is estimated at an average of 19,000,000 lb per annum, of which 8,000,000 is a subsidy from the emperor of China to the Tibetan monasteries.

China green tea. ***Bricks and tablets.*** ***Brick tea for Tibet.***

The Japanese production is almost entirely green tea for North American use. It is prepared in two distinctive classes named by the final process of manufacture applied in each instance, viz. basket-fired, *i.e.* dried over a hot stove in a basket, and pan-fired, *i.e.* in machine-made pans. The industry is a declining one, because of change in the American taste, and the area under cultivation has diminished by nearly 20 per cent. in the ten years since 1896. The mulberry leaf for the more profitable silk trade has taken its place. The export production of the island of Formosa is limited to a particular class of tea termed Oolong, practically all produced for the United States of America. It is scarcely known in England save by experts. The Tea Cess Committees of India and Ceylon have both sent representatives in recent years to study the manner of growth and production, but in neither country has there been so far any successful attempt to produce commercially tea of the class. A radical difference exists in connexion with the method of growth, in that the plants are never grown from seed, but are always propagated from layerings. Soil, situation and climatic conditions have doubtless much influence on the peculiar character of the tea produced. The manufacturing methods are elaborate and careful, and the produce has in its choicest qualities a particular delicacy and bouquet possessed by no other variety of tea.

Japan. ***Formosa Oolong.***

As the planting, productive and manufacturing processes of India may be taken to be generally representative of Ceylon and Java also, and therefore of the tea of modern commerce in most lands outside of China and Japan, the methods followed will be described with some fullness.

Indian tea trade.

A rich and exuberant growth of the plants is a first essential of successful tea cultivation. This is only obtainable in warm and moist localities where rains are frequent and copious. The climate indeed which favours tropical profusion of jungle growth—still steaming heat—is that most favourable for the cultivation of tea, and such climate, unfortunately, is often trying to the health of Europeans. It was formerly supposed that comparatively temperate latitudes and steep sloping ground afforded the most favourable situations for planting, and much of the disaster which attended the early stages of the tea enterprise in India is traceable to this erroneous conception. Tea thrives best in light friable soils of good depth, through which water percolates freely, the plant being specially impatient of marshy situations and stagnant water. Undulating well-watered tracts, where the rain escapes freely, yet without washing away the soil, are the most valuable for tea gardens. Many of the original Indian plantations were established on hill-sides, after the example of known districts in China, where hill slopes and odd corners are commonly occupied with tea-plants.

Climate.

The methods described hereafter are those generally followed in India and Ceylon in the manner of the most modern application, but variations must take place according to district and elevation. Propagation is from seed only. The seed is rather larger than a hazel nut, with a thicker and darker shell and perfectly spherical shape. When ripe (about the month of November) the seeds are placed a few inches apart in carefully prepared nurseries, which are watered, shaded and weeded till the regular rains of May and June admit of the shading being removed. The seedlings should then be 6 ins. to 8 ins. high and ready to plant out in the fields. These are prepared by cutting down and burning the jungle, which is afterwards hoed, lined and staked in parallel rows running both ways. The intervals of planting vary, but 4½ ft. by 4½ ft. is a very common distance. Pits 15 ins. to 18 ins. deep are dug for each plant, and refilled loosely—then the seedlings are carefully placed in them. With favourable weather they should be 15 ins. to 18 ins. high by the end of the first year. Sometimes the plants are grown in the nursery for a whole year or more and put out during the cold weather. After two years' growth the bushes should be 4 to 6 ft. high. They are then cut down to about 8 ins. and are allowed to grow again up to 2 or 3 ft. before, towards the end of their third year, being plucked regularly. The object of this cutting down is to cause the bushes to spread out and cover the ground area usually allowed to each plant, *i.e.* about 20 sq. ft. The yield in the third year is small, probably less than ½ oz. finished tea per bush. At 7 to 10 years old, when in full bearing, 4 to 5 oz. would be considered a good return. The annual production per acre from matured plants was in 1906 in the principal producing districts of India:—

Planting out.

Darjeeling	317 ℔
Assam	402 „
Travancore	452 „
Sylhet	515 „
Cachar	542 „
Dooars	569 „

Individual estates of large area gave as much as 1280 ℔ per acre. In Ceylon the average yield per acre was 440 ℔, but there are verified records of 996 ℔ per acre within the year from an estate of 458 acres. On the same property an area of 100 acres gave 1100 ℔ per acre on the average over a period of 18 years.

Cultivation.

Cultivation in the northern parts of India is done by digging over the soil—locally termed hoeing—once in the winter quarter and six times in the nine months of the harvesting season. To keep an estate clean and in good cultivation it requires to be gone over every six weeks. The labourers being barefooted, a spade is useless, so a "khodalee" or hoe (much like a very heavy and long-bladed garden Dutch hoe) is used. It is raised well over the head and dropped forcibly into the ground, then pulled towards the wielder to turn over the soil. In southern India and Ceylon clean hand-weeding is the method of cultivation, almost no hoeing being done. In northern India the plucking season begins in April. During the first flush (*i.e.* the breaking out of young green shoots after pruning and the rest of winter) the bush is encouraged to grow by leaving 3 or 4 fully developed leaves after removing the tip of the shoot. It takes about 6 weeks to remove entirely the whole of the first and succeeding flushes, going round the estate once a week. In the second flush two leaves only are left. In the third and fourth flushes only one large leaf, and after that—say during October, November and part of December—no soft leaf growth is left that can be harvested in good order. In northern India, where the weather in the winter months is cold and dry, growth practically ceases, and then the whole area is pruned and cut down to about 16 ins. high all over, but in Travancore and Ceylon it grows continuously and is only pruned when found expedient at intervals of 15 months to 2 years. In certain cases of high-lying estates, where the growth is slow, it is allowed to run 3 years from pruning. The finest teas are produced at high elevations in Darjeeling and Ceylon and in the plains of Assam, but the quality from individual estates varies much from season to season, and even from week to week. There are at times marked differences between the produce of adjoining estates, with apparently identical conditions of soil and situation. Tea grows and thrives from about sea-level in the tropics to 7000 ft. in more temperate conditions. The life of a well-cared-for bush has been estimated at 50 years, in spite of its numerous enemies. Those include mites, termites (or white ants), thread blight, grey blight, caterpillars (naked or in bags) and caterpillars armed with stinging hairs to protect them, and borers, red and black, some of which eat the core out of the wood, while others content themselves with eating only the bark.

During recent years in India a new development has taken place in planting tea upon what are termed "bheels,"—lands resembling to a great extent the peat bogs of Ireland and Scotland. When opened up by an elaborate and complete system of drainage, they have been found to possess the power of producing enormously heavy yields, and it is from such estates that the greatest yields in India have come.

In Ceylon, and to some extent in India, the careful and systematic application of chemical manures, compounded on scientific lines, has been found to increase largely the yield of leaf, and much interplanting of nitrogen-producing growths has been done with a view to restoring to the soil the most necessary constituents.

Manufacture.

In the early days an attempt was made to copy the Chinese methods, and the various processes were manual. Now, from the plucking stage onwards, almost everything is done by machinery. During the season of yield the flushes are plucked every 7 to 10 days, and, as a rule, in India the opening bud and two leaves below it are plucked. To take more than this would be considered coarse and less would be fine plucking. These are of course quite immature, the longest rarely being one inch in length. The lower leaves on the young shoots are too old and hard to manufacture into tea. The plucking is done by women and children, and is now practically the only part of the work where the tea is touched by hand. The plucking season continues in some districts of India till December. As they are plucked, the green leaves are thrown into baskets, and twice daily the pluckings are taken into the factory. They are then spread out thinly on trays or racks made of bamboo, canvas or wire netting, under cover, for some 18 or 30 hours (according to the temporary weather conditions) to wither, after which they are in a soft, flaccid condition ready for rolling. On a successful wither the amount of the tea ferment or enzyme is dependent. The object of rolling is to crush the leaves and to break their cells so as to liberate the juices. The leaves are passed repeatedly through a machine driven by steam or other power giving a rotary motion, the operation occupying about 40 to 60 minutes. The next process is familiarly termed fermentation, but is really an oxidation of the leaves. Should the leaf be intended to be cured as green tea, the fermenting process is omitted and some other processes applied, but in India very little green tea is manufactured. Many people still cherish the antiquated belief that black and green teas are grown upon different varieties of the tea-plant, which is quite a mistake, the difference being merely one of preparation. After being rolled, the leaves are spread out in layers of 1 to 2 ins. thick in a cool house, and left to undergo the chemical action resulting from their condition. This process is checked after from 2 to 3 hours, according to climatic conditions. A further brief rolling to close up the open leaves is followed by the first firing, which is effected by subjecting the leaves to the gradual action of hot air up to a temperature of 240° F. Various applications of the same system are in use, but the most popular is to place the leaves on trays of wire network in a high temperature for about twenty minutes, after which they are firm and crisp. Up to this point of the manufacture the leaf has been in the stalk, the leaves and bud being unseparated. They are now broken apart and sorted by mechanical sifters into the various grades or qualities, which are described as Orange Pekoe, Pekoe, Pekoe Souchong and Souchong, each of which names represents approximately the leaf-bud and the three lower leaves. In addition to these four classes, out of each are sifted all the smaller fragments of leaf broken in the process of manufacture, which are termed *Broken* Orange Pekoe, &c. These broken grades are frequently objected to by the consumer, under the impression that they are inferior in quality, but in the opinion of experts, the more the leaf is broken up, the better is the liquor upon infusion. Upon completion of the sifting, the tea is again fired, and while warm it is packed tightly into lead-lined chests, and the lead covers completely soldered over it, so that it may be kept perfectly air-tight until required for use.

Machinery.

The machinery in use is very varied in character, and it has been evolved principally by practical planters of a mechanical turn. Many estate superintendents have begun their careers as engineers, and it is not unusual for a large estate, or group of estates, to have one member of the European staff who is a qualified engineer. The motive power is generally a steam engine, but the greater economy and facility of oil engines have led to their fairly wide adoption. Where water power is available, turbines of a variety of types are in use. The machines to be driven are air-fans, rollers, roll-breakers, sifters, cutters and packers, and there are besides numerous types of driers or desiccators. The names associated with the most successful and widely used machines are those of the Messrs Jackson (makers, Marshalls of Gainsborough) and Mr S. C. Davidson, of the Sirocco Works, Belfast. The production of the empty boxes for packing, called chests or half-chests, is in itself a large industry. The heavy old-fashioned country-made packages are rapidly being replaced by light-tared boxes made from several thicknesses of veneer pressed closely together, most of which come from Russia.

Green tea.

A production temporarily in excess of the world's demand of several years ago, led to the offering of bonuses for the production in India and Ceylon of green teas, with a view to lessening the black tea output. The methods adopted were successful, and after some vicissitudes a satisfactory business has been established, especially with the United States of America and Canada. The methods of producing this tea are not so complicated as those followed in China and Japan. The principal difference from the manner described of making black tea lies in the omission of the withering and fermenting, and the substitution for those of a steaming or panning process. The effect of either is to destroy the possibility of fermentation by subjecting the leaf, as soon as it is plucked, to a brief period of great heat. This completely destroys the ferment or enzyme, and renders it possible to conserve the tea in what is really nearer its natural form than the black tea that is so well known to the consumer.

Tea Consumption.—The following table gives particulars relative to the principal consuming countries, from which it will be seen that Great Britain and its English-speaking dependencies are the great consumers:—

Tea Consumption of Chief Consuming Countries in 1906.

China . . . . Unknown
Japan . . . . ,,

	Total per Annum.	Rate per Person of Population.	Rate of Duty per lb.
	lb		
United Kingdom . . .	269,503,000	6·17	5d.
Russia	135,400,000	0·94	Certain kinds free for Asiatic Russia or over Asiatic frontier —others 2¾d. to 1s. 11½d.
United States of America	84,842,000	0·89	Free.
Dominion of Canada. .	23,969,000	4·34	,,
Commonwealth of Australia.	27,959,000	6·88	,,
Dominion of New Zealand	6,141,000	6·5	,,
Germany	6,354,000	0·11	(If British grown) 1·35d.
France	2,428,000	0·06	9d. (surtax 2¾d. if not direct import).
Holland	7,874,000	1·45	2½d.
South Africa	7,572,000	1·4	4d. (Natal tea free)
Argentine Republic . .	2,870,000	0·49	4½d.
Tibet.	19,000,000	13½ lb	High, but uncertain.
India (estimated) . . .	7,240,000	?	Free.
Burma (average about).	19,000,000	?	,,
Persia (average about) .	6,000,000	?	4½d. to 7d.
	626,152,000		

The countries of smaller consumption absorbed about 25,000,000 lb, but there is a considerable excess in the returns of production over those of consumption. This arises partly from the latter relating in certain instances to an earlier period, and partly from the fact that much of the yield of 1906 was afloat or undespatched at the close of that year.

The following table gives the approximate rates of duty per English lb during 1907 in places not referred to above:—

Austria and Hungary . . . . 9¾d. imported by sea, by land 11d.
Bahamas . . . . . 6d.
Barbados . . . . . 3d. and 20% ad val.
Belgium . . . . . Free.
Bermuda . . . . 6¼% ad val.
Brazil . . . . 50% ad val.
British E. Africa . . . . . 10% ad val.
British Guiana . . . . 8d.
Bulgaria . . . . . 4½d. plus 4½d. excise and octroi 1½d.
Chile . . . . 9d.
Cyprus . . . . . . 4d.
Denmark . . . . 4d.
Ecuador . . . . . 2½d.
Egypt . . . . 8% ad val.
Fiji . . . . 6d.
Gibraltar . . . . Free.
Greece . . . . . . 1½d.
Grenada . . . . . 6d.
Honduras . . . . 2½d.
Italy . . . . 11d.
Jamaica . . . . . 1s.
Lagos . . . . 1d.
Malta . . . . Free.
Mauritius . . . . 3d.
Mexico . . . . . . 6d.
Morocco . . . . . 10% ad val.
Newfoundland 33% ad val.
Nigeria . . . . . . 10d.
Norway . . . . . 1s.
Peru . . . . 65% ad val. and 10%.
Portugal . . . . . 2s. 0½d.
Rumania . . . . 3½d. and 4½d. excise.
Sierra Leone . 10% ad val.
Spain . . . . 6½d. (if transhipped in a European port 1s. 7½d. cwt. additional).
St Helena . . . . Free.
Straits Settlements . . . . . Free.
Sweden . . . . . 3d.
Switzerland . . In receptacles weighing less than 5 kilos. 1¾d. over 1·10d.
Tobago and Trinidad . . . 6d.
Turkey . . . . . . 11%.
Uganda . . . . . 10%.
Uruguay . . . . . 5¾d.
Venezuela . . . 6d.

The rate per head of population within the United Kingdom has not increased much during recent years, and in the Australasian colonies it has apparently fallen greatly as compared with recorded averages of 12 lb per head in Victoria and 9 lb in New South Wales in 1884. The modern statistics of the commonwealth may be more accurately kept, and there may be less waste in use, but it is not supposed that there is any diminution in the free use of the beverage which has always characterized the antipodean colonist. One important factor in keeping down the amount per person is the substitution in use, which for a generation has been in progress, of the stronger teas of India and Ceylon for the old-fashioned weaker produce of China. The progressive increase in the consumption of tea in Great Britain and Ireland during 50 years from 1836 to 1886 is shown in the table below. The dotted line represents the average monthly consumption in each year; the fluctuations in price of good sound China congou are traced by the black line; and the years in which reduced customs duty came into operation are indicated along the base. From 1860 onwards, the amount of Indian tea entered for home consumption is shown in monthly average by a black column. This column brings out the remarkable fact that the Indian tea alone consumed in 1886 equalled the consumption of all kinds in 1860, and was double the quantity of all kinds in 1836. The table, however, shows merely the general development of consumption, but a similar one on next page, bringing the figures up to 1907, shows the gradual and almost total displacement of China tea by that grown in the English dependencies. In both, the price fluctuations and fiscal changes are shown that their effect upon consumption may be judged. The prices below are the annual averages for all Indian teas sold in the London public auction market during the years stated. Lowness of price has not been the only factor in increasing the rate of consumption. The lean years and the fat years of the general labour market always tell, and the low range

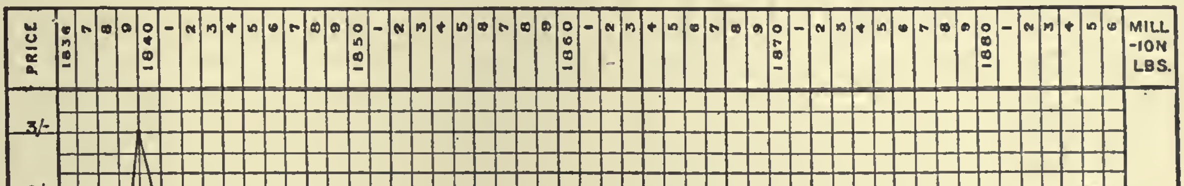


FIG. 5.

of prices for sugar during recent times has undoubtedly assisted in increasing the amount available for expenditure on tea. In Russia tea costs more to the consumer than in any country where modern transit by railway and steamer exists. The reason is the enormous proportion of the retail selling price which is exacted by the government by way of duty. But in return the government, with a paternal care for its people, makes absolutely certain that the tea reaches their hands as pure and unadulterated as when it first entered the country. Russian tea has always had a high reputation—largely a sentimental one, however. The quantity taken by the country is very large, but when spread over the enormous population the rate of consumption per person is not great. The extreme poverty of the great body of the people and the high price doubtless explain this. The method of use differs much from that followed in England. The samovar, or urn for boiling the water, is always much in evidence. Tea that makes a dark, strong liquor is preferred—not that such liquor is used, but that the greatest possible quantity of tea-coloured water may be drained from the teapot by refilling it over and over again from the samovar. The tea is generally drunk from glasses and while very hot, with a liberal addition of sugar and a flavouring of lemon. The method of use is

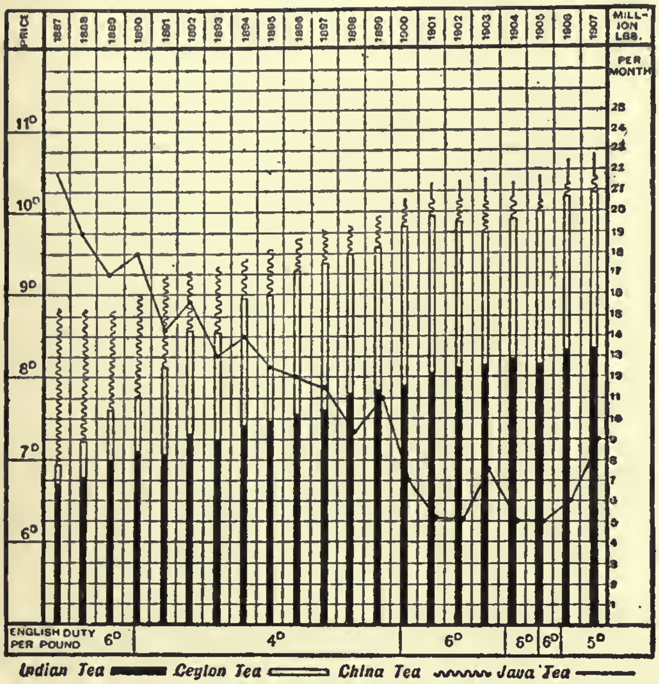


FIG. 6.—Diagram showing the alterations in the relative proportions of different growths of tea consumed during the 21 years ended the 31st of December 1907; the variations in the London average prices for Indian teas, and the changes in the English rate of duty. Vertical lines show the average monthly consumption in Great Britain and Ireland in millions of pounds. The diagonal line shows the average price per ℔ of all Indian tea sold in the London public auctions.

probably a more healthy one than that followed in many parts of the United Kingdom, where strong infusions of powerful teas are indulged in too frequently.

The United States of America and the great colonial dependencies follow generally the English way of using the beverage.

France, considering that it is England's nearest neighbour, has a remarkably small tea consumption: ·06 ℔ per person per annum, or about $\frac{1}{100}$th only of the English rate. The increase in consumption there has been so small that it probably arises mainly from the increasing number of English and English-colonial visitors that spend portions of each year in the country.

Germany, and the Germanic peoples, take slightly more per person, but the statistics are rather indefinite. Holland, in Europe, comes next to England, and uses principally the product of her dependency Java. The other nations of Europe are very small consumers. Some of the peoples of eastern Europe take their tea with an admixture of rum. In Morocco and generally throughout North Africa there is a considerable demand for green tea, which is drunk hot out of glasses, the liquor being almost saturated with sugar and strongly flavoured with mint.

In China and Japan tea is generally drunk without any other qualifying or flavouring addition. Exceedingly delicate teas can therefore be used unimpaired. In Japan the ceremony of serving tea has, among the better classes, been raised to a high art, which the girls have to study at school for protracted periods.

In Mongolia and other parts of Central Asia tea is made into a kind of soup, somewhat on the lines of the following written regarding tea in Tibet by Colonel Waddell in his book *Lhasa and its Mysteries*. Writing of the Tibetan he states: "As a beverage he drinks, all day long, cupfuls of hot buttered tea, which is really a soup or broth made by boiling tea-leaves with rancid butter and balls of dough, and adding a little salt, and straining—a decoction which was invariably nasty to our taste, though no doubt it is wholesome; for it is not merely a stimulating hot drink in the cold, but overcomes the danger of drinking unboiled water in a country where the water supply is dangerously polluted."

Geography of Tea.—The successful commercial production of tea on a large scale is confined to a strictly limited area enclosed by about 40° of latitude (5° S. to 35° N.) and about 73° of longitude (67° to 140° E.), while the consumption shows itself to a large extent to have strictly geographical limitations. The southern hemisphere ranks lightly in the matter of consumption, the only other country worth mentioning there besides the Australasian and Cape dependencies being Argentina. A straight line of latitude runs through all of these. In the northern hemisphere (excluding the races who consume their own produce) the material consumption of tea is in regions lying 40° N. and above it, but here there is an interesting subdivision to be made. In the United States of America and Canada, in some portions of Europe and of Asia, and along the north of Africa, there is a free use made of green or unfermented teas with pale, pungent infusions. The demand for such, as a general rule, lies principally in lower latitudes, while the farther north the consumer lives he seems to require more of the black or fermented tea of India, Ceylon or China, with the dark, thick, heavy liquor its infusion produces.

Transportation.—In the early part of the 19th century the tea shipped to England was destined to supply many countries, as London was then, and until comparatively recent times, the common warehouse and central market for the world, and England the common carrier. Throughout that century fairly steady and rapid progress was shown—especially in its earlier periods—in the trade from China, which reached its maximum in 1879. And it is here that some of the romance of commerce comes in. As the trade grew in importance, the advantages of rapid transit for the tea of new season's production began to be appreciated, and the slow and stately progress of the old East Indiaman became out of date. A type of vessel, specially designed for the rapid carrying of tea from China to England via the Cape of Good Hope, was introduced, known as the "China Clipper," and the competition was always keen as to which ship should make the most rapid passage. This culminated in the year 1866, when nine ships sailed almost simultaneously from Foochow, three of them crossing the bar in company. These three were all built by the same builders in Greenock, and came in ahead of all the others, making the long voyage of fully 16,000 m. in 99 days. They each docked in a separate dock in London upon the same day, and all within two hours of each other. The two leading ships had not seen each other for 70 days and met off the Lizard, from which point they ran a neck-and-neck race before a strong westerly wind, with every rag of canvas set.

The opening of the Suez Canal in 1869 soon changed the course of all trade with the East, and in a few years the sending of tea per sailing ship round the Cape of Good Hope was a thing of the past. Romance was no more, although there was extreme competition in building steamers with great power and speed to land their cargoes rapidly by the new route. This reached its height in 1882, when the s.s. "Stirling Castle" made the phenomenal run, for those times, of 28 days from Woosung to London.

But England, which formerly supplied almost everything to her own colonies and to many foreign countries besides, has, under the modified conditions of abundant steam tonnage everywhere, become less and less of a distributive country. Consequently, direct shipments are made now from the countries of production to those of consumption. America gets its tea largely through its western seaboard from China, Japan, Ceylon and India, while not a little is reaching it of recent years by steamers running direct from those countries via the Suez Canal to New York. The Australian demand is fed by steamers from Calcutta and Colombo, with some additions direct from China and Java.

The extensive Russian trade is now largely conducted over the Siberian railroad, and this, next to the transit to London, represents the largest volume of tea traffic passing in one channel. This route has displaced much of the protracted caravan business through Manchuria and Mongolia. A most interesting and adventurous episode in connexion with Russian trade was the effort repeated over several successive years by the late Captain Wiggins to convey tea entirely by sea from Chinese ports around the North Cape and through the Kara Sea to the Obi and Yenisei rivers. When successful, the journey, although about seven times the mileage of the old direct caravan route, took four months instead of eighteen, and was of course much less expensive.

The only protracted camel or mule caravan journeys remaining in connexion with the tea trade are those in Persia and Morocco, where the conservatism of race delays the introduction of even wheel roads, not to mention railways.

Tea Adulteration.—In the earlier days of the tea trade, adulteration, especially prior to importation, was frequent, because the prices obtainable made it remunerative. Now, intentional adulteration is practically non-existent, chiefly because of the fact that in the places of production the price obtainable is so low that any possible adulterant would be too costly to collect. Most countries have a close check upon this at the time of importation, and the customs authorities in Great Britain submit to analysis all samples of a doubtful character. Impure teas are not permitted to pass into consumption, but the quantity condemned after analysis as unfit for food in the year 1906 was 41 packages, out of a total of 317,000,000 lb.

Effect on Health.—The effect of the use of tea upon health has been much discussed. In the days when China green teas were more used than now, the risks to a professional tea-taster were serious, because of the objectionable facing materials so often used. In the modern days of machine-made black tea, produced under British supervision, both the tea-taster and the ordinary consumer have to deal with a product which, if carefully converted into a beverage and used in moderation, should be harmless to all normal human beings. There has been constant controversy as to whether China tea is better than that of other growths, but the verdict first of all of Great Britain, and subsequently of all the other large consuming countries, has relegated the produce of the Celestial Empire to a very subordinate position. A limited section of medical opinion has recommended China tea for reasons of health, and undoubtedly the inferior strength it possesses reduces the risk arising from improper use, but it also reduces the stimulating and comforting effects the ordinary tea-drinker hopes to experience. Next to water, tea is the beverage most widely in use throughout the world as regards the number of its votaries as well as the total liquid quantity consumed.

Bibliography.—The statistics given are taken as far as possible from official returns, and where such are unavailable they have been carefully compiled from reliable data.

The literature of tea is very copious, but scattered in pamphlet form to a great extent. In addition to the books quoted in the text, the following may be mentioned:—Bontekoe, *Tractat van het excellenste Kruyd Thee* (The Hague, 1679); Sylvestre Dufour, *Traités Nouveaux et Curieux du Café, du Thé, et du Chocolat* (2nd ed., Lyons, 1688; translation of 1st edition by John Chamberlayne, London, 1685; translations also in Spanish and Latin); J. G. Houssaye, *Monographie du Thé* (Paris, 1843); Robert Fortune, *Three Years' Wanderings in China* (London, 1847); Id., *A Journey to the Tea Countries of China* (London, 1852); S. Ball, *Tea Cultivation in China* (London, 1848); J. J. L. L. Jacobson, *Handboek voor de Kultuur en Fabrikatie van Thee* (3 vols., 1843); S. A. Schwarzkopf, *Die narkotischen Genussmittel*—i. *Der Thee* (Halle, 1881); Lieut.-Colonel E. Money, *Cultivation and Manufacture of Tea* (3rd ed., London, 1878); F. T. R. Deas, *Young Tea Planter's Companion* (London, 1886). See also parliamentary papers and official publications of Indian government; Monographs on brick tea, Formosa tea and other special studies, prepared for the Tea Cess Committees of India and Ceylon; *Journals of the Royal Asiatic Society*, *Journal of the Society of Arts*, *Geographical Journal*, *Tea and Coffee Trade Journal* (New York), &c. For practical planting details, see *Tea; its Cultivation and Manufacture*, by David Crole (1897), with a full bibliography; also Rutherford's *Planter's Handbook*. For scientific aspects see *Chemistry and Agriculture of Tea*, by M. Kelway Bamber (1893). (J. McE.)

TEA-CADDY, a box, jar, canister or other receptacle for tea. The word is believed to be derived from *catty*, the Chinese pound, equal to about a pound and a third avoirdupois. The earliest examples that came to Europe were of Chinese porcelain, and approximated in shape to the ginger-jar. They had lids or stoppers likewise of china, and were most frequently blue and white. The English kilns at first imitated them, but speedily devised forms and ornament of their own, and there was hardly a ceramic factory in the country which did not compete for the supply of the new fashion. But tea-caddies were not for long confined to procelain or faïence. They were presently made in a great variety of materials, and in an equal variety of shapes. Wood, pewter, tortoise-shell, brass, copper and even silver were employed, but in the end the material most frequently used was wood, and there still survive vast numbers of Georgian box-shaped caddies in mahogany, rosewood, satinwood and other choice timbers, often mounted in brass and delicately inlaid, with knobs of ivory, ebony or silver. Although many examples were made in Holland, principally of the earthenwar of Delft, the finer varieties enamelled, enriched with ciphers, and emblazoned with heraldry, the tea-caddy was a typically English product. As the use of the jar waned and that of the box increased, the provision of different receptacles for green and black tea was abandoned, and the wooden caddy, with a lid and a lock, was made with two and often three divisions, the centre portion being reserved for sugar. Chippendale's caddies in Louis Quinze fashion were delightful, with their claw and ball feet and exquisite finish. On the whole the mahogany or rosewood caddy of the latter part of the 18th and the early years of the 19th century was, from the artistic point of view, the most elegant and satisfying. The wood was rich and well-marked, the inlay simple and delicate, the form graceful and unobtrusive. Even when it took the shape of a miniature sarcophagus, imitated from the massive wine-coolers of the Empire period, with little claw feet and brass rings, it was a decidedly pleasing object. The larger varieties were known as tea-chests. As tea grew cheaper it became less important that it should be kept constantly under the mistress's eye, and the tea-caddy gradually fell into desuetude. It has, however, never gone entirely out of use, though handsome examples are now most commonly regarded as ornaments or preserved in collections.

TEACH [Thatch or Thach], **EDWARD** (d. 1718), English pirate, popularly known as Blackbeard, is believed to have been born at Bristol. He is said to have gone out to the West Indies during the war of the Spanish Succession, to have engaged in privateering, and after the declaration of peace (1713) to have turned pirate, but he is not actually heard of in this capacity till the end of 1716. The following year he captured a large French merchantman, rechristened her "Queen Anne's Revenge," and converted her into a warship of forty guns. His robberies and outrages in the Spanish main, the West Indies, and on the coasts of Carolina and Virginia, quickly earned him an infamous notoriety. He made his winter quarters in a convenient inlet in North Carolina, the governor of which colony was not above sharing in the proceeds of his crimes, but the governor of Virginia at last despatched two sloops, manned from the British warships on the station, to cut him out. On the 22nd of November 1718 Lieutenant Maynard, commanding the attacking forces, boarded Teach's sloop, after a sharp fight, and himself shot the pirate dead. Teach seems to have been an ignorant ruffian. His personal appearance was remarkable. His nickname was due to his habit of tying up the ends of his long and bushy black beard with ribbon and curling them back over his ears. Johnson in his *General History of the Pyrates* gives his name as Teach, but according to the official records it was really Thatch or Thach.

TEAK,[1] the most valuable of all known timbers. For use in tropical countries it has no equal, and for certain purposes it is preferable to other woods in temperate climates also. Its price is higher than that of any other timber, except mahogany.[2] Great efforts have been made to find substitutes, but no timber has been brought to market in sufficient quantities combining the many valuable qualities which teak possesses.

The first good figure and description of the tree was given by Rheede,[3] the best modern picture being that given by Brandis.[4] The younger Linnaeus called it *Tectona grandis*. It is a large deciduous tree, of the natural order Verbenaceae, with a tall, straight but often buttressed stem, a spreading crown, and the branchlets four-sided with large quadrangular pith. It is a native of the Indian peninsula, Burma and Siam, and is also found in the Philippine Islands, in Java and elsewhere in the Malay Archipelago. In India proper its northern limit is 24° 40′ on the west side of the Aravalli Hills, and in the centre, near Jhansi, in 25° 30′ N. lat. In Burma it extends

[1] The Sanskrit name of teak is *saka*, and it is certain that in India teak has been known and used largely for considerably more than 2000 years. In Persia teak was used nearly 2000 years ago, and the town of Siraf on the Persian Gulf was entirely built of it. *Saj* is the name in Arabic and Persian; and in Hindi, Mahratti and the other modern languages derived from Sanskrit the tree is called *sag*, *sagwan*. In the Dravidian languages the name is *teka*, and the Portuguese, adopting this, called it *teke*, *teca*, whence the English name.

[2] The rate in the London market since 1860 has fluctuated between £10 and £20 per load of 50 cub. ft.

[3] *Hortus Malabaricus*, vol. iv. tab. 27, 1683.

[4] *Forest Flora of North-West and Central India*, Ill. t. 44.

to near Myitkyina, in lat. 25° 30′. In Bengal or Assam it is not indigenous, but plantations have been formed in Assam as far as the 27th parallel. In the Punjab it is grown in gardens to the 32nd.

Teak requires a dry tropical climate, and the most important forests are found in those districts of India where, during the summer months, heavy rains are brought by the south-west monsoon, the winter months being nearly rainless. In the interior of the Indian peninsula, where the mean annual rainfall is less than 30 in., teak is more scarce, and it thrives best with a mean annual fall of more than 50 in. The mean annual temperature which suits it best lies between 75° and 81° Fahr. Near the coast the tree is absent, and inland the most valuable forests are on low hills up to 3000 ft. It grows on a great variety of soils, but there is one indispensable condition—perfect drainage or a dry subsoil. On level ground, with deep alluvial soil, teak does not always form regularly shaped stems, probably because the subsoil drainage is imperfect.

During the dry season the tree is leafless; in hot localities the leaves fall in January, but in moist places the tree remains green till March. At the end of the dry season, when the first monsoon rains fall, the fresh foliage comes out. The leaves, which stand opposite, or only whorled in very young specimens, are from 1 to 2 ft. in length and from 6 to 12 in. in breadth. On coppice shoots the leaves are much larger, and not rarely from 2 to 3 ft. long. In shape they somewhat resemble those of the tobacco plant, but their substance is hard and the surface rough. The small white flowers are very numerous, on large erect cross-branched panicles, which terminate the branches. They appear during the rains, generally in July and August, and the seed ripens in the succeeding January and February. On the east side of the Indian peninsula, the teak flowers during the rains in October and November. In Java the plantations are leafless in September, while during March and April, after the rains have commenced, they are clothed with foliage and the flowers open. During the rainy season the tree is readily recognized at a considerable distance by the whitish flower panicles, which overtop the green foliage, and during the dry season the feathery seed-bearing panicles distinguish it from its associates. The small oily seeds are enclosed in a hard, bony, 1–4-celled nut, which is surrounded by a thick covering, consisting of a dense felt of matted hairs. The fruit thus formed is further enclosed in the enlarged membranous calyx, in appearance like an irregularly plaited or crumpled bladder. The tree seeds freely every year, but its spread by means of self-sown seed is impeded by the forest fires of the dry season, which in India generally occur in March and April, after the seeds have ripened and have partly fallen. Of the seeds which escape, numbers are washed down the hills by the first heavy rains of the monsoon. These collect in the valleys, and it is here that groups of seedlings and young trees are frequently found. A portion of the seed remains on the tree; this falls gradually after the rains have commenced, and thus escapes the fires of the hot season. The germination of the seed is slow and uncertain; a large amount of moisture is needed to saturate the spongy covering; many seeds do not germinate until the second or third year, and many do not germinate at all. Where the teak tree is associated with dense clumps of bamboo, natural reproduction is almost absent, except when the bamboo flowers and dies, and even then, if the dry bamboos and the resultant bamboo seedlings are not burnt, such young teak as may germinate are likely to be smothered at once.

The bark of the stem is about half an inch thick, grey or brownish grey, the sapwood white; the heartwood of the green tree has a pleasant and strong aromatic fragrance and a beautiful golden-yellow colour, which on seasoning soon darkens into brown, mottled with darker streaks. The timber retains its aromatic fragrance to a great age. On a transverse section the wood is marked by large pores, which are more numerous and larger in the spring wood, or the inner belt of each annual ring, while they are less numerous and smaller in the autumn wood or outer belt. In this manner the growth of each successive year is marked in the wood, and the age of a tree may be determined by counting the annual rings.

The principal value of teak timber for use in warm countries is its extraordinary durability. In India and in Burma beams of the wood in good preservation are often found in buildings several centuries old, and instances are known of teak beams having lasted more than a thousand years.[1] Being one of the most durable of Indian timbers, teak has always been used for buildings, particularly for temples, and in India it has been the chief timber employed for shipbuilding. When iron commenced to be extensively used for the last-named purpose, it was supposed that the demand for teak would decrease. This, however, was not the case, for the wood was for long very largely used in shipbuilding, and though its employment in war-vessels has diminished, it is still in very great demand for "liners" and similar ships. It is also used for furniture, for door and window frames, for the construction of railway carriages, and for many other purposes. White ants eat the sapwood, but rarely attack the heartwood of teak. It is not, however,

Teak (*Tectona grandis*).

proof against the borings of the teredo, from whose attacks the teak piles of the wharves in the Rangoon river have to be protected by a sheathing of metal.

Once seasoned, teak timber does not split, crack, shrink, or alter its shape. In these qualities it is superior to most timbers. In contact with iron, neither the iron nor the teak suffers, and in this respect it is far superior to oak. It is not very hard, is easily worked, and takes a beautiful polish. It has great elasticity and strength, and is not very heavy. The average weight of perfectly seasoned wood fluctuates between 38 and 46 ℔ per cub. ft.[2] Its weight, therefore, is a little less than that of English oak. Green teak timber, however, is heavier than water, so that,

[1] In one of the oldest buildings among the ruins of the old city of Vijayanagar, on the banks of the Tungabhadra in southern India, the superstructure is supported by planks of teakwood 1½ in. thick. These planks were examined in 1881; they were in a good state of preservation and showed the peculiar structure of teak timber in a very marked manner. They had been in the building for 500 years (*Indian Forester*, vii. 260). In the wall of a palace of the Persian kings near Bagdad, which was pillaged in the 7th century, two Americans found in 1811 pieces of Indian teak which were perfectly sound (Ouseley, *Travels in Various Countries of the East*, ii. 280, n. 67). In the old cave temples of Salsette and elsewhere in western India pieces of teak have been found in good preservation which must have been more than 2000 years old.

[2] At 44·8 ℔ per cub. ft. a load of 50 cub. ft. weighs a ton (2240 ℔), hence in the Burma ports a ton of teak timber is taken as equivalent to a load of 50 cub. ft.

unless thoroughly seasoned, the wood cannot be floated. In Burma, therefore, where the rivers are used to float the timber to the seaports, the method of seasoning teak by girdling has been practised from time immemorial. Girdling consists in making a deep circular cut through bark and sap into the heartwood, so as completely to sever communication between bark and sapwood above and below the cut. In teak, as in oak and other trees with well-marked heartwood, the circulation of the sap only takes place in the sapwood, and the girdled tree therefore dies after a few days if the operation has been effectually performed. But if even the smallest band of sapwood is left connecting the outer layers of wood above and below the girdle, the tree is not killed, and often recovers completely. The girdled tree is allowed to stand one or two years, and longer if a very large-sized tree. Being exposed to the wind and to the action of the sun, the timber of a girdled tree seasons more rapidly and more completely than that of a tree felled green. The teak produced in the presidencies of Madras and Bombay and in the Central Provinces is as a rule felled green, and even when dry it generally is a little heavier than the timber from Burma.[1] For a long time to come, the rivers of Burma and Siam will continue to afford the most convenient and most economical routes for the extraction of teak timber from those countries. Indeed, the forests drained by the Salwin and its feeders are not likely ever to be worked otherwise than on the present plan, under which the logs are floated singly over the rapids and are caught and rafted lower down, at the kyodan or rope station, 70 miles above Moulmein.

As already mentioned, teakwood contains an aromatic oil, which gives it a peculiarly pleasant smell and an oily surface when fresh cut. To this oil may probably with justice be ascribed its great durability. In Burma the oil is extracted from the timber on a small scale, to be used for medicinal purposes, by filling an earthen pot, which is placed inverted upon another, with chips of wood, and putting fire round it, upon which the oil runs down into the lower vessel.

According to the colour and texture of the wood, several varieties of teak are distinguished in India, Burma and Java; in the timber trade, however, these distinctions are of no importance. Teak, as well as other trees, when standing isolated, forms side branches far down the stem, and the wood of such trees is more knotty and wavy, and generally heavier and darker-coloured than that of trees which have grown close together in a dense forest. Apart from the manner in which the tree had grown up in the forest, soil, elevation and climate have a great influence upon the grain and the mechanical qualities of teak as of other timbers. Most of the larger logs brought to market have an irregular crack or hollow in the centre, which commences at the butt and often runs up a long way. There is little doubt that this is generally due to the action of the fires, which scorch and often destroy the bark of young trees. Such external injuries are apt to induce decay in the wood. Moreover, most teak seedlings which come up naturally are cut down to the ground by the fires of the hot season; some are killed, but many sprout again during the rains, and this is generally repeated year after year, until a sapling is produced strong enough to outlive the fire. Such saplings have a very large pith, which dries up, causing a hollow in the heart; or a piece of the old shoot killed by the fire is enclosed by the new wood, and this also is apt to give rise to a hollow.

The leaves of the teak tree contain a red dye, which in Malabar was formerly used to dye silk and cotton. Natives of Burma use the leaves as plates, to wrap up parcels, and for thatching.

In its youth the tree grows with extreme rapidity. Two-year-old seedlings on good soil are 5 to 10 ft. high, and instances of more rapid growth are not uncommon. In the plantations which have been made since 1856 in Burma, the teak has on good soil attained an average height of 60 ft. in 15 years, with a girth, breast high, of 19 in. This is between 16° and 18° N. lat., with a mean annual temperature of 78° F. and a rainfall of 100 in. In the Burma plantations it is estimated that the tree will, under favourable circumstances, attain a diameter of 24 in. (girth 72 in.) at the age of 80. Timber of that size is marketable, but the timber of the natural forests which is at present brought to market in Burma has grown much more slowly, the chief reason being the annual forest fires, which harden and impoverish the soil. In the natural forests of Burma and India teak timber with a diameter of 24 in. is never less than 100 and often more than 200 years old. In future, the timber grown in plantations and in forests under regular management may be expected to be much faster grown; and there is no ground for anticipating that rapidly grown timber will be less valuable than that of slow growth, which is at present brought to market.

Like the other trees of the dry deciduous forest, teak does not attain any extraordinary size. The trees are not generally more than 100 to 150 ft. high, even under the most favourable circumstances, and stems more than 100 ft. to the first branch are not often found. Exceptionally tall trees were measured in 1861 in the Gwaythay forest in Pegu, east of the Sitang river, on gneiss. The stems had 106 to 114 ft. to the first branch, with a girth, at 6 ft. off the ground, from 7 to 16 ft. Larger girths, up to 25 ft., are not uncommon.

The teak tree does not usually form pure forests. It is associated with bamboos and with a great variety of other trees, which have little market value, and, as a rule, thrives best in such company. Hence in the plantations established in Burma the object has been to raise forests of teak mixed with bamboos and other trees.

Most of the teak timber produced in India is used in the country. The produce of the forests of Travancore, Cochin, the Madras presidency, Coorg, Mysore, Bombay, Berar and the Central Provinces is all so consumed. Formerly there was a considerable export from the ports of the western coast—Malabar, Kanara, Surat and Broach—but the country at present requires all the teak which its forests can produce; indeed the demand is in excess of the supply, and considerable quantities are imported from Burma to Calcutta, Madras, Bombay and other Indian ports. Small quantities are still exported from the ports of the western coast to Arabia and the coast of Africa. The chief export is from Burma, principally from Rangoon and Moulmein. Of the other teak-producing countries, Java exports a little; there have also been exports from Saigon; and since 1882 Bangkok has sent considerable quantities to Europe. But the Burma coast is the chief source of supply at present. Rangoon was for a long time an important place for shipbuilding, teak being the chief timber used: between 1786 and 1825 111 European vessels were built at Rangoon, aggregating 35,000 tons. At the same time timber was exported, and, when the country was taken by the British in 1852, teak was the chief article of export. Moulmein became British territory at the close of the first Burmese war in 1826. At that time the place was a large fishing village, and it was mainly through the export of teak timber and the shipbuilding trade that it attained its present importance. From 1829 to 1841 upwards of 50,000 loads of teak timber were exported, and, in addition, 68 vessels were built during that period, aggregating 15,680 tons, and estimated to have required for their construction 24,000 loads of teak timber. The forests from which Moulmein first derived its supplies are situated on the Attaran river, a feeder of the Salwin. In 1836, however, timber began to come down from more distant forests, and in 1841 one-fourth only of the supply was brought from the Attaran forests.

The increase in the export of timber from the Burma ports was slow at first, but has gone on rapidly since Rangoon became a British port. Since that time the timber brought to the Burma ports has come from the following sources:—(1) from the forests in the British coast provinces, Pegu and Tenasserim; (2) from the forests in the former kingdom of Burma, floated to Rangoon down the Sitang and Irrawaddy rivers; (3) from the forests in the Shan states formerly tributary to Burma, from the Karenni country, and from western Siam, whence it is floated to Moulmein by the Salwin river.

The following table shows the figures of the imports and exports of British India for the years 1901–2 to 1905–6:—

	Imports.		Exports.	
	Cub. Tons.	Value Rs.	Cub. Tons.	Value Rs.
1901–2....	17,842	13,03,968	60,671	71,53,855
1902–3....	32,081	24,96,317	57,500	68,67,879
1903–4....	34,588	30,55,695	73,913	91,45,605
1904–5....	46,915	42,46,190	46,912	60,05,383
1905–6....	71,676	62,17,331	52,768	70,41,660
1906–7....	61,696	60,71,557	44,202	61,48,291
Average..	44,133	38,98,483 =£259,899	55,994	70,60,445 =£470,696

Nearly the whole of the imports came from Siam, and of the exports four-fifths were from Burma. The balance of the imports consisted of timber from Java, that of the exports of supplies sent from peninsular ports. Two-thirds of the exports went to the United Kingdom, the other chief markets being ordinarily Germany, Ceylon and Australia. The recent great increase in the general teakwood trade is evidenced by the fact that the imports increased in six years from 17,842 tons to 61,696 tons. But it is noticeable that, whereas in 1901–2 the timber exported very largely exceeded the imports, in 1905–6 and 1906–7 the imports were larger than the exports, evidence of the great increase in Indian demand for teak timber; and, in all probability, of the steady regular outturn of the Indian forests, in comparison with increased imports from Siam, where the forests are not, like those in Burma, under regular working plan, designed to give a permanent annual yield and avoid any danger of exhaustion of the forests.

In British India, including Burma, a large portion of the teak-producing tracts have since 1856 been placed under conservancy management with the object of preventing overcutting and maintaining a permanent and gradually increasing supply. This is the object of the working plans referred to. The area of teak forest

[1] It has been erroneously stated that the tree in Burma is tapped for its oil before felling.

available in India and Burma is considerable, and every endeavour is made to conserve it and increase its production. Similar measures have been taken in Siam under the advice of officers borrowed from British India; and in the teak-producing native states in the peninsula the necessity for careful management is now well understood. The teak plantations in Java had come into bearing by 1908 and it was expected that the teak areas in the Philippine Islands would be similarly developed. (D. Br.; J. S. Ga.)

TEAL (O.E. *tele*), a variety of duck, whose name is of uncertain origin, but doubtless cognate with the Dutch *Taling* (formerly *Talingh* and *Telingh*), and this apparently with the Scandinavian *Atteling-And* (Brünnich, *Ornithol. Borealis*, p. 18) and *Atling*. It seems impossible not to connect the latter with the Scottish *Atteile* or *Atteal*, to be found in many old records, though this last word (however it be spelt) is generally used in conjunction with teal, as if to mean a different kind of bird; and commentators have shown a marvellous ineptitude in surmising what that bird was.

The Teal is the *Anas crecca* of Linnaeus, *Nettion crecca* of modern ornithology, and the smallest of the European *Anatidae*, as well as one of the most abundant and highly esteemed for the table. It breeds in many parts of the British Islands, making its nest in places very like those chosen by the Wild Duck, *A. boscas*; but there is no doubt that by far the greater number of those that are taken in decoys, or are shot, during the autumn and winter are of foreign origin. While the female presents the usual inconspicuous mottled plumage of the same sex in most species of *Anatinae*, the male is one of the handsomest of his kind. His deep chestnut head and throat are diversified on either side by a line of buff, which, springing from the gape, runs upward to the eye, in front of which it forms a fork, one prong passing backward above and the other below, enclosing a dark glossy-green patch, and both losing themselves in the elongated feathers of the hind-head and nape. The back and sides of the body appear to be grey, an effect produced by delicate transverse pencillings of black on a dull white ground. The outer lanceolate scapulars have one-half of their webs pure white, forming a conspicuous stripe along the side of the back. The breast is of a pale salmon or peach-blossom colour, each feather in front bearing a roundish dark spot, but these spots lessen in number and size lower down, and the warm tint passes into white on the belly. The tail coverts above and below are velvety black, but those at the side are pale orange.

The teal inhabits almost the whole of Europe and Asia,—from Iceland to Japan,—in winter visiting Northern Africa and India. It occasionally occurs on the western shores of the Atlantic; but its place in North America is taken by its representative, *A. carolinensis*, the male of which is easily to be recognized by the absence of the upper buff line on the side of the head and of the white scapular stripe, while he presents a whitish crescentic bar on the sides of the lower neck just in front of the wings.

Species more or less allied to these two are found in most other parts of the world, and among such species are some (for instance, the *N. gibberifrons* of the Australian region) in which the male wears the same inconspicuous plumage as the female. But the determination of the birds which should be technically considered "Teals," and belong to the genus *Nettion*, as distinguished from other groups of *Anatinae*, is a task not yet successfully attempted, and much confusion has been caused by associating with them such species as the Garganey (*q.v.*) and its allies of the group *Querquedula*. Others again have not yet been discriminated from the Wigeons (*q.v.*), the Pintail-Ducks, *Dafila*, or even from the typical form of *Anas* (see Duck), into each of which genera the Teals seem to pass without any great break. In ordinary talk "Teal" seems to stand for any Duck-like bird of small size, and in that sense the word is often applied to the members of the genus *Nettopus*, though some systematists will have it that they are properly Geese. In the same loose sense the word is often applied to the two most beautiful of the family *Anatidae*, belonging to the genus *Aex* (commonly misspelt *Aix*)—the Carolina Duck of North America, *Ae. sponsa* (not to be confounded with the above-named *Anas carolinensis* or *Nettion carolinense*), and the Mandarin-Duck of China, *Ae. galericulata*. Hardly less showy than these are the two species of the subgenus *Eunetta*,—the Falcated Duck, *E. falcata*, and the Baikal Teal, *E. formosa*,—both from Eastern Asia, but occasionally appearing in Europe. Some British authors have referred to the latter of these well-marked species certain Ducks that from time to time occur, but they are doubtless hybrids, though the secret of their parentage may be unknown; and in this way a so-called Bimaculated Duck, *Anas bimaculata*, was for many years erroneously admitted as a good species to the British list, but of late this has been properly discarded. (A. N.)

TEANO (anc. *Teanum Sidicinum*), a town of Campania, Italy, in the province of Caserta, 21 m. N.W. of that town on the main line to Rome from Naples, forming conjointly with Calvi an episcopal see. Pop. (1901) 6067 (town); 13,505 (commune). It stands at the S.E. foot of an extinct volcano, Rocca Monfina (3297 ft.), 643 ft. above sea-level. The cathedral dates from 1530, but has many columns obtained from the ruins of the ancient town. There is a feudal castle built by the dukes of Sessa in the 15th century. Below the town on the S.E. is the old church of S. Paride.

The ancient Teanum Sidicinum (there is a Teanum Apulum, *q.v.*, in Apulia) was the capital of the Oscan tribe of the Sidicini which drove the Aurunci from Rocca Monfina. They probably submitted to Rome in 334 B.C. and their troops were grouped with those of Campania in the Roman army. Thus the garrison of Regium, which in 280 attacked the citizens, consisted of one cohort of Sidicini and two of Campanians. Like Cales, Teanum continued to have the right of coinage, and, like Suessa and Cales, remained faithful to Rome in both the Hannibalic and the Social wars. Its position gave it some military importance, and it was apparently made a colony by Claudius, not by Augustus. Strabo speaks of it as the most important town on the Via Latina, and only coming after Capua among the towns in the interior of Campania. It lay on the Via Latina, here joined by a branch road from Suessa, of which remains still exist, and which continued E. to Allifae. Remains of a theatre and an amphitheatre still exist, and some extensive baths, containing several statues, and some Roman dwellings, both some way below the modern town, were excavated in 1908. A tomb with a Christian mosaic representing the visit of the three kings to Bethlehem was found in 1907 (V. Spinazzola in *Notizie degli Scavi*, 1907, 697; E. Gabrici, *ibid.*, 1908, 399).

TEANUM APULUM, an ancient town of Apulia, Italy, on the road between Larinum and Sipontum, 18 m. E. of the former, at the crossing of the Fortore near the modern village of S. Paolo di Civitate. It was called Teate in earlier times, as appears from its numerous coins, which have Oscan legends. It submitted to Rome in 318 B.C., being then the chief town of Apulia. It was afterwards known as Teanum Apulum, and was a *municipium*. Some ruins and an old bridge over the Fortore still exist.

TEA-POY (Hindustani *tēpāī*), a small table, supported upon a tripod, or even upon four legs, for holding a tea-service or an urn. The word was also sometimes applied to a large porcelain or earthenware tea-caddy, and more frequently to the small bottles, often of Battersea enamel, which fitted into receptacles in the caddy and actually contained the tea.

TEAR, a drop of the liquid secretion of the lachrymal gland, constantly produced in a certain quantity and flowing through the nasal duct without notice, but, when stimulated by pain, emotion or artificial excitation, increasing so that it flows over the eyelids and runs down the cheeks and is the visible result of crying or weeping (see Eye). The O.E *teār*, *taer*, is represented in other Teutonic languages by Dan. *taar*; Swed. *tår*; Goth. *tagr*, &c. The O.H.G. was *zahar*; the mod. Ger. *Zähre* was formed from the M.H.G. plural *Zahere*. The commoner word in Ger. *Thräne*, cf. Du. *traan*, is closely allied. The original root is seen in Gr. δάκρυ, Lat. *lacrima*, *lacruma*, for *dacruma*, whence Fr. *larme*, and It., Sp., and Port. *lagrima*.

The generally accepted Indo-Germ. root is *dak-*, to bite, cf. Gr. δάκνειν, and Skt. *daç*, to bite, tears being "biting" or "bitter" things. The Du. *traan*, in the sense of tear-drop, was particularly applied to the blubber of whales reduced to oil by boiling, whence has come the tautological English "train-oil," often identified with the lubricant used for the wheels of railway trains. For the so-called "tear-vessels," which are properly small vases containing unguents, see LACRYMATORY.

"Tear" (O.E. *teran*), to pull apart violently, to rend, is, of course, a distinct word; it is cognate with Gr. δέρειν, to flay, pull off, and the root is seen in Gr. δέρμα, skin, whence "dermatology," "epidermis," &c.

TEASEL. Wild teasel is a common plant of the English copses and hedges, with a tall, stout, rigid, prickly stem, bearing large spreading opposite leaves, the midrib of which is prickly, and conspicuous oblong heads, the purplish flowers in which are subtended by very long, narrow, stiff, upright bracts. The plant is known botanically as *Dipsacus sylvestris*. Fuller's teasel, *D. Fullonum*, in which the bracts are hooked, is probably a cultivated form of the wild species; the dry heads are used to comb up the nap on cloth. The genus *Dipsacus* gives its name to the family *Dipsaceae*, to which also belongs the Scabious (*Scabiosa*), represented in Britain by several species.

TEATE MARRUCINORUM [mod. Chieti, *q.v.*], the chief town of the Marrucini, the whole of whose territory was placed under its municipal jurisdiction by the Romans, after the "Social War." It was thus a town of some importance. Under the church of SS. Pietro e Paolo and the adjoining houses are extensive substructures (in *opus reticulatum* and brickwork) of the 1st century A.D., belonging to a building erected by M. Vectius Marcellus (probably mentioned by Pliny, *H.N.*, II., 199) and Helvidia Priscilla. There are also remains of large reservoirs and of a theatre.

TEBESSA (the Roman Theveste), a town of Algeria in the department of Constantine, 146 m. S.E. of Bona by rail and 12 m. W. of the Tunisian frontier, on a plateau 2950 ft. above the sea. Pop. (1906) 5722. The modern town, which is within the walls of the Byzantine citadel, boasts nothing of interest save a church built out of the ancient ruins. The Byzantine walls, pierced by three gates, are in tolerable preservation. They are strengthened by numerous square towers. One of the gates is formed by the quadrifrontal arch of Caracalla, a rare form of construction. The arch, erected about A.D. 212, is in good preservation. A pair of monolithic columns, disengaged, flank each façade. An inscription on the frieze gives the history of its construction; it was built by two brothers as a condition of inheriting the property of a third brother. The most important ruins are those of the great basilica. This building, one of the finest Roman monuments in Algeria, bears evidence of having been built at various epochs; the earlier portions probably date from not later than the beginning of the 2nd century A.D. The basilica was partially destroyed by the Berbers in the 5th century, and was rebuilt in A.D. 535 by the Byzantine general Solomon, who surrounded it with a wall about 25 feet high, still standing. The main building, consisting of a nave with apsidal end and two aisles, was approached through a peristyle, which was surrounded by an arcade. Many of the columns of the basilica have fallen, but the bases of all are in their original positions. A quatrefoil chapel on the east side of the basilica is a Byzantine addition. The tessellated pavement which covers the basilica proper is in almost perfect condition. It is kept covered, for purposes of preservation, by a layer of earth. Next the basilica (and within the same enclosing walls) are the ruins of the forum, converted into a monastery in the 4th or 5th century, and regarded by Sir R. Lambert Playfair as the oldest known example of the *monasteria clericorum*. The whole of the basilica and its dependencies have been cleared and are kept in order by the *Service des Monuments historiques*, the principal work having been accomplished by Héron de Villefosse. Noteworthy among the buildings within the ancient citadel is a small tetrastyle temple, variously ascribed to Jupiter and Minerva, the portico supported by six monolithic columns of cippolino, four being in front. After the French occupation in 1842, the building was used successively as a soap factory, a prison, a canteen, a parish church, and, lastly, as a museum.

Theveste was founded towards the close of the 1st century A.D. In the succeeding century it was connected with Carthage by a great highway. In the 5th century, under Vandal dominion, it declined in importance. Refounded by the Byzantines in the 6th century, the city disappeared from history at the time of the Arab conquest of the country in the 7th century. In the 16th century the Turks placed a small garrison of janissaries in the place, but Tebessa continued to be but a small village until the establishment of French rule.

Nine miles from Tebessa are the extensive phosphate quarries of Jebel Dyr, where is also an interesting megalithic village.

See Sir R. Lambert Playfair, *Handbook for Travellers in Algeria and Tunis* (London, 1895), pp. 233–40, *Guides-Joanne, Algérie et Tunisie* (Paris, 1906).

TECHNICAL EDUCATION. The term now generally adopted to designate the special training of persons in the arts and sciences that underlie the practice of some trade or profession, is called "technical education." Schools in which this training is provided are known as technical schools. In its widest sense, technical education embraces all kinds of instruction that have direct reference to the career a person is following or preparing to follow; but it is usual and convenient to restrict the term to the special training which helps to qualify a person to engage in some branch of productive industry, and the instruction so provided is generally known as "technological instruction." This specialized education may consist of the explanation of the processes concerned in production, or of instruction in art or science in its relation to industry, but it may also include the acquisition of the manual skill which production necessitates.

General theory.

The terms "technical" and "technological" (Gr. τέχνη, art or craft) as applied to education, arose from the necessity of finding words to indicate the special training which was needed in consequence of the altered conditions of production during the 19th century. Whilst the changed conditions of production, consequent mainly on the application of steam power to machinery, demanded a special training for those who were to be engaged in productive industry, the prevalent system of education was not adapted to the requirements of these persons, and schools were wanted in which the necessary instruction could be obtained. Other circumstances resulting mainly from the application of steam power to machinery rendered technical education necessary. Production on a large scale led to a great extension of the principle of the division of labour, in consequence of which it was found economical to keep a man constantly engaged at the same kind of work, since the more he practised it the quicker and more skilful he became. Thus employed, the workman learned little or nothing of the process of the manufacture at which he assisted, or of other departments of the work than the particular one in which he was engaged, and his only opportunity of acquiring such knowledge was outside the workshop or factory in a technical school. The economy effected by the division of labour led to the extension of the principle to other industries than those in which machinery is largely employed. There are many trades in which manual skill is as necessary now as ever, but even in these the methods of instruction prevailing under the old system of apprenticeship are now almost obsolete.

Changed conditions of production.

In many industries, including trades in which machinery is not as yet extensively employed, production on a large scale has increased the demand for unskilled labour, numbers of hands being required to prepare the work to be finished by a few skilled artisans. Rapidity of execution is attained by keeping a workman at the same work, which after a time he succeeds in mechanically performing and continues to do until some machine is invented to take his place. In most trades, as formerly practised, the master

Apprenticeship.

employed a few apprentices who assisted him in his work, and who learnt from him to understand the details of their craft, so that, when the term of their apprenticeship was over, they were competent to practise as journeymen. But now the master frequently has neither time nor opportunity to instruct young lads, and the old relation of master and apprentice is changed into that of manufacturer and workman. In consequence of these altered relations between employer and employed, there has arisen an acknowledged want of properly trained workmen in a number of trades in which skilful hand work is still needed; and in these trades a demand has arisen for technical schools, or some other substitute for what was formerly done by apprenticeship, as a means of suitably training workmen and foremen. The ever-increasing competition in production has led to the employment, in many trades, of children to do work of a mechanical kind requiring little skill; but, whilst thus employed, these young people have little opportunity of learning those parts of their trade in which skill and special knowledge are needed; and when they are grown up, and seek higher wages, they are dismissed to make room for other children. Numbers of young people are thus thrown upon the labour market, swelling the percentage of the unemployed, who are competent to do nothing more than children's work, and to earn children's wages, and who know no trade to which they can apply their hands. To remedy this, by creating some substitute for the old apprenticeship, is one of the objects of a system of technical education; though in suitable trades an independent movement for reviving apprenticeship (*q.v.*) under improved conditions has also made some way.

A complete system of technical education should provide the necessary instruction for the different classes of persons engaged in productive industry. It is usual to divide these persons into three classes:—(1) workmen or journeymen; (2) foremen or overseers; (3) managers or masters.

Classes of workers. The industries in which they are employed may be grouped under four heads:—(1) those involving the use of extensive machinery, such as iron and steel manufacture, machine-making, the textile industries, and some of the chemical trades; (2) those which mainly require the use of hand tools, as cabinet-making, brick-work, plumbing, and tailoring; (3) those depending on artistic skill, as wood and stone carving, metal-chasing, enamelling, decorative work, and industrial designing generally; (4) agriculture in all its branches, and forestry. These industries will be referred to as manufactures, handicrafts, art industries and agriculture. The foregoing classification comprises groups which necessarily, to some extent, overlap one another. Every factory contains a carpenter's and smith's shop, and handicraftsmen of group (2) are required in every manufacturing concern. Whilst the industries in which hand labour is exclusively employed are becoming fewer and fewer, there are many trades which, owing to the frequent invention of labour-saving appliances, are passing gradually from the class of handicrafts to that of manufactures. In these trades, of which watch- and clock-making and boot- and shoe-making may be taken as examples, there is still a demand for goods largely if not entirely produced by hand work. In such trades, owing to the absence of facilities for instruction in the ordinary shops, there is a want of skilled hand labour which there is an increasing difficulty in satisfying, and to supply this want technical schools of different kinds have been established. Then, again, there are many branches of manufacturing industry which greatly depend for their success upon the designer's art, and it is necessary that the industrial designer should possess a knowledge of the processes of the manufacture in which his designs will be utilized, as well as of the properties and capabilities of the material to which they will be applied. Indeed, it is the possession of this knowledge which mainly distinguishes the industrial designer from the ordinary artist. To determine the best training for such designers is one of the problems of technical education. There are many trades, too, in which the handicraftsman and the designer should be united. This is the case in such industries as silversmith's and goldsmith's work. In these and other trades the true artisan is the artist and handicraftsman combined.

Manufactures and handicrafts. In order to reconcile some of the different views which are held as to the objects of technical education, it is necessary to keep in mind the broad distinction, above referred to, between the conditions of production on a large scale, as in those industries in which goods are manufactured by the use of extensive labour-saving machinery, and in those trades in which hand work is chiefly employed. Much of the diversity of opinion regarding the objects of technical education is due to the difference of standpoint from which the problem is regarded. The volume of the trade and commerce of Britain depends mainly on the progress of its manufacturing industries. It is these which chiefly affect the exports and imports. The aim of manufacturers is to produce cheaper and better goods than can be produced by other manufacturers at home or abroad; and technical education is valuable to them, in so far as it enables them to do so. It also helps to widen the area of productive industry, and to encourage varieties of activity which the free and unfettered conditions of competition tend unduly to restrict. On the other hand, the artisan engaged in hand industries looks to technical education for self-improvement, and for the means of acquiring that general knowledge of the principles and practice of his trade, which he is unable to obtain in the commercial shop. Hence the artisan and the manufacturer approach the consideration of the question from different sides. To the spinner or weaver who almost exclusively employs women to tend his machinery, or to the manufacturing chemist whose workpeople are little more than labourers employed in carrying to and fro materials, knowing little or nothing of the scientific principles underlying the complicated processes in which they are engaged, the technical education of the workpeople may seem to be a matter of little moment. What such manufacturers require are the services of a few skilled engineers, artistic designers or scientific chemists. From the manufacturer's point of view, therefore, technical instruction is not so much needed for the *hands* he employs in his work as for the *heads* that direct it. But in trades in which machinery plays a subsidiary part, technical teaching supplies the place of that instruction which, in former times, the master gave to his apprentice, and the workman is encouraged to attend technical classes with a view to acquiring that knowledge of the theory and practice of his trade, on the acquisition of which his individual success greatly depends. In the former class of industries, technical education is needed mainly for the training of managers; in the latter, for the training of workmen. Hence has arisen a double cry,—for the teaching of art and of the higher branches of science, with a view to their application to manufacturing industry, and for the specialized instruction in drawing, and in the scientific facts which help to explain the processes and methods connected with the practice of different crafts and trades. This double cry has led to the establishment of technical universities and of trade schools.

Foremen and managers. Owing to the conditions under which manufacturing industry is now carried on, it is difficult to select competent foremen from the rank and file of the workmen. The ordinary hands gain a very limited and circumscribed acquaintance with the details of the manufacture in which they are engaged, and have little opportunity of acquiring that general knowledge of various departments of work, and of the structure and uses of the machinery employed, which is essential to the foreman or overseer. It is in evening technical classes that this supplementary instruction, which it is the workman's interest to acquire and the master's to encourage, can be obtained; and it is from the more intelligent workmen who attend these classes that masters and employers will select as foremen those students who are found to possess the essential qualifications. The history of invention shows how frequently important improvements in machinery are made by the workman or minder in charge of it, and adds weight to the arguments already adduced for giving technical instruction to persons of all grades employed in manufacturing industry. To these advantages of technical education, as affecting the workmen themselves as well as the progress of the industry in which they are engaged, must be added the general improvement in the character of the work produced, resulting from the superior and better-trained intelligence of those who have had the benefit of such instruction.

It will be seen from the foregoing that a complete system of technical education must make provision for the training of those who are to be occupied as journeymen or foremen in different branches of trade or industry, and also for those who aim at becoming managers or masters or heads of manufacturing firms, scientific advisers or professional engineers. As technical education necessarily implies specialized teaching, the curriculum and methods of instruction adopted in the elementary and secondary schools, where students receive their preliminary training, are matters closely related to any scheme of technical instruction, and the trend of educational opinion is in favour of associating the general instruction given in those schools with the specialized teaching of the technical institutions. Indeed, it is daily becoming more difficult to draw any hard-and-fast line between professional and general education. It is now universally recognized that the foundations of technical instruction must be laid in the elementary and the secondary schools, and many of the changes which have been made in the organization of those schools had their origin in the requirements of technical institutions.

Professional and general education.

A short survey of the methods adopted in different countries to provide the specialized teaching applicable to different pursuits, and of its relation to the general school system of those countries, will serve as a fitting introduction to the consideration of the legislative and other changes which have gradually been made in the British school system with a view to modern industrial conditions. The study of foreign systems of education is serviceable, as showing the relation of such systems to the industrial needs of each country and to the genius and character of the people. In the organization of technical education in England, full advantage has been taken of foreign experience, although no attempt has been made to imitate too closely foreign methods. Detailed information as to what has been done abroad is found in the published reports of the several English commissions which have been appointed to inquire into the subject, and in the valuable series of special reports issued from the Board of Education. From these reports, which show how varied have been the attempts to adapt school training to modern industrial requirements, certain general principles may be inferred, which are equally applicable to the conditions under which the trade and commerce of different countries is now carried on.

Study of foreign systems.

These general principles may be briefly enunciated as follows:—

1. The education of all persons who may expect to be occupied in some form of productive industry may be considered as consisting of two parts, (*a*) general, (*b*) special.

General principles.

2. The general education is the preliminary training provided in elementary and secondary schools, and the curriculum of those schools should be varied so as to have some reference to the future pursuits of the pupils.

3. The special or supplementary instruction should be adapted to the requirements of different grades and classes of workers, and to different trades or occupations as practised in different localities.

A complete system of technical education would afford facilities of training adapted to every kind and grade of industry; but, owing to the complexity of the problem, such a system is nowhere to be found. In every country the scheme of education and method of instruction have varied from time to time, as the conditions regulating trade and industry have changed. But recently in all civilized countries, the effort has been made to provide a general and specialized education adapted to different pursuits for each of these great classes of workers: (1) operatives, (2) foremen and overseers, (3) masters and managers.

1. *Workmen.*—Many attempts have been made to provide a substitute for apprenticeship, but hitherto with no great success. Two classes of workpeople have to be considered—(1) those engaged in manufacturing industries, and (2) those engaged in handicraft industries. The education of all classes of workpeople begins in the public elementary schools; and, in view of the future occupation of the children, it may be taken for granted that primary instruction should be practical, and should include drawing and elementary science. It should indeed be closely associated with manual training, consisting of workshop exercises and field work in the case of boys in urban and rural schools respectively, and of instruction in the domestic arts in the case of girls. The lessons in drawing and in elementary science should form part of the manual training, and the school curriculum should be unified so that all the subjects of instruction should be grouped together as parts of an organized system. The desired diversity should be found in the different kinds and grades of manual work. Reading, writing and arithmetic would be taught incidentally in close connexion with the practical exercises. In nearly every country of Europe, and in the United States, the trend of education practice is in this direction. In France, Belgium, Holland and Sweden handicraft instruction is generally included in the curriculum of elementary schools. Rudimentary science is also taught in nearly all the primary schools of Europe. Modelling is taught both to boys and girls in many Continental schools; and in Sweden "sloyd" (Sw. *slöjd*, manual dexterity, cf. Eng. "sleight"), a system of manual training, in which simple and useful articles, especially of wood, are constructed with the fewest possible tools, is taught with considerable success to children of both sexes.

Elementary education.

In Germany and Switzerland, there exists an excellent system of evening continuation schools, known as *Fortbildungs-* or *Ergänzungs-Schulen*, in which the instruction of the children who leave school before fourteen, and of those who leave at that age, is continued. In all these schools drawing is taught with special reference to local industries. In England great progress has been made in recent years in developing evening classes in which the pupils' elementary instruction is continued with a view to the specialized teaching provided in the technical school. The teaching in these continuation schools is generally varied according as the pupil is occupied in trade or office work, and the practice is becoming general of requiring him to pass a qualifying examination to secure admission to classes in technology. It will be seen, therefore, that the training of most workpeople, and of nearly all those who are engaged in manufacturing industry, consists of:—(1) primary teaching in elementary schools; (2) practice in the factory or shop, supplemented by further elementary teaching; (3) evening instruction in technology.

Continuation schools.

In all the principal towns throughout Europe evening classes have been established for teaching drawing, painting and designing, and the elements of science in their application to special industries. The instruction, however, is less practical than that provided in the corresponding schools in England. The classes abroad are mainly supported by the municipalities, by the chambers of commerce, by industrial or trade societies, by county boards, and in some cases by the fees of the pupils. They receive little or no support from the state. They are well attended by workpeople of all grades, who are encouraged by their employers to profit by these opportunities of instruction. In England evening technical instruction is more systematically organized than in any other country. It is under the general direction of the Board of Education, and of the City and Guilds of London Institute.

The Board of Education prescribe the conditions under which grants are paid to schools providing technical instruction. In former years these grants were paid on the results of the examination of individual students; but this method of apportioning state aid has been almost entirely abandoned. The Board still hold annual examinations in science and art and in certain branches of applied science; but the more specialized examinations in technology and trade subjects are held annually by the City and Guilds of London Institute, through its department of technology. These latter examinations are utilized by the Board, and the certificates granted on the results are recognized in the appointment of teachers. The technical schools in which these classes are held are under the direct control of the local educational authorities, and are largely supported by grants from local rates. Year by year a larger share of responsibility is being thrown upon the local authorities, with a view to encouraging greater variety of instruction and further adaptation of the teaching to local needs. The Board continue, however, to indicate the range of subjects to be taught in preparation for their annual examinations, and the City and Guilds of London Institute issues each year a programme containing suggested courses of training in nearly a hundred trade subjects.

Evening technical classes.

In the evening classes in science, art and technology, which have been established throughout the United Kingdom, the workman or foreman engaged in any manufacturing industry has the opportunity, by payment of a very small fee, of studying art in all its branches, science theoretically and practically, and the technology of any particular industry. Provided his early education enables him to take advantage of this instruction, no better system has been suggested of enabling workmen, whilst earning wages at an early age, to acquire manual skill by continuous practice, and at the same time to gain a knowledge of the principles of science connected with their work and explanatory of the processes of the manufacture in which they are engaged.

For those engaged in handicraft trades this evening instruction is equally valuable, and not only in England, but equally in other parts of Europe, there exist evening trade schools in which the workman is able to supplement the "sectional" practice he acquires in the shop by more general practice in other branches of his trade. In Vienna, for example, and elsewhere in Austria, there are found practical evening classes for carpenters, turners, joiners, metal-workers and others. Throughout Europe schools for weaving, with practical work at the loom and pattern-designing, have existed for many years.

Trade schools. To provide a training more like the old system of apprenticeship, schools have been established in many parts of Europe and in the United States which are known as professional, trade or apprenticeship schools (*écoles professionelles, écoles des apprentis, Fachschulen*). The object is to train workmen; and the pupils, after completing their course of instruction in such a school, are supposed to have learnt a trade. The school is the substitute for the shop. In such a school the pupils have the advantage of being taught their trade systematically and leisurely, and production is made subsidiary to instruction. Under such an artificial system of production, the pupil is less likely to acquire excellence of workmanship and smartness of habit than in the mercantile shop, under the strain of severe competition. Moreover, the cost of maintenance of these schools renders it impossible to look to them as a general substitute for apprenticeship. By sending into the labour market, however, a few highly trained workmen, who are absorbed in various works and exert a beneficial influence on other workmen, these schools serve a useful purpose. Schools of this kind have been tried with more or less success in different countries. In Paris there is the well-known École Diderot for the training of mechanics, fitters, smiths, &c.; and similar schools have been established in other parts of France. For many years a society of Christian Brethren has directed a large school situated in the Rue Vaugirard, Paris, in which different trades are taught. All the secular and general instruction is given gratuitously by the brothers, and in the several shops attached to the school skilled workmen are employed, who instruct the pupil apprentices, and utilize their labour. This system combines many of the advantages of shop work and school work, but it depends financially for its success upon the religious spirit which actuates its promoters and supporters. The Artane school, near Dublin, is conducted on somewhat similar principles, but is intended for a lower class of children. In Austria, particularly in the rural districts, there are numerous day schools for the training of carpenters, joiners, turners, cabinetmakers, workers in stone and marble, in silver and other metals, &c. Schools of the same class are found in Germany, Italy and Holland, and schools very similar in character have been organized to a limited extent in England. The demand that called them into existence in other parts of Europe and in America has been felt in the United Kingdom. The difficulty of securing for apprentices in a commercial shop systematic training in handicraft has led to the establishment of a few trade schools which receive children from the elementary school about the age of thirteen for a three years' course of instruction. In these schools the time is about equally divided between ordinary school subjects and the practice of some handicraft, such as cabinet-making, upholstery, waistcoat-making, millinery. Parents are encouraged to allow their children to receive this further education by the offer of free teaching and maintenance grants. Such schools, however, must be regarded as educational experiments, to be superseded if found necessary by reason of changes in the conditions under which the trade is practised. Any system of technical education, however, should be sufficiently elastic to permit of such experiments and of the introduction of types of instruction to meet special and even temporary needs. It is only in certain cases that apprenticeship schools can be said to answer satisfactorily the purpose for which they have been established. Where a new industry, especially in rural districts, has to be created; where decaying industries need to be revived; where machinery is superseding hand work, and, owing to the demands for ordinary hands, there is a dearth of skilled workmen; where through the effects of competition and other causes the trade is carried on under conditions in which competent workmen cannot be properly trained in the ordinary shop,—in these cases, and in various art industries, an apprenticeship school may prove to be the best means of training workmen and of advancing particular trades. Generally, an apprenticeship school should be looked upon as a temporary expedient, as a form of relief applied at the birth of a new industry or to meet some special conditions under which a trade is practised. The proper training school for workmen is the factory or shop.

In the United States there are only a few schools which have been specially organized with a view to the training of workmen for special trades. The line between technical and general education is not very clearly defined in any of the states' schools. It is also difficult to give any such general review of the system of education in America as can be presented in connexion with France or Germany or Italy, owing to the fact that each separate state has its own organization, over which the Federal government exercises no direct control. In none of the states is technical education differentiated by class distinctions to the same extent as in continental countries. The ambition of every workman is to become a master, and this general ambition gives rise to an enthusiasm for education among all classes, which does not exist to the same extent in any other country. In the United States are found evening technical schools and schools of design for those who have passed from the common schools into commercial work; but the desire for further instruction is so marked that many of those who have received only an elementary education endeavour, by working during the vacations, or by other means, to save enough money to attend the higher technical schools, and so acquire the necessary skill and knowledge to improve their position in the factory or workshop.

Training of foremen. 2. *Foremen.*—The foreman must be familiar with the various branches of work he is to overlook; and the training which the workman receives in the factory or shop affords him but scanty opportunities of obtaining this general knowledge. The foreman needs also a generally superior education. How then are foremen to be trained? The problem is somewhat easier than that of training workmen, because the number required is fewer. The variety of schools in Europe devoted to this purpose is very great. There are three distinct ways in which foremen are being trained.

(*a*) The evening technical classes in Britain and on the continent offer to ambitious workmen an opportunity of acquiring a knowledge of other departments of the trade than those in which they are engaged, as well as of the scientific principles underlying their work. These classes serve the double purpose of improving the workpeople and of affording a means of discovering those who are best fitted to occupy higher posts.

(*b*) Special schools have been established for the training of foremen. There are many schools of this kind in which selected boys are received after leaving the higher elementary or secondary school. The best known are those at Châlons, Aix, Nevers, Angers and Lille in France. These schools are intended for the training of foremen in engineering trades. They are state institutions, in which practical mechanical work in the shops is supplemented by theoretical instruction. The first of these schools was founded in 1803. The course lasts three years, and the students spend from six to seven hours a day in the workshop, and are trained as fitters, founders, smiths and pattern-makers. As in all such schools, saleable goods are produced, but, as production is subordinated to instruction, the school does not bind itself to deliver work at a given date, and therefore does not compete with any manufacturing establishment. The students on leaving these schools are competent at once to undertake the duties of foremen and draughtsmen. At Komotau, Steyr, Klagenfurt, Ferlach and many other places schools have been established on somewhat similar principles. In Germany there are special schools for the training of foremen in the building trade, which are chiefly frequented in the winter, and numerous schools are found in all parts of the continent for the training of weavers. At Winterthur in Switzerland a school has been established the main purpose of which is the training of foremen. In Italy there are numerous technical institutes, the object of which is to train young men for intermediate posts in industrial works. In London, the Finsbury technical college of the City and Guilds of London Institute has a day department, the main purpose of which is the training of youths as foremen, works managers, &c.; but in this school the character of the instruction deviates considerably from that given in French schools, and aims rather at preparing youths to learn, than at teaching them their trade.

(*c*) A third method adopted for the training of foremen is by encouraging selected children of the ordinary elementary schools to continue their education in schools of a higher grade of a technical character. It is thought that, by developing to a higher degree the intelligence and skill of those children who show aptitude for scientific and practical work, they will be able, when they enter the shop, to learn their trade more quickly and more thoroughly, and to acquire that general knowledge of their work, and to exhibit those special aptitudes, which may qualify them for the position of foreman or overseer. The education given in these schools, although having some bias towards the future career of the pupil, is disciplinary in character, and consists of the subjects of primary instruction further pursued,—of drawing, modelling, science, mathematics and manual exercises. The curriculum is varied according to local requirements, the technology of the staple industries forming in many cases part of the instruction. Such schools, under varied forms, have been established in most European countries, some of the best examples of them being found in Paris, Lyons, Reims, Rouen, and in other towns of France. One of the oldest of these schools is the École Martinière at Lyons. The school was founded in 1820 by a bequest from Major-General Martin, who had fought against the English under Tippoo Sahib. In this school, in which the education is gratuitous, as in nearly all the higher elementary schools of France, instruction is given in drawing, modelling, chemistry, mechanics and physics, in the working of wood and iron, and in German and English in addition to the subjects of an ordinary school education. Surveying is also taught to some of the pupils, and the instruction generally is of a very practical character. The students visit factories under the guidance of the masters, and on their return write out full descriptions of their visits. The school hours are from seven till eleven in the morning and from one till seven in the afternoon. The boys from this school rapidly obtain places in the commerical and industrial houses of Lyons, and many of them, after a time, succeed in obtaining high positions. A very similar school, on more modern lines, has been established at Reims, and is accommodated in a building especially adapted to the purpose. In this school instruction is directed towards the staple industries of the district, namely, weaving, dyeing and engineering. There are many other similar schools in France, the object of which is to give the children of artisans and small shopkeepers a higher practical education in order to fit them to occupy the posts of foremen, overseers and superior clerks in manufacturing and commercial firms. In Germany the *real* schools, in which Latin is not taught, known as *Ohnelatein Realschulen*, have very nearly the same objects as the higher elementary schools of France. The instruction in these German schools is not so practical as in the schools of France. Drawing is always well taught, and the schools generally contain good chemical laboratories, as well as collections of physical apparatus and museums. From the pupils of these schools the ranks of foremen are largely recruited. They receive no special trade instruction, but the general training is so arranged as to qualify them for higher posts in industrial works. The cost of this higher education seldom exceeds £3 per annum. In Bavaria there is found a type of school called *Industrie-Schule*, which serves very well for the training of engineers and industrial chemists, who aim at occupying intermediate posts, and desire to enter upon commercial work at an earlier age than students attending a university or technical college. The instruction in these *Industrieschulen* is largely practical, but is combined with some amount of literary and linguistic training. Some of the students proceed to the technical university, but the majority find posts as foremen or overseers soon after completing their school course. In most of these schools, as well as in the chief intermediate commercial schools, the exit certificate exempts a lad from two of the three years' compulsory military service, and this regulation, to which nothing corresponds in England, is an incentive to parents to allow their children to receive higher instruction, which operates very forcibly in largely increasing the number of well-educated youths in Germany.

Manual training schools in U.S.

A special feature of the education provided in the United States is what is known as the "manual training" school. This is a school admirably adapted for the training of foremen, although not especially intended for any particular industrial class. The manual training school is a secondary school in which a large part of the time is given to workshop exercises. The whole subject of manual training is more scientifically developed in some of the states of America than in any European country. The school is pervaded by the kindergarten spirit, and leads up, without break of continuity, to courses of instruction given in the higher technical colleges. The movement in favour of manual training in the United States is general and extends even to the private schools where youths are prepared for the university. At the same time, the purely practical teaching is invariably combined with scientific and literary instruction. In these, as in other schools, the principle is fully recognized that the primary aim of education is to make citizens and not tradesmen. It is difficult to take any one manual training school as typical of others, seeing how the curriculum varies in different states. The practical work includes exercises in carpentry, joinery, wood-turning, wood-carving, forging, foundry-work, machine fitting, stonework, and weaving and appropriate exercises for girls. The general idea underlying the scheme of instruction in these schools is that the teaching must be educative till the age of fifteen, and should then, and only then, develop into specialized and professional training.

Training of managers and masters.

3. *Masters.*—Some of the best schools for the training of future masters, managers, engineers, manufacturers and industrial chemists are found in Germany and Switzerland, and are known as technical high schools. Schools of a similar character are found in other countries.

In Germany the *technische Hochschule* or Polytechnicum is an institution of university type in which the education has special reference to industrial purposes. In many respects the teaching coincides with that given in the universities. The chief distinction consists in the arrangement of courses of instruction in the several departments, in the admission of students having a non-classical preliminary training, and in the absence of certain faculties found in the university and the addition of others. It is not correct to say that the technical high school is a professional school as distinguished from the university; for the faculties of law, medicine and theology give to the university as distinctly a professional character as the faculty of engineering gives to the technical high school. Nor can it be said that the scientific studies at the universities are less practical than at the technical high school. For, whilst workshops for instruction in the use of tools are found in very few of the German high schools, the laboratories for the practical study of chemistry and physics are as well equipped at some of the German universities as at the technical high schools. At the same time, engineers of every description, architects and builders, besides a great number of manufacturing chemists, find in the technical high school the scientific and special training which the future lawyer or physician, and in many cases the industrial chemist, seeks in the university.

German universities and technical high schools.

In some of the large cities—in Berlin, Vienna and Munich, for instance—the two institutions co-exist; and in certain cases, in which a very special training is required to fit a youth for his career, the German student, after spending three or four years at a technical high school, passes on to another institution, such as a dyeing school, in which his studies are further specialized with a view to his future work.

Taking the technical high school of Munich as a type of other similar institutions, we find that it consists of seven departments:—(1) the general; (2) the civil engineering; (3) the building; (4) the mechanical engineering; (5) the industrial chemical; (6) the agricultural, and (7) electrical technology. In other institutions there are architectural, pharmaceutical and mining schools. The programme of the Munich school gives a list of about 200 different courses of instruction distributed over the several departments. A separate professor is engaged to lecture on that particular subject with which he is specially conversant, and the number of such professors attached to a technical high school is very large. In the engineering department there are several distinct courses of lectures under the direction of professors who are experts in their special subject. The largest of all these institutions is that of Berlin, which was completed in 1884 at a cost of about £450,000. It is situated in what was a suburb of Berlin, and is generally known as the Charlottenburg Institution. It includes departments for the highest specialized instruction in nearly all branches of technology. Other schools in Germany are less complete, but most of them have one or more departments which are specially organized with a view to the highest grade of technical instruction. Both in the universities and in the technical high schools facilities for scientific research are provided, and the students are encouraged to undertake original investigations. The technical high schools are now placed on the same educational platform as the universities and have the power to confer the degree of Doctor of Engineering on students fulfilling the required conditions.

Higher technical training in France.

In France, the institutions in which the highest technical instruction is given are concentrated in the capital. There are a large number of provincial colleges such as the École Centrale at Lyons, the École des Mineurs at St Étienne and the Institut du Nord at Lille, where the education is somewhat more practical, but where the mathematical and scientific teaching is not carried to so high a point. Several of the French provincial colleges in which the higher forms of technical instruction are well developed became in 1898, under the law of 1896, separate universities. The École Centrale of Paris, in which the majority of French engineers who are not employed in the government service are trained, is a rare instance of an institution for higher technical instruction which is self-supporting and independent of government aid. Other special institutions in Paris, some of which are associated with the university of Paris, are the École des Mines, the École des Ponts et Chaussées, and the Collège de France, an old foundation in which facilities are afforded for the highest scientific research.

In Switzerland and elsewhere.

In Switzerland the federal polytechnic of Zurich is in many ways similar to the schools of Germany and Austria. Italy has three superior technical institutes—one at Milan, one at Turin and one at Naples, in which technical education is given on the same lines as in German polytechnic schools. Holland has an excellent institution at Delft, which was opened in 1864. In each of the state universities of Belgium there is a faculty of applied science, and degrees are granted on a course of training in science and technology; and in Russia the imperial technical school at Moscow is a high-class engineering school in which the theoretical studies are supplemented, to a greater extent than in the German schools, by workshop practice. It will be seen, therefore, that in nearly all European countries, instruction in engineering in all its branches and in chemical technology has become a recognized part of a university course, and that the faculty of applied science has been so enlarged as to provide technical education of the highest grade.

Some of the best schools for the higher technical instruction—for the training of masters and of those who are to occupy the position of managers in engineering and industrial works—are found in the United States. On leaving the secondary school, the American student may go at once into business: or he may proceed to a college, with a four years' course of general instruction; or he may enter a professional or technical school. Some students prolong their education by taking the general course before proceeding to the technical institution. As in the lower, so in the higher grades of instruction, the distinction between general and technical education is not very clearly defined. There are some institutions devoted almost exclusively to professional training; whilst in others the engineering faculty exists side by side with other faculties of university rank. The general interest in higher education which is shown by the desire of students of all classes to obtain it, in many cases at considerable individual sacrifice, and by the value which masters and employers attach to a college-trained youth, is partly due to the large proportion of pupils from the ordinary schools who proceed to the secondary or high schools. It is estimated that the pupils between the ages of fourteen and eighteen in attendance at these schools constitute at least one per cent. of the entire population of the United States. In several of the American institutions known as colleges, but not easily distinguishable from the universities, courses of general or technical instruction are provided of all intermediate grades, but above that given in the high schools. In addition to these there are some well-known institutions which provide courses of professional and general instruction of the highest grade under professors of eminence and distinction, and facilities for research which are not surpassed in any German university or technical high school. To the foundation and maintenance of these schools wealthy citizens have given or bequeathed enormous sums of money, and they further enjoy the proceeds of the sale of lands which were set apart under the Morrill Act of 1862 to give assistance to institutions providing instruction in agriculture and the mechanical arts. Several colleges whose work was mainly literary took advantage of this act to establish scientific and technical courses in order to secure the income to be obtained by compliance with its provisions.

Higher technical training in United States.

Without entering into great detail, it may be said that the schools providing advanced technical instruction may be grouped under three headings: (1) those which are free from state or government control and are maintained from funds arising out of endowments and students' fees, such as the Massachusetts Institute of Technology and the Stevens Institute of Technology, Hoboken; (2) schools which form part of, or are affiliated to, the universities, which are equally independent of public control, such as Columbia University, New York, and the Sibley College of Mechanical Arts, Cornell University; (3) schools and colleges attached to state universities, receiving grants from the state, such as the universities of Illinois and Michigan.

Contributions from private sources towards the establishment and equipment of these institutions are far in excess of those in any other part of the world. Between the years 1890 and 1901 these contributions amounted to about £23,000,000.

The American universities, with which the technical institutions are in many cases closely associated, differ from those in the United Kingdom in their examinations for degrees. In this respect they have adopted the practice of the German and other continental universities. The examinations are almost uniformly conducted by the teachers. The external examiner is practically unknown. This system allows considerable freedom to the teacher, and is said by competent judges to be attended with excellent results. In many of the states, particularly in the east, even the matriculation, or entrance examination, is being superseded by a system known as the "accrediting" system of the secondary or high schools, where the students receive their general education. According to this system, the schools are inspected by the professors of the university, and those in which the equipment, the courses of instruction, and the method of teaching are found to be satisfactory, are included in a list of "accredited" or approved schools, and the pupils of such schools, who produce a certificate of having satisfactorily attended the prescribed course of study, are admitted to the university without passing any entrance examination. An advantage of this system is that it brings the professors of the university into direct relationship with the schools in which the students receive their preliminary training, and closely connects the instruction provided in the school with the higher and more specialized teaching of the university.

The widespread appreciation of the advantages of the higher education among all classes of the American people, and the general recognition among manufacturers, engineers and employers of labour, of the value to them, in their own work, of the services of college-trained men, has largely helped to increase the number of students in attendance at the universities and technical institutions, and to encourage in every state the foundation of schools for advanced professional training.

The institutions in which the highest technical instruction is provided are those devoted to the teaching of engineering in all its branches, including mining engineering, and of chemistry in its application to manufacturing industry; besides schools of agriculture and forestry and schools of design.

Of these the Massachusetts Institute of Technology at Boston is the most typical. It was founded in 1859 with a view to supplying a complete system of industrial education, supplementary to the general training of other institutions. In 1861 an act was passed incorporating a body of persons for the purpose, *inter alia*, of aiding in the advancement of science in its application to the arts, agriculture, manufactures and commerce. The institute offers thirteen distinct courses. Of these, eight are devoted to engineering, including naval architecture; four to chemistry, physics, biology and geology, and one to preparation for professional teaching. In 1904 there were 183 instructors on the permanent staff of this institution. As indicating the practical character of the teaching in this and in other similar schools, it should be noted that the railway companies co-operate in making provision for tests on a large scale, and in permitting the use of locomotives on their line for the purpose of giving practical training to the students.

At Columbia University, New York, the school of applied science was established in 1864, and consists of a fairly complete school of technology with a four years' course of instruction. An interesting department at Columbia is the professorial school for the study of education and the training of teachers. The importance of manual training is recognized by the fact that the professor of this subject has a seat in the faculty of applied science. Two schools of observation and practice are maintained—the Horace Mann School and the Experimental School. The former comprises three departments, a kindergarten, an elementary and a high school. The experimental school is under the immediate direction of the professor of the theory and practice of teaching. The facilities provided for the professorial and technical training of teachers are one of the most valuable features in the educational system of the United States.

Higher technical instruction in Britain.

In England there is a growing tendency to associate technical with secondary education. The central technical college of the City and Guilds of London Institute, was an institution established exclusively for the purpose of providing the highest grade of engineering education. In this respect it compared more nearly than any other institution with the technical high schools of Germany. The Royal School of Mines, connected with the Royal College of Science, was a similar institution, providing the highest teaching for mining engineers. In Birmingham, Leeds and Sheffield, schools of applied science were established under the names respectively of the Mason College, the Yorkshire College of Science, and Firth College, which gradually developed into technical colleges to which a literary side was attached with provision for advanced humanistic studies. The oldest of these colleges was the Owens College, Manchester, which combined the curriculum of a university with that of a technical high school. Its school of applied chemistry was, for many years, one of the most flourishing in the country. In 1882 a somewhat similar school was founded in Liverpool as a university college, and the Yorkshire College of Science similarly widened its curriculum. To this college, a textile school, including a department for dyeing and design for textiles, was added by the munificence of the Clothworkers' Company of London. This department soon developed into one of the best-equipped institutions in the country for the study of the technology of textile manufacture. The three colleges at Manchester, Liverpool and Leeds were incorporated in the year 1885 into the federal Victoria University. Other textile schools for day students, providing a full course of advanced instruction, were founded at Bradford, Huddersfield, Halifax, Bolton, and in other parts of Yorkshire and Lancashire. In 1903 University College, Manchester, received a royal charter as the Victoria University of Manchester, and the University College of Liverpool became a separate university. In the following year the Yorkshire College received a charter of incorporation as the University of Leeds. These three universities provide full courses of instruction in engineering and in the industrial applications of science. Charters of incorporation as universities were also granted to the colleges at Birmingham and Sheffield. The Birmingham University, covering an area of over twenty-five acres, contains blocks of buildings devoted to the teaching of mining and engineering, and at Sheffield there is a special school dealing with the metallurgy of iron and steel.

The University of Manchester soon after its incorporation entered into arrangements with the municipal school of technology in that city, by which the faculty of technology was in part carried on in the well-equipped buildings of the municipal school, the largest institution of the kind in Great Britain. It was publicly opened in the year 1902. In these new universities ample provision is made for the teaching of electrical engineering and electro-technics generally, and the laboratories provided for this purpose are well equipped with machinery and apparatus, and compare not unfavourably with some of the most recently erected in Germany. Schools for mining engineers have been established at Wigan and Camborne and Redruth. In Wales, at different times, local colleges of university rank were opened in Cardiff, Bangor and Aberystwith, and those three colleges were subsequently united in the University of Wales. In all these local universities the technical instruction forms part of the ordinary university courses in which degrees are granted.

Other colleges outside London, besides those named, which participate in the government grant allocated to universities and colleges, giving higher grade instruction of a technical character, are University College, Bristol; Armstrong College, Newcastle-on-Tyne; and the university colleges at Nottingham, Reading and Southampton.

The University of Cambridge has a school of engineering with well-equipped laboratories for the teaching of pure and applied sciences. The universities of Edinburgh and Glasgow recognized at an early date, as part of a university course, the teaching of science in its application to engineering; and at University College, Dundee, there is a good school for the teaching of the technology of spinning and weaving, more particularly with reference to the manufacture of jute and linen.

The University of London.

In London, University College and King's College fulfilled for many years the function of a university and technical high school. Soon after the reorganization of the University of London in 1901, by which that institution was changed from an examining body into a teaching university, University College and King's College, which were named in the charter as schools of the university, transferred their funds, buildings, &c., to the university and became incorporated therein. The East London College, originally founded as a technical school in connexion with the People's Palace at Mile End, was admitted in 1907 as a school of the university, and under the statutes of the university certain teachers in the Polytechnic institutes became recognized teachers, and their students were admitted to graduation as internal students. Most of the students so admitted graduate in the faculty of engineering. For several years it was apparent that the work of the City Guilds Central College and that of the Royal College of Science and School of Mines overlapped to some extent, and that the teaching in each separate institution was incomplete and needed to be supplemented by that provided in the others. A departmental committee was accordingly appointed by the president of the Board of Education in the year 1904 to consider the working of the government College of Science and the School of Mines and their relation to other similar schools, and as a result of the report of that committee, published in 1906, a charter of incorporation was granted in 1907 to a new institution under the name of the Imperial College of Science and Technology, in which the teaching given in the three schools would be co-ordinated under a new governing body, consisting of members appointed by the Crown, the Board of Education, the City and Guilds of London Institute, the University of London and the principal engineering societies, with power to negotiate with the university for the transfer to the new institution of the engineering departments of University College and of King's College. The Exhibition Commissioners of 1851 agreed to grant unoccupied sites of land at South Kensington for the extension of, and the addition of new departments to, the existing colleges, and large annual endowments were promised by the government and the London County Council in addition to sums of money from private sources. The new Imperial College of Science and Technology is constituted by charter a school of the university, and is intended to provide the highest instruction in engineering and applied science, with facilities for advanced research work. The scheme was intended, when complete, to supply the metropolis with a technical school of the highest grade, similar to some extent to the well-known institutions in Berlin (Charlottenburg) and Massachusetts, but adapted to the special industrial needs of the British empire.

Legislative Enactments.—The state organization of technical education in the United Kingdom is mainly the result of enactments passed in and after the year 1890. Before that date, however, as early as 1877, the Livery Companies of London, with a view to fulfilling the purposes for which by charter they were originally incorporated, began to consider how best they could initiate a national scheme of technical education, for which, owing to the depression of trade and the changed conditions under which British industries were conducted, a strong demand had arisen. They consulted leading manufacturers and some of the best-known scientific authorities, and in 1880 an association was formed of the City corporation and some of the wealthier City companies under the name of the City and Guilds of London Institute for the advancement of technical education. The scheme of the institute was to establish a central institution at South Kensington, somewhat on the lines of the high schools of Germany, and one or more technical schools of intermediate grade in London, and to encourage by means of grants of money and by examinations for certificates technical classes and trade schools in different parts of the United Kingdom. In March 1880, an organizing director and secretary was appointed to develop and give effect to the scheme. As indicating the importance of the movement King Edward VII., then prince of Wales, accepted the office of president of the institute, which thus led the way to the establishment, under the direction of the government and under the control of local authorities, of a national system of technical education. The successive steps by which the system was evolved, and how it was gradually incorporated into the general scheme of education, are matters of interest in the history of education. A definition of "technical instruction" applicable to the varied teaching of the United Kingdom was, in the first instance, fixed by act of parliament. The term included instruction in science, art, and technology, and also in manual training; and by "technology" was understood the practical application of different kinds of knowledge to a particular trade, or industry, or employment.

State organization of technical education in United Kingdom.

Action of Livery Companies of London.

The National Association.

The progress of technical education was very much helped by the formation of the "National Association for the Promotion of Technical Education," which was inaugurated at a meeting held on the 1st of July 1887 and dissolved when its objects had been fulfilled, in June 1907, after twenty years of useful work. The general objects of the association were to promote and watch legislation, to spread information, and to discuss and assist in giving effect to the recommendations of royal commissions appointed to inquire into educational methods and organization. To its activity the development of technical education in England had been largely due. The first legislative effort to give effect to the recommendations of the Royal Commission on Technical Instruction, whose report was published in 1884, was a bill introduced into parliament in July 1887. The purpose of this bill was to enable school boards and local authorities to provide out of the rates technical schools, or to contribute to their support. A special provision of the bill was that a poll might be demanded by fifty ratepayers before any action could be taken under the powers it conferred. Technical instruction was so defined as to include subjects aided or sanctioned by the Science and Art Department. The bill was read a second time on 9th of August 1887, but never reached the committee stage. In the following March a new bill was introduced on behalf of the "National Association." It empowered school boards to provide technical instruction in schools under their management, and to contribute to the maintenance of higher technical institutes. The definition of technical instruction was widened so as to include the use of tools, commercial subjects, modern languages, and any subjects sanctioned jointly by the Education Department at Whitehall and the Science and Art Department at South Kensington, which at that time were practically separate government departments. The bill gave very extensive powers to school boards. It was withdrawn without a second reading, in view of the avowed intention of the government to deal with the subject. On the 17th of May 1888 the government bill was introduced. It contained several new features which pointed in the direction of subsequent legislation. Whilst school boards were again empowered to provide technical instruction in their own schools, they were also required, under certain conditions, to aid in the supply of technical and manual training in voluntary schools. At the same time the local control of secondary technical instruction was placed in the hands of a separate authority, viz., the "authority empowered to carry out the Public Libraries Acts." Additional rates, limited in each case to 1d. in the £, might be levied. The bill bristled with difficulties. It aimed at placing the voluntary schools, as regards technical instruction, under the control of school boards, but set up a new authority for the control of technical instruction higher than elementary. There was a growing belief, however, that school boards were not the most suitable bodies for the direction or control of technical education. This belief arose from the difficulty of devising means for securing equal advantages to both classes of elementary schools, and from the general unwillingness to extend school board authority beyond the limits of elementary instruction.

Bill of 1888.

No reference was made to technical education in the Queen's Speech in opening the parliamentary session of 1889, but the subject had been fully discussed during the recess. The difficulties in the way of legislation on the lines previously attempted were now clearly understood, and it was recognized that separate and distinct measures would have to be adopted for providing technical instruction in elementary schools and in schools of a higher grade. During the year 1889 three bills were introduced by private members. Two only of these bills were considered: the one dealing with elementary education, and enabling school boards to give technical teaching in schools under their management; the other enabling local authorities to establish or contribute to technical schools and classes. The former bill was fully discussed, but in the absence of any practical settlement of the voluntary school difficulty the government withdrew its support, and the bill was dropped. About this time the passing of another legislative measure helped very considerably towards the solution of the difficulty. The Local Government bill, which became law in 1888, enacted that "a council shall be established in every administrative county . . . and be entrusted with the management of the administrative and financial business of that county." A number of new representative bodies known as county councils were thus created, with powers similar in character to those possessed by the old boroughs. To these newly constituted bodies were transferred all business previously conducted by the quarter sessions. The act conferred similar powers on certain boroughs, according to their population, which were known as county boroughs. By utilizing these county municipal bodies for educational purposes the necessity of entrusting technical instruction to school boards was avoided; and accordingly, on the 24th of July 1889, the government introduced into the House of Commons a bill conferring upon county and county borough councils, and also upon urban sanitary authorities, the power to levy a rate not exceeding 1d. in the £ for the purpose of promoting technical and manual instruction in their district. This bill met with serious opposition from school board authorities and their friends, who resented the limitations it imposed on their educational aspirations; but the government was resolved to pass it, and after much obstruction it became law on the 19th of August 1889, having passed through all its stages in the House of Lords in a single sitting. The bill marked an epoch in the history of education, being the first legislative enactment dealing with technical instruction in England.

Local Government Act, 1888.

The act (Technical Instruction Act, 1889) provided that:

> The expression "technical instruction" shall mean instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments. It shall not include teaching the practice of any trade or industry or employment, but, save as aforesaid, shall include instruction in the branches of science and art with respect to which grants are for the time being made by the Department of Science and Art, and any other form of instruction (including modern languages and commercial and agricultural subjects), which may for the time being be sanctioned by that department by a minute laid before parliament, and made on the representation of a local authority that such a form of instruction is required by the circumstances of its district.

Although at first received with no great favour, the act proved useful, and is important as representing the outcome of a number of abortive attempts at legislation, occupying three years, and intended to give practical effect to some of the recommendations of the Royal Commission of 1884. The act definitely settled the question as to the local authority for technical instruction, and decided it against the school board. It contained no provision, however, for the supply of technical instruction to children in either voluntary or board schools, and even expressly excluded from any share in its benefits all scholars receiving instruction in the obligatory or standard subjects. A way was soon found, however, of providing for technical instruction in elementary schools without any fresh act of parliament, and the difficulty of reconciling the interests of voluntary and board schools, which had impeded previous attempts at legislation, was thus avoided.

London School Board Joint Committee.

Early in 1886 the School Board for London, finding that it was unable to expend on technical instruction any part of the school board rate, applied to the City and Guilds of London Institute for financial help. The application was favourably received, and in the following year a joint-committee was formed, consisting of representatives of the Board, of the Institute and of the Drapers' Company. With the funds supplied by the Company and the Institute the committee were enabled to try some interesting educational experiments. Six centres for workshop instruction were equipped, and children were received into the classes from voluntary and board school. A scheme of instruction was prepared with the object of bringing into prominence the disciplinary character of the teaching, and of distinguishing it from the rule-of-thumb methods adopted in the workshop of commerce; and the experience of foreign schools, especially those in France, was utilized. The fears of trade unions lest the action of the school board would have the effect of increasing the number of trade carpenters were minimized, and the real value of manual training as a part of general education was for the first time illustrated. The experiment proved so successful that H.M. inspectors reported most favourably on the usefulness of the teaching, and on the value of the instruction in improving the general intelligence of the pupils, and particularly in rendering them more skilful and observant. Indeed, it was found that their progress in ordinary school studies was quickened by the practical training of the shop. As the result of these experiments the "use of tools" was recognized in the government code of 1890 as a subject of school instruction on which grants were to be paid, and towards the cost of which the school board rate was applicable. Later, following further experiments by the joint-committee, laundry-work and housewifery were included in the curriculum, and the problem of introducing so-called technical teaching into elementary schools was solved without any special legislation. Since 1890 manual training has formed a part of the elementary school system. The instruction includes the use of wood-working and metal-working tools, but stops short of teaching any particular trade, and is thus differentiated from the teaching given in the municipal schools of Paris. The new code also provided for a more rational system of object-lessons and of rudimentary science teaching, encouraging practical exercises and experiments to be worked by the pupils themselves. The joint-committee having completed its work, ceased to exist in 1900.

Local Taxation Act, 1890.

The act of 1889 and the code of 1890 enabled local authorities and school boards to provide out of the rates technical instruction for the working classes. The rate available under the act was limited to one penny in the pound, and very gradually, and with some hesitation, certain local authorities put the act in force. The motive power required for promoting technical instruction, other than that in elementary schools, was, however, still wanting, and might have remained so for some time longer if it had not been for the accident that in the following year, during the discussion in parliament of the question of compensation relating to public-houses, the residue of the beer and spirit duty was found to be unappropriated, and was allocated to county and county borough councils and made available for the purposes of technical education. The Local Taxation (Customs and Excise) Act, which became law on the 18th of August 1890, was "an act for the distribution and application of certain duties of customs and excise," and it provided that the residue of the English share of these duties should be distributed between county and county borough funds, and made applicable "for the purposes of technical education within the meaning of the Technical Instruction Act, 1889." By the express terms of this act this disposition of the residue, which then amounted to £743,000 for England and Wales, was revocable by parliament, and the allocation of the fund to education was left to the discretion of the local authorities. The grant accordingly was not generally regarded as permanent, and local authorities hesitated to commit themselves to any definite educational schemes. Indeed, it was seriously doubted whether such a windfall was likely to be made a permanent annual contribution from the state to the purposes of technical education. But gradually small sums were provisionally voted in aid of existing schools; and when the then Chancellor of the Exchequer declared that, if the "whisky" money (as it was commonly called) were found to be well and carefully expended, no future Chancellor would be able to divert it to any other purpose, local authorities began to consider how the money that had fallen into their hands might be best employed to meet local educational needs. Special committees were accordingly formed, consisting in many cases not only of members of the county or county borough council, but also of other persons versed in educational matters, to whom the preparation of schemes of instruction suitable to the several districts was referred. The committees so constituted, known as technical instruction committees, were established in different parts of the country, and to these bodies was delegated, subject to periodic reports to the council, the responsibility of dealing with the moneys at their disposal. The technical instruction committees proceeded in nearly all cases to elect as secretary a gentleman of scholarly attainments and educational experience, capable of advising as to the organization of schools and classes in accordance with the terms of the act and the special requirements of the district. As a result of the acts of 1889 and 1890 local educational authorities altogether distinct from school boards came into existence, each with an organizing secretary acting as educational officer for the district. The creation of these educational authorities, with functions, however, limited to technical instruction, marks the most important step in the organization of education since the establishment of school boards.

Technical instruction committees.

By special minutes of the Science and Art Department new subjects were from time to time included under the term "technical," and the definition of technical education was gradually widened. Among the subjects first added to the list were those included in the "programme of technological examinations" of the City and Guilds of London Institute, and the teaching of technology, as distinct from science, was thus for the first time officially recognized and aided by grants from public funds. Later, commercial subjects and modern languages, the theory and practice of agriculture, and the arts and crafts underlying various cottage industries were accepted as branches of technical instruction; and whilst, on the one hand, the definition was so widened as to include nearly all that is comprised in the curriculum of a secondary school, the teaching of certain technological subjects approached so near to trade teaching that the provision excluding "the practice of any trade or industry or employment" from the teaching sanctioned by the act appeared likely to be overlooked. Practical instruction in engineering, weaving, printing, photography, plumbing, carpentry, brickwork, bookbinding and other subjects was encouraged by the City and Guilds Institute, acting as a central authority for education of a distinctly technological character; but notwithstanding the continued increase in the number of practical classes in different branches of technology, the teaching of technology as distinct from that of science and art received at this time no direct support by means of grants in aid from the state. Under the new conditions, however, of assessing the government grant, introduced into the Directory of 1901–02, instruction in technology received some form of recognition.

Curriculum.

The county of London remained for some time behind other counties in utilizing the provisions to the Technical Instruction Act of 1889, by devoting to educational purposes the funds placed at its disposal by the Local Taxation (Customs and Excise) Act, 1890. The funds applicable to London, which in the first instance amounted to about £163,000, but soon reached a total of about £200,000, were wholly employed for a period of two years in relief of the rates. The wants of London were not at first understood; and it was thought that sufficient funds for educational purposes might be obtained from other sources. A scheme for the utilization of a fairly large income arising from the City parochial charities had been under the consideration of the Charity Commissioners. It was first published in 1888, and, after some discussion and modification, was sanctioned by parliament. According to that scheme a capital sum of about £150,000, supplemented by a like amount obtained from the City companies and other sources, was made available for the building of technical and recreative institutions for the poorer classes of the working population of London, similar to the Polytechnic in Regent Street and the People's Palace in Mile End Road. The scheme created a central governing body for the general supervision of these institutions, and placed at its disposal an income of about £50,000 available for educational purposes, which, with the falling-in of leases, was certain to increase. Provision for the endowment of eight polytechnics and of other educational institutions was made in the scheme, and the Goldsmiths' Company undertook to erect and maintain from its corporate funds a ninth, which has since been presented by the Company to the University of London, and under the name of the Goldsmiths' College is used mainly as a school for the training of teachers. Since then other similar but somewhat smaller institutions have been established.

Schemes for London.

Before the erection of these new institutions was completed it was ascertained that the annual income at the disposal of the trustees for the purposes of maintenance and equipment was altogether inadequate; and a committee of inquiry having been appointed by the London County Council, an exhaustive report on the educational needs of the metropolis was prepared, which led to the formation of a Technical Education Board for London, consisting of members of the County Council, who formed the majority of the board, and also of representatives of the City Parochial Trustees, of the City and Guilds Institute, of the School Board, and of other bodies; and to the board so constituted the council entrusted the spending of the funds available under the Local Taxation Act, 1890. The board held its first meeting on the 28th of April 1893, but ceased to have a separate existence in 1903 on the passing of the London Education Bill. During those eleven years the board, with the assistance of its organizing secretary, succeeded in arranging a comprehensive and varied scheme of scholarships, which, among other benefits, enabled children from the elementary schools to continue their education in intermediate schools, and to pass on to the higher technical institutes and universities. It supplemented by large grants the income of the polytechnic institutions; it established or assisted in establishing new trade schools; it provided laboratories, and aided in the teaching of practical science in a large number of secondary schools; it encouraged the teaching of modern languages and commercial subjects; it assisted in founding a school of economics, which has become a constituent part of the new University of London, and utilized in nearly all instances with the best possible results the large annual income allocated by the County Council to technical education.

Work of the Technical Education Board, London.

The close connexion between technical and secondary education was clearly indicated in the comprehensive definition of the former term given in the act. But it soon became manifest that no great progress could be made in technical education unless further provision were made for secondary education and unless some improvement could be effected in the methods adopted in secondary schools. The cry of Matthew Arnold for the better organization of secondary education had, so far, met with no adequate response. There was still an insufficient supply of secondary schools, and a complete absence of advice or control by any central authority. The urgency of this need was recognized by the "National Association for the Promotion of Technical Education," which at a meeting held in July 1889 resolved to alter its title by the addition of the words "and Secondary" after "Technical." This verbal alteration represented a widespread conviction that technical and secondary education are of necessity closely associated, and that future efforts should be directed towards the improvement and organization of secondary education and the union of different grades and branches of education under a single government department. That the Technical

Connexion with secondary education.

Instruction Act would need to be followed by a Secondary Education Act was generally recognized. Accordingly, after much discussion, the government in the year 1896 introduced into parliament a comprehensive measure dealing with education as a whole and embodying the principal recommendation of the Royal Commission on Secondary Education. The bill was well received, and, if the government had persevered with it, would have passed into law, and the question would have been settled for a generation. It was wrecked owing to the difficulty of satisfying the aspirations of the smaller boroughs to be constituted as local education authorities. No further action was taken till 1898, when a new bill was introduced by the government, creating a Board of Education, and combining under one department the functions of the Education Department at Whitehall and of the Science and Art Department at South Kensington, with certain powers relating to the educational work of the Charity Commissioners. The bill was fully discussed during the recess, and in a slightly altered form it became law in the early part of the year 1899, and came into operation in April 1900. The Board of Education called into existence by the act thus became the central authority for elementary, secondary and technological instruction. Provision was made in the act for the creation of a consultative committee of educational experts to be appointed by the president, whose special duty was to prepare and keep a register of all qualified teachers. As then constituted, the board consisted of the secretary, responsible to the president for the administration of both primary and secondary education, of two principal assistant secretaries, and of subordinate officers. An assistant secretary for secondary and another for technological instruction were appointed, both under the direction of the principal assistant secretary at the South Kensington branch. With a view to co-ordinating the technological instruction to be carried on by the board with that undertaken by the City and Guilds of London Institute and other bodies, a departmental committee was appointed in November 1900 on which those bodies were represented. As a result of the recommendations of that committee arrangements were made for co-ordinating to some extent the work of the City and Guilds Institute with that of the Board of Education. In the regulations issued in 1902 for assessing the amount of state aid to be given by way of grants to technical schools it was provided that the whole instruction given in any school, in technology as well as in science and art, should be considered; formal recognition was given to the certificates issued by the Institute, and the Examination Board of the Technological Department of the Institute was strengthened by the addition of four members nominated by the Board of Education. The teaching of science and art, as applied to specific trades and industries, was thus brought under the direct supervision of the central educational authority.

Creation of Board of Education.

It was, however, the Education Act of 1902 which freed technical education from the restriction which had prevented its natural development. For some time the opinion had been gaining strength that all grades of education should be controlled by the same local authorities. The distinction between elementary and secondary education had been bridged over by various types of higher grade schools, and the difficulty of assigning to school boards the control of elementary schools, and to municipal bodies, also popularly elected, the control of education other than elementary, was found to be almost insuperable. A comprehensive measure of reform was regarded as indispensable. This necessity was emphasized by the fact that the managers of many voluntary schools, notwithstanding the state aid which they received as government grants, found the strain almost intolerable of meeting the ever-increasing requirements of the government as regards elementary education by means of private subscriptions. The new Education Act transferred to the local authorities, acting through education committees to be constituted by schemes to be approved by the authorities at Whitehall, the functions and duties of school boards, the separate existence of which, after a life of thirty-two years, was thus terminated. The same act threw upon the rates the burden of contributing to the support of voluntary schools, which, under certain conditions of management, were placed, as regards secular instruction, entirely under the control of the local authorities. School education of all grades was thus brought under the control of the same bodies, both as regards central and local administration, and the government and local authorities were free, under certain limitations imposed by the act, to prepare schemes for elementary, secondary and technical instruction, and for the award of scholarships enabling children to proceed from the elementary schools to the universities. By this act a national and unified system of education was effected for England and Wales.

Unification of education under Act of 1902.

In accordance with the act, which did not apply to London, municipal bodies were expected to appoint education committees from among their members and to co-opt a certain number of persons, including some women, versed in educational matters or representing educational interest. The London County Council, which had not regarded with favour the abolition of the school boards, showed no disposition to accept the aid of persons from outside who were not directly elected to represent the ratepayers, and although in 1903 an act was passed for the direction of education in London, the Board of Education reluctantly assented to a scheme prepared by the London County Council which vested the control of education in the hands of a committee consisting exclusively of members of the council with the addition of some women. At the municipal elections of 1907 the Progressives, who had hitherto formed the majority of the council, were defeated, and the Municipal Reformers reversed in this respect the policy of the previous council.

The London Act of 1903;

The Act of 1902 was strongly opposed by Nonconformists and by the Liberal party generally, and at the general election of 1906 a parliament was returned pledged to effect such changes in it as would give to the local authorities a more direct control over voluntary schools. Accordingly, one of the first measures introduced was a new Education Bill, which, after a protracted discussion, was passed by the House of Commons and amended in several particulars by the Upper Chamber. The amendments of the Lords were rejected *en bloc* and the bill was withdrawn. In the following year some of the less contentious clauses were embodied in the Education (Administrative Provisions) Bill, which received the royal assent, and among its clauses was one which widened the definition of education, so as to include any kind of training which might be pronounced by the board to be educational in character. By an administrative act of the board, a new department under a separate secretary, but responsible to the Minister of Education, was created for Wales, which thus, without any act of parliament, practically acquired independent control of its educational machinery.

The Bill of 1906.

The Act of 1907.

The foregoing statements refer more particularly to England and Wales, to which prior to 1907 all acts of parliament dealing with education subjects were generally applicable. In Scotland and in Ireland the organization of technical instruction proceeded on different lines. A Technical Schools Act, applicable to Scotland only, was passed in 1887. This act enabled school boards by means of the school funds to provide and maintain technical schools. The act has proved to be practically inoperative. In Scotland, however, school boards have been entrusted with much larger powers, and possess greater influence, than in England. Many of the secondary schools of Scotland are under the direction and control of school board authorities. The residue of the beer and spirit duties under the Local Taxation Act applicable to Scotland was much less, even relatively to the population, than in England, and was, moreover, divided directly among so many different authorities as to be in most cases of little or no real value for educational purposes. Recently attempts have been made to combine the funds distributed among different neighbouring authorities, so as to bring them under the control of a single body for the benefit of a larger area. In the year 1896–97 the Education Department of Scotland was entirely separated from that of England, and there was a consequent transfer of functions and grants from the latter to the former. By the passing of the Local Taxation (Scotland) Act, 1898, the residue grant was relieved of certain charges, and additional funds thus became available for technical education. No grants for science or art instruction are made to Scottish schools from the English Board of Education; but several of the technical schools avail themselves of the examinations of the board, and also of those of the City and Guilds of London Institute. Among the equipped technical colleges in Scotland may be mentioned the Heriot-Watt College of Edinburgh, the Glasgow and West of Scotland Technical College, Glasgow, the Robert Gordon College, Aberdeen, and the Technical College, Dundee. These do not differ in any essential points from corresponding schools in England. The system of instruction is very similar, and among the subjects taught will be found most of those included in the Regulations of the Board of Education and in the programme of the City and Guilds of London Institute. Special attention is given in some of these schools to the teaching of the principles and practice of the different branches of textile manufacture. Manual training forms an important part of the curriculum of primary and secondary schools, and the instructions to inspectors on science teaching issued by the Scottish Education Department show a just recognition by the department of the proper methods to be adopted in the teaching of science as a part of general education. Under the Scottish system leaving certificates are awarded on the results of examinations held at the close of the ordinary school course. These examinations cause the minimum of interference with the ordinary school work. At the universities of Edinburgh, Glasgow and Aberdeen the higher technical instruction in such subjects as engineering and naval architecture is well developed.

Scotland.

Ireland remained behind Great Britain as regards facilities for technical education. Although the Technical Instruction Act (1889) applied to Ireland as well as to England and Wales, very little use was at first made of its provisions. Moreover, the Irish share of the funds available under the Local Taxation Act is definitely allocated to intermediate education. A committee known as the Recess Committee published in 1896 some valuable and important recommendations, which led to the passing of the Agriculture and Technical Instruction (Ireland) Act of 1899. The reports of two commissions, one on manual and practical instruction in primary schools, and the other on intermediate education, contained suggestions which gave encouragement to the practical

Ireland.

teaching of technology and helped to promote a better system of instruction in Irish schools.

The work was successfully commenced under the direction of the newly constituted Department of Agriculture and Technical Instruction, consisting of an Agricultural Board, a Board of Technical Instruction, a Council of Agriculture, and a Consultative Committee of Education. The department had an endowment of £166,000 a year, which was distributed among the several branches. It took over the duties of several other administrative bodies, and the grant for science and art for Ireland, and the grant in aid of technical instruction in Ireland as defined by the Technical Instruction Act of 1889, previously administered from South Kensington, was transferred to the new department. Among the industries for which the department is now occupied in organizing courses of instruction are engineering, textiles (particularly linen manufacture), shipbuilding, agriculture and the fisheries. The operations of the department extend to all grades of schools, from the Royal College of Science, Dublin, organized as a Central Technical College, to the elementary and secondary schools which the department enters for the administration of the science and art grants to the evening technical classes conducted by local authorities. The first annual report of the department, published November 1901, showed that successful efforts had been made to improve science teaching as a part of general education, and to develop on correct lines manual training and technological instruction. The municipal school of technology at Belfast, opened in 1907, is an institution similar in many respects to those of Manchester and Birmingham, and providing technical instruction in connexion with a great variety of industries. There is also a large school at Dublin, and schools have been established in Cork, Limerick and elsewhere.

Results of Experience.—Experience has helped to establish certain principles as applicable to technical education. It is now generally admitted that whilst the age at which the ordinary school training should cease, and technical or professional education should commence, must vary for different classes of workers, the teaching special to any industry or employment should supplement, and not form part of, general education. The subjects entering into the school curriculum may be, and in certain cases should be, selected with reference to their applicability to certain callings, but they should be so taught as to become instrumental in the formation of mental habits and the development of character, the mere knowledge or skill acquired being of secondary importance. In the teaching of science there has been a marked change in method. Formerly the usefulness of the knowledge to be derived from the study of nature gave to physical science its chief claim to a place in the school curriculum, but it is now held that the real value of the study consists in the opportunities it affords of exercising the pupil in accurate observation, and of developing resourcefulness and powers of independent thought and reasoning. Whilst the opinion in favour of postponing as long as circumstances permit all specialized instruction has become of late years more pronounced, there has been a growing tendency, not only in England but also on the Continent and in the United States, to associate technical teaching more closely with workshop practice. The professional or trade teaching, which is supplementary to primary or secondary education, is more practical and less easily distinguishable by the ordinary observer from the training of the factory or workshop. This tendency is shown in all grades of technical education. The technical institutes established in London and in the large English manufacturing towns, attended mainly by evening students, are provided not only with expensive laboratory apparatus for the teaching of applied science, but also with tools and machines for the teaching of technology; and some of the departments of these schools are equipped so as to resemble a small factory. This is the case in the departments devoted to the teaching of mechanical and electrical engineering, weaving, and spinning, watch- and clock-making, boot and shoe manufacture, and the different branches of the building and printing trades.

Changes in the conception of what technical education should be.

So far, however, no attempt has been made, except in very special cases, to teach the practice of any special trade. The teaching of technology is distinct from trade teaching. In all the technical institutes of London, and in most of those of other towns, none but persons actually engaged in the industry, the technology of which they are desirous of studying, are admitted to the workshop classes. The instruction given in such classes is very different as regards method, and also in its aims and objects, from the training of apprentices in the factory or trade shop. The tools and appliances are the same, but they are used rather as a help to the teachers in illustrating principles than as a means of enabling the student to acquire that dexterity and skill which constant practice can alone secure. With the general cessation of apprenticeship, as formerly understood, it is only in the school workshop that the young artisan has any opportunity of learning the use, and the principles underlying the use, of the instruments and appliances connected with his trade; and in those industries in which automatic machinery is gradually displacing hand labour he is altogether dependent upon school teaching for any knowledge he may wish to acquire of the processes involved in the particular manufacture, in some small section of which he is exclusively engaged. Modern technological teaching is essentially practical, but it is nevertheless different in kind from the mechanical and sectional practice of the factory of commerce; and except in some few, mainly artistic, crafts, there is no entrance to a trade through the door of the school workshop. In other countries, particularly in France, the case is different. The school, in many branches of industry, is accepted as a substitute for the shop, and the lad is so trained that he acquires in the school not only a knowledge of the principles of the trade, but sufficient dexterity and skill to enable him, on leaving school, to take his place among wage-earning operatives. It is only in day schools, in which the pupils spend the greater part of their time in workshop exercises, that trade teaching can be so developed. There are schools in England in which manual training in wood and metal work is carried beyond the limits of mere educational discipline; but even in those schools no special trades are taught, and the experience of recent years has only tended to emphasize the principle, that the education given in the ordinary day schools, whether primary or secondary, should be formative and general, rather than technical or professional.

Relations with practical trade.

Owing partly to climatic conditions, and partly to the fact that the hours of labour are somewhat shorter in England than abroad, evening schools of technology are likely to occupy a permanent place in the English system of technical education. In these schools all grades of workmen will continue to receive their special supplementary instruction; and it is from among the workmen so trained that foremen and works managers will generally be selected. Some intermediate teaching, however, is necessary between that of the elementary school and the technical class as a preparation for technological instruction. A knowledge of workshop arithmetic and geometrical drawing is indispensable, and it is in the evening continuation classes that such knowledge may be best acquired. These classes supply the teaching which may be regarded as the connecting link between elementary and technological instruction, and attendance at such classes will gradually become a necessary condition of entry to a technological course.

By means of scholarships a large number of children from the elementary schools are now enabled to continue and complete their general education in day schools of a higher grade. Nearly every county has its scheme of scholarships, providing facilities for the further education of children who show special abilities and aptitudes. These scholarships are awarded under conditions which differ very widely in different localities. Pupils from the higher-grade schools enter industrial life at a later age than those from the elementary schools, and, by reason of the more advanced instruction they have received, are at once qualified to enter classes in technology. In these schools practical teaching is further developed, both in the laboratory and workshop, but as a part only of the ordinary school course; and it would be incorrect to describe such schools as *technical* in the strict sense of the term. The position of these higher-grade schools in the general educational scheme was the subject of an important action (*Rex* v. *Cockerton*, 1901) in which it was decided by the law courts that the school boards were unable to apply the rates to the support of such schools. They were accordingly withdrawn from the sphere of elementary education, and have since been treated as schools of a secondary type. The judgment on appeal was conclusive, that the school board rates could be employed only for the provision of elementary education for children, whether in the day or evening, and this decision paved the way for the dissolution of school boards, and to the transfer of their duties and functions to the county and borough councils under the Act of 1902.

Types of secondary schools. As regards secondary schools proper, in their relation to technical education, it is important that the curriculum of such schools should be sufficiently varied to afford a sound liberal and preparatory training for the different branches of professional work. It is generally admitted that at least three types or departments of schools are needed—(*a*) the classical, (*b*) the mathematical, and (*c*) the modern language type; and that each of these divisions should contain sub-departments. The first of these varieties would be available for the general training of students wishing to enter the legal, theological or literary professions; the second for those preparing for engineering, manufacturing or agricultural pursuits; and the third would be found best fitted as a preparation for a commercial calling. These schools would correspond to some extent to the three kinds of secondary schools found in Germany, and would be available for students preparing to enter one or other of the faculties of a modern university. The organization of different types of secondary schools, and the curriculum appropriate to each, are matters which continue to occupy the attention of educational experts. In accordance with the regulations for secondary schools issued by the Board of Education in 1907, substantial grants were made to secondary schools which conformed to certain conditions as regards local control and undenominational religious instruction, or the directive influence of the board as regards curriculum and management over all such schools was strengthened. At the same time, manual training and domestic science were made essential parts of the curriculum in boys' and girls' schools respectively.

The demand for technical education, which originally led to the formation of the City and Guilds of London Institute, directed attention to the methods of teaching science, drawing and other subjects, and to the necessity of including science in the curriculum of all grades of schools. The methods of science teaching have been greatly improved. Experimental work has become essential, and methods of investigation and research have been applied to the teaching of a number of subjects to which formerly they would have seemed inapplicable. A close connexion has thus been established between the workshop and the classroom, and practical instruction is now regarded as a necessary part of general education both elementary and secondary, and as no less disciplinary than the merely literary and oral teaching it has partly superseded. This change in the school curriculum and in the methods of instruction has narrowed the true significance of the term "technical" as applied to education. By the term "technical" as commonly used is now understood "technological" or "professional," and whilst technological instruction may supplement either primary or secondary education, it is necessarily distinct from either.

The conviction has been steadily gaining ground that success in manufacturing industry, in the higher walks of commerce, and in every pursuit requiring technical knowledge, depends very largely upon the thorough and complete training of those who are charged with the control of the different kinds of work in which the army of operatives are engaged. Intelligent and highly skilled workers are indispensable; but unless they are properly directed by efficient and expert officers they can effect but little. *German example.* It is undoubtedly due to the careful training of the masters and leaders of industry that the Germans have achieved so large a measure of success in different technical pursuits. The recognition of this fact is slowly but surely influencing educational thought and action in Great Britain; but Germany is still ahead in the facilities afforded for higher education, and in the advantage taken of the facilities that exist. The number of students in her universities and technical high schools is still in excess of those receiving a similar training in Great Britain. The establishment, however, of local universities and the schemes for the award of scholarships adopted by local education authorities, will tend year by year to lessen this disparity. Meanwhile, Germany has relaxed none of her former efforts, but is steadily occupied in the enlargement and improvement of her educational institutions. New schools have been erected, wherever and for whatever purpose they are needed, equipped with every modern appliance for scientific investigation and research. Each professional career has its corresponding high school or university department. The economy of a wise and liberal expenditure on higher education is a recognized fact in German statecraft.

For those who are intended to occupy the highest posts in industrial life, a sound secondary education, supplemented by appropriate university training, is the best preparation. It is only in the university or tertiary grade of education that specialized or technological training for the higher industrial posts should commence. At this stage of education, general and professional teaching are more closely associated, and the names of the faculties of the new universities in the United Kingdom will in future indicate the several branches of professional work to which the different courses of university study are intended to lead. Of late there has been a marked development of distinctly technical instruction in connexion with the colleges of university rank. The error of restricting university studies to a certain limited range of subjects, which led in Germany to the establishment of technical high schools as institutions distinct from the universities, has been avoided. Engineering, in the broadest sense of the term, has been recognized as a branch of university education of the same order as medicine or law. Laboratories and workshops have for many years formed part of the equipment of the principal university colleges. In the statutes of the university of London a separate faculty is assigned to engineering, and part of the work of the polytechnic institutes is correlated with that of the reconstituted university. A survey of the field of education shows that whilst the difference between technical and general education is well marked in the primary and secondary stages, it is the function of the university to liberalize professional teaching, and to afford opportunities for specialized study and research in the higher branches of knowledge applicable to the practical work of industrial life.

AUTHORITIES.—See Sir Philip Magnus, *Industrial Education*, 1888, and presidential address to education section of British Association, 1907; Schönhof, *Industrial Education in France*, 1888; Holzapfel, *Die technischen Schulen, &c.* (1897); Report of British Royal Commission on Technical Instruction, 1884, and later special reports issued by the Board of Education; annual Reports of the United States Commissioner of Education and of the United States Commissioner of Labour; Report of English Departmental Committee on the Royal College of Science and School of Mines.

(P. M.*)

TECK, a ducal castle in the kingdom of Württemberg, immediately to the N. of the Swabian Jura and S. of the town of Kirchheim, crowning a ridge (2544 ft.) of the same name. It was destroyed in the Peasants' War (1525).

The duchy of Teck was acquired early in the 11th century by Berthold, count of Zähringen, whose great-grandson Albert, or Adalbert, styled himself duke of Teck. In 1381 it passed both by conquest and purchase to Württemberg. The title, which had lapsed with the extinction of the Zähringen line in 1439, was revived in 1495 by the German King Maximilian I., who bestowed it upon the dukes of Württemberg. The dignity was renounced by Duke Frederick William Charles upon his elevation to the rank of king in 1806. In 1863 the title "prince of Teck" was conferred by King William I. of Württemberg upon the children of Duke Alexander of Württemberg

(1804–1885) by his morganatic marriage with Claudine, countess Rhédey, ennobled as countess of Hohenstein; in 1871 Prince Francis, the eldest son of Duke Alexander, was created duke of Teck. His eldest son Adolphus (b. 1868) was in 1910 the holder of the title.

TECUCI (*Tecuciu*), the capital of the Tecuci department of Rumania, picturesquely situated among wooded hills, on the right bank of the river Bêrlad, and at the junction of railways from Bacau, Bêrlad and Galatz. Pop. (1900) 13,401. Tecuci has a large transit trade in grain, timber, cattle and horses, on their way from northern and eastern Moldavia to the Danubian ports. The neighbourhood of Tecuci was the scene of a fierce battle in 1476 between Stephen the Great and the Turks.

TECUMSEH, TECUMTHE, or TECUMTHA[1] (*c.* 1768–1813), American Shawnee chief, was probably born in the old Shawnee village of Piqua, near the site of Springfield, Ohio, between 1768 and 1780. While still a youth he took part in attacks on settlers passing down the Ohio and in widely extended hunting expeditions or predatory forays to the west and south; and he served in the Indian wars preceding the Treaty of Greenville in 1795. About 1800 his eloquence and his self-control made him a leader in conferences between the Indians and whites. After 1805 the Indians of the North-West became aroused by a series of treaties calling for new cessions of their territory and by the prospect of war between Great Britain and the United States. This presented to Tecumseh and to his brother Tenskwatawa (*i.e.* the Open Door), popularly called "the Prophet," the opportunity to put into operation a scheme which followed the ambitious dream of Pontiac. With some scattered Shawnee clans as a nucleus, the brothers proceeded to organize, first near Greenville, Ohio, and later on the White and Tippecanoe rivers in Indiana, "the Prophet's town," which was based on a sort of communism and was apparently devoted to peace, industry and sobriety, but their actual plan was to combine all of the Indians from Canada to Florida in a great democratic confederacy to resist the encroachment of the whites. Tribal organizations were to be disregarded, but all warriors were to be represented at periodical assemblages where matters of interest to all Indians were to be definitely decided. The twofold influence that was to dominate this league was the eloquence and political ingenuity of Tecumseh and the superstitious reverence aroused by "the Prophet." This programme alarmed the whites along the north-western border. In the course of the next three years Governor William Henry Harrison of Indiana held interviews with each of the brothers, and during one of these, at Vincennes in 1810, the respective leaders narrowly avoided a hostile encounter. Nevertheless "the Prophet" and Tecumseh reiterated their determination to remain at peace with the United States if the Indians were unmolested in their territory, and if all cessions beyond the Ohio were given up by the whites. The treaty of Fort Wayne in 1809, which called for the cession to the whites of some three million acres of land in central Indiana, was a direct challenge to this programme, and when, during Tecumseh's absence in the South, Harrison made a hostile move against "the Prophet's" town, the latter ventured to meet him, but was defeated on the 17th of November 1811 in the famous battle of Tippecanoe, which broke the personal influence of "the Prophet" and largely destroyed the confederacy built up by Tecumseh. Tecumseh still professed to be friendly toward the United States, probably because his British advisers were not ready to open hostilities, but a series of border outrages indicated that the fatal moment could not long be postponed. When, in June 1812, war broke out Tecumseh joined the British, was commissioned a brigadier-general in the British army, and participated in the skirmishes which preceded General William Hull's surrender at Detroit. He took an active part in the sieges of Fort Meigs, where he displayed his usual clemency toward his prisoners. After the battle of Put-in-Bay, when Colonel Henry Proctor began to retreat from Malden, Tecumseh bitterly reproached him for his cowardice and finally forced him to join battle with Harrison on the Thames river on the 5th of October 1813. In this battle Tecumseh was killed, as traditionally reported, by Colonel Richard M. Johnson of Kentucky, although this has never been fully substantiated. Like Pontiac, whom he doubtless imitated consciously, he had a wonderful eloquence and a power of organization rare among the Indians. His brother, "the Prophet," remained with a small band of Shawnees and died west of the Mississippi in 1834.

See Benjamin Drake, *The Life of Tecumseh and of his Brother the Prophet* (Cincinnati, 1841); and Homer J Webster, *Harrison's Administration of Indiana Territory* (Indianapolis, 1907).

[1] The name is said to mean "meteor," or "flying panther."

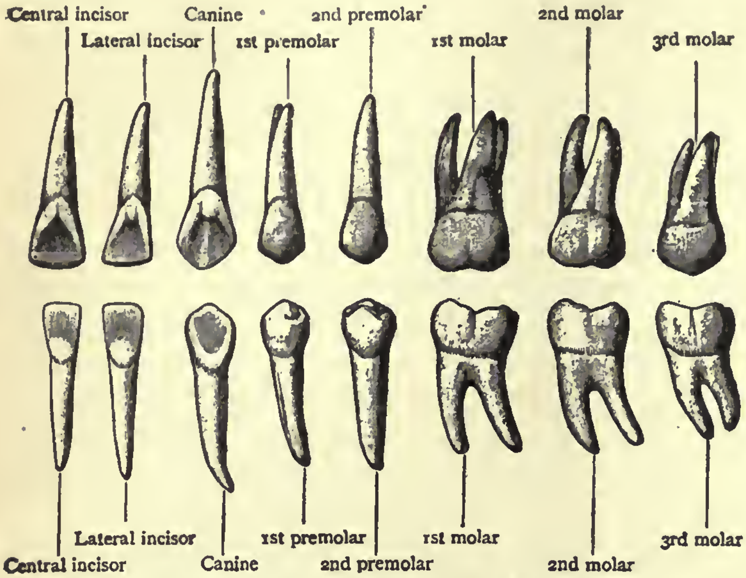
TEDDINGTON, an urban district in the Uxbridge parliamentary division of Middlesex, England, close to the Thames, 13 m. W.S.W. of St Paul's Cathedral, London, on the London and South-Western railway. Pop. (1901) 14,037. The district is residential and the town is a resort of visitors both to the river and to Bushey Park, which lies immediately south (see HAMPTON). The National Physical Laboratory, for making scientific investigations of industrial importance, and for mechanical testing, was opened in Bushey House in 1902.

TEES, a river of England, rising on the eastward slope of Cross Fell in the Pennine Chain, and traversing a valley about 85 m. in length to the North Sea. In the earliest part of its course it forms the boundary between the counties of Westmorland and Durham. The head of the valley, of which the upper portion is known as Teesdale, is not without desolate grandeur, the hills, exceeding 2500 ft. in height at some points, consisting of bleak moorland. A succession of falls or rapids, where the river traverses a hard series of black basaltic rocks, is known as Caldron Snout; and from a point immediately below this to its mouth the Tees forms the boundary between Durham and Yorkshire almost without a break. The dale becomes bolder below Caldron Snout, and trees appear, contrasting with the broken rocks where the water dashes over High Force, one of the finest falls in England. The scenery becomes gentler but more picturesque as the river descends past Middleton-in-Teesdale (Durham), the terminus of a branch of the North-Eastern railway from Darlington. In this locality lead and ironstone are worked. The ancient town of Barnard Castle, Eggleston Abbey, and Rokeby Hall, well known through Sir Walter Scott's poem, are passed; and then the valley begins to open out, and the river traverses in sweeping curves the rich plain east and south of Darlington. The course of the valley hitherto has been generally E.S.E., but it now turns N.E. and, nearing the sea, becomes an important commercial waterway, having on its banks the ports of Stockton-on-Tees, Thornaby-on-Tees and Middlesbrough, and forming an outlet for the rich ironworking district of Cleveland in the North Riding of Yorkshire. It is also navigable for barges up to High Worsall, 11 m. above Stockton. For the last five miles the course, below Middlesbrough, is estuarine. The drainage area is 708 sq. m. No important tributary is received.

TEETH (O.E. *teþ*; plural of tooth, O.E. *toþ*), the modified papillae or elevations of the mucous membrane of the mouth, impregnated with lime salts. Each tooth has a biting part or crown covered by enamel, a neck where the gum surrounds it, and one or more roots or fangs fitting into sockets (alveoli) in the jaw bone. For surgery of the teeth see DENTISTRY.

There are thirty-two permanent teeth in man, sixteen in the upper and sixteen in the lower jaw; they are also arranged in symmetrical sets of eight teeth on each side. The two teeth on each side of the mid-line in front are "incisors" and have chisel-shaped crowns. The mesial or central incisor of the upper jaw is broader than any of the others, consequently it bites against the central and lateral incisors of the lower jaw, and the same want of exact adaptation continues throughout the series, so that every tooth in the upper jaw except the last molar bites against its corresponding tooth of the lower jaw and the tooth behind that.

Next to the incisors comes the "canine tooth," the crown of which is somewhat peg-shaped, while behind this are the two "premolars" or "bicuspids," whose crowns are flattened from before backward and bear two cusps, the larger of which



From Ambrose Birmingham, in Cunningham's *Text-Book of Anatomy.*

Fig. 1.—The Permanent Teeth of the Right Side, Inner or Lingual Aspect.

The upper row shows the upper teeth, the lower row the lower teeth. The cingulum is distinct on the upper incisors and both canines, the lingual cusp on the upper lateral incisor and the upper canine.

is the external or labial cusp, while the smaller is the internal or lingual. As a rule there is a single root, though sometimes in the first upper premolar it is double.

The three "molars" are placed behind the premolars, and the upper and lower sets can be easily distinguished because the upper have three roots while the lower have only two. Of the three roots which the upper molars bear two are lateral or external and one mesial (see fig. 1), so that it is easy to tell the outer from the inner side of an upper molar. The front can, as a rule, be identified by the fact that the roots are generally bent a little backward at their tips, and this applies to other teeth than the upper molars. In the lower jaw, owing to the two fangs being anteroposterior, it is not possible to tell the lateral from the mesial surface of the molars by them, although the backward inclination of their tips shows the front from the back. When it is remembered that the upper teeth overlap the lower externally it is reasonable to expect that the lower molars would show some rounding due to wearing away of the edge of the crown on the outer side, and this is the case. The grinding surface of the crowns of the upper molars shows three or four cusps, while on that of the lower four or five are found.

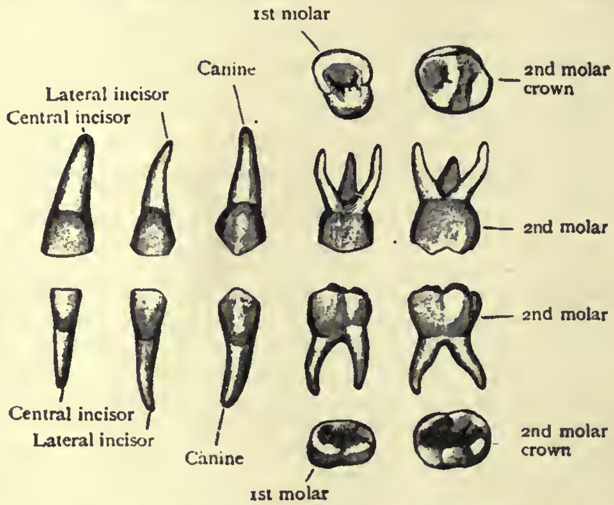
Of the three molars the first is the largest, and the third, or wisdom tooth, the smallest, while the upper wisdom tooth is smaller than the lower.

In the "milk teeth" or temporary dentition of the child there are only twenty teeth, ten in each jaw and five in each segment. They are two incisors, one canine, and two so-called molars. These molars occupy the position which the permanent premolars later on take, and it is held by many that the adult molars really belong to the milk dentition, although they cannot appear until the jaw has grown backward sufficiently far to make room for them. The temporary teeth differ from the permanent in their smaller size, their whiter colour, the greater constriction of their necks, and in the fact that the roots of the molars are widely splayed.

The dates at which the milk teeth are cut are very variable. The lower central incisors come first between the sixth and ninth month, or even later; then, after a few months, come the central and lateral upper incisors; again a few months' rest and the lower lateral incisors appear, followed closely by the first molars. After another rest of four or five months come the canines, the eruption of which is a slow process, while by about the end of the second year the second molars have appeared, and the milk dentition is complete. It will be seen from the above that the milk teeth are cut in batches with resting intervals between.

As C. S. Tomes points out, we do not know what causes the eruption of the teeth; the growth of the roots is not of itself enough to account for it. It is possible, however, that blood-pressure may be the determining cause. The first permanent tooth to be cut is the first molar, and this happens during or soon after the sixth year. It does not displace any of the milk teeth, but comes down behind the second milk molar. During the seventh year the central milk incisors fall out and their place is taken by the permanent ones; the shed teeth are mere shells of the crown, all the root having been absorbed, though not, as might be thought, owing to direct pressure of the succeeding tooth.

The lateral incisors succeed their milk predecessors at about eight years old, the first premolar takes the place of the first temporary molar about nine, the second premolar that of the second temporary molar about ten, the canine about eleven, while the second molar comes down behind the first about twelve, and so is known as the "twelve-year-old tooth." The third molar, or wisdom tooth, usually appears between eighteen and twenty, but may be much later, indeed it is sometimes never cut at all, and when it is, it often does not come down to a level with the other teeth. It is believed that man is gradually undergoing a suppression of his last molar teeth, which, if the process continue, will lead to our successors having a different dental formula from our own. It is interesting to notice that



From Ambrose Birmingham, in Cunningham's *Text-Book of Anatomy.*

Fig. 2.—The Milk Teeth of the Left Side.

The masticating surfaces of the two upper molars are shown above. In the second row the upper teeth are viewed from the outer or labial side. In the third row the lower teeth are shown in a similar manner; and below are the masticating surfaces of the two lower molars. In the specimen from which the first upper molar was drawn the two outer or buccal cusps were not distinctly separated, as is often the case.

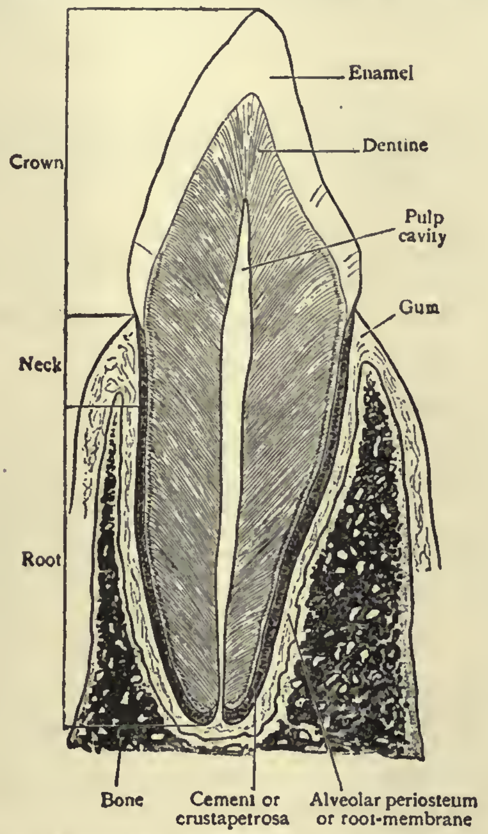
in some of the lower races of mankind the last molar tooth is nearly as large as those in front of it, and this is the case in the anthropoid apes. A. Keith and D. Braden Kyle have pointed out that the second and third molar teeth are successively formed in the posterior wall of the maxillary antrum and their crowns look backward. It is owing to the gradual growth backward of this antrum and the maxilla that they are rotated round a quarter of a circle and so at last look downward (see A. Keith, *British Journal of Dental Science*, vol. xlv., June 16, 1902).

Extra teeth are occasionally met with in the incisor, premolar and molar regions; their significance will be better realized after the embryology and comparative anatomy of the subject have been sketched.

For an accurate and detailed description of man's teeth see *A Manual of Dental Anatomy*, by C. S. Tomes, London, 1904.

Histology.

If a section be made vertically through a tooth all the exposed part or crown is seen to be covered with enamel, which, microscopically, is composed of a number of fine hexagonal prisms arranged at right angles to the surface of the tooth, and formed chiefly of calcium phosphate with small amounts of calcium carbonate, magnesium phosphate and calcium fluoride, but containing practically no organic matter. The enamel rests on the "dentine," of which hard yet elastic substance by far the greater part of the tooth is composed. It is made of the same salts as the enamel, but contains in addition a good deal of organic matter and forms a structureless mass through which the fine "dentinal tubes" run from the pulp cavity to the periphery.



From Ambrose Birmingham, in Cunningham's *Text-Book of Anatomy*.

Fig. 3.—Vertical Section of Canine Tooth, to illustrate its various parts, and its structure.

Surrounded by the dentine is the "pulp cavity," which is filled by the tooth pulp, a highly vascular and nervous mass of branched connective tissue cells, which, in a young tooth, has a layer of epithelial cells, the "odontoblasts," lying close against the wall of the cavity and forming new dentine. Slender processes ("Tomes's fibrils") project from these cells into the dentinal tubes, and are probably sensory. A nerve and artery enter the apex of the root of the tooth, but it is not understood how the nerve ends.

Surrounding the dentine where it is not covered by enamel is the "cement" or "crusta petrosa," a thin layer of bone which is only separated from the bony socket by the alveolar periosteum.

Embryology.

The lip is marked off from the rest of the mouth region by a "lip groove," which, in the case of the lower jaw, grows obliquely downward and backward, and the mass of ectodermal cells bounding it penetrates for some distance into the surrounding mesoderm below the bottom of the groove. This is known as the "tooth band."

On the under surface of this oblique tooth band (still taking the lower jaw), and close to its edge, appear ten thickenings, below each of which the mesoderm rises up into a "dental papilla," and so moulds the thickening into a cap for itself—the "enamel organ." The superficial cells of the dental papilla become the "odontoblasts" and manufacture the dentine, while those cells of the cap (enamel organ) which are on its concave surface and therefore nearest the dental papilla are called "ameloblasts," and form the enamel. The cutting or grinding part of the tooth is first formed, and the crown gradually closes round the dental papilla, so that at last, when the root is formed, the central part of the papilla remains as the pulp cavity surrounded by dentine except at the apex of the root. The roots, however, are formed slowly, and as a rule are not complete until some time after the tooth is cut. The mesoblastic connective tissue surrounding the developing tooth becomes condensed into a fibrous bag which is called the tooth-sac, and round this the lower jaw grows to form the alveolus. The crusta petrosa which covers the root is developed from the tooth-sac. It will therefore be seen that, of the various structures which make up a tooth, the enamel is derived from the ectoderm, while the dentine, pulp and crusta petrosa or cement are mesodermal.

So far only the milk dentition of the lower jaw has been accounted for.

Returning to the tooth band, it was noticed that the enamel organs were formed not at the extreme edge but a little way from it. From the extreme edge, which, it will be remembered, points inward toward the tongue, the permanent tooth germs are derived, and it is therefore clear that the permanent teeth must come up on the lingual side of their milk predecessors.

For further details and literature see *Dental Anatomy*, by C. S. Tomes, London, 1904; and *Development of the Human Body*, by J. P. McMurrich, London, 1906.

Comparative Anatomy.

The details of the teeth vary so greatly in different animals and groups of animals, and, on account of their being the most durable tissues of the body, are so important for classificatory purposes, that they are dealt with freely in the various zoological articles. All that can be done here is to give a broad general survey of the subject, taking the details of man's dentition, already set forth, as a point of departure.

In some fishes the teeth are continuous over the edges of the jaws with the scales on the surface of the body, and there is no doubt that teeth should be regarded as modified scales which have migrated into the mouth.

In the Cyclostomata (lampreys and hags) the teeth are horny cones, but beneath them there are papillae of the mesoderm covered with ectoderm which resemble the dental papillae and enamel organs although no calcification occurs except in Bdellostoma. In the Elasmobranchii (cartilaginous fishes) the teeth are arranged in several rows, and as those of the front row fall out the hinder row take their place; sometimes they are triangular and very sharp as in the sharks, sometimes flattened and arranged like a pavement for crushing as in rays. These teeth only represent the crowns of man's teeth, and they are not embedded in sockets except in the case of the teeth in the saw of the saw-fish (Pristis); moreover the dentine of which they are largely composed resembles bone and fills up the whole pulp cavity. From its structure it is known as *osteodentine*.

In the Teleostomi (teleostean and ganoid fishes) there is great variability; sometimes, as in the sturgeon, there are no teeth at all, while at others every bone bounding the mouth, including the branchial arches, bears teeth. As an example of a very full tooth armature the pike's mouth and pharynx may be instanced. Both in the pike and the hake hinged teeth occur; these bend backward during the passage of prey down the throat, but are re-erected by elastic ligaments. As a rule, the dentine of the Teleostomi is of the variety already described as osteodentine, but sometimes, as in the hake, it is vascular and is known as vasodentine.

In the Amphibia teeth are not so numerous as in the fishes, though like them they are not confined to the jaws, since vomerine teeth are very constant. The toad is edentulous, while the frog has no teeth in the lower jaw. An extinct order of tailed amphibians, the Stegocephali, are often called labyrinthodonts on account of the complex way in which the enamel is involuted into the interior of the teeth. Amphibians' teeth are usually anchylosed to the jaw, that is to say, directly united by bone.

In the Reptilia many and various arrangements of the teeth are found. In the Chelonia (turtles) there are no teeth, although the ectodermal ingrowth (dental band) from which they are developed in other animals is present in the embryo. The place of the teeth in these reptiles is taken by horny jaw-cases.

In the Ophidia the non-poisonous snakes have two rows of teeth in the upper jaw, one on the maxillae and another on the palatine and pterygoid bones, while in the lower jaw there is only one row. These teeth are sharp pegs anchylosed to the bones and so strongly recurved that one of these snakes would be unable, even if it wished to do so, to let any prey which had once entered its mouth escape. The poisonous snakes have a special poison fang in the maxilla of each side; these have a deep groove or canal running down them which transmits the poison from the poison gland. In the colubrine snakes, such as the cobra, the poison fang is always erect, but in the viperine, such as our own adder and the rattlesnake, there is a mechanism by which the tooth is only erected when the jaws are opened for striking. At other times the teeth lie flat in the roof of the mouth.

In the lizards or Lacertilia the teeth usually consist of a series of pegs in the upper and lower jaw, each resembling the one in front of it; sometimes, as in the chameleon, they are anchylosed by their bases to the bone, but at others, as in the iguana, they are fused by their sides to a ridge of bone which forms a low wall on their lateral surface. In the former case the dentition is spoken of as "acrodont," in the latter as "pleurodont."

In the Crocodilia the teeth are fitted into definite sockets as in mammals and are not anchylosed with the jaws. This arrangement is spoken of as "thecodont."

Existing birds are toothless, but palaeontology shows that they originally had teeth of a reptilian character.

In all these lower vertebrates, then, the teeth are similar or nearly similar in character; at least they are not divided into definite incisor, canine, premolar and molar regions. Their dentition is therefore known as "homodont." Another characteristic is that in almost all of them there is an arrangement for a continuous succession of teeth, so that when one is lost another from behind takes its place, and to this arrangement the term "polyphyodont" is applied. With a few exceptions a homodont dentition is also polyphyodont.

In the Mammalia the different groups of teeth (incisor, canine, &c.) already noticed in man are found, and these animals are characterized, with some exceptions, by having a "heterodont" as opposed to a homodont dentition. In the mammals too the polyphyodont or continuous succession of teeth is reduced to a "diphyodont" dentition, which means that there is only one relay of teeth to replace the first set. In the marsupials the reduction of the succession is carried still further, for only one premolar in each segment of the jaw is replaced, while in the toothed whales there is no succession at all. When one set has to do duty throughout life the dentition is called "monophyodont." There is a great deal of discussion as to how the complex back teeth of mammals with their numerous cusps were derived from the simple conical teeth which are generally assumed, though not by all, to have been the primitive arrangement. One simple way of accounting for the change is by the concrescence theory, namely that several conical homodont teeth have fused and so formed a single multitubercular tooth; but, although this process may be partly true, it does not account for all the facts at our disposal. Another theory, which is more favoured at the present time, is known as the "tritubercular," and is largely based on the researches of E. D. Cope and H. F. Osborn, two American palaeontologists. According to this theory a simple peg-like, or, as it is called, "haplodont," tooth develops two additional smaller pegs or cones, one in front and one behind the original main cone, possibly owing to the irritation of the teeth against which it bites in the other jaw. This is known as the triconodont stage, and it is found in some of the oldest extinct mammals. As a later adaptation it is found that the two small cones, the anterior of which is called the "paracone" and the posterior the "metacone," become external to the original "protocone" in the upper jaw and internal in the lower.

The surface of the tooth has now a triangular shape with a cone at each angle, and this is the "tritubercular tooth" which is of very common occurrence among the ancestral mammals. Other cusps may be developed later, and so the quadricuspid and quinquecuspid molar teeth of man and other mammals are accounted for. This theory, although in a brief outline it sounds feasible enough, has really many points of difficulty, and those who are interested in the subject will find a fuller account in C. S. Tomes' *Dental Anatomy* (London, 1904), and in W. L. H. Duckworth's *Morphology and Anthropology* (Cambridge, 1904), in both of which references to the original literature, which is now very voluminous, are given. Marett Tims (*J. Anat. and Phys.*, vol. xxxvii. p. 131) suggests that the evolution of the mammalian teeth is to be explained partly by the tritubercular and partly by the concrescence theory.

It is impossible, in the space assigned, to give even a brief review of mammalian odontology, but it may clear the ground for the special zoological articles if an attempt is made to define what is meant by the different classes of teeth.

Incisor teeth are those which in the upper jaw have their sockets in the premaxillary bone; they are generally chisel-shaped, and with their opponents of the lower jaw act like scissors. They are specially well marked in the rodents, and in these animals the pulp throughout life continues to form fresh dentine, so that the teeth are ever growing, and it is absolutely necessary for their owners to be continually gnawing in order to wear them away at their cutting edges. The tusks of the elephant and the single tusk of the male narwhal are modified incisors, while in the ruminants the incisor teeth are wanting in the upper jaw.

The *canine tooth* is the first tooth behind the premaxillo-maxillary suture, provided it be not far behind it; it is almost always the first of the premaxillary series, speaking accurately, which is elongated and sharply pointed. As its name implies it is well marked in dogs and other Carnivora, but is found in many other orders. It is the special offensive and defensive weapon of many mammals, and is greatly developed in some of the ungulates which are without horns, *e.g.*, the musk deer. The tusks of the walrus and wild boar are canines. In many of the Insectivora, especially the mole, the canine is very hard to identify, as in these animals an incisor or a premolar may take on caniniform characters, or there may be no tooth at all with these characters.

The *premolar teeth* are those in the maxillary bone which are preceded by milk teeth. This definition, of course, includes the canine as a modified premolar, and so it should no doubt be considered, though, if it is desired to keep it distinct, "behind the canine" must be added.

Unfortunately for an accurate definition the first premolar behind the canine is not always preceded by another tooth, and so it becomes an unsettled question whether, in these cases, the tooth is a retained milk tooth or a permanent one which has had no predecessor; it is probable, however, that the latter is the right interpretation.

The *molar teeth* are those, behind the premolars, which are not preceded by temporary teeth. As was pointed out, in man's dentition they are probably teeth of the first or milk dentition which appear late.

In front of the premolar teeth, and between them and the canine, if it be present, or the incisors, if it be absent, there is often a space called the "diastema." It is best marked in the orders of Rodentia and Ungulata, and in the horse is familiar as the place where the bit lies.

In recording the teeth of any particular mammal it saves time and space if a dental formula be used. This simply means setting down the number of each kind of tooth in one side of the upper and lower jaw in their order from before backward. Thus man's formula would be, incisors $\frac{2}{2}$, canines $\frac{1}{1}$, premolars $\frac{2}{2}$, molars $\frac{3}{3}$. This is condensed into $\frac{2.1.2.3}{2.1.2.3}$.

Some other types of dental formulae are—

Catarrhine (old world) monkeys	$\frac{2.1.2.3}{2.1.2.3}$
Platyrhine (new world) monkeys	$\frac{2.1.3.3}{2.1.3.3}$
Marmosets	$\frac{2.1.3.2}{2.1.3.2}$
Most lemurs	$\frac{2.1.2.3}{2.1.2.3}$
or	$\frac{2.1.3.3}{2.1.3.3}$
Insectivorous bats (full series) (The upper incisors and both premolars may be reduced by one)	$\frac{2.1.3.3}{3.1.3.3}$
Frugiverous bats (The molars may be reduced)	$\frac{2.1.2.3}{2.1.3.3}$
Insectivora (teeth variable and somewhat uncertain)	
Hedgehog	$\frac{3.1.3.3}{2.1.2.3}$
Mole (Five different dental formulae have been assigned to this animal)	$\frac{3.1.4.3}{3.1.4.3}$
Carnivora—	
Cat family (Felidae)	$\frac{3.1.3.1}{3.1.2.1}$
Dog family (Canidae), Bear family (Ursidae)	$\frac{3.1.4.2}{3.1.4.3}$
Civet family (Viverridae), Racoon family (Procyonidae)	$\frac{3.1.4.2}{3.1.4.2}$
Hyaena family (Hyaenidae)	$\frac{3.1.4.1}{3.1.3.1}$
Weasel family (Mustelidae)	$\frac{3.1.4.1}{3.1.4.2}$
Eared seal family (Otariidae)	$\frac{3.1.4.1 \text{ or } 2}{2.1.4.1}$
Seal family (Phocidae)	$\frac{3.1.4.1}{3.1.4.1}$
Walrus family (Trichechidae), adult	$\frac{1.1.3.0}{0.1.3.0}$
In a young animal (probably)	$\frac{3.1.3.2}{3.1.3.1}$

Ungulata—

Hippopotamus	$\frac{2.1.4.3}{2.1.4.3}$
Pig family (Suidae)	$\frac{3.1.4.3}{3.1.4.3}$
Camel	$\frac{1.1.3.3}{3.1.2.3}$
Chevrotain (Tragulidae)	$\frac{0.1.3.3}{3.1.3.3}$
Deer family (Cervidae)	$\frac{0.(0 \text{ or } 1).3.3}{3.1.3.3}$
Hollow-horned ruminants (Bovidae)	$\frac{0.0.3.3}{3.1.3.3}$
Tapir	$\frac{3.1.4.3}{3.1.3.3}$
Horse (Equidae)	$\frac{3.1.3.3}{3.1.3.3}$
Rhinoceros	$\frac{(0-2).0.4.3}{(0-1).(0-1).4.3}$
Procavia (Hyrax)	$\frac{(1-2).0.4.3}{2.0.4.3}$
Elephant	$\frac{\text{d.i. 1. i. 1. c. 0. d.m. } (3-4) \text{ m. } 3}{0 \quad 0 \quad 0 \quad (3-4) \quad 3}$

In this animal there are no premolars, but the milk molars (d.m) and true molars gradually replace one another from before backward throughout life, so that there are never more than two back teeth in each segment of the jaw at any one time.

Rodentia—

Typical rodents (Simplicidentata)	$\frac{1.0.(0-1).3}{1.0.(0-1).3}$
Hares and rabbits (Duplicidentata)	$\frac{2.0.3.3}{1.0.2.3}$

Cetacea.—In the living toothed whales (Odontoceti) the dentition is homodont and may be as great as $\frac{60}{60}$. There is every reason to believe, however, that they are derived from heterodont ancestors. In the whalebone whales (Mystacoceti) the teeth are replaced by the whalebone in the adult, but in the embryo slightly calcified teeth are present which are afterwards absorbed.

The homodont dentition of the whales is a retrograde process, and is therefore not comparable to the homodont dentition of the vertebrates below mammals.

Sirenia.—The dentition is monophyodont. The manatee has i. $\frac{2}{2}$, c. $\frac{0}{0}$, back teeth $\frac{11}{11}$.

In the Edentata the ant-eaters (Myrmecophagidae) and pangolins (Manidae) are toothless, though the latter have foetal tooth germs. The aard varks (Orycteropodidae) are somewhat heterodont, while the armadillos (Dasypodidae) and sloths (Bradypodidae) have a homodont dentition, which, like that of the whales, is retrogressive. In the giant armadillo (*Priodon gigas*) the formula is $\frac{25}{25}$. This animal therefore has a hundred teeth. In none of the Edentata are the teeth covered with enamel.

In the Marsupialia the typical formula is $\frac{3.1.3.4.}{3.1.3.4.}$ They are divided into *diprotodont*, in which there are not more than $\frac{3}{3}$ incisors, often $\frac{3}{1}$ as in kangaroos, and *polyprotodont*, in which the incisors are more than $\frac{3}{3}$, as in the Tasmanian wolf (Thylacinus) and Tasmanian devil (Sarcophilus). The marsupial teeth are often regarded as all milk teeth, yet the order is not really monophyodont because the germs of the permanent teeth are formed and aborted. Modern research, however, casts grave doubt on the accuracy of this view.

In the Monotremata the Echidna or spiny ant-eater is quite edentulous, while the duck-mole (Ornithorhynchus) has functional molar teeth in youth, though in the adult these are lost, and their place is taken by horny plates.

Reviewing the various tooth formulae of mammals the following is usually regarded as typical:—

$$\frac{3.1.4.3}{3.1.4.3}$$

This, it will be noticed, is the formula of the pig, and it is also that of almost all the Eocene Ungulata. Although the majority of mammals are diphyodont, or, in other words, the working teeth belong to two dentitions, evidences have lately been submitted of vestiges of two other series, one on the labial side of the milk teeth and one on the lingual side of the permanent series. If these are substantiated there would be four dentitions—(1) premilk; (2) milk; (3) permanent; (4) post-permanent. The theory, though it bridges over the gap between the polyphyodont lower vertebrates and the apparently diphyodont mammals, is not by any means established. As the teeth are of such importance in the classification of animals, it will save continually repeated explanations in other articles if some of the chief terms by which they are described are recapitulated and briefly defined here.

1. *Acrodont*, a tooth which is anchylosed by its base to the summit of a parapet on the jaw.
2. *Bilophodont*, a molar tooth having two transverse ridges on its grinding surface, as in the tapir.
3. *Brachyodont*, a low-crowned molar tooth—the opposite of hypsodont.
4. *Bunodont*, a tooth bearing conical cusps.
5. *Diphyodont*, having two series of teeth (milk and permanent).
6. *Diprotodont*, a marsupial with not more than $\frac{3}{3}$ incisors, often only one on each side of the mandible.
7. *Haplodont*, a tooth having a simple conical crown with a single root.
8. *Heterodont*, a dentition in which the teeth are not all alike, chiefly characteristic of the Mammalia.
9. *Homodont*, a dentition in which the teeth are all alike as in many of the lower vertebrates and some mammals.
10. *Hypsodont*, a high-crowned molar tooth, such as that of the horse,—the opposite to brachydont.
11. *Lophodont*, a transversely ridged molar tooth; cf. bilophodont.
12. *Monophyodont*, having only one dentition (cf. diphy- and polyphy-odont).
13. *Multituberculate*, a tooth, the crown of which bears numerous conical cusps; held by some to be the primitive condition of the mammalian teeth.
14. *Pleurodont*, a tooth anchylosed to the inner side of a parapet on the jaw.
15. *Polybunodont*, a synonym for multituberculate.
16. *Polyphyodont*, having an endless succession of teeth, as in most vertebrates below the mammals.
17. *Polyprotodont*, a marsupial having an incisor formula of more than $\frac{3}{3}$.
18. *Protodont*, a stage met with in fossil mammals which is an advance on the haplodont tooth in that two small cusps are added to the main cone.
19. *Secodont*, a back tooth adapted to cutting as in many of the Carnivora.
20. *Selenodont*, a molar tooth with crescentic ridges on its grinding surface as in most ruminants.
21. *Thecodont*, a tooth embedded in a socket or alveolus, as in mammals.
22. *Triconodont*, a fossil stage in advance of the protodont. There are three well-marked cones in an antero-posterior line.
23. *Tritubercular*, a fossil stage succeeding the triconodont. The main cone is external in the lower teeth and internal in the upper. A very common form of back tooth in fossil forms and one which gives its name to the "tritubercular theory." (F. G. P.)

TEETOTALISM, the practice of total abstinence from all intoxicating liquors, hence that form of the temperance movement of which the basis is the "pledge" to abstain from all intoxicating liquors (see TEMPERANCE). There seems no doubt that the word, whatever its actual origin, is a strengthened form of "total," probably influenced by "teetotum" (*q.v.*). According to the *Century Dictionary*, the secretary of a New York temperance society introduced a total abstinence pledge among its members, who were thus divided into those who had taken the old pledge, the O.P.'s, to abstain from spirituous liquors, and the T.'s, who had taken the new or total pledge. The English version, taken from the account by Joseph Livesey in the *Staunch Teetotaler*, January 1867, is that one Richard Turner, a Preston artisan and popular temperance speaker, declared at a meeting about 1833, that "nothing but tee-tee-total would do." This repetition of the initial letter does not appear to have been due to his stammering but to have been a mere emphasis on the word. The expression seems to have obtained instant recognition and popularity. Both versions are apparently authentic, and there seems no reason to suppose that they are not independent.

TEETOTUM, a form of top, used in various games of chance; the body is of polygonal shape, marked with letters or numbers, which decide the result of the game, according to the side which remains uppermost on the fall of the top after spinning. Strutt, who was born in 1749, mentions (*Sports and Pastimes*) the teetotum as used in games when he was a boy. It seems that in its earliest form the body was square, marked on the four sides by the letters A. (Lat. *aufer*, take up or away), indicating that the player takes one from the pool, D. (Lat. *depone*, put down), when a fine has to be paid, N. (Lat. *nihil*, nothing), and T. (Lat. *totum*), when the whole pool is taken. Other accounts give such letters as P.N.D. (*dimidium*, half), or H. and T. or other combinations of letters.

TEGEA, an ancient Greek city of Arcadia, situated on a plateau which is enclosed by Mts. Parthenium and Maenalus on E. and W., and by two transverse ranges which separate it from the plateau of Orchomenus and the Eurotas valley respectively. The Tegean territory occupied the southern part of this space; the northern half, sundered by projecting spurs from the parallel ranges, belonged to Mantineia. The entire plain was well adapted for pasturage and corn-growing, but was liable to floods owing to the lack of free outlets for its water-courses. Hence the regulation of the *zerethra* or subterranean conduits which drained away the overflow southward was a matter of vital importance both to Tegea and to Mantineia, and a cause of frequent quarrels. By its vicinity to the watersheds of the Eurotas and Alpheus, and its command over the main roads from Laconia to Argos and the Isthmus, Tegea likewise was brought into conflict with Sparta.

Tegea was one of the most ancient cities of Peloponnesus; tradition ascribed its concentration (*synoecism*) out of eight or nine primitive cantons to a mythical king Aleus. From the fact that several Cretan townships passed for colonies of Tegea, it may be inferred that this city had oversea connexions in prehistoric days. The prominence which legend assigns to its king Echemus in opposing the Heraclid invasion shows that it was one of the chief Peloponnesian communities in the pre-Dorian epoch. For several centuries Tegea served as a bulwark of Arcadia against the expanding power of Sparta; though ultimately subdued about 550 B.C. it was allowed to retain its independence and its Arcadian nationality. During the Persian invasion the Tegeans displayed a readiness unusual among Peloponnesian cities; in the battle of Plataea they were the first to enter the enemy's camp. A few years later they headed an Arcadian and Argive league against Sparta, but by the loss of two pitched battles (Tegea and Dipaea) were induced to resume their former loyalty (about 468–467). In 423 they broke out into open war with the Mantineians, and when the latter rebelled against Sparta and allied themselves with Argos and Athens, the Tegeans stood firmly by Sparta's side: in the decisive battle of Mantineia (418) their troops had a large share in the overthrow of the coalition. During the early 4th century before Christ Tegea continued to support Sparta against the Mantineians and other malcontents. After the battle of Leuctra the philo-Laconian party was expelled with Mantineian help. Tegea henceforth took an active part in the revival of the Arcadian League and the prosecution of the war in alliance with Thebes against Sparta (371–362), and the ultimate defection of Mantineia confirmed it in its federalist tendencies. The foundation of the new federal capital Megalopolis threw Tegea somewhat into the shade. It showed itself hostile to the Macedonians, and in 266 joined the Chremonidean League against Antigonus Gonatas. To the incorporation of Mantineia into the Achaean League (233) Tegea replied by allying itself with the Aetolians, who in turn made it over to Cleomenes III. of Sparta (228). From the latter it was transferred by Antigonus Doson to the Achaean League (222); in 218 it was again occupied by the Spartans but reconquered in 207 by the Achaean general Philopoemen. In Augustus' time Tegea was the only important town of Arcadia, but its history throughout the Roman and Byzantine periods is obscure; it ceased to exist as a Greek city after the Gothic invasion of 395. During the Frankish occupation its place was taken by the fortress of Nikli. At the time of the Turkish conquest (1458) Nikli had been superseded by a fair-sized town called Mouchli, which in turn disappeared when the new city of Tripolitsa was founded about 3 m. N.W. The site is now occupied by the small village of Piali.

AUTHORITIES.—Strabo pp. 337, 388; Pausanias viii. 44–49, 53–54; Herodotus i. 65 ff., ix. 35, 70; Thucydides v. 32–73; Xenophon, *Hellenica*, vi., vii.; Polybius ii. 46, 54 ff., v. 17, xi. 18; W. M. Leake, *Travels in the Morea* (London, 1830), i. pp. 88–100, ii. 328–334; E. Curtius, *Peloponnesos* (Gotha, 1851), i. pp. 247–264; W. Loring in *Journal of Hellenic Studies*, xix. (1899) pp. 25–89; Schwedler, *De Rebus Tegeaticis* (Leipzig, 1886); Ἱστορία τῆς Τεγέας. Ἐκδ. ὑπὸ τοῦ Τεγεατικοῦ Συνδέσμου (Athens, 1896); for coins: B. V. Head, *Historia Numorum* (Oxford, 1887), pp. 350–351; and art. NUMISMATICS, section *Greek*, § " Arcadia."

(M. O. B. C.)

Archaeology.—The temple of Athena Alea at Tegea is described by Pausanias as excelling all others in the Peloponnese both in size and in beauty of construction. The original temple was said to have been built by Aleus, the founder of the city; it was superseded by a larger one which was destroyed by fire in 395 B.C. The rebuilding was entrusted to Scopas, the great sculptor; and it is probable that he not only acted as architect, but also provided the sculptural groups which ornamented the pediments. Like the temple at Phigalia, it combined the forms of all three orders—Doric, Ionic and Corinthian. Pausanias asserts that the outer order was Ionic; but excavations have proved that it was Doric. The pedimental groups of the temple represented at the front, the hunt of the Calydonian boar, and, at the back, the battle of Achilles and Telephus. Both subjects were intimately associated with the temple, for Atalanta had dedicated in it the face and tusks of the boar, which had been awarded to her as the first to wound it; and Telephus was the son of Heracles and the priestess Auge. Two heads of heroes and that of the boar were found before 1880; later excavation, in 1883, showed the plan of the temple, which had six columns at front and back, and thirteen at the sides. In 1900 the French school at Athens recovered more fragments of sculpture, including a head of Heracles and the torso and possibly the head of Atalanta, these last two of Parian marble. The other heads are badly damaged owing to the fact that the white marble from Doliana, of which they are made, does not resist damp. But they still show in the intensity of their expression the power of expressing passion for which Scopas was famous beyond all other ancient sculptors. See GREEK ART, fig. 63.

See G. Treu, *Mittheil. d. deutsch. Inst. Athen.*, vi. 1881; W. Dörpfeld, ibid., viii. 1883; G. Mendel, *Bulletin de correspondance hellénique*, xxv. 1901; Pausanias viii. 45–47. (E. GR.)

TEGERNSEE, a lake of Germany, in the province of Upper Bavaria, situated in a beautiful mountain country, 2382 ft. above the sea, 34 m. S. from Munich by rail to Gmund, a village with a station on the north shore. The lake is 4 m. long, averages $1\frac{1}{4}$ m. broad, and is about 235 ft. deep. Its waters discharge through the Mangfall into the Inn. The southern part is environed by high and well-wooded hills, while on the northern side, where it debouches on the plain, the banks are flat and less attractive. Prosperous villages and handsome villas stud its shores, and it is one of the most frequented summer resorts in the vicinity of Munich.

The village of Tegernsee (pop. 1742 in 1905), on the east bank, has a parish church dating from the 15th century, a ducal castle which was formerly a Benedictine monastery, and a hospital, founded in connexion with the large ophthalmic practice of the late Duke Charles Theodore of Bavaria.

See Freyberg, *Aelteste Geschichte von Tegernsee* (Munich, 1822); Hack, *Tegernsee* (Munich, 1888); Breu, *Der Tegernsee, limnologische Studie* (Munich, 1906).

TEGETTHOFF, WILHELM VON, BARON (1827–1871), Austrian admiral, son of Lieutenant-Colonel Karl von Tegetthoff, was born at Marburg, in Styria, on the 23rd of December 1827. After passing through the naval college at Venice, he first served afloat in 1845, and in 1848 was made an ensign. In 1849 he was present at the blockade of Venice, resulting in its surrender. In 1852 he was promoted to be a lieutenant, and during the Crimean war was employed on a sort of police duty at the Sulina mouth of the Danube, which brought him to the favourable notice of the Archduke Maximilian, who in 1854 had been appointed head of the navy with the style of rear-admiral. After some time in a semi-official scientific expedition in Egypt, Arabia, and the Red Sea down to the island of Socotra, Tegetthoff was promoted to the rank of captain of the third class, and in 1858 he commanded the corvette "Erzherzog Friedrich" on the coast of Morocco, then in a very disturbed state. The corvette returned to Trieste on the imminence of the war with France; but during 1859 the French fleet commanded the Adriatic in vastly superior force, against which the Austrians were powerless. After the peace Tegetthoff made a voyage to Brazil as aide-de-camp to Maximilian, and in 1860–63 commanded a large frigate in the Levant during the disturbances in Syria, and on the coast of Greece or in the Piraeus at the time of the Greek revolution. Towards the end of 1863 he was sent to the North Sea as commodore in command of two frigates, with which, together with three small Prussian gunboats, he fought an action with the Danish squadron, and though without any decisive success, succeeded in raising the blockade of the mouths of the Elbe and Weser. The Austrian emperor answered Tegetthoff's telegraphic despatch by another promoting him to be rear-admiral, and conferring on him the Order of the Iron Crown. In 1865 he commanded a small squadron in the Mediterranean, and in the war of 1866 was placed in command of the whole effective force of the Austrian navy. With all his efforts, however, this was markedly inferior to the Italian force opposed to it, and when the two fleets met off Lissa on the 20th of July, the decisive victory of the Austrians was entirely due to the personal superiority of Tegetthoff and the officers whom he in great measure had trained. In numbers, in ships, and in armament the Italians were much the more powerful, but they had neither a capable chief nor efficient officers. Tegetthoff was immediately promoted, by telegraph, to the rank of vice-admiral, and among the many decorations conferred on him was one from his former commander, the unfortunate Maximilian, at this time emperor of Mexico, whose body was in the following year brought home by Tegetthoff. In March 1868 he was appointed head of the naval section of the War Office and commander-in-chief of the navy, which offices he held till his death at Vienna, after a very short illness, on the 7th of April 1871—in the words of the semi-official notice—"zu früh für Österreich."

(J. K. L.)

TEGGIANO (anc. *Tegianum*, formerly called *Diano*), a town in Campania, Italy, in the province of Salerno, 45 m. S.E. of that town. Pop. (1901) 5095. It is situated 2090 ft. above sea-level on an isolated eminence above the upper part of the valley of the Negro (anc. *Tanager*), to which it gives the name of Val di Diano. It represents the ancient Tegianum a municipal town of Lucania, made into a colony by Nero, of which the ruins can be traced at the foot of the hill, with an ancient Roman bridge. An Oscan sepulchral inscription in Greek letters has been found here (cf. W. Corssen in *Ephemeris Epigrafica*, ii. 153). It possesses a castle, several churches of some interest, and three conventual buildings. In 1497 it was strong enough to resist, under Antonio Sanseverino of Salerno, the siege undertaken by Frederick of Aragon. (T. As.)

TEGNÉR, ESAIAS (1782–1846), Swedish writer, was born on the 13th of November 1782, at Kyrkerud in Wermland. His father was a pastor, and his grandparents on both sides were peasants. His father, whose name had been Esaias Lucasson, took the surname of Tegnerus—altered by his fifth son, the poet, to Tegnér—from the hamlet of Tegnaby in Småland, where he was born. In 1792 Tegnerus died. In 1799 Esaias Tegnér, hitherto educated in the country, entered the university of Lund, where he graduated in philosophy in 1802, and continued as tutor until 1810, when he was elected Greek lecturer. In 1806 he married Anna Maria Gustava Myhrman, to whom he had been attached since his earliest youth. In 1812 he was named professor, and continued to work as a lecturer in Lund until 1824, when he was made bishop of Vexiö. At Vexiö he remained until his death, twenty-two years later. Tegnér's early poems have little merit. He was comparatively slow in development. His first great success was a dithyrambic war-song for the army of 1808, which stirred every Swedish heart. In 1811 his patriotic poem *Svea* won the great prize of the Swedish Academy, and made him famous. In the same year was founded in Stockholm the Gothic League (*Götiska förbundet*), a sort of club of young and patriotic men of letters, of whom Tegnér quickly became the chief. The club published a magazine, entitled *Iduna*, in which it printed a great deal of excellent poetry, and ventilated its views, particularly as regards the study of old Icelandic literature and history. Tegnér, Geijer, Afzelius, and Nicander became the most famous members of the Gothic League. Of the very numerous poems written by Tegnér in the little room at Lund which is now shown to visitors as the Tegnér museum, the majority are short, and even occasional lyrics. His celebrated *Song to the Sun* dates from 1817. He completed three poems of a more ambitious character, on which his fame chiefly rests. Of these, two, the romance of *Axel* (1822) and the delicately-chiselled idyl of *Nattvardsbarnen* ("The First Communion," 1820), translated by Longfellow, take a secondary place in comparison with Tegnér's masterpiece, of world-wide fame. In 1820 he published in *Iduna* certain fragments of an epic or cycle of epical pieces, on which he was then working, *Frithjofs saga* or the Story of Frithiof. In 1822 he published five more cantos, and in 1825 the entire poem. Before it was completed it was famous throughout Europe; the aged Goethe took up his pen to commend to his countrymen this "alte, kräftige, gigantisch-barbarische Dichtart," and desired Amalie von Imhoff to translate it into German. This romantic paraphrase of an ancient saga was composed in twenty-four cantos, all differing in verse form, modelled somewhat, it is only fair to say, on an earlier Danish masterpiece, the *Helge* of Öhlenschläger. *Frithjofs saga* is the best known of all Swedish productions; it is said to have been translated twenty-two times into English, twenty times into German, and once at least into every European language. It is far from satisfying the demands of more recent antiquarian research, but it still is allowed to give the freshest existing impression, in imaginative form, of life in early Scandinavia. In later years Tegnér began, but left unfinished, two important epical poems, *Gerda* and *Kronbruden*. The period of the publication of *Frithjofs saga* (1825) was the critical epoch of his career. It made him one of the most famous poets in Europe; it transferred him from his study in Lund to the bishop's palace in Vexiö; it marked the first breakdown of his health, which had hitherto been excellent; and it witnessed a singular moral crisis in the inner history of the poet, about which much has been written, but of which little is known. Tegnér was at this time passionately in love with a certain beautiful Euphrosyne Palm, the wife of a town councillor in Lund, and this unfortunate passion, while it inspired much of his finest poetry, turned the poet's blood to gall. From this time forward the heartlessness of woman is one of Tegnér's principal themes. It is a remarkable sign of the condition of Sweden at that time that a man not in holy orders, and so little in possession of the religious temperament as Tegnér, should be offered and should accept a bishop's crosier. He did not hesitate in accepting it: it was a great honour; he was poor; and he was anxious to get away from Lund. No sooner, however, had he begun to study for his new duties than he began to regret the step he had taken. It was nevertheless too late to go back, and Tegnér made a respectable bishop as long as his health lasted. But he became moody and melancholy; as early as 1833 he complained of fiery heats in his brain, and in 1840, during a visit to Stockholm, he suddenly became insane. He was sent to an asylum in Schleswig, and early in 1841 he was cured, and able to return to Vexiö. It was during his convalescence in Schleswig that he composed *Kronbruden*. He wrote no more of importance; in 1843 he had a stroke of apoplexy, and on the 2nd of November 1846 he died in Vexiö. From 1819 he had been a member of the Swedish

Academy, where he was succeeded by his biographer and best imitator Böttiger.

See Böttiger, *Teckning af Tegnérs Lefnad*; Georg Brandes, *Esaias Tegnér*; Thommander, *Tankar och Löjen*. (E. G.)

TEGUCIGALPA, the capital of Honduras and of the department of Tegucigalpa; situated 3200 ft. above sea-level, on the river Choluteca, and at the head of a railway to the port of San Lorenzo on Fonseca Bay. Pop. (1905) about 35,000. Tegucigalpa is the largest and finest city in the republic. The majority of its houses are of one storey, built round a central court; the windows are usually unglazed but protected by iron bars which project into the narrow cobble-paved streets. The focus of civic life is near the central park, in which stands a bronze equestrian statue of Francisco Morazan (1792–1842), the Hondurian statesman and soldier. Fronting the park is a domed cathedral, one of the largest and most ornate churches in Honduras. Other noteworthy buildings are the government offices, university, school of industry and art, national printing works, and law courts. A lofty ten-arched bridge over the Choluteca connects the city with its principal suburb, Concepcion or Comayaguela. Tegucigalpa became capital of Honduras, a status it had previously shared with Comayagua, in 1880. During the 18th century the neighbourhood was famous for its gold, silver and marble, but in modern times the mines and quarries have greatly declined in value, and farming is the chief local industry. In 1907 Tegucigalpa was occupied by the Nicaraguan invaders.

TEGULA, the Latin term for the convex covering tile of a roof, as distinguished from the *imbrex*, the concave tile (see TILES).

TEHERAN (more properly TEHRAN), a province of Persia, with capital of the same name (which is also the capital of the Persian empire). It pays a yearly revenue of about £100,000, and comprises the districts of Saujbulagh, Shahriar, Feshaviyeh, Shimran, Kasran and Veramin. The first three, situated north-west, west and south of the city of Teheran, are very fertile, and supply the capital with grain, grapes and melons. Shimran, the district north of the city, and on the slopes of the Elburz (rising to an elevation of 12,600 ft.) has 63 villages (one, Tajrish, the seat of the governor, with a population of over 3000), which are much frequented during the summer months by the inhabitants of the city seeking relief from the great heat. One of the villages, Gulhek or Gulahek, but correctly Kulhek (with a guttural K, and meaning a small, reedy mere), situated 800 ft. above the city of Teheran and 6½ m. from it, was given in fief to the British government by Fath Ali Shah about 1830 for the summer quarters of the British legation. Zergendeh, a village adjoining Gulhek, is held in a similar manner by the Russian government, and the Russian legation stays there during the summer. Kasran is a hilly district north-east of Teheran, with numerous coal mines (inferior coal of the Jurassic period) and streams abounding with salmon trout. The Veramin district, south-east of Teheran city, has 123 villages, and supplies the city and surrounding districts with wheat, barley and rice. It is watered by the Jajrud river, and is considered one of the most fertile districts of Persia.

TEHERAN, the capital of Persia and of the province of the same name, 70 m. S. of the southern shore of the Caspian Sea. It is situated on an immense gravel deposit which slopes down from the foot of the Elburz mountain (rising to an altitude of 12,600 ft.) 8 or 9 m. N. of the city, and extends for 16 m. to near Shah-abdul-Azim, 5½ m. S. of it. Teheran was formerly a kind of polygon about 4 m. in circumference, with a mud wall and towers, a dry ditch and six gates, but in 1869 Nasr-ud-din Shah decided upon enlarging the city; the old wall and towers were demolished, the ditch was filled up and used for building sites, and an enceinte consisting of a ditch and 58 unequal bastions according to Vauban's first system was constructed and completed in 1874. The city then took the shape of an irregular octagon, and its circumference (a line through the salient angles of the bastions) measures 19,596 metres, or 12·18 m. The area within the bastions is about 7½ sq. m. There are twelve gates, which are closed from two hours after sunset to an hour before sunrise. According to observations taken in 1895 by British officers in connexion with determining the longitude of Madras, the longitude of Teheran (pillar at the north-western corner of the British legation grounds) is 51° 25′ 2·8″ E. The latitude of the old telegraph office, which was situated almost due S., is 35° 41′ 6·83″ N., and its elevation 3810 ft. The northern gates of the city are 282 ft. above the southern ones. Teheran has little to distinguish it in general outward appearance from other cities of the country, though in recent years (since the above-mentioned extension) many broad and straight streets and a number of buildings of western architecture, shops with show windows, electric lamps, cabs, &c., have been introduced. "We are in a city which was born and nurtured in the East, but is beginning to clothe itself at a West-End tailor's" (Curzon). Most of the innovations are to be seen only in the northern part of the town where the Europeans and many well-to-do natives reside. The ark or citadel, situated nearly in the centre of the town, contains the shah's palace and a number of modern buildings of respectable appearance, for instance the foreign office, the war office, customs, telegraph station, arsenal, &c. Immediately north of the ark are the Maidan Tupkhaneh (Artillery Square), 270 yds. by 120, and the great Maidan i Mashk (Maidan of drill), the military parade ground, 550 yds. by 350. South of the ark are the bazaars, the central arcade and caravanserai built *c.* 1850 by the prime minister Mirza Taki Khan, commonly known as the amir, and beyond them, as well as on the east and west, are the quarters of the old town, with narrow, crooked and mostly unpaved and unclean streets. Teheran has 6½ m. of tramways (single lines) and is connected with Shah-abdul-Azim by a single line of railway of one-metre gauge and 5½ m. long (the only railway in Persia). Water is freely supplied to the town by means of about thirty underground canals (*kanats*), led from the slope of the northern hills and running 5 to 10 m. at considerable depths below the surface. The water supply would be ample for the requirements of the population if it could be regularly and equally distributed; but the supply in the months of October and November is only about one-half of that during March, and much water is lost through open ditches and by leakage. The distribution therefore is irregular: in winter and early spring, when the gardens require very little water from the canals, the supply is too great, and in summer it is too little. It has been calculated that the mean water supply amounts to the enormous quantity of 921,000 gallons per hour all the year round, but that, after deducting the quantity wasted in distribution, irrigation of gardens, filling tanks and baths, watering streets, &c., there remain forty-two gallons per head daily during the month of April, seventeen during July, August and September, and ten during October and November. Even the last quantity would suffice if evenly distributed, but as most of the canals are private property and independent of government or municipal control, the distribution is unequal, and it frequently happens that when some parts of the city have water in abundance others have hardly any. Teheran has many mosques, all of recent date, the finest being the one called Masjed i Sipahsalar, built by Mirza Husain Khan Sipahsalar Azam, who was prime minister for ten years until 1884. It is situated in the new part of the city and adjoining it is the Baharistan palace, once the residence of Sipahsalar, afterwards occupied by the national assembly. Another notable mosque is the Masjed i Shah, completed *c.* 1840. There are also many colleges and schools, some of them with European teachers, including the "German School" (1907) with a yearly subsidy of £2200 from the shah. Before Nasr-ud-din's first voyage to Europe in 1873 only four western states had legations and consulates at Teheran; now twelve states are represented.

The present population of Teheran is about 280,000, including 600 Europeans, 4000 Jews, the same number of Armenians, 200 Zoroastrians, and a garrison of 3000 to 4000. The climate is considered unhealthy, particularly in the summer and early autumn, when typhoid, ague and other fevers are prevalent, but something in the way of sanitation has been effected and there is a distinct improvement. The author of the *Zīnat el majālis*, writing in 1596, states that cholera frequently visited the city, and, the north being shut off by high mountains, the air was hot and evil-smelling and the water unwholesome, in fact the climate was so bad that even the Angel of Death ran away from it. The mean yearly temperature calculated from observations taken for a number of years ending 1902 was 62·6° F., the highest temperature observed was 111°, the lowest 3°, giving a difference of 108° between extremes. The hottest month is July, with a mean of 85·2°, the coldest January, with a mean of 34·25°. The mean annual rainfall during a period of 15 years ending 31st December 1907, was 10 ins.

In the *Jehankusha i Juvaini*, a Persian history written in the 13th century, the name of the town is written Tiran, while other works have the name as it is now written, viz. Tehran. The latter spelling is due to Arab influence, old Persian names being frequently Arabicized and sometimes becoming unrecognizable. Two villages in the neighbourhood of Isfahan appear as Tiran in old documents, while in modern revenue accounts and lists they are written Tehran. The *Mujem el Buldan*, a geographical dictionary written in 1224, describes Teheran as a village 4 m. distant from Rai (Rhages). Pietro della Valle, who passed a night (June 6–7, 1618) at Teheran, writes "Taheran" (perhaps thinking it to be a plural of *taher*, "the pure"), and Sir Thomas Herbert, who visited it on the 14th of June 1627, calls it "Tyroan," and states that it contained 3000 houses built of sun-dried bricks and had its water supply from a little river which flowed through it in two branches. Almost the whole of the city was destroyed by the Afghans in 1723, and Teheran did not regain any importance until the close of the century when Agha Mahommed Khan, the founder of the Kajar dynasty, made it his capital and residence. Dr Olivier, who visited Teheran in 1796, says, "In spite of Agha Mohammed Khan's efforts to induce people to settle and merchants and manufacturers to establish themselves there, the population of Teheran does not amount to 15,000 souls, including a garrison of 3000." (A. H.-S.)

TEHRI, a native state in Northern India, in political subordination to the United Provinces: area, 4200 sq. m.; population (1901) 268,885; estimated revenue, £28,000. It lies entirely amid the Himalayas, containing ranges from 20,000 to 23,000 ft. above sea-level, and also the sources of both the Ganges and the Jumna, with the places of pilgrimage associated with them. The forests, which have been leased to the British government, are very valuable, yielding several kinds of pine, oak and cedar. The crops are rice, small millets, wheat, potatoes and a little tea. The chief, whose title is raja, is descended from a Rajput family which formerly ruled over all Garhwal. The existing state was created by the British after the war with Nepal in 1815. The town of Tehri, on the river Bhagirathi (as the Ganges is here called) has a pop. (1901) of 3387.

TEHUANTEPEC (from *tecuani-tepec*—"jaguar-hill"), the town which gives its name to the isthmus, gulf and railway, stands on the Tehuantepec river about 15 m. from its mouth and 13 m. by rail from Salina Cruz. Pop. (1904, estimated) 10,000. It is a typical, straggling Indian town, occupying the slope of a hill on the Pacific side of the divide, with a beautiful view of the river valley and the distant sierras to the N. The streets are little more than crooked paths up the hillside, and the habitations are for the most part thatched, mud-walled huts. The population of the town and of the surrounding district is composed almost wholly of Indians of the great Zapoteca family. The Tehuanas of Tehuantepec are noted for the beauty and graceful carriage of their women, who are reputed to be the finest-looking among the native races of Mexico. The women are the traders in Tehuantepec and do little menial work—a result, apparently, of the influence of beauty. The local industries include the making of "caña," a cane spirit, and the weaving of cotton fabrics, dyed with the juice of a marine shell-fish (*Purpura patula*) found on the neighbouring coast. Indigo was formerly grown in the vicinity and cochineal gathered for export, but both of these industries have declined.

TEHUANTEPEC, an isthmus of Mexico lying between the Gulfs of Campeche (Campeachy) and Tehuantepec, with the Mexican states of Tabasco and Chiapas on the E., and Vera Cruz and Oaxaca on the W. It includes that part of Mexico lying between the 94th and 96th meridians of W. longitude, or the south-eastern parts of Vera Cruz and Oaxaca, with perhaps small districts of Chiapas and Tabasco. It is 125 m. across at its narrowest part from gulf to gulf, or 120 m. to the head of Laguna Superior on the Pacific coast. The Sierra Madre breaks down at this point into a broad, plateau-like ridge, whose elevation, at the highest point reached by the Tehuantepec railway (Chivela Pass) is 735 ft. The northern side of the isthmus is swampy and densely covered with jungle, which has been a greater obstacle to railway construction than the grades in crossing the sierra. The whole region is hot and malarial, except the open elevations where the winds from the Pacific render it comparatively cool and healthful. The annual rainfall on the Atlantic or northern slope is 156 in. (Enock) and the maximum temperature about 95° in the shade. The Pacific slope has a light rainfall and dryer climate.

Since the days of Cortés, the Tehuantepec isthmus has been considered a favourable route, first for an interoceanic canal, and then for an interoceanic railway. Its proximity to the axis of international trade gives it some advantage over the Panama route, which is counterbalanced by the narrower width of the latter. When the great cost of a canal across the isthmus compelled engineers and capitalists to give it up as impracticable, James B. Eads proposed to construct a quadruple track ship-railway, and the scheme received serious attention for some time. Then came projects for an ordinary railway, and several concessions were granted by the Mexican government for this purpose from 1857 to 1882. In the last-named year the Mexican government resolved to undertake the enterprise on its own account, and entered into contracts with a prominent Mexican contractor for the work. In 1888 this contract was rescinded, after 67 m. of road had been completed. The next contract was fruitless through the death of the contractor, and the third failed to complete the work within the sum specified (£2,700,000). This was in 1893, and 37 m. remained to be built. A fourth contract resulted in the completion of the line from coast to coast in 1894, when it was found that the terminal ports were deficient in facilities and the road too light for heavy traffic. The government then entered into a contract with the London firm of contractors of S. Pearson & Son, Ltd., who had constructed the drainage works of the valley of Mexico and the new port works of Vera Cruz, to rebuild the line and construct terminal ports at Coatzacoalcos, on the Gulf coast, and Salina Cruz, on the Pacific side. The work was done for account of the Mexican government. Work began on the 16th of December 1899, and was finished to a point where its formal opening for traffic was possible in January 1907.

The railway is 192 m. long, with a branch of 18 m. between Juile and San Juan Evangelista. The minimum depth at low water in both ports is 33 ft., and an extensive system of quays and railway tracks at both terminals affords ample facilities for the expeditious handling of heavy cargoes. The general offices, shops, hospital, &c., are located at Rincon Antonio, at the entrance to the Chivela Pass, where the temperature is cool and healthful conditions prevail. At Santa Lucrecia, 109 m. from Salina Cruz, connexion is made with the Vera Cruz & Pacific railway (a government line), 213 m. to Cordova and 311 m. to Mexico city.

TEHUELCHE, Chuelche, or Huilliche ("Southern People"), the generic name given by the whites of Argentina to the Indian tribes of Patagonia (*q.v.*).

TEIGNMOUTH, JOHN SHORE, 1st Baron (1751–1834), governor-general of India, was born on the 8th of October 1751, the son of Thomas Shore, a supercargo in the service of the

East India Company. He was educated at Harrow, and went out to India as a writer in the Bengal Civil Service in 1769. He became a member of the Supreme Council (1787–89), in which capacity he assisted Lord Cornwallis in introducing many reforms, but did not approve his permanent settlement of Bengal. On the retirement of Cornwallis, he was appointed governor-general (1793–98), adopting a policy of non-interference, but deposed Wazir Ali, for whom he substituted Saadat Ali as nawab of Oudh. His term of office was also signalized by a mutiny of the officers of the Indian army, which he met with concessions. He was created a baronet in 1792, and Baron Teignmouth in the peerage of Ireland in 1798. On his retirement from India he was appointed member of the board of control (1807–28), and was for many years president of the British and Foreign Bible Society. He died on the 14th of February 1834.

See *Memoirs of Lord Teignmouth*, by his son (1843).

TEIGNMOUTH, a seaport and market town in the Ashburton parliamentary division of Devonshire, England, at the mouth of the river Teign, on the English Channel, 15 m. S. by E. of Exeter, by the Great Western railway. Pop. of urban district (1901) 8636. Two parishes, East and West Teignmouth, form the town. It lies partly on a peninsula between the river and the sea, partly on the wooded uplands which enclose the valley and rise gradually to the high moors beneath Heytor. The Den, or Dene, forms a promenade along the sea-front, with a small lighthouse and a pier. St Michael's church in East Teignmouth was rebuilt in 1824 in Decorated style, but retains a Norman doorway and other ancient portions; of St James', in West Teignmouth, the south porch and tower are Norman. There are a theological college for Redemptorists, and a Benedictine convent, dedicated to St Scholastica. The entrance to the harbour has been improved by dredging, and the two quays accommodate vessels drawing 13 ft. at neap tides. Pipeclay and china clay, from Kingsteignton, are shipped for the Staffordshire potteries, while coal and general goods are imported. Pilchard, herrings, whiting and mackerel are taken, and salmon in the Teign. Malting, brewing and boatbuilding are also carried on. East Teignmouth was formerly called Teignmouth Regis, and West Teignmouth, Teignmouth Episcopi.

Teignmouth (*Teinemue*, *Tengemue*) possessed a church of St Michael as early as 1044, when what is now East Teignmouth was granted by Edward the Confessor to Leofric, bishop of Exeter, and an allusion to salterers in the same grant proves the existence of the salt industry at that date. Teignmouth is not mentioned in the Domesday Survey, but in 1276 what is now West Teignmouth appears as a mesne borough held by the dean and chapter of Exeter; what is now East Teignmouth continuing with the bishop, who was accused in that year of holding in his manor a market which should be held in the borough. The bishop's manor was alienated in 1550 to Sir Andrew Dudley, but West Teignmouth remained with the dean and chapter until early in the 19th century. In the middle ages Teignmouth was a flourishing port, able to furnish 7 ships and 120 mariners to the Calais expedition of 1347, and depending chiefly on the fishing and salt industries. In the early part of the 17th century the town had fallen into decay, but it speedily recovered, and in 1744 could contribute twenty vessels to the Newfoundland shipping trade. The borough was never represented in parliament, nor incorporated by charter. The Saturday market, which was held up to the 19th century, is mentioned in 1220, and was confirmed by royal charter in 1253, together with a fair at Michaelmas. Teignmouth was burned by French pirates in 1340, and was again devastated by the French on the 26th of June 1690.

See *Victoria County History, Devonshire; The Teignmouth Guide and Complete Handbook to the Town and Neighbourhood* (Teignmouth, 1875).

TEIRESIAS, in Greek legend, a famous Theban seer, son of Eueres and Chariclo. He was a descendant of Udaeus, one of the men who had sprung up from the serpent's teeth sown by Cadmus. He was blind from his seventh year, for which various causes were alleged. Some said that the gods had blinded him because he had revealed to men what they ought not to know. Others said that Athena (or Artemis) blinded him because he had seen her naked in the bath; when his mother prayed Athena to restore his sight, the goddess, being unable to do so, purged his ears so that he could understand the speech of birds, and gave him a staff wherewith to guide his steps (Apollodorus iii. 6). According to Sostratus, author of an elegiac poem called *Teiresias*, he was originally a girl, but had been changed into a boy by Apollo at the age of seven; after undergoing several more transformations from one sex to the other, she (for the final sex was feminine) was turned into a mouse and her lover Arachnus into a weasel (Eustathius on *Odyssey*, p. 1665). Teiresias' grave was at the Tilphusian spring; but there was a cenotaph of him at Thebes, and also in later times his "observatory," or place for watching for omens from birds, was pointed out (Pausanias ix 16; Sophocles, *Antigone*, 999). He had an oracle at Orchomenus, but during a plague it became silent and remained so in Plutarch's time (*De Defectu Oraculorum*, 44). According to Homer (*Od.* x. 492, xi. 90), Teiresias was the only person in the world of the dead whom Proserpine allowed to retain his memory and intellect unimpaired, and Circe sends Odysseus to consult him concerning his return home. He figured in the great paintings by Polygnotus in the Lesche at Delphi.

TEISSERENC DE BORT, PIERRE EDMOND (1814–1892), French writer and politician, was born at Châteauroux on the 17th of September 1814, and entered the civil service after the completion of his education at the École Polytechnique. He was a railway expert, becoming secretary-general of the Railway Commission established in 1842, government commissioner to the authorized railway companies, administrator of the Lyons-Mediterranean railway, and commissioner to examine foreign railways. In 1846 he was returned to the Chamber of Deputies for Hérault, but the revolution of 1848 drove him into private life, from which he only emerged after the downfall of the Empire, when in February 1871 he was returned to the National Assembly. He supported the government of Thiers and was minister of agriculture and commerce in 1872–73. He sat in the Left Centre, and steadily supported republican principles. He entered the Senate in 1876, and was minister of agriculture in the Dufaure-Ricard cabinet of that year, retaining his portfolio in the Jules Simon ministry which fell on the 16th of May 1877. In 1878, when he joined the new Dufaure cabinet, he opened the Paris exhibition of agriculture and manufactures, the original suggestion of which had been made by him during his 1876 ministry. In 1879 he was sent as ambassador to Vienna, whence he was next year recalled on the score of health. Two years later he re-entered the Senate, where he did good service to the cause of "Republican Defence" during the Boulangist agitation. He died in Paris on the 29th of July 1892. His works consist of discussions of railway policy from the technical and economic side.

TELAMONES (Gr. τελάμων, supporter, from τλῆναι, to bear), in architecture the term used by the Romans as equivalent to Atlantes (the Greek term) for male figures employed to carry architraves and cornices. The best-known examples are those in the tepidarium of the baths of Pompeii, which consist of small figures in terra-cotta, 2 ft. high, placed between niches and carrying a cornice.

TELANG, KASHINATH TRIMBAK (1850–1893), Indian judge and oriental scholar, was born at Bombay on the 30th of August 1850. By profession an advocate of the high court, he also took a vigorous share in literary, social, municipal and political work, as well as in the affairs of the university of Bombay, over which he presided as vice-chancellor from 1892 till his death. At the age of five Telang was sent to the Amarchaud Wadi vernacular school, and in 1859 entered the high school in Bombay which bears the name of Mountstuart Elphinstone. Here he came under the influence of Narayan Mahadev Purmanand, a teacher of fine intellect and force of character, afterwards one of Telang's most intimate friends.

From this school he passed to the Elphinstone College, of which he became a fellow, and after taking the degree of M.A. and LL.B., decided to follow the example of Bal Mangesh Wagle, the first Indian admitted by the judges to practise on the original side of the high court, a position more like the status of a barrister than a vakil or pleader. He passed the examination and was enrolled in 1872. His learning and other gifts soon brought him an extensive practice. He had complete command of the English language, and his intimacy with Sanskrit enabled him to study and quote the Hindu law-books with an ease not readily attained by European counsel. Telang, finding his career assured, declined an offer of official employment. But in 1889 he accepted a seat on the high court bench, where his judgments are recognized as authoritative, especially on the Hindu law. He was syndic of the university from 1881, and vice-chancellor from 1892 till his death. In that year also he was elected president of the local branch of the Royal Asiatic Society. These two offices had never been held by a native of India before. The decoration of C.I.E. conferred on him in 1882 was a recognition of his services as a member of a mixed commission appointed by the government to deal with the educational system of the whole of India. He was nominated to the local legislative council in 1884, but declined a similar position on the viceroy's council. Along with P.M. Metha, he was the originator of the Bombay Presidency Association. When a student he had won the Bhugwandas scholarship in Sanskrit, and in this language his later studies were profound. His translation of the *Bhagwadgita* into English prose and verse is a standard work; and he criticized Professor Weber's hypothesis that the story of the *Ramayana* was influenced by the Homeric epics. While devoted to the sacred classics of the Hindus, Telang did not neglect his own vernacular, Mahratti literature being enriched by his translation of Lessing's *Nathan the Wise*, and an essay on *Social Compromise*. He died at Bombay on the 1st of September 1893.

TELAV, a town of Russian Transcaucasia, in the government of Tiflis, 63 m. N.E. of the town of Tiflis, on the river Alazan and at an altitude of 2420 ft. Pop. (1897) 11,810, chiefly Armenians (9000) and Georgians (2000). Telav is a very old town, founded in 893, and until 1797 it was the capital of Kakhetia, and has ruins of old forts. In the neighbourhood are the Ikaltoi monastery (6th century), the Shuanty monastery (16th century), and the originally 10th century Alaverdi church, visited by many pilgrims. Wine is exported.

TELEGONY (Gr. τῆλε, far, and γόνος, offspring), the name now given to the hypothesis that offspring sometimes inherit characters from a previous mate of their dam. Until recent years the supposed inheritance of characters acquired by a dam from one or more of her former mates was usually designated by breeders "throwing back"; by physiologists, "infection of the germ," or simply "infection." The doctrine of "infection," like the somewhat allied doctrine of "maternal impressions," seems to be alike ancient and widespread. Evidence of the antiquity of the belief in "maternal impressions" we have in Jacob placing peeled rods before Laban's cattle to induce them to bring forth "ring-straked speckled and spotted" offspring; evidence of the antiquity of the "infection" doctrine we have, according to some writers, in the practice amongst the Israelites of requiring the childless widow to marry her deceased husband's brother, that he might "raise up seed to his brother." Whatever may have been the views of stockowners in the remote past, it is certain that during the middle ages the belief in "infection" was common amongst breeders, and that during the last two centuries it met with the general approval of naturalists, English breeders being especially satisfied of the fact that the offspring frequently inherited some of their characters from a former mate of the dam, while both English and Continental naturalists (apparently without putting the assertions of breeders to the test of experiment) accounted for the "throwing back" by saying the germ cells of the dam had been directly or indirectly "infected" by a former mate. It is noteworthy that L. Agassiz, C. Darwin, W. B. Carpenter, and G. J. Romanes were all more or less firm believers in the doctrine of infection, and that a few years ago, with the exception of Professor A. Weismann, all the leading biologists had either subscribed to the telegony doctrine or admitted that "infection of the germ" was well within the bounds of possibilities. Even Professor Weismann did not deny the possibility of the offspring throwing back to a previous mate. The widespread belief, he admitted, "may be justifiable and founded on fact," but he was careful to add that "only the confirmation of the tradition by methodical investigation, in this case by experiment, could raise telegony to the rank of a fact." In assuming this attitude Professor Weismann decidedly differed from Herbert Spencer, who some years ago mentioned that he had evidence "enough to prove the fact of a previous sire asserting his influence on a subsequent progeny."

The importance of determining whether there is such a thing as telegony is sufficiently evident. If a mare or other female animal is liable to be "infected" by her first or by subsequent mates, telegony will rank as a cause of variation, and breeders will be justified in believing (1) that pure-bred females are liable to be "corrupted" when mated with sires of a different breed; and (2) that inferior or cross-bred females, if first mated with a high-class sire, will thereafter produce superior offspring, however inferior or cross-bred her subsequent mates. If, on the other hand, "infection of the germ" is impossible, telegony will not count as a factor in variation, and breeders will no longer be either justified in regarding mares and other female animals as liable to be "corrupted" by ill-assorted unions, or benefited by first having offspring to a high-class, or it may be more vigorous, mate. Though, according to breeders, evidence of telegony has been found in nearly all the different kinds of domestic mammals and birds, most stress has been laid on instances of "infection" in the horse and dog families.

Telegony in the Horse Family.—Beecher at the end of the 17th century pointed out that "when a mare has had a mule by an ass and afterwards a foal by a horse, there are evident marks on the foal of the mother having retained some ideas of her former paramour, the ass." That mares used in mule breeding are liable to be infected is still widely believed, but irrefragable evidence of the influence of the ass persisting, as Agassiz assumed, is conspicuous by its absence. Darwin says, "It is worth notice that farmers in south Brazil . . . are convinced that mares which have once borne mules when subsequently put to horses are extremely liable to produce colts striped like a mule" (*Animals and Plants*, vol. i. p. 436). Baron de Parana, on the other hand, says, "I have many relatives and friends who have large establishments for the rearing of mules, where they obtain from 400 to 1000 mules in a year. In all these establishments, after two or three crossings of the mare and ass, the breeders cause the mare to be put to a horse; yet a pure-bred foal has never been produced resembling either an ass or a mule."

The prevalence of the belief in telegony at the present day is largely due to a case of supposed infection reported to the Royal Society in 1820 by Lord Morton. A chestnut mare, after having a hybrid by a quagga, produced to a black Arabian horse three foals showing a number of stripes—in one more stripes were present than in the quagga hybrid. The more, however, the case so intimately associated with the name of Lord Morton is considered, the less convincing is the evidence it affords in favour of "infection." Stripes are frequently seen in high-caste Arab horses, and cross-bred colts out of Arab mares sometimes present far more distinct bars across the legs and other zebra-like markings than characterized the subsequent offspring of Lord Morton's seven-eighths Arabian mare. In the absence of control experiments there is therefore no reason for assuming Lord Morton's chestnut mare would have produced less striped offspring had she been mated with the black Arabian before giving birth to a quagga hybrid. To account for the stripes on the subsequent foals, it is only necessary (now that the principles of cross-breeding are better understood) to assume that in the cross-bred chestnut mare there lay latent the characteristics of the Kattiawar or other

Indian breeds, in which stripes commonly occur. Darwin and others having regarded Lord Morton's mare as affording very strong evidence in support of the infection hypothesis, it was considered some years ago desirable to repeat Lord Morton's experiment as accurately as possible. The quagga having become extinct, a number of mares were put to a richly striped Burchell zebra, and subsequently bred with Arab, thoroughbred and cross-bred sires. Other mares were used for control experiments. Thirty mares put to a Burchell zebra produced seventeen hybrids, and subsequently twenty pure-bred foals. The mares used for control experiments produced ten pure-bred foals. Unlike Lord Morton's quagga hybrids, all the zebra hybrids were richly, and sometimes very distinctly, striped, some of them having far more stripes than their zebra parent. Of the subsequent foals, three out of Highland mares presented indistinct markings at birth. But as equally distinct markings occurred on two pure-bred Highland foals out of mares which had never seen a zebra, it was impossible to ascribe the stripes on the foals born after zebra hybrids to infection of their respective dams. Further, the subsequent foals afforded no evidence of infection, either in the mane, tail, hoofs or disposition. Of the pure-bred foals, *i.e.* the foals by pure-bred sires out of mares which had never been mated with a zebra, two were striped at birth and one acquired stripes later—they were revealed as the foal's coat was shed. Moreover, while the faint markings on the foals born after hybrids completely disappeared with the foals' coat, the stripes on the three pure-bred colts persisted. One of the permanently striped colts, a bay, was out of a black Shetland mare by a black Shetland sire, one was by a dun Norwegian pony out of a roan-coloured Arab mare, while the third was by a Norwegian pony out of a half-bred bay Arab mare. It has been asserted by believers in telegony that evidence of infection may appear in the second though not present in the first generation. By way of testing this assumption, a bay filly, the half-sister of a richly striped hybrid, was put to a cross-bred Highland pony, and a Highland mare, while nursing her hybrid foal, was put to a colt the half-brother of a hybrid. The result was two fillies which in no single point either suggest a zebra or a zebra hybrid. Similar results having been obtained with horses and asses, there is no escape from the conclusion that the telegony tradition is not confirmed by such methodical investigations as were suggested some years ago by Professor Weismann (see Cossar Ewart, *The Penycuik Experiments*, 1899).

Telegony in Dogs.—Breeders of dogs are, if possible, more thoroughly convinced of the fact of telegony than breeders of horses. Nevertheless, Sir Everett Millais, a recognized authority, has boldly asserted that after nearly thirty years' experience, during which he made all sorts of experiments, he had never seen a case of telegony. Recent experiments support Millais's conclusion. Two of the purest breeds at the present day are the Scottish deerhound and the Dalmatian (spotted carriage-dog), A deerhound after having seven pups to a Dalmatian was put to a dog of her own breed. The result was five pups, which have grown into handsome hounds without the remotest suggestion of the previous Dalmatian mate of their dam. A similar result was obtained with a deerhound first mated with a retriever. Many accidental experiments on telegony are made annually with dogs. Two such experiments may be mentioned. A black-brindled Scottish terrier belonging to a famous breed had first a litter of pups to a curly-haired liver-and-white cocker-spaniel. The pups were spaniel-like in build, and of a brown-and-white colour. Subsequently this terrier had pups to a black-brindled terrier. All the pure-bred pups were typical terriers, and evidence of their dam having escaped infection is the fact that three of them proved noted prize-winners. The subject of the second undesigned experiment was a wire-haired fox-terrier. In this case the first sire was a white Pomeranian, the second a cross-bred Irish terrier. Having had ample opportunity of being "corrupted," the fox-terrier was mated with a prize dog of her own strain. The result was three pups, all in make and markings pure terriers, and one of the three was regarded as an unusually good specimen of the breed.

Experiments with cats, rabbits, mice, with sheep and cattle, with fowls and pigeons, like the experiments with horses and dogs, fail to afford any evidence that offspring inherit any of their characters from previous mates of the dam; *i.e.* they entirely fail to prove that a female animal is liable to be so influenced by her first mate that, however subsequently mated, the offspring will either in structure or disposition give some hint of the previous mate. In considering telegony it should perhaps be mentioned that some breeders not only believe the dam is liable to be "infected" by the sire, but also that the sire may acquire some of the characteristics of his mates. This belief seems to be especially prevalent amongst breeders of cattle; but how, for example, a long-horned Highland bull, used for crossing with black hornless Galloway cows, could subsequently get Galloway-like calves out of pure Highland heifers it is impossible to imagine.

In conclusion, it may be pointed out that it was only natural for breeders and physiologists in bygone days to account for some of their results by the "infection" hypothesis. Even now we know surprisingly little about the causes of variation, and not many years ago it was frequently asserted that there was no such thing as reversion or throwing back to an ancestor. But even were the laws of heredity and variation better understood, the fact remains that we know little of the origin of the majority of our domestic animals. On the other hand, from the experiments of Mendel and others, we now know that cross-bred animals and plants may present all the characters of one of their pure-bred parents, and we also know that the offspring of what are regarded as pure-bred parents sometimes revert to remote, it may be quite different, ancestors. The better we understand the laws of heredity and variation, and the more we learn of the history of the germ cells, the less need will there be to seek for explanations from telegony and other like doctrines. (J. C. E.)

TELEGRAPH (Gr. τῆλε, far, and γράφειν, to write), the name given to an apparatus for the transmission of intelligence to a distance. Etymologically the word implies that the messages are written, but its earliest use was of appliances that depended on visual signals, such as the semaphore or optical telegraph of Claude Chappe. The word is still sometimes employed in this sense, as of the ship's telegraph, by means of which orders are mechanically transmitted from the navigating bridge to the engine room, but when used without qualification it usually denotes telegraphic apparatus worked by electricity, whether the signals that express the words of the message are visual, auditory or written.

Land and Submarine Telegraphy will be considered in Part I., with a section on the commercial aspects. In Part II. Wireless Telegraphy is dealt with.

Part I.—Land and Submarine Telegraphy

Historical Sketch.—Although the history of practical electric telegraphy does not date much further back than the middle of the 19th century, the idea of using electricity for telegraphic purposes is much older. It was suggested again and again as each new discovery in electricity and magnetism seemed to render it more feasible. Thus the discovery of Stephen Gray and of Granville Wheeler that the electrical influence of a charged Leyden jar may be conveyed to a distance by means of an insulated wire gave rise to various proposals, of which perhaps the earliest was that in an anonymous letter[1] to the *Scots Magazine* (vol. xv. p. 73, 1753), in which the use of as many insulated conductors as there are letters in the alphabet was suggested. Each wire was to be used for the transmission of one letter only, and the message was to be sent by charging the proper wires in succession, and received by observing the

[1] From correspondence found among Sir David Brewster's papers after his death it seems highly probable that the writer of this letter, which was signed "C. M.," was Charles Morrison, a surgeon and a native of Greenock, but at that time resident in Renfrew.

movements of small pieces of paper marked with the letters of the alphabet and placed under the ends of the wires. A very interesting modification was also proposed in the same letter, viz. to attach to the end of each wire a small light ball which when charged would be attracted towards an adjacent bell and strike it. Some twenty years later G. L. Le Sage proposed a similar method, in which each conductor was to be attached to a pith ball electroscope. An important advance on this was proposed in 1797 by Lomond,[1] who used only one line of wire and an alphabet of motions. Besides these we have in the same period the spark telegraph of Reiser, of Don Silva, and of Cavallo, the pith ball telegraph of Francis Ronalds (a model of which is in the collection of telegraph apparatus in the Victoria and Albert Museum), and several others.

Next came the discovery of Galvani and of Volta, and as a consequence a fresh set of proposals, in which voltaic electricity was to be used. The discovery by Nicholson and Carlisle of the decomposition of water, and the subsequent researches of Sir H. Davy on the decomposition of the solutions of salts by the voltaic current were turned to account in the water voltameter telegraph of Sömmering and the modification of it proposed by Schweigger, and in a similar method proposed by Coxe, in which a solution of salts was substituted for water. Then came the discovery by G. C. Romagnosi and by H. C. Oersted, of the action of the galvanic current on a magnet. The application of this to telegraphic purposes was suggested by Laplace and taken up by Ampere, and afterwards by Triboaillet and by Schilling, whose work forms the foundation of much of modern telegraphy. Faraday's discovery of the induced current produced by passing a magnet through a helix of wire forming part of a closed circuit was laid hold of in the telegraph of Gauss and Weber, and this application was at the request of Gauss taken up by Steinheil, who brought it to considerable perfection. Steinheil communicated to the Göttingen Academy of Sciences in September 1838 an account of his telegraph, which had been constructed about the middle of the preceding year. The currents were produced by a magneto-electric machine resembling that of Clarke. The receiving apparatus consisted of a multiplier, in the centre of which were pivoted one or two magnetic needles, which either indicated the message by the movement of an index or by striking two bells of different tone, or recorded it by making ink dots on a ribbon of paper.

Steinheil appears to have been anticipated in the matter of a recording telegraph by Morse of America, who in 1835 constructed a rude working model of an instrument; this within a few years was so perfected that with some modification in detail it has been largely used ever since (see below). In 1836 Cooke, to whom the idea appears to have been suggested by Schilling's method, invented a telegraph in which an alphabet was worked out by the single and combined movement of three needles. Subsequently, in conjunction with Wheatstone, he introduced another form, in which five vertical index needles, each worked by a separate multiplier, were made to point out the letters on a dial. Two needles (for some letters, one only) were acted upon at the same time, and the letter at the point of intersection of the direction of the indexes was read. This telegraph required six wires, and was shortly afterwards displaced by the single-needle system, still to a large extent used on railway and other less important circuits. The single-needle instrument is a vertical needle galvanoscope worked by a battery and reversing handle, or two "tapper" keys, the motions to right and left of one end of the index corresponding to the dashes and dots of the Morse alphabet. To increase the speed of working, two single-needle instruments were sometimes used (double-needle telegraph). This system required two line wires, and, although a remarkably serviceable apparatus and in use for many years, is no longer employed. Similar instruments to the single and double needle apparatus of Cooke and Wheatstone were about the same time invented by the Rev. H. Highton and his brother Edward Highton, and were used for a considerable time on some of the railway lines in England. Another series of instruments, introduced by Cooke and Wheatstone in 1840, and generally known as "Wheatstone's step-by-step letter-showing" or "ABC instruments," were worked out with great ingenuity of detail by Wheatstone in Great Britain and by Bréguet and others in France. The Wheatstone instrument in the form devised by Stroh is still largely used in the British Postal Telegraph Department. Wheatstone also described and to some extent worked out an interesting modification of his step-by-step instrument, the object of which was to produce a letter-printing telegraph. But it never came into use; some years later, however, an instrument embodying the same principle, although differing greatly in mechanical detail, was brought into use by Royal E. House, of Vermont, U.S., and was very successfully worked on some of the American telegraph lines till 1860, after which it was gradually displaced by other forms. Various modifications of the instrument are still employed for stock telegraph purposes.

[1] See Arthur Young, *Travels in France*, p. 3.

Construction of Telegraph Circuits.—The first requisite for electro-telegraphic communication between two localities is an insulated conductor extending from one to the other. This, with proper apparatus for originating electric currents at one end and for discovering the effects produced by them at the other end, constitutes an electric telegraph. Faraday's term "electrode," literally "a way (ὁδός) for electricity to travel along," might be well applied to designate the insulated conductor along which the electric messenger is despatched. It is, however, more commonly and familiarly called "the wire" or "the line." The apparatus for generating the electric action at one end is commonly called the *transmitting apparatus* or *instrument*, or the *sending apparatus* or *instrument*, or sometimes simply the *transmitter* or *sender*. The apparatus used at the other end of the line to render the effects of this action perceptible to the eye or ear, is called the *receiving apparatus* or *instrument*.

Overground lines.

In the aerial or overground system of land telegraphs the use of copper wire has become very general. The advantage of the high conducting power which copper possesses is of especial value in moist climates (like that of the United Kingdom), since the effect of leakage over the surface of the damp insulators is much less noticeable when the conducting power of the wire is high than when it is low, especially when the line is a long one. Copper is not yet universally employed, price being the governing factor in its employment; moreover, the conducting quality of the iron used for telegraphic purposes has of late years been very greatly improved.

In the British Postal Telegraph system five sizes of iron wire are in general use, weighing respectively 200, 400, 450, 600 and 800 lb per statute mile, and having electrical resistances (at 60° F.) of 26·64, 13·32, 11·84, 8·88 and 6·66 standard ohms per statute mile respectively. The sizes of copper wire employed have weights of 100, 150, 200 and 400 lb per statute mile, and have electrical resistances (at 60° F.) of 8·782, 5·855, 4·391 and 2·195 standard ohms respectively. Copper wire weighing 600 and 800 lb per mile has also been used to some extent. The copper is "hard drawn," and has a breaking strain as high as 28 tons per sq. in.; the test strain required for the iron wire is about 22½ tons. The particular sizes and descriptions of wires used are dependent upon the character of the "circuits" the longer and more important circuits requiring the heavier wire.

The lines are carried on poles, at a sufficient height above the ground, by means of insulators. These vary in form, but essentially they consist of a stem of porcelain, coarse earthenware, glass or other non-conducting substance, protected by an overhanging roof or screen. The form in general use on the British postal lines is the "Cordeaux screw," but the "Varley double cup" is still employed, especially by the railway companies.

The latter form consists (fig. 1) of two distinct cups (*c*, C), which are moulded and fired separately, and afterwards cemented together. The double cup gives great security against loss of insulation due to cracks extending through the insulator, and also gives a high surface insulation. An iron bolt (*b*) cemented into the centre of the inner cup is used for fixing the insulator to the pole or bracket.

This form of insulator is still largely used and is a very serviceable pattern, though possessing the defect that the porcelain cup is not removable from the iron bolt on which it is mounted. The Cordeaux insulator (fig. 2) is made in one piece. A coarse screw-thread is formed in the upper part of the inner cup, and this screws on to the end of the iron bolt by which it is supported. Between a shoulder, *a*, in the iron bolt and a shoulder in the porcelain cup, *c*, is placed an indiarubber ring, which forms a yielding washer and enables the cup to be screwed firmly to the bolt, while preventing

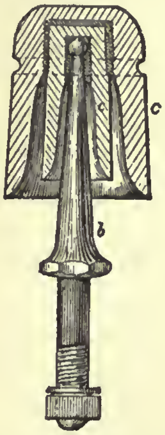


FIG. 1.—Varley's Double Cup Insulator, one-fourth full size.

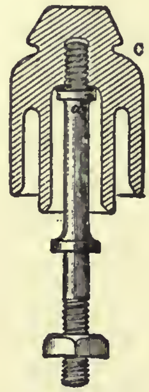


FIG. 2.—Cordeaux Insulator.

the abrasion of the porcelain against the iron. The advantage of the arrangement is that the cup can at any time be readily removed from the bolt. At the termination of a line a large insulator (fig. 3), mounted on a strong steel bolt having a broad base flange, is employed. Connexion is made into the office (or to the underground system, as is often the case) from the aerial wire by means of a copper conductor, insulated with gutta-percha, which passes through a "leading in" cup, whereby leakage is prevented between the wire and the pole. The insulators are planted on creosoted oak arms, $2\frac{1}{2}$ in. sq. and varying in length from 24 to 48 ins., the 24 and 33 in. arms taking two, and the 48 in. four, insulators. The

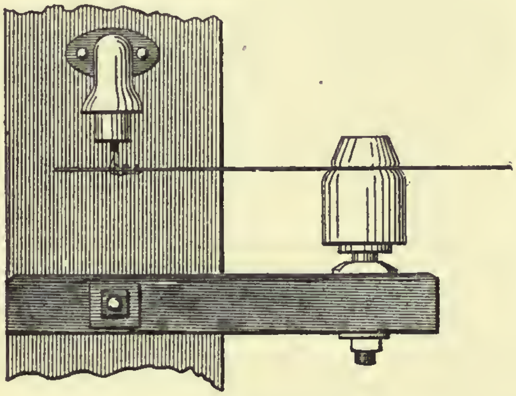


FIG. 3.—Terminal Insulator.

unequal lengths of the 24 and 33 in. arms are adopted for the purpose of allowing one wire to fall clear of that beneath it, in the case of an insulator breaking or the securing binder giving way. The poles are of red fir, creosoted, this method of preservation being the only one now used for this purpose in the United Kingdom. The number of poles varies from about 15 to 22 per m. of line; they are planted to a depth of from 2 to 4 ft. in the ground. For protection from lightning each pole has an "earth wire" running from the top, down to the base.

Underground lines.

Gutta-percha-covered copper wires were formerly largely used for the purpose of underground lines, the copper conductor weighing 40 ℔ per statute mile, and the gutta-percha covering 50 ℔ (90 ℔ total). The introduction of *paper* cables, *i.e.* copper wires insulated with carefully dried paper of a special quality, has practically entirely superseded the use of wires insulated with gutta-percha. The paper cables consist of a number of wires, each enveloped in a loose covering of well-dried paper, and loosely laid up together with a slight spiral "lay" in a bundle, the whole being enclosed in a stout lead pipe. It is essential that the paper covering be loose, so as to ensure that each wire is enclosed in a coating not of paper only, but also of air; the wires in fact are really insulated from each other by the dry air, the loose paper acting merely as a separator to prevent them from coming into contact. The great advantage of this air insulation is that the electrostatic capacity of the wires is low (about one-third of that which would be obtained with gutta-percha insulation), which is of the utmost importance for high-speed working or for long-distance telephonic communication. As many as 1200 wires are sometimes enclosed in one lead pipe.

Between London and Birmingham a paper cable 116 m long and consisting of 72 copper conductors, each weighing 150 ℔ per statute mile, was laid in 1900. The conductors are enclosed in a lead pipe, $2\frac{1}{4}$ in. in outside diameter and $\frac{1}{8}$ in. thick, which itself is enclosed in cast iron spigot-ended pipes, 3 in. in internal diameter, and buried 2 ft. below the surface of the roadway. At intervals of 2 m. "test pillars" are placed for the purpose of enabling possible faults to be accurately located. Each conductor has a resistance (at 60° F.) of 5·74 ohms per statute mile, and an average electrostatic capacity per mile between adjacent wires of 0·06 microfarad, or between wire and earth of 0·1 microfarad; the insulation resistance of each wire is about 5000 megohms per mile. The underground system of paper cables has been very largely extended. Cables between London, Glasgow, Edinburgh, Liverpool Leeds, Bristol, Exeter and other important towns have been laid. and eventually telegraphic communication between every important town in the United Kingdom will be rendered safe from interruptions caused by gales or snowstorms.

The one disadvantage of paper cables is the fact that any injury to the lead covering which allows moisture to penetrate causes telegraphic interruption to the whole of the enclosed wires, whereas if the wires are each individually coated with gutta-percha, the presence of moisture can only affect those wires whose covering is defective There is no reason for doubting, however, that, provided the lead covering remains intact, the paper insulation is imperishable; this is not the case with gutta-percha-covered wires.

Testing.

In order to maintain a system of telegraph lines in good working condition, daily tests are essential. In the British Postal Telegraph Department all the most important wires are tested every morning between 7.30 and 7.45 A.M., in sections of about 200 miles. The method adopted consists in looping the wires in pairs between two testing offices, A and B (fig. 4); a current is sent from a battery, E, through

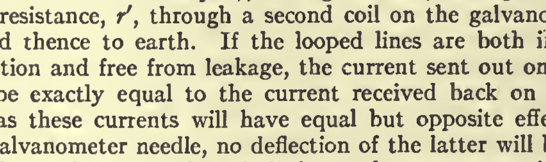


FIG. 4.—Method of testing Circuits.

one coil of a galvanometer, *g*, through a high resistance, *r*, through one of the wires, 1, and thence back from office B (at which the wires are looped), through wire 2, through another high resistance, *r'*, through a second coil on the galvanometer, *g*, and thence to earth. If the looped lines are both in good condition and free from leakage, the current sent out on line 1 will be exactly equal to the current received back on line 2; and as these currents will have equal but opposite effects on the galvanometer needle, no deflection of the latter will be produced. If, however, there is leakage, the current received on the galvanometer will be less than the current sent out, and the result will be a deflection of the needle proportional to the amount of leakage.

The galvanometer being so adjusted that a current of definite strength through one of the coils gives a definite deflection of the needle, the amount of leakage expressed in terms of the insulation resistance of the wires is given by the formula

$$\text{Total insulation resistance of looped lines} = \tfrac{1}{2}R(D/d - \tfrac{1}{2});$$

in which R is the total resistance of the looped wires, including the resistance of the two coils of the galvanometer, of the battery, and of the two resistance coils *r* and *r'* (inserted for the purpose of causing the leakage on the lines to have a maximum effect on the galvanometer deflections). In practice the resistances *r*, *r'* are of 10,000 ohms each. The deflection observed on the galvanometer when the lines are leaky is d, while D is the deflection obtained through *one* coil of the galvanometer with all the other resistances in circuit; and assuming that no leakage exists on the lines, this deflection is calculated from the "constant" of the instrument, *i.e.*, from the known deflection obtained with a definite current. For the purpose of avoiding calculation, tables are provided showing the values of the total insulation according to the formula, corresponding to various values of d. If the insulation per mile, *i.e.*, the total insulation multiplied by the mileage of the wire loop, is found to be less than 200,000 ohms, the wire is considered to be faulty. The climatic conditions in the British Islands are such that it is not possible to maintain, in unfavourable weather, a higher standard than that named, which is the insulation obtained when all the insulators are in perfect condition and only the normal leakage, due to moisture, is present.

Batteries.

There are three kinds of primary batteries in general use in the British Postal Telegraph Department, viz., the Daniell, the bichromate, and the Leclanché. The Daniell type consists of a teak trough divided into five cells by slate partitions coated with marine glue. Each cell contains a zinc plate, immersed in a solution of zinc sulphate, and also a porous chamber containing crystals of copper sulphate and a copper plate. The electromotive force of each cell is 1·07 volts and the resistance 3 ohms. The Fuller bichromate battery consists of an outer jar containing a solution of bichromate of potash and sulphuric acid, in which a plate of hard carbon is immersed; in the jar there is also a porous pot containing dilute sulphuric acid and a small quantity (2 oz.) of mercury, in which stands a stout zinc rod. The electromotive force of each cell is 2·14 volts, and the resistance 4 ohms. The Leclanché is of the ordinary type, and each cell has an electromotive force of 1·64 volts and a resistance of 3 to 5 ohms (according to the size of the complete cell, of which there are three sizes in use). Dry cells, *i.e.* cells containing no free liquid, but a chemical paste, are also largely employed; they have the advantage of great portability.

Accumulators.

Primary batteries have, in the case of all large offices, been displaced by accumulators. The force of the set of accumulator cells provided is such as to give sufficient power for the longest circuit to be worked, the shorter circuits being brought up approximately to a level, as regards resistance, by the insertion of resistance coils in the circuit of the transmitting apparatus of each shorter line. A spare set of accumulators is provided for every group of instruments in case of the failure of the working set. For working "double current," two sets of accumulators are provided, one set to send the positive and the other set the negative currents; that is to say, when, for example, a double current Morse key is pressed down it sends, say, a positive current from one set, but when it is allowed to rise to its normal position then a negative current is transmitted from the second set of accumulators. It is not possible to work double current from one set alone, as in this case, if one key of a group of instruments is up and another is down, the battery would be short-circuited and no current would flow to line. The size of the accumulators employed varies from a cell capable of an output of 8 ampere-hours, to a size giving 750 ampere-hours.

Submarine Cables.—A submarine cable (figs. 5–7), as usually manufactured, consists of a core a in the centre of which is a strand of copper wires varying in weight for different cables between 70 and 650 lb to the nautical mile. The stranded form was suggested by W. Thomson (Lord Kelvin) at a meeting of the Philosophical Society of Glasgow in 1854, because its greater flexibility renders it less likely to damage the insulating envelope during the manipulation of the cable. The central conductor is covered with several continuous coatings of gutta-percha, the total weight of which varies between 70 and 650 lb to the mile. Theoretically for a given outside diameter of core the greatest speed of signalling through a cable is obtained when the diameter of the conductor is ·606 $(1/\sqrt{\epsilon})$ the diameter of the core, but this ratio makes the thickness of the gutta-percha covering insufficient for mechanical strength. Owing to the high price of gutta-percha the tendency, of recent years, has been to approximate more closely to the theoretical dimensions, and a thickness of insulating material which formerly would have been considered quite insufficient is now very generally adopted with complete success. Of two transatlantic cables laid in 1894, the core of one consisted of 500 lb copper and 320 lb gutta-percha per mile, and that of the other of 650 lb copper and 400 lb gutta-percha; whereas for the similarly situated cable laid in 1866 the figures were 300 lb copper and 400 lb gutta-percha. The core is served with a thick coating of wet jute, yarn or hemp (h), forming a soft bed for the sheath, and, to secure immunity from the ravages of submarine boring animals, *e.g. Teredo navalis*, it has been found necessary, for depths not exceeding 300 fathoms, to protect the core with a thin layer of brass tape. The deep sea portion is sheathed with galvanized iron or steel wires (in the latter case offering a breaking strain of over 80 tons per sq. in., with an elongation of at least 5 per cent.), the separate wires being first covered with a firm coating of tape and Chatterton's compound (a

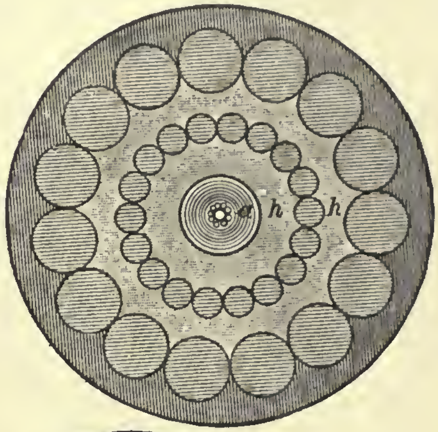


FIG. 5.

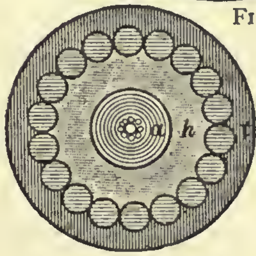


FIG. 6.

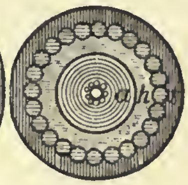


FIG. 7.

FIGS. 5–7.—Sections of three types of Submarine Cables, full size. Fig. 5.—Type of shore end. Fig. 6.—Intermediate type. Fig. 7.—Deep sea type.

mixture of gutta-percha, rosin and Stockholm tar). Sometimes the wires are covered with the compound alone, and the whole cable after being sheathed is finally covered with tarred tape. The weight of the iron sheath varies greatly according to the depth of the water, the nature of the sea bottom, the prevalence of currents, and so on. Fig. 5 shows the intermediate type again sheathed with a heavy armour to resist wear in the shallow water near shore. In many cases a still heavier type is used for the first mile or two from shore, and several intermediate types are often introduced, tapering gradually to the thin deep-water type.

The cost of the cable before laying depends on the dimensions of its core, the gutta-percha, which still forms the only trustworthy insulator known, constituting the principal item of the expense; for an Atlantic cable of the most approved construction the cost may be taken at £250 to £300 per nautical mile.

Manufacture.

In manufacturing a cable (fig. 8) the copper strand is passed through a vessel A containing melted Chatterton's compound, then through the cylinder C, in which a quantity of gutta-percha, purified by repeated washing in hot water, by mastication, and by filtering through wire-gauze filters, is kept warm by a steam-jacket. As the wire is pulled through, a coating of gutta-percha, the thickness of which is regulated by the die D, is pressed out of the cylinder by applying the requisite pressure to the piston P. The newly coated wire is passed through a long trough T, containing cold water, until it is sufficiently cold to allow it to be safely wound on a bobbin B′ This operation completed, the wire is wound from the bobbin B′ on to another, and at the same time carefully examined for air-holes or other flaws, all of which are eliminated. The coated wire is treated in the same way as the copper strand—the die D, or another of the same size, being placed at the back of the cylinder and a larger one substituted at the front. A second coating is then laid on, and after it passes through a similar process of examination a third coating is applied, and so on until the requisite number is completed. The finished core changes rapidly in its electric qualities at first, and is generally kept for a stated interval of time before being subjected to the specified tests. It is then placed in a tank of water and kept at a certain fixed temperature, usually 75° F., until it assumes approximately a constant electrical state. Its conductor and dielectric

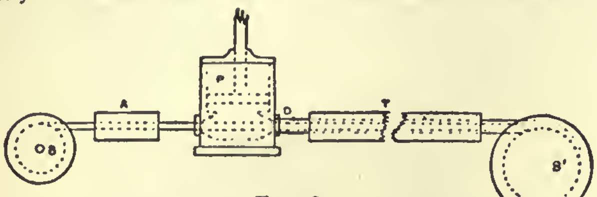


Fig. 8.

resistance and its electrostatic capacity are then measured. These tests are in some cases repeated at another temperature, say 50° F., for the purpose of obtaining at the same time greater certainty of the soundness of the core and the rate of variation of the conductor and dielectric resistances with temperature. The subjection of the core to a hydraulic pressure of four tons to the square inch and an electric pressure of 5000 volts from an alternating-current transformer has been adopted, by one manufacturer at least, to secure the detection of masked faults which might develop themselves after submergence. Should these tests prove satisfactory the core is served with jute yarn, coiled in water-tight tanks, and surrounded with salt water. The insulation is again tested, and if no fault is discovered the served core is passed through the sheathing machine, and the iron sheath and the outer covering are laid on. As the cable is sheathed it is stored in large water-tight tanks and kept at a nearly uniform temperature by means of water.

Laying.

When the cable is to be laid it is transferred to a cable ship, provided with water-tight tanks similar to those used in the factory for storing it. The tanks are nearly cylindrical in form and have a truncated cone fixed in the centre, as shown at C, fig. 9. The cable is carefully coiled into the tanks in horizontal flakes, each of which is begun at the outside of the tank

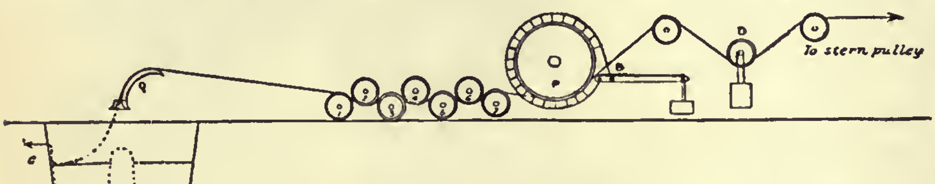


Fig. 9.—Diagram of Cable Tank and Paying-out Apparatus of Submarine Cable.

and coiled towards the centre. The different coils are prevented from adhering by a coating of whitewash, and the end of each nautical mile is carefully marked for future reference. After the cable has been again subjected to the proper electrical tests and found to be in perfect condition, the ship is taken to the place where the shore end is to be landed. A sufficient length of cable to reach the shore or the cable-house is paid overboard and coiled on a raft or rafts, or on the deck of a steam-launch, in order to be connected with the shore. The end is taken into the testing room in the cable-house and the conductor connected with the testing instruments, and, should the electrical tests continue satisfactory, the ship is put on the proper course and steams slowly ahead, paying out the cable over her stern. The cable must not be overstrained in the process of submersion, and must be paid out at the proper rate to give the requisite slack. This involves the introduction of machinery for measuring and controlling the speed at which it leaves the ship and for measuring the pull on the cable. The essential parts of this apparatus are shown in fig. 9. The lower end e of the cable in the tank T is taken to the testing room, so that continuous tests for electrical condition can be made. The upper end is passed over a guiding quadrant Q to a set of wheels or fixed quadrants 1, 2, 3, . . . then to the paying-out drum P, from it to the dynamometer D, and finally to the stern pulley, over which it passes into the sea. The wheels 1, 2, 3, . . . are so arranged that 2, 4, 6, . . . can be raised or lowered so as to give the cable less or more bend as it passes between them, while 1, 3, 5, . . . are furnished with brakes. The whole system provides the means of giving sufficient back-pull to the cable to make it grip the drum P, round which it passes several times to prevent slipping. On the same shaft with P is fixed a brake-wheel furnished with a powerful brake B, by the proper manipulation of which the speed of paying out is regulated, the pull on the cable being at the same time observed by means of D. The shaft of P can be readily put in gear with a powerful engine for the purpose of hauling back the cable should it be found necessary to do so. The length paid out and the rate of paying out are obtained approximately from the number of turns made by the drum P and its rate of turning. This is checked by the mile marks, the known position of the joints, &c., as they pass. The speed of the ship can be roughly estimated from the speed of the engines; it is more accurately obtained by one or other of the various forms of log, or it may be measured by paying out continuously a steel wire over a measuring wheel. The average speed is obtained very accurately from solar and stellar observations for the position of the ship. The difference between the speed of the ship and the rate of paying out gives the amount of slack. The amount of slack varies in different cases between 3 and 10 per cent., but some is always allowed, so that the cable may easily adapt itself to inequalities of the bottom and may be more readily lifted for repairs. But the mere paying out of sufficient slack is not a guarantee that the cable will always lie closely along the bottom or be free from spans. Whilst it is being paid out the portion between the surface of the water and the bottom of the sea lies along a straight line, the component of the weight at right angles to its length being supported by the frictional resistance to sinking in the water. If, then, the speed of the ship be v, the rate of paying out u, the angle of immersion i, the depth of the water h, the weight per unit length of the cable w, the pull on the cable at the surface P, and A, B constants, we have—

$$P = h\{w - (A/\sin i)f(u - v\cos i)\} \qquad (\alpha)$$

and

$$w\cos i = Bf(v\sin i) \qquad (\beta),$$

where f stand for "function." The factors $Af\ (u - v\cos i)$ and $Bf\ (v\sin i)$ give the frictional resistance to sinking, per unit length of the cable, in the direction of the length and transverse to the length respectively.[1] It is evident from equation (β) that the angle of immersion depends solely on the speed of the ship; hence in laying a cable on an irregular bottom it is of great importance that the speed should be sufficiently low. This may be illustrated very simply as follows: suppose $a\ a$ (fig. 10) to be the surface of the sea, $b\ c$ the bottom, and $c\ c$ the straight line made by the cable; then, if a hill H, which is at any part steeper than the inclination of the cable, is passed over, the cable touches it at some point t before it touches the part immediately below t, and if the friction between the cable and the ground is sufficient the cable will either break or be left in a long span ready to break at some future time. It is important to observe that the risk is in no way obviated by the increasing slack paid out, except in so far as the amount of sliding which the strength of the cable is able to produce at the points of contact with the ground may be thereby increased. The speed of the ship must therefore be so regulated that the angle of immersion is as great as the inclination of the steepest slope passed over. In ordinary circumstances the angle of immersion i varies between six and nine degrees.

The "slack indicator" of Messrs Siemens Brothers & Co. yields a continuous indication and record of the actual slack paid out. It consists of a long screw spindle, coupled by suitable gearing with the cable drum, and thus rotating at the speed of the outgoing cable; on this screw works a nut which forms the centre of a thin circular disk, the edge of which is pressed against the surface of a right circular cone, the line of contact, as the nut moves along the screw, being parallel to the axis of the latter. This cone is driven by gearing from the wire drum, so that it rotates at the speed of the outgoing wire, the direction of rotation being such as to cause the nut to travel towards the smaller end of the cone. If both

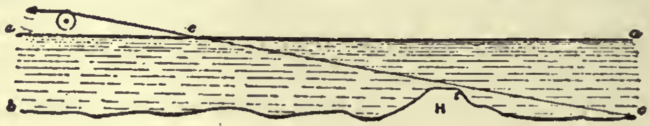


Fig. 10.

nut and screw are rotating at the same speed, the position of the former will remain fixed; and as the nut is driven by friction from the surface of the cone, this equality of speed will obtain only when the product of the diameter (d) of the cone at that position multiplied into its speed of rotation (n) equals the product of the diameter (a) of the disk multiplied into the speed of rotation (N) of the screw, or $N/n = d/a$, and thus the ratio of cable paid out to that of wire paid out is continuously given by a pointer controlled

[1] See Sir W. Thomson (Lord Kelvin) *Mathematical and Physical Papers*, vol. ii. p. 165.

by the disk, for any difference in speed between nut and screw will cause the nut to move along the screw until the diameter of the cone is reached which fulfils the above conditions for equality in speed. In fig. 11 the edge of the disk serves as the pointer and the scale gives the percentage of slack, or $(N-n)/n$. The wire being paid out without slack measures the actual distance and speed over the ground, and the engineer in charge is relieved of all anxiety in estimating the depth from the scattered soundings of the preliminary survey, or in calculating the retarding strain required to produce the specified slack, since the brakesman merely has to follow the indications of the instrument and regulate the strain so as to keep the pointer at the figure required—an easy task, seeing that the ratio of speed of wire and cable is not affected by the motion of the ship, whatever be the state of the sea, whereas the

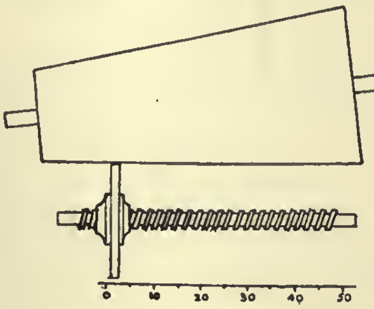


Fig. 11.—Slack Indicator.

strain will in heavy weather be varying 50 per cent. or more on each side of the mean value. Further, the preliminary survey over the proposed route, necessary for deciding the length and types of cable required, can afford merely an approximation to the depth in which the cable actually lies, since accidents of wind and weather, or lack of observations for determining the position, cause deviations, often of considerable importance, from the proposed route. From the continuous records of slack and strain combined with the weight of the cable it is a simple matter to calculate and plot the depths along the whole route of the cable as actually laid. Fig. 12, compiled from the actual records obtained during the laying of the Canso-Fayal section of the Commercial Cable Company's system, shows by the full line the actual strain recorded which secured the even distribution of 8 per cent. of slack, and by the dotted line the strain that would have been applied if the soundings taken during the preliminary survey had been the only source available, although the conditions of sea and weather favoured

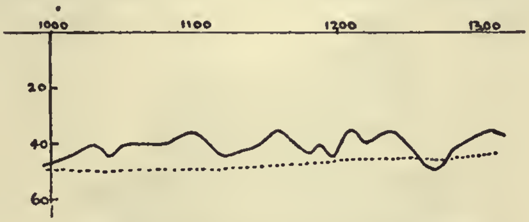


Fig. 12.—Records of Strain and Depths.

close adherence to the proposed route. The ordinates of the curve give the strain in cwts., and the abscissae the distance in miles measured from the Canso end; as the strain is proportional to the depth, 18 cwts. corresponding to 1000 fathoms, the black line represents to an exaggerated scale the contour of the sea bed.

Repairing.

Owing to the experience gained with many thousands of miles of cable in all depths and under varying conditions of weather and climate, the risk, and consequently the cost, of laying has been greatly reduced. But the cost of effecting a repair still remains a very uncertain quantity, success being dependent on quiet conditions of sea and weather. The *modus operandi* is briefly as follows: The position of the fracture is determined by electrical tests from both ends, with more or less accuracy, depending on the nature of the fracture, but with a probable error not exceeding a few miles. The steamer on reaching the given position lowers one, or perhaps two, mark buoys, mooring them by mushroom anchor, chain and rope. Using these buoys to guide the direction of tow, a grapnel, a species of five-pronged anchor, attached to a strong compound rope formed of strands of steel and manila, is lowered to the bottom and dragged at a slow speed, as it were ploughing a furrow in the sea bottom, in a line at right angles to the cable route, until the behaviour of the dynamometer shows that the cable is hooked. The ship is then stopped, and the cable gradually hove up towards the surface; but in deep water, unless it has been caught near a loose end, the cable will break on the grapnel before it reaches the surface, as the catenary strain on the bight will be greater than it will stand. Another buoy is put down marking this position, fixing at the same time the actual line of the cable. Grappling will be recommenced so as to hook the cable near enough to the end to allow of its being hove to the surface. When this has been done an electrical test is applied, and if the original fracture is between ship and shore the heaving in of cable will continue until the end comes on board. Another buoy is then lowered to mark this spot, and the cable on the other side of the fracture grappled for, brought to the surface, and, if communication is found perfect with the shore, buoyed with sufficient chain and rope attached to allow of the cable itself reaching the bottom. The ship now returns to the position of original attack, and by similar operations brings on board the end which secures communication with the other shore. The gap between the two ends has now to be closed by splicing on new cable and paying out until the buoyed end is reached, which is then hove up and brought on board. After the "final splice," as it is termed, between these ends has been made, the bight, made fast to a slip rope, is lowered overboard, the slip rope cut, and the cable allowed to sink by its own weight to its resting-place on the sea bed. The repair being thus completed, the various mark buoys are picked up, and the ship returns to her usual station.

The grappling of the cable and raising it to the surface from a depth of 2000 fathoms seldom occupy less than twenty-four hours, and since any extra strain due to the pitching of the vessel must be avoided, it is clear that the state of the sea and weather is the predominating factor in the time necessary for effecting the long series of operations which, in the most favourable circumstances, are required for a repair. In addition, the intervention of very heavy weather may mar all the work already accomplished, and require the whole series of operations to be undertaken *de novo*. As to cost, one transatlantic cable repair cost £75,000; the repair of the Aden-Bombay cable, broken in a depth of 1900 fathoms, was effected with the expenditure of 176 miles of new cable, and after a lapse of 251 days, 103 being spent in actual work, which for the remainder of the time was interrupted by the monsoon; a repair of the Lisbon-Porthcurnow cable, broken in the Bay of Biscay in 2700 fathoms, eleven years after the cable was laid, took 215 days, with an expenditure of 300 miles of cable. All interruptions are not so costly, for in shallower waters, with favourable conditions of weather, a repair may be only a matter of a few hours, and it is in such waters that the majority of breaks occur, but still a large reserve fund must be laid aside for this purpose. As an ordinary instance, it has been stated that the cost of repairing the Direct United States cable up to 1900 from its submergence in 1874 averaged £8000 per annum. Nearly all the cable companies possess their own steamers, of sufficient dimensions and specially equipped for making ordinary repairs; but for exceptional cases, where a considerable quantity of new cable may have to be inserted, it may be necessary to charter the services of one of the larger vessels owned by a cable-manufacturing company, at a certain sum per day, which may well reach £200 to £300. This fleet of cable ships now numbers over forty, ranging in size from vessels of 300 tons to 10,000 tons carrying capacity.

Life.

The life of a cable is usually considered to continue until it is no longer capable of being lifted for repair, but in some cases the duration and frequency of interruptions as affecting public convenience, with the loss of revenue and cost of repairs, must together decide the question of either making very extensive renewals or even abandoning the whole cable. The possibility of repair is affected by so many circumstances due to the environment of the cable, that not even an approximate term of years has yet been authoritatively fixed. It is a well-ascertained fact that the insulator, gutta-percha, is, when kept under water, practically imperishable, so that it is only the original strength of the sheathing wires and the deterioration allowable in them that have to be considered. Cables have frequently been picked up showing after many years of submergence no appreciable deterioration in this respect, while in other cases ends have been picked up which in the course of twelve years had been corroded to needle points, the result probably of metalliferous deposits in the locality. It is scarcely possible from the preliminary survey, with soundings several miles apart, to obtain more than a general idea as to the average depth along the route, while the nature of the constituents of the sea bed can only be revealed by a few small specimens brought up at isolated spots, though fortunately the globigerine ooze which covers the bottom at all the greater ocean depths forms an ideal bed for the cable. The experience gained in the earlier days of ocean telegraphy, from the failure and abandonment of nearly 50 per cent. of the deep-sea cables within the first twelve years, placed the probable life of a cable as low as fifteen years, but the weeding out of unserviceable types of construction, and the general improvement in materials, have by degrees extended that first estimate, until now the limit may be safely placed at not less than forty years. In depths beyond the reach of wave motion, and apart from suspension across a submarine gully, which will sooner or later result in a rupture of the cable, the most frequent cause of interruption is seismic or other shifting of the ocean bed, while in shallower waters and near the shore the dragging of anchors or fishing trawls has been mostly responsible. Since by international agreement the wilful damage of a cable has been constituted a criminal offence, and the cable companies have avoided crossing the fishing banks, or have adopted the wise policy of refunding the value of anchors lost on their cables, the number of such fractures has greatly diminished.

Instruments for Land Telegraphy.—At small country towns or villages, where the message traffic is light, the Wheatstone "A B C" instrument is used. In this apparatus electric currents are generated by turning a handle (placed in front of the instrument), which is geared, in the instruments of the most recent pattern, to a Siemens shuttle armature placed between the two arms of a powerful horseshoe permanent magnet. When one of a series of keys (each corresponding to a letter) arranged round a pointer is depressed, the motion of the pointer, which is geared to the shuttle armature, is arrested on coming opposite that particular key, and the transmission of the currents to line is stopped, though the armature itself can continue to rotate. The depression of a second key causes the first key to be raised. The currents actuate a ratchet-wheel mechanism at the receiving station, whereby the hand on a small dial is moved on letter by letter. A noticeable feature in the modern A B C indicator, as well as in all modern forms of telegraph instruments, is the adoption of "induced" magnets in the moving portion of the apparatus. A small permanent magnet is always liable to become demagnetized, or have its polarity reversed by the action of lightning. This liability is overcome by making such movable parts as require to be magnetic of soft iron, and magnetizing them by the inducing action of a strong permanent magnet. Although formerly in very extensive employment, this instrument is dropping out of use and the "sounder" (and in many cases the telephone) is being used in its place.

A B C instrument.

At offices where the work is heavier than can be dealt with by the A B C apparatus, the "Single Needle" instrument has been very largely employed; it has the advantage of slight liability to derangement, and of requiring very little adjustment. A fairly skilled operator can signal with it at the rate of 20 words per minute. The needle (in the modern pattern) is of soft iron, and is kept magnetized inductively by the action of two permanent steel magnets. The coils are wound with copper wire (covered with silk), 10 mils. in diameter, to a total resistance of 200 ohms. The actual current required to work the instrument is 3·3 milliamperes (equivalent approximately to the current given by 1 Daniell cell through 3300 ohms), but in practice a current of 10 milliamperes is allowed. A simple, but important, addition to enable the reading from the instrument to be effected by sound is shown in fig. 13; in this arrangement the needle strikes against small tubes formed of tin-plate. Although a most serviceable instrument and cheap as regards maintenance, the "single needle" has (except for railway telegraph purposes) been discarded in favour of the "sounder," to secure the advantage of using one general pattern of apparatus, as far as possible, and to avoid the necessity of two different types of instrument being learnt by the telegraphist.

Single needle instrument.

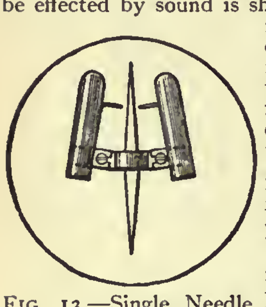


Fig. 13.—Single Needle with sounding arrangement.

The well-known code of signals (fig. 14) introduced by Morse is still employed in the United States and Canada, and the international code in vogue in Europe differs only slightly from it.

The instruments used for land telegraphs on this system are of two types—"sounders," which indicate by sound, and "recorders," which record the signals.

Recorders vary in details of construction, but all have the same object, namely, to record the intervals during which the current is applied to the line. In the earlier forms of instrument the record was made by embossing lines on a ribbon of paper by means of a sharp style fixed to one end of a lever, which carried at the other end the armature of an electromagnet. The form of Morse recorder almost universally used in Europe makes the record in ink, and hence is sometimes called the "ink-writer." This method has the advantage of distinctness, and so is less trying to the eyes of the operators. Although the "ink-writer" is still in use it is practically an obsolete instrument, and has been displaced by the "sounder."

Morse ink-writer.

Operators who used the recorder soon learned to read the message by the click of the armature against its stop, and as this left the hands and eyes free to write, reading by sound was usually preferred. Thus, when it is not necessary to keep a copy, a much simpler instrument may be employed and the message read by sound. The earliest successful form was "Bright's bell" sounder, which consisted of two bells of distinct tone or pitch, one of which was sounded when the current was sent in one direction and the other when it was reversed. This instrument was capable of giving very considerable speed, but it was more complicated than that now in use, which consists only of an electromagnet, with its armature lever arranged to stop against an anvil or screw in such a way as to give a distinct and somewhat loud sound. Dots and dashes are distinguished by the interval between the sounds of the instrument in precisely the same way as they are distinguished when reading from the recorder by sound. Fig. 15 shows the modern pattern of "sounder" as used by the British Post Office. The magnet is wound to a resistance of 40 ohms (or 900 ohms when worked from accumulators), and the instrument is worked with a current of 400 milliamperes (25 milliamperes with accumulators).

Sounder.

INTERNATIONAL CODE

A	·—	O	———	4	····—
B	—···	P	·——·	5	·····
C	—·—·	Q	——·—	6	—····
Ch	————	R	·—·	7	——···
D	—··	S	···	8	———··
E	·	T	—	9	————·
F	··—·	U	··—	0	—————
G	——·	V	···—	.	·····
H	····	W	·——	,	·—·—·—
I	··	X	—··—	;	—·—·—·
J	·———	Y	—·——	:	———···
K	—·—	Z	——··	?	··——··
L	·—··	1	·————	!	——··——
M	——	2	··———		
N	—·	3	···——		

AMERICAN CODE

A	·—	O	· ·	3	···—·
B	—···	P	·····	4	····—
C	·· ·	Q	··—·	5	———
D	—··	R	· ··	6	······
E	·	S	···	7	——··
F	·—·	T	—	8	—····
G	——·	U	··—	9	—··—
H	····	V	···—	0	———
I	··	W	·——	.	··——··
J	—·—·	X	·—··	,	·—·—
K	—·—	Y	·· ··	?	—··—·
L	———	Z	··· ·	!	———·
M	——	1	·——·	&	· ···
N	—·	2	··—··		

Fig. 14.—Morse Alphabets.

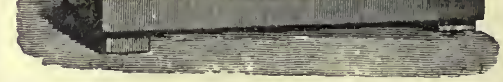


Fig. 15.—Modern "Sounder."

Methods of Working Land Circuits.—The arrangement on the "open-circuit" system for single-current working is shown in fig. 16, in which L_1 represents the line, G a galvanometer, used simply to show that the currents are going to line when the message is being transmitted, K the transmitting key, B the battery, I the receiving instrument, and E the earth-plate. The complete circuit is from the plate E through the instrument I, the key K, and the galvanoscope G to the line L_1, then through the corresponding instruments to the earth-plate E at the other end, and back through the earth to the plate E. The earth is always, except for some special reason, used as a return, because it offers little resistance and saves the expense and the risk of failure of the return wire. The earth-plate E ought to be buried in moist earth or in water. In towns the water and gas pipe systems form excellent earth

Open circuit, single-current system.

plates. It will be observed that the circuit is not in this case actually *open*; the meaning of the expression "open circuit" is "no battery to line." In normal circumstances the instruments at both ends are ready to receive, both ends of the line being to earth through the receiving instruments. A signal is sent by depressing the key K, and so changing the contact from *a* to *b*, and thus putting the battery to line. On circuits where the traffic is small it is usual to make one wire serve several stations. At an intermediate or wayside station W, a "switch" S, consisting of three blocks of brass fixed to an insulating base, is sometimes used (not in Great Britain). W may be made the terminal station of L_1 by inserting plug 3, and of L_2 by inserting plug 2, or the instruments may be cut out of circuit by inserting plug 1. In ordinary circumstances the messages from all stations are sent through the whole line, and thus the operator at any station may transmit, if the line is free, by manipulating his key.

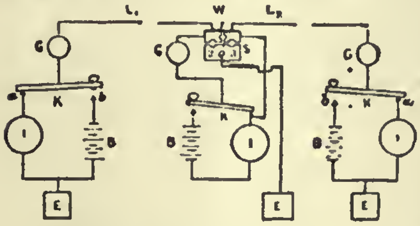


FIG. 16.—Open Circuit, Single-current System.

Closed-circuit system.

The connexions for single-current working on the "closed-circuit" system are shown in fig. 17. It differs from the open circuit in only requiring one battery (although, as in the figure, half of it is often placed at each end), in having the receiving instrument between the line and the key, and in having the battery continuously to the line. The battery is kept to the line by the bar *c*, which short-circuits the keys. When signals are to be sent from either station the operator turns the switch *c* out of contact with the stop *b*, and then operates precisely as in open circuit sending. This system is more expensive than the open-circuit system, as the battery is always at work; but it offers some advantages on circuits where there are a number of intermediate stations, as the circuit is under a constant electromotive force and has the same resistance no matter which station is sending or receiving. The arrangement at a wayside station is shown at W. When the circuit is long and contains a large number of stations, the sending battery is sometimes divided among them in order to give greater uniformity of current along the line. When only one battery is used the current at the distant end may be considerably affected by the leakage to earth along the line.

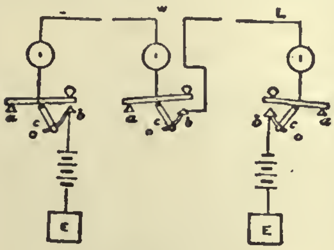


FIG. 17.—Closed Circuit, Single-current System.

Single-current relay working.

If long circuits were worked direct with ordinary instruments, high battery power would be required in order to send sufficient current to actuate the apparatus. In such cases it is usual to employ a local battery to produce the signals, and to close the local battery circuit by means of a circuit-closing apparatus called a *relay*, which is practically an electromagnetic key which has its lever attached to the armature of the magnet and which can be worked by a very weak current. The arrangement at a station worked by relay on the "single-current" system is shown in fig. 18, where L is the line wire, joined through the key K to one end of the coil of the relay magnet R, the other end of which is put to earth. When a current passes through R the armature A is attracted and the local circuit is closed through the armature at *b*. The local battery B_1 then sends a current through the instrument I and records the signal. In the form of relay indicated in the figure the armature is held against the stop *a* by a spring S.

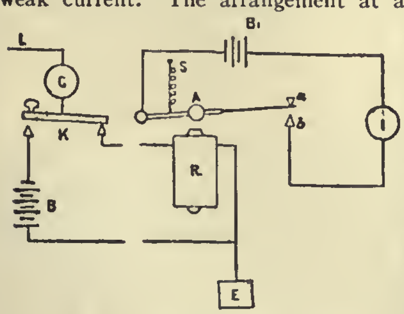


FIG. 18.—Single-current Relay Working.

Double-current system.

"Single-current" working by means of a non-polarized relay (fig. 18), although general in America, is not adopted in England. In the latter country, when such working is resorted to, a "polarized relay" (fig. 20) with a bias is used, but on all important lines worked by sounders the "double-current" system is employed. In this the tongue of the relay is kept over to the spacing side by means of a current flowing in one direction, but on the depression of the signalling key the current is reversed, moving the relay tongue over to the marking side.

Polarized relays.

The Siemens polarized relay, shown in fig. 19, consists of an armature *a*, pivoted at one end *h* in a slot at one end N of a permanent magnet *m*, the other pole *s* of which is fixed to the yoke *y* of a horse-shoe electromagnet M. The armature is placed between the poles of the electromagnet, and being magnetized by the magnet *m* it will oscillate to the right or left under the action of the poles of the electromagnet M according as the current passes through M in one direction or the other. This form of relay is largely used, but in Great Britain it has been entirely displaced by the form shown in fig. 20, which is the most modern pattern of relay used by the British Post Office, known as the "Post Office Standard Relay." In this instrument

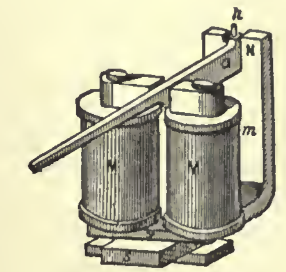


FIG. 19.—Siemens Polarized Relay.

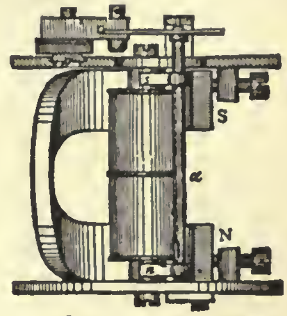


FIG. 20.—Post Office Standard Relay.

there are two soft iron tongues, *n*, *s*, fixed upon and at right angles to an axle *a*, which works on pivots at its ends. These tongues are magnetized by the inducing action of a strong horse-shoe permanent magnet, S N, which is made in a curved shape for the sake of compactness. The tongue plays between the poles of two straight electromagnets. The coils of the electromagnets are differentially wound with silk-covered wire, 4 mils (= ·004 inch) in diameter, to a total resistance of 400 ohms. This differential winding enables the instrument to be used for "duplex" working, but the connexions of the wires to the terminal screws are such that the relay can be used for ordinary single working. Although the relay is a "polarized" one, so that it can be used for "double-current" working, it is equally suitable for "single-current" purposes, as the tongue can be given a bias over to the "spacing" side, *i.e.* to

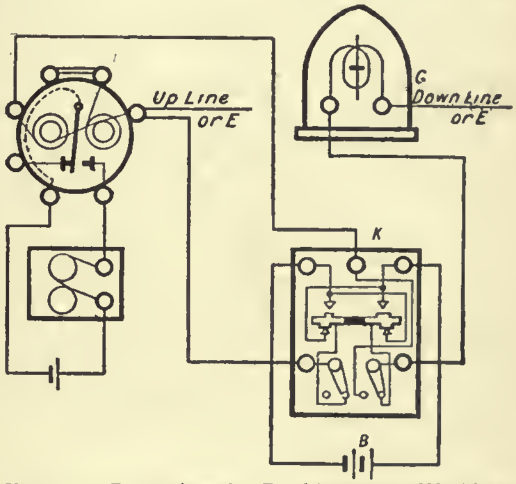


FIG. 21.—Connexions for Double-current Working.

the side on which no current passes through the local circuit. The standard relay will work single current with a current of 3 milliamperes, though in practice about 10 would be used. Worked double current—that is, with the tongue set neutral, having no bias either to the spacing or marking side—the relay will give good signals with 1½ milliampere of current, though in practice 10 milliamperes are provided. The lightness of the moving part enables great rapidity of action to be obtained, which for fast speed working is very essential. The relay tongue, being perfectly free to move, can be actuated by a comparatively weak current. Normally a switch attached to the key cuts the battery off, and connects the line direct through the receiving relay; this switch is turned to "send" when transmission commences, and is moved back to "receive" when it ceases: this movement is done quite mechanically by the telegraphist, and as it is practically never forgotten, automatic devices (which have often been suggested) to effect the turning are wholly unnecessary.

Fig. 21 shows the general arrangement of the connexions for double-current working; the galvanometer G is used for the purpose of indicating whether a station is calling, in case the relay sticks or is out of adjustment. The key K (shown in general plan), when worked, sends reversed currents from the battery B. In cases where "universal battery" working, *i.e.* the working of several instruments from one set of batteries or accumulators, is adopted, the positive and negative currents have to be sent from independent batteries, as shown by fig. 22. The stop *a* of the key K is connected through a switch S with one pole of the battery B, and the stop *b* in the usual way with the other pole. Suppose the arm *c* of the switch S to be in contact with 2; then when the key is manipulated it sends alternately positive and negative currents into the line. If the positive is called the signalling current, the line will be charged positively each time a signal is sent; but as soon as the signal is completed a negative charge is communicated

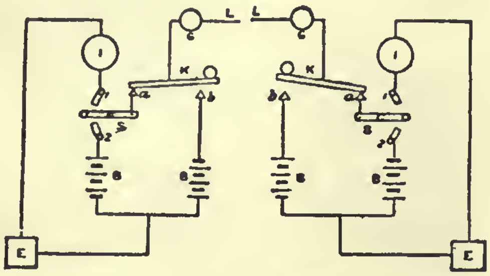


FIG. 22.—Universal Battery Working.

to the line, thus hastening the discharge and the return of the relay tongue to its insulated stop.

Spark coils.

When a local instrument such as a sounder (fig. 15) is worked from a relay, the dying away of the magnetism in the iron cores of the electromagnet, when the relay tongue moves from the marking to the spacing side, *i.e.* when the local battery is cut off, sets up an induced current of high tension, which causes a spark to jump across the contact points of the relay, and by oxidizing them makes it necessary for them to be frequently cleaned. In order to avoid this sparking, every local instrument in the British Postal Telegraph Department has a "spark" coil connected across the terminals of the electromagnet. The spark coil has a resistance about ten times as great as that of the electromagnet it shunts, and the wire of which it is composed is double wound so as to have no retarding effect on the induced current, which circulates through the spark coil instead of jumping in the form of a spark across the contact points. The device is a most effectual one.

Repeaters.

On long circuits worked by the Wheatstone fast-speed apparatus, and especially on those in which a submarine cable is included, it is found necessary to introduce "repeaters" half-way, in order to enable a high speed to be maintained. The speed at which a circuit can be worked depends upon what is known as the "KR" of the line, *i.e.* the product of the total capacity and the total resistance, both the capacity and the resistance having a retarding effect on the signals. By dividing a line into two halves the working speed will be dependent upon the KR of the longest half, and as *both* K and R are directly proportional to the length of the line, the KR product for the half of a circuit is but one quarter that of the whole length of the circuit, and the retardation is correspondingly small. Thus the speed on a line at which the repeater is situated exactly midway will be four times that of the line worked direct. Repeaters (or translators, as they are sometimes termed) are in Great Britain only used on fast-speed circuits; they are in no case found necessary on circuits worked by hand, or at "key speed" as it is called.

Duplex telegraphy.

Duplex telegraphy consists in the simultaneous transmission of two messages, one in each direction, over the same wire. The solution of this problem was attempted by J. W. Gintl of Vienna in 1853 and in the following year by Frischen and by Siemens and Halske. Within a few years several methods had been proposed by different inventors, but none was at first very successful, not from any fault in the principle, but because the effect of electrostatic capacity of the line was left out of account in the early arrangements. The first to introduce a really good practical system of duplex telegraphy, in which this difficulty was sufficiently overcome for land line purposes, was J. B. Stearns of Boston (Mass.). In order that the line between two stations may be worked on the duplex system it is essential that the receiving instrument shall not be acted on by the outgoing currents, but shall respond to incoming currents. The two methods most commonly employed are the differential and bridge methods.

Differential method.

In fig. 23, representing the "differential" method, B is the sending battery, B_1 a resistance equal to that of the battery, R a rheostat and C an adjustable condenser. Suppose the key to be depressed, then a current flows through one winding of the differential relay to line and through the other winding and rheostat to earth. Now if the values of the rheostat and condenser are adjusted so as to make the rise and fall of the outgoing current through both windings of the relay exactly equal, then no effect is produced on the armature of the relay, as the two currents neutralize each other's magnetizing effect.

Incoming currents pass from line through one coil of the relay, the key, and either the battery or battery resistance, according as whether the key is raised or depressed. The result is that the armature of the relay is attracted, and currents are sent through the sounder from the local battery, producing the signals from the distant station. When the key is in the middle position, that is, not making connexion with either the front or back contacts, the received currents pass through both coils of the relay and the rheostat; no interference is, however, felt from this extra resistance because, although the current is halved, it has double the effect on the relay, because it passes through two coils instead of one.

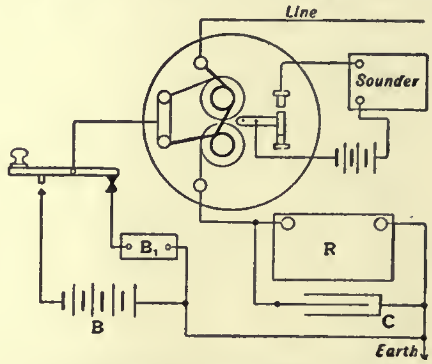


FIG. 23.—Duplex Working: differential method.

Bridge method.

In the "bridge" method (fig. 24), instead of sending the currents through the two coils of a differentially wound relay or receiving instrument as in Frischen's method, two resistances *a* and *b* are inserted, and the receiving instrument is joined between P and Q. The currents thus divide at the point D, and it is clear that if the difference of potential between P and Q is unaffected by closing the sending key, then no change of current will take place in the instrument circuit. The

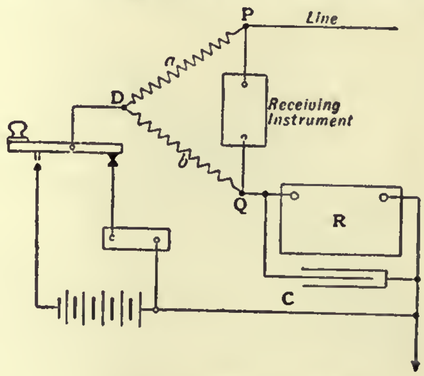


FIG. 24.—Duplex Working: bridge method.

relative potential of P and Q is not affected by the manipulation of the sending key if the resistance of *a* bears the same proportion to that of *b* as the resistance of the line does to that of the resistance R; hence that is the arrangement used. One very great advantage in this method is that the instrument used between P and Q may be of any ordinary form, *i.e.* relay, Hughes, siphon recorder, &c.

Duplex working on cables.

Most important cables, such as those of the Eastern Telegraph Company and the various Atlantic cables, are worked duplex on Muirhead's plan. What may be called a mechanical method of duplexing a cable was described by Lord Kelvin in a patent taken out by him in 1858. In this, as in the ordinary methods, a differentially wound receiving instrument was used, one coil being connected with the cable and the other with the earth; but it differed from other methods in requiring no "artificial" or balancing cable. The compensation was to be obtained by working a slide resistance included in the circuit of the compensating coil, either by the sending key or by clockwork released by the key, so as to vary the resistance in that circuit according to any law which might be required to prevent the receiving instrument being affected by the outgoing current. Four years later Varley patented his artificial cable, which was the first near approach to a successful solution of the duplex problem on the principle now adopted. It was not, however, a sufficiently perfect representation of a laid cable to serve for duplexing cables of more than a few hundred miles in length. By a modification of the bridge method, applied with excellent results by Dr Muirhead to submarine work, condensers are substituted for *a* and *b*, one being also placed in the circuit between P and Q. In this case no current flows from the battery through the line or instruments, the whole action being inductive. As we have already stated, the distribution of the capacity along the resistance R must in submarine cable work be made to correspond very accurately with the distribution of the capacity along the resistance of the cable. This is accomplished by Dr Muirhead in the following manner. One side of a sheet of paraffined paper is covered with a sheet of conducting substance, say tinfoil, and over the other side narrow strips of the same substance are arranged gridironwise to form a continuous circuit along the strip. The breadth and thickness of the strip and the thickness of the paraffined paper are adjusted so that the relative resistance and capacity of this arrangement are the same as those of the cable with which it is intended to be used. A large number of such sheets are prepared and placed together, one over the other, the end of the strip of the first sheet being connected with the beginning of the strip of the second, and so on to the last sheet, the whole representing the conductor of the cable. In the same way all the conducting sheets on the other side of the paper are connected together and form the earth-plate of this artificial cable, thus representing the sea. The leakage through the insulator of the cable is compensated for by connecting high resistances between different points of the strip conductor and the earth coating. Faults or any other irregularity in the cable may be represented by putting resistances of the proper kind into the artificial line. This system of duplexing cables has proved remarkably successful.

Quadruplex telegraphy.

Quadruplex telegraphy consists in the simultaneous transmission of two messages from each end of the line. The only new problem introduced is the simultaneous transmission of two messages in the same direction; this is sometimes called "diplex transmission." The solution of this problem was attempted by Dr J. B. Stark of Vienna in 1855, and during the next ten years it was worked at by Bosscha, Kramer, Maron, Schaak, Schreder, Wartmann and others. The first to attain practical success was Edison, and his method with some modifications is still the one in most general use.

The arrangement is shown in fig. 25, and indicates the general principle involved. K_1 and K_2 are two transmitting keys; the former reverses the direction of the line current, the latter increases the strength irrespective of direction, by joining on another battery when the key is depressed. R_1 and R_2 are relays for receiving the

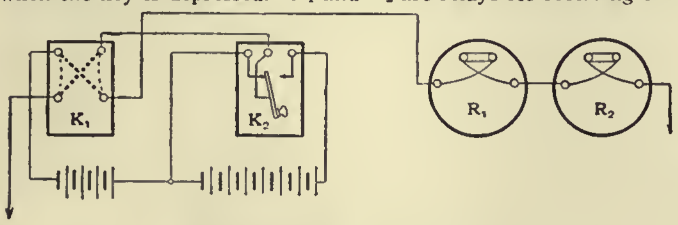


FIG. 25.—Quadruplex Working.

currents; the former is polarized and responds to reversals of current, while the latter is non-polarized and responds only to the increased current from K_2 irrespective of the direction of that current. This arrangement can be duplexed in the way already explained, by providing differential relays and arranging for the outgoing currents to divide differentially through the two relays at each end.

Multiplex telegraphy.

The "multiplex" system devised by Patrick B. Delany (which was adopted to a limited extent in Great Britain, but has now been entirely discarded) had for its object the working of a number of instruments simultaneously on one wire. The general principle of the arrangement of the apparatus is shown by fig. 26. Arms *a* and *b*, one at each station A and B, are connected to the line wire, and are made to rotate simultaneously over metallic segments, 1, 2, 3, 4, and 1′, 2′, 3′, 4′, at the two stations, so that when the arm *a* is on segment 1 at A, then *b* is on segment 1′ at B, and so on. At each station sets of telegraph apparatus are connected to the segments, so that when the arms are kept rotating the set connected to 1 becomes periodically connected to the set connected to 1′, the set connected to 2 to the set connected to 2′, and so on. In practice the number of segments actually employed is much greater than that indicated on the figure, and the segments are arranged in a number of groups, as shown by fig. 27, all the segments 1 being connected together, all the segments 2, all the segments 3, and all the segments 4. To each group is connected a set of apparatus; hence during a complete revolution of the arms a pair of instruments (at station A and station B) will be in communication four times, and the intervals during which any particular set of instruments at the two stations are not in connexion with each other become much smaller than in the case of fig. 26. In practice this subdivision of the segments is so far extended that the intervals of disconnexion become extremely

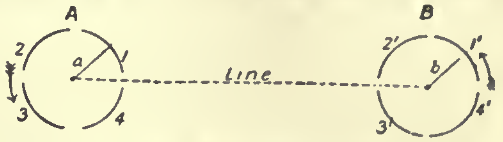


FIG. 26.—Multiplex Working.

small, and each set of apparatus works as if it were alone connected to the line. As many as 162 segments in eight groups are practically used. The arm which moves round over the segments rotates at the rate of three revolutions per second, and is kept in motion by means of an iron toothed wheel, the rim of which is set in close proximity to the poles of an electromagnet. Through this electromagnet pass impulses of current regulated in frequency by a tuning-fork contact breaker; these impulses, acting on the teeth of the iron wheel, by a series of pulls keep it in uniform rotation. If the rates of vibration of the two tuning-forks at the two stations could be maintained precisely the same, the two arms would rotate in synchronism, but as this uniform vibration cannot be exactly

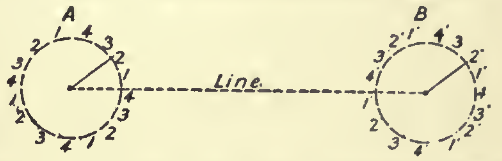


FIG. 27.—Grouping of Segments in Multiplex System.

preserved for any length of time, a means is provided whereby the rate of vibration of either of the forks can be slowed down, so as to retard the rate of rotation of one or other of the arms. This is effected by means of "correcting" segments, of which there are six sets containing three each. Should the rotating arms fail to pass over these correcting segments at their synchronous positions, correcting currents pass to a relay which cuts off momentarily the current actuating the tuning-fork, thereby altering the rate of vibration of the latter until the arms once more run together uniformly. The actual number of sets of apparatus it was possible to work multiplex depended upon the length of the line, for if the latter were long, retardation effects modified the working conditions. Thus between London and Manchester only four sets of apparatus could be worked, but between London and Birmingham, a shorter distance, six sets (the maximum for which the system is adapted) were used.

Chemical Telegraphs.—A method of recording signals in the Morse code, formerly used to a considerable extent, was to use a chemically prepared ribbon of paper. Suppose, for instance, the paper ribbon to be soaked in a solution of iodide of potassium and a light contact spring made to press continuously on its surface as it is pulled forward by the mechanism. Then, if a current is sent from the spring to the roller through the paper, a brown mark will be made by the spring due to the liberation of iodine. This was the principle of the chemical telegraph proposed by Edward Davy in 1838 and of that proposed by Bain in 1846. Several ingenious applications of his method were proposed and practically worked, as, for example, the copying telegraph of Bakewell and of Cros, by means of which a telegram may be transmitted in the sender's own handwriting; the pantelegraph of Caselli; the autographic telegraphs of Meyer, Lenoir, Sawyer and others; and the autographic typo-telegraph of Bonelli; all forms of the apparatus have, however, fallen into disuse.

Automatic Telegraphs.—It was found impossible to make the Morse ink writer so sensitive that it could record signals sent over land lines of several hundred miles in length, if the speed of transmission was very much faster than that which could be effected by hand, and this led to the adoption of automatic methods of transmission. One was proposed by Bain as early as 1846, but it did not come into use. That now employed is, however, practically a development of his idea. It consists in punching, by means of "a puncher," a series of holes in a strip of paper in such a way that, when the strip is sent through another instrument, called the "transmitter," the holes cause the circuit to be closed at the proper times and for the proper proportionate intervals for the message to be correctly printed by the receiving instrument or recorder. The most successful apparatus of this kind is that devised by Wheatstone; others were devised by Siemens and Halske, Garnier, Humaston, Siemens, and Little.

Wheatstone system.

In the Wheatstone automatic apparatus three levers are placed side by side, each acting on a set of small punches and on mechanism for feeding the paper forward a step after each operation of the levers. The punches are arranged as shown in fig. 28, and the levers are adjusted so that the left-hand one moves *a*, *b*, *c* and punches a row of holes across the paper (group 1 in the figure), the middle one moves *b* only and punches a centre hole (2 in the figure), while the right-hand one moves *a*, *b*, *d*, *e* and punches

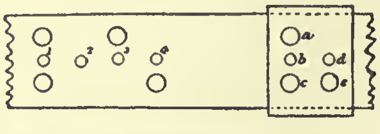


Fig. 28.—Wheatstone Punching Apparatus.

four holes (3 and 4 in the figure). The whole of this operation represents a dot and a dash or the letter "a." The side rows of holes only are used for transmitting the message, the centre row being required for feeding forward the paper in the transmitter. The perforation of the paper when done by hand is usually performed by means of small mallets, but at the central telegraph office in London, and at other large offices, the keys are only used for opening air-valves, the actual punching being done by pneumatic pressure. In this way several thicknesses of paper can be perforated at the same time, which is a great convenience for press work, since copies of the same message have often to be transmitted to several newspapers at the same time.

The mode of using the paper ribbon for the transmission of the message is illustrated in fig. 29. An ebonite beam B is rocked up and down rapidly by a train of mechanism, and moves the cranks

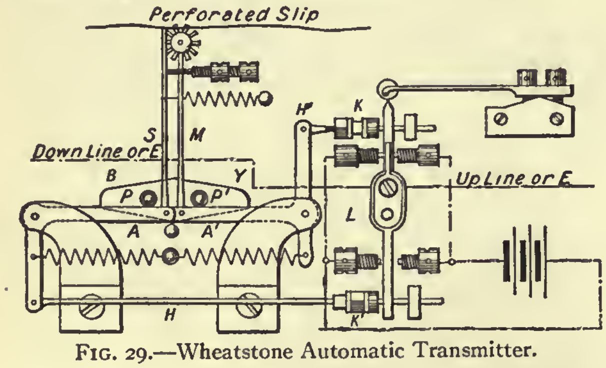


Fig. 29.—Wheatstone Automatic Transmitter.

A and A′ by means of two metal pins P, P′. A and A′ carry two light vertical rods S, M, the one as much in front of the other as there is space between two successive holes in the perforated ribbon. To the other ends of A, A′, rods H, H′ are loosely hinged, their ends passing loosely through holes in the end of the bar L. By means of two collars K, K′, the lever L is made to oscillate in unison with the beam B. The operation is as follows: the paper ribbon or perforated slip is moved forward by its centre row of holes at the proper speed above the upper ends of the rods S, M; should there be no holes in the ribbon then the cranks A, A′ will remain stationary, although the beam B continues to rock, since the rods S, M are pressing against the ribbon and cannot rise. Should, however, a row of holes, like group 1, fig. 28, be in the ribbon, the rod M will first be allowed to pass through the paper, and the corresponding movement of crank A′ will, through the agency of collet K, throw over lever L, and the battery zinc will be put to the line; at the next half stroke of the beam, S will pass through, and crank A by its movement will, through the agency of collet K′, throw over lever L in the reverse direction, so that the battery copper will be put to the line. Thus for a dot, first a negative and then a positive current is sent to the line, the effect of the current continuing during the time required for the paper to travel the space between two holes. Again, suppose groups 3 and 4 to be punched. The first part will be, as before, zinc to the line; at the next half stroke of the beam M will not pass through, as there is no hole in the paper; but at the third half stroke it passes through and copper is put to the line. Thus for a dash the interval between the positive and the negative current is equal to the time the paper takes to travel over twice the space between two successive holes. Hence for sending both a dot and a dash, reverse currents of short duration are sent through the line, but the interval between the reversal is three times as great for the dash as for the dot.

In the receiving instrument the electromagnet is constructed in precisely a similar way to the relay (fig. 20), so that the armature, if pulled into any position by either current, remains in that position, whether the current continues to flow or not, until a reverse current is made to act on the magnet. For the dot the armature is deflected by the first current, the ink-wheel being brought into contact with the paper and after a short interval pulled back by the reverse current. In the case of the dash the ink-wheel is brought into contact with the paper by the first current as before and is pulled back by the reverse current after three times the interval. The armature acts on an inking disk on the principle described above, save only that the disk is supplied with ink from a groove in a second wheel, on which it rolls: the grooved wheel is kept turning with one edge in contact with ink in an ink-well. By this method of transmission the battery is always to the line for the same interval of time, and alternately with opposite poles, so that the effect of electrostatic induction is reduced to a minimum.

Although it is quite possible to obtain good signals at a rate corresponding to 600 letters per minute, in practice it is found that such a high speed is not advisable, as it is difficult or impossible for even the most skilled operators properly to handle and transcribe from the "slip" on which the signals are recorded.

Squier and Crehore system.

In Squier and Crehore's "Synchronograph" system "sine waves" of current, instead of sharp "makes and breaks," or sharp reversals, are employed for transmitting signals, the waves being produced by an alternating-current dynamo, and regulated by means of a perforated paper ribbon, as in the Wheatstone automatic system. The arrangement has been found under certain conditions to give better results than those obtained with sharp reversals.

The undulator.

In the undulator apparatus, which is similar in general principle to the "siphon recorder" used in submarine telegraphy, a spring or falling weight moves a paper strip beneath one end of a fine silver tube, the other end of which dips into a vessel containing ink. The siphon is supported on a vertical axle carrying two armatures which are acted upon by two electromagnets. It is in fact the electromagnet and spindle of a telegraph relay with a siphon in place of the tongue. Screw adjustments are provided for closing or opening the air gap between the electromagnets and armatures, for raising or lowering the siphon, and for adjusting the point of the siphon to the centre or side of the paper strip. The received signals are recorded on the paper strip in an undulating continuous line of ink, and are distinguished by the length of deviation from zero. The amplitude of the signals can be varied in several ways, either by a shunt across the electromagnet, or by altering the tension of the controlling springs or by altering the air gap between electromagnets and armatures. Up to 100 words per minute the signals are easily readable, but beyond that speed they are more difficult to translate, although experts can read them when received at 200 words per minute.

Pollak-Virag System.—In the improved Pollak-Virag system the received signals are recorded in characters similar to ordinary handwriting. The operator actuates a typewriter form of perforator which punches varying groups of holes, representing the different characters, in a paper strip about one inch wide. This slip is then passed through a transmitter fitted with brush contacts and connected to the two line wires of a metallic loop. One circuit is formed by the loop itself, and a second, quite independent, by the two wires in parallel, earthed at each end. At the receiving end there are two telephone receivers, one joined in the loop circuit, the other in the earth return circuit. The diaphragms of these are mechanically connected to a small mirror and control its movement in accordance with the strength and direction of the received currents. One diaphragm gives the mirror a movement in a vertical direction while the other gives it a horizontal motion. The two acting together can thus give the mirror any desired movement within limits. A ray of light is directed upon the mirror, and the motion of the latter, due to the varying strengths and direction of the received currents, is made to write the transmitted signals upon a strip of bromide photographic paper about three inches wide.

The line of writing is of course continuous, there being no break, although there is a space between words. The writing, although not well formed, is sufficiently distinct for ordinary messages; the figures 3, 5, and 8 are, however, liable to be mistaken for each other, being very similar in appearance. The bromide paper is automatically passed through a developing bath, a fixing bath, and drying rollers. This operation occupies about twelve seconds, giving a message written in column form ready for delivery. It is not a system likely to have general application.

Type Printing Telegraphs.—The first considerable improvement in type printing telegraphs was made by D. E. Hughes in 1855.

Hughes instrument. In the Hughes instrument two trains of clockwork mechanism, one at each end of the line, are kept moving at the same speed. Each instrument is provided with a keyboard, resembling that of a small piano, the key levers of which communicate with a circular row of vertical pins. A horizontal arm fixed to a vertical shaft in gear with the mechanism sweeps over these pins at the rate of about two revolutions per second. When a key is depressed, slightly raising one of the pins, the horizontal arm will pass over it and in doing so will momentarily join the battery to the line. The current thus sent to the line may be made either to act directly on the printing instrument or to close a local circuit by means of a relay. For simplicity we will suppose direct action. The current then passes through the coils of an electromagnet, which releases the printing mechanism. The electromagnet consists of two coils, each wound on a soft iron core fixed to the poles of a strong permanent horse-shoe magnet. The armature of the electromagnet is normally attracted by the effect of the permanent magnet, but it is furnished with two antagonistic springs tending to throw it upwards. These springs are so adjusted that they are not quite able to release the armature. When a current comes in from line it passes through the electromagnet in such a direction as to weaken the effect of the permanent magnet; hence the springs are able to release the armature, which rises smartly and in its turn releases the printing mechanism. Either a weight or a motor is used for making the movements of the mechanism required to effect the printing of the signals. The type-wheel is carried round continuously by the mechanism to which it is attached by a friction disk and ratchet drive. An axle carrying four cams is normally at rest, but it is thrown into gear with the mechanism when the armature rises, makes one complete revolution, and comes to rest ready for the next signal. In its revolution one of its cams engages with the correcting wheel attached to the type-wheel in order to ensure that the latter is in the correct position for printing a complete letter; the second cam lifts the paper against the type-wheel and prints the letter; the third moves forward the paper tape one space to be ready for the printing of the next letter; and the last cam replaces the armature on the cores of the electromagnet. This complete operation occupies about one-twelfth of a second. It is of course necessary that two instruments working together should have the same speed. This is obtained by causing one of them to send a series of signals from one particular key, while the operator at the other station adjusts his speed until he receives the same signal after short-circuiting his electromagnet for ten revolutions. Both type-wheels are then set to zero by the lever provided for that purpose, and released by the current from the letter-blank key; then all subsequent signals will be recorded similarly at the sending and receiving ends. If by any chance wrong signals are printed or the instruments get out of phase, the sender is stopped by the receiver sending a few signals, after which both type-wheels are again set to zero and correspondence continued. This system of telegraphic printing has a great advantage over the step-by-step system in avoiding the necessity for the rapidly acting electric escapement, which, however skilfully planned and executed, is always liable to failure when worked too rapidly. In Hughes's instrument almost perfect accuracy and certainty have been attained; and in actual practice it has proved to be decidedly superior to all previous type-printing telegraphs, not only in speed and accuracy, but in less liability to mechanical derangement from wear and tear and from accident. It involves many novel features: the receiving electromagnet is of peculiar construction and remarkable efficiency and the transmitting apparatus has a contrivance to prevent unintentional repetitions of a letter through the operator holding his finger too long on a key. This instrument was for some years extensively used in the United States, until superseded by G. M. Phelps's modification of it, known as the "American combination printing telegraph," because it embodied part of Hughes's and part of House's instruments. With this modified form somewhat greater speed was obtained, but it was found difficult to drive, requiring the use of steam or some such motive-power. In a subsequent modification introduced in 1875 an electromotor was applied to drive the printing mechanism. This allowed a shorter train and stronger wheelwork to be used, securing more certain action, and involving less risk of derangement. Hughes's form was taken up by the French government in 1860, and is very largely in use not only in France but in all European countries, including Great Britain.

Baudot system. The system brought out in 1874 by Émile Baudot and since considerably developed is a multiplex system giving from two to six channels on one wire, each channel giving a working speed of thirty words per minute. The channels can be worked in either direction according to the traffic requirements. The line is joined at each end to distributors which are arranged to maintain uniform speed and to control their respective receivers. Each channel consists of a keyboard and receiver both electrically connected to certain parts of the distributor. The keyboard has five keys similar to those of a piano, and the letters and figures are obtained by the different combinations which can be formed by the raised and depressed keys. In the raised position a negative battery is connected to the distributor and in the depressed position a positive battery. At regular intervals a rotating arm on the distributor connects the five keys of each keyboard to line, thus passing the signals to the distant station, where they pass through the distributor and certain relays which repeat the currents corresponding to the depressed keys and actuate electromagnets in the receivers. Each receiver is provided with five electromagnets corresponding to the five keys of the keyboard, and the armatures of the electromagnets can thus repeat the various combinations for all the signals allocated to the different combinations of the keys. When a combination of signals has been received and the armatures have taken up their respective positions corresponding to the transmitting keyboard, certain mechanism in the receiver translates the position of the five armatures into a mechanical movement which lifts the paper tape against a type-wheel and prints the corresponding letter. The movement for any particular combination of armatures can only take place once per revolution of the type-wheel and at one particular place. The signals must therefore be sent at regular intervals, and to ensure this being done correctly a telephone or time-tapper is provided at each keyboard to warn the operator of the correct moment to depress his keys. The Baudot apparatus can have certain channels extended so as to form a means of continuous communication between one station and two or three others by means of one line. It can also be duplexed or repeated similar to any other telegraph system.

Murray system. In the Murray system the messages are first prepared in the form of a strip of perforated paper about half an inch wide. Perforating machines equipped with typewriter keyboards are used for the preparation of the messages, two or three keyboard perforators being employed at each end of the telegraph lines on which the Murray system is used. The messages in the form of perforated tape are then passed through an automatic transmitter, something like a Wheatstone transmitter, at a speed of about 100 words a minute. At the receiving station electrical mechanisms record the signals once more as perforations in a paper strip forming an exact replica of the transmitting tape. This received perforated tape is then used to control what is known as the printer or automatic typewriter, a machine that translates the tape perforations into letters and prints the messages in Roman type in page form. This printer is purely mechanical, and its speed is very high. An experimental printer constructed about the middle of 1908 by the British Post Office, operated successfully at the rate of 210 words (1260 letters) per minute. The usual working speed is from 100 to 120 words per minute. The Murray automatic system was designed specially for dealing with heavy traffic on long lines. As it uses the Baudot telegraph alphabet it has an advantage in theory over the Wheatstone using the Morse alphabet in regard to the speed that can be obtained on a long telegraph line in the ratio of eight to five, and this theoretical advantage is more or less realized in practice. The Murray automatic system is not regarded as suitable for short telegraph lines or moderate traffic, printing telegraphs on the multiplex principle being considered preferable in such circumstances. One of the longest circuits upon which it has been successfully worked is that between St Petersburg and Omsk, a distance of approximately 2400 miles of iron wire, with three repeating stations. As in some other systems retransmission is effected from the received perforated tape.

Creed system. The Creed system is a development of the Morse-Wheatstone system, and provides a keyboard perforator which punches Morse letters or figures on a paper strip by depressing typewriter keys. The slips are passed through an ordinary Wheatstone transmitter and actuate Wheatstone receiving apparatus which in turn controls a "Creed receiving perforator." This machine reproduces a copy of the original transmitting slip, which can be passed on to any other Wheatstone circuit or can be run through a "Creed printer," which is a pneumatic machine actuating a typewriter by means of valves. Messages are thus typed upon a slip which is gummed to the telegraph form. The speed of the receiving perforator ranges from 20 to 150 words per minute.

Rowland system. In the Rowland multiple method of telegraphic working, the transmitter consists of a mechanical keyboard provided with a series of levers, which effect certain combinations of positive and negative currents for each letter. These currents are furnished by an alternator which transmits sine currents over the line and operates a motor at the distant end of the line, both machines running in synchronism. At the receiving end of the circuit a shaft is coupled to the motor; this is provided with gearing which rotates four combining commutators and four type-wheels, which print the letters on the band of paper. There are four transmitters and four receivers, which are operated independently by means of an adaptation of the multiplex system of working, and each circuit is provided with a number of segments set apart for its own use. Each transmitter is therefore able to transmit a separate series of positive and negative currents in different combinations; these are distributed, by suitably arranged distributors and relays at the receiving end of the line, into their respective receivers. The function of the "combiner" in each receiving instrument is so to group the received combination of positive and negative currents that they operate polarized relays in such a manner that the position of the tongues corresponds with the operation of the levers on the transmitter. Since each letter is represented by a specific combination of positive and negative currents, it is possible, by means of the combinations, to close a local circuit at any given interval, and so cause the paper to be pressed against the periphery of the type-wheel at the time when the letter required is opposite. The paper is also caused to advance automatically for each letter, start a fresh line, and also to commence a fresh form at the completion of each message.

Telautograph.—Instruments such as the telautograph and telewriter are apparatus for transmitting a facsimile of handwriting inscribed on a paper at one end of a line, the reproduction being made automatically at the other end of the line at the same time that the message is being written.

A successful apparatus for effecting this was devised by Cowper and was known as the writing telegraph. The telautograph is on a similar principle to the Cowper apparatus, the motion of the transmitting pencil or stylus used in writing being resolved by a system of levers into two component rectilinear motions, which are used to control and vary the currents in two distinct electrical circuits. By the action of the two variable currents on the electromagnetic mechanism in the receiver, the two component motions are reproduced and by their combined action on a second system of levers the receiving pen is caused to duplicate the motions of the transmitting pencil. The motion communicated to rollers by the pencil serves to cut resistance in or out of the two line circuits which are connected to the rollers, and thus two independent variable line currents are obtained. In the receiver there is a strong electromagnet, excited by a local current, which has in its circuit two annular air gaps, across which the magnetic field is practically uniform and constant. In these annular spaces there are suspended by springs two light coils of fine copper wire, capable of being moved vertically, and connected in such a manner as to be traversed by the two variable line currents from the transmitter. These coils are drawn down, by the magnetic action of the field on the currents in the coils, into the annular spaces, against the pull of the springs, more or less strongly, according to the strengths of the two line currents. Each coil is attached to a shaft by a bell crank arrangement, and to these shafts there is secured a system of levers similar to that at the transmitter carrying the receiving pencil at the junction. The shafts are turned by the pull of the magnet upon the coils, and the motions of the transmitting pencil are thus reproduced.

Korn telephotograph system.

The Korn telephotographic apparatus is based on the principle of an apparatus devised by Shelford Bidwell in 1881 for the electrical transmission of pictures to a distance, in which use was made of the change in electrical resistance which selenium undergoes when acted upon by light. In the Korn apparatus the light from a Nernst electric lamp is concentrated to a point by means of a lens on the original picture, which is wound on a glass cylinder in the shape of a transparent photographic film. A totally reflecting prism placed inside the glass cylinder projects the light which penetrates the film upon a selenium cell situated at the end of the cylinder. An illumination of variable intensity (according to the deeper or lighter shades of the portion of the picture on which the light falls) thus takes place on the selenium cell. As the glass cylinder, driven by a motor, revolves upon its axis while also advancing (by means of a screw thread on the axis), all portions of the picture are successively brought under the beam or pencil of light and cause a beam of varying intensity to fall on the selenium cell. Owing to the variable illumination of the selenium thus produced, the resistance of the latter, and therefore the intensity of the current sent through the line to the receiving station by the battery, will be altered accordingly. At the receiving station a cylinder—which revolves synchronously with the transmitting cylinder—is covered with a photographic film or paper, upon a point of which a pencil of light from a Nernst lamp is concentrated. Before reaching the paper the light passes through perforations in two iron plates which are, in fact, the pole pieces of a strong electromagnet; between these is an aluminium shutter which is attached to two parallel wires or thin strips. When there is no current the shutter covers the perforations and no light passes, but when a current traverses the wires they are depressed by electromagnetic action, carrying the shutter with them, and a quantity of light proportional to the current strength is admitted through the perforations. By means of this "light-relay" the intensity of the light acting at any moment upon the sensitized paper is made proportional to the illumination of the selenium in the transmitter. To eliminate the sluggish action of the selenium transmitter a selenium cell similar to that at the transmitting station is arranged at the receiving apparatus, and exposed to precisely similar variations of light, the arrangement being such that the lag of this cell counteracts the lag of the transmitting cell. The synchronous revolutions of the transmitting cylinders are effected by making one cylinder revolve slightly faster than the other; after each revolution the cylinder which is accelerated is arrested for a moment by means of a special relay until the difference of speed is accurately compensated for. This device was originally adopted in the d'Arlincourt copying telegraph.

Submarine Telegraphy.—For working long submarine cables the apparatus ordinarily employed on land lines cannot be used, as the retarding effect of the electrostatic capacity of the cable is so marked that signals fail to be recorded except at a very slow speed of working. The transmitted signals or electric impulses, which on a land line are sharply defined when received, become attenuated and prolonged in the case of a long cable, and are unable to actuate the comparatively heavy moving parts of which the land line instruments are formed. Other patterns of apparatus are therefore necessary.

The arrangement of the apparatus for working some of the most recent cables is shown in Fig. 30. The cable is supposed to be worked duplex; but, if S, C_1, C_2, and AC are removed and the key connected directly with C_3, the arrangement for simplex working is obtained. The apparatus consists of a sending battery B, a reversing transmitting key K, a slide of small resistance S, three condensers C_1, C_2, C_3, an artificial cable AC, the receiving instruments I and G, and one or more resistances R for adjusting the leakage current. The peculiar construction of AC has been already referred to. The conductor of the cable is practically insulated, as the condensers in the bridge have a very high resistance; hence no appreciable current ever flows into or out of the line. Two receiving instruments, a siphon recorder and a mirror galvanometer, are shown; one only is absolutely necessary, but it is convenient

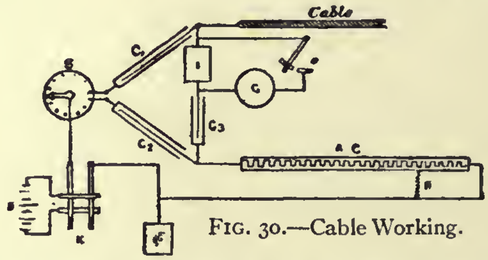


FIG. 30.—Cable Working.

to have the galvanometer ready, so that in case of accident to the recorder it may be at once switched into circuit by the switch *s*. When one of the levers of K is depressed, the condenser C_1 and the cable, and the condenser C_2 and the artificial cable, are simultaneously charged in series; but, if the capacity of C_1 bears the same proportion to the capacity of the cable as the capacity of C_2 bears to the capacity of the artificial cable, and if the other adjustments are properly made, no charge will be communicated to C_3. After a very short interval of time, the length of which depends on the inductive retardation of the cable, the condensers corresponding to C_1 and C_3 at the other end begin to be charged from the cable, and since the charge of C_3 passes through the receiving instrument I or G the signal is recorded. The charging of C_3 at the receiving end will take place, no matter what is the absolute potential of the condensers, consequently the incoming signals are not affected by those which are being transmitted from that end. In actual practice the receiving instrument is so sensitive that the difference of potential between the two coatings of the condenser C_3 produced by the incoming signal is only a very small fraction of the potential of the battery B. When the key is released the condensers and cables at once begin to return to zero potential, and if the key is depressed and released several times in rapid succession the cable is divided into sections of varying potential, which travel rapidly towards the receiving end, and indicate their arrival there by producing corresponding fluctuations in the charge of the condenser C_3. All cables of any great length are worked by reverse currents. A modification (known as the cable code) of the ordinary single needle alphabet is used; that is to say, currents in one direction indicate dots and in the other direction dashes.

The general principle on which the instruments for working long submarine cables are based is that of making the moving parts very light and perfectly free to follow the comparatively slow rise and fall of the electric impulses or waves. The simplest form of receiving instrument (formerly much used) is known as the "mirror."

Mirror Instruments.

In this instrument a small and very light mirror, about $\frac{3}{8}$ in. in diameter, attached to a stretched fibre and having a small magnetic needle fixed to its back, is arranged within a galvanometer coil so that the influence of the latter causes the mirror (through the action of the magnetic needle) to be turned through a small angle in one direction or the other according to the direction of the current through the coil. A ray of light from a lamp is thrown on the mirror, whence it is reflected upon a white surface or scale set at a distance of about 3 ft., forming a bright spot on the surface; the slightest angular deflexion of the mirror, owing to its distance from the scale, moves the spot of light a very appreciable distance to the right or left according to the direction of the angular movement. These indications form the telegraph alphabet and are read in the same manner as in the case of the "single needle" instrument used on land.

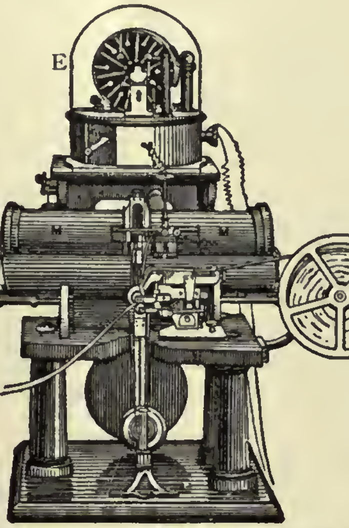


FIG. 31.—Lord Kelvin's early Siphon Recorder.

Spark recorder. The spark recorder in some respects foreshadowed the more perfect instrument—the siphon recorder—which was introduced some years later. Its action was as follows. To an indicator, suitably supported, a to-and-fro motion was given by the electromagnetic actions due to the electric currents constituting the signals. The indicator was connected with a Ruhmkorff coil or other equivalent apparatus, designed to cause a continual succession of sparks to pass between the indicator and a metal plate situated beneath it and having a plane surface parallel to its line of motion. Over the surface of the plate and between it and the indicator there was passed, at a regularly uniform speed, in a direction perpendicular to the line of motion of the indicator, a material capable of being acted on physically by the sparks, through either their chemical action, their heat, or their perforating force. The record of the signals given by this instrument was an undulating line of fine perforations or spots, and the character and succession of the undulations were used to interpret the signals desired to be sent.

Siphon recorder. In the original form of the siphon recorder (fig. 31), for which Lord Kelvin obtained his first patent in 1867, the indicator consisted of a light rectangular signal-coil of fine wire, suspended between the poles of two powerful electromagnets M, M so as to be free to move about its longer axis, which is vertical, and so joined that the electric signal currents through the cable pass through it. A fine glass siphon tube is suspended with freedom to move in only one degree, and is connected with the signal-coil and moves with it. The short leg of the siphon tube dips into an insulated ink-bottle, so that the ink it contains becomes electrified, while the long leg has its open end at a very small distance from a brass table, placed with its surface parallel to the plane in which the mouth of the leg moves, and over which a slip of paper may be passed at a uniform rate, as in the spark recorder. The ink is electrified by a small induction electrical machine E placed on the top of the instrument; this causes it to fall in very minute drops from the open end of the siphon tube upon the brass table or the paper slip passing over it. When therefore the signal-coil moves in obedience to the electric signal-currents passed through it, the motion communicated to the siphon is recorded on the moving slip of paper by a wavy line of ink-marks very close together. The interpretation of the signals is according to the Morse code,—the dot and dash being represented by deflexions of the line of dots to one side or other of the centre line of the paper. A very much simpler form of siphon recorder, constructed by Dr Muirhead, is now in general use. The magnet between the poles of which the rectangular signal coil moves is built up of a number of thin flat horseshoe-shaped permanent magnets of a special quality of steel, and is provided with adjustable pole pieces. The signal coil is suspended by fibres and is mounted together with a fixed soft iron core on a brass plate affixed to a rack, with which a pinion operated by a milled head screw engages. To the brass plate is attached an arm carrying the bridge piece. A wire or fibre carrying the aluminium siphon cradle is stretched across this bridge piece, and on it is also mounted the small electromagnet, forming part of the "vibrator" arrangement with its hinged armature, to which one end of the stretched wire carrying the siphon is fastened. The ink-box is made adjustable, being carried by an arm attached to a pillar provided with a rack with which a pinion operated by a milled head screw engages. The motor is usually supported on a platform at the back of the instrument, its driving-wheel being connected to the shaft of the paper roller by means of a spirally wound steel band. In what is known as the "hybrid" form of recorder the permanent magnets are provided with windings of insulated copper wire; the object of these windings is to provide a means of "refreshing" the magnets by means of a strong current temporarily sent through the coils when required, as it has been found that, owing to magnetic leakage and other causes, the magnets tend to lose their power, especially in hot climates. Instruments of the siphon recorder type have been made to work both with and without electrification of the ink. In the latter case, which is the standard practice, mechanical vibration of the siphon is substituted in the place of electrification of the ink, so as to eliminate the effect of atmospheric conditions which frequently caused discontinuity in the flow of ink.

Fig. 33 shows a facsimile of part of a message received and recorded by a siphon recorder, such as that of fig. 31, from one of the Eastern Telegraph Company's cables about 830 miles long. As the earth is used for completing the electric circuit, the signals received on such sensitive instruments as these are liable to be disturbed by the return currents of other systems in their immediate neighbourhood, which also use the earth as return, when such are of the magnitude generated by the working of electric tramways or similar undertakings, and to obviate this it is necessary to form the "earth" for the cable a few miles out at sea and make connexion thereto by an insulated return wire, which is enclosed in the same sheathing as the core of the main cable.

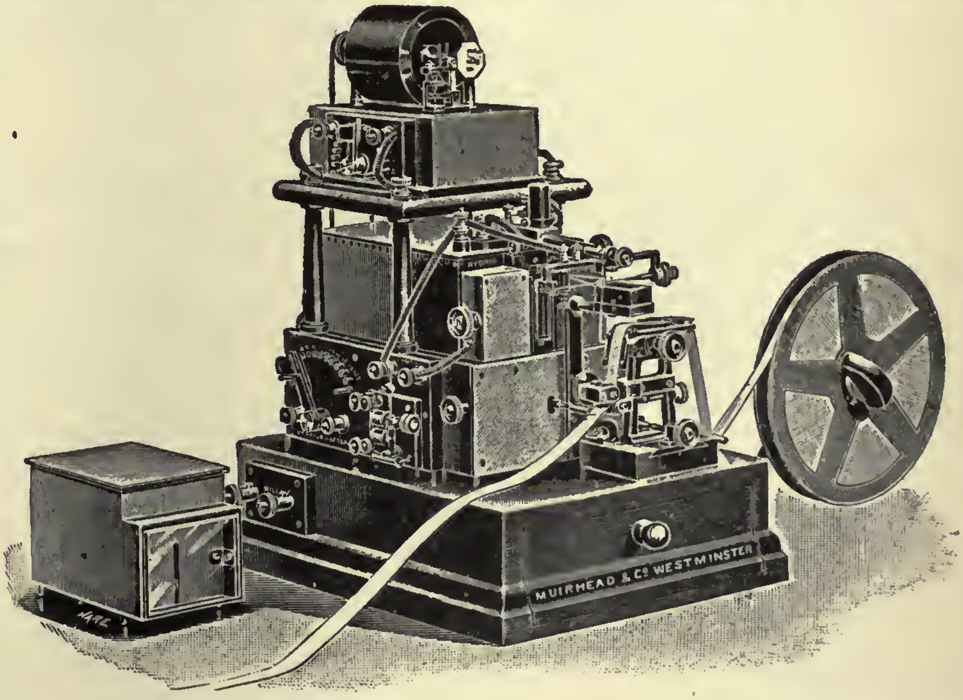


FIG. 32.—Muirhead's Siphon Recorder.

The heavier cores, with the consequent advance in speed of working attainable, have necessitated the introduction of automatic sending, the instruments adopted being in general a modification of the Wheatstone transmitter adapted to the form of cable signals, while the regularity of transmission thus secured has caused its introduction even on circuits where the speed cannot exceed that of the ordinary operator's hand signalling.

Automatic curb sender.

The automatic curb sender was originally designed by Lord Kelvin for the purpose of diminishing the effect of inductive retardation in long cables. In ordinary hand-sending the end of the cable is put to one or the other pole of the battery and to earth alternately, the relative time during which it is to battery and to earth depending to a great extent on the operator. By the automatic curb sender the cable is put to one or the other pole of the battery and then to the reverse pole for definite proportionate times during each signal. The cable is thus charged first positively and then negatively, or *vice versa*, for each signal. Owing to the difficulty of maintaining perfect balance on duplexed cables, curb sending is not now used, but the signals are transmitted by means of an apparatus similar to the Wheatstone automatic transmitter used on land lines and differing from the latter only in regard to the alphabet employed; the signals from the transmitter actuate a relay having heavy armatures which in turn transmit the signals to the cable; this arrangement gives very firm signals, a point of great importance for good working. The actual speed or rate of signalling is given approximately by the formula, $S=120/(KR)$, where S is the number of words per minute, R the total resistance of the conductor in ohms, and K the total capacity in farads. The speed of a cable is given in words per minute, the conventional number of five letters per word being understood, though in actual practice, owing to the extensive use of special codes, the number of letters per word is really between eight and nine; and this forms a considerable factor in lowering the earning capacity of a cable.

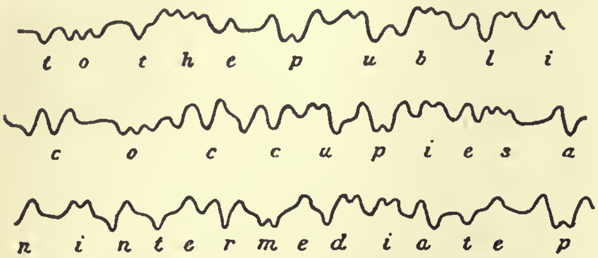


FIG. 33.—Facsimile of Siphon Recorder Message.

Relays.

A relay capable of working at the end of a long cable has long been a desideratum. The difficulty experienced is that of securing a good electrical contact under the very slight pressure obtainable from an instrument excited by attenuated arrival-currents. In an instrument invented by S. G. Brown (Brit. Pat. 1434 of 1899) it is sought to overcome this difficulty by causing the point of a contact-arm, representing the siphon in the ordinary form of recorder, to traverse the cylindrical surface of a rapidly rotating drum. This surface is divided into two parallel halves by a short insulating space on which the arm normally rests, so that two separate conducting surfaces are provided, with either one of which the arm will make contact in its excursions in one direction or the other from the central position, the direction and duration of contact being governed by the motion of the suspended coil. The great reduction in friction and in electrical resistance of the contact thus effected between the recurved end of the arm and the rotating surface secures the transmission of signals at such a high rate of speed that the combination of this relay with a special form of curb sender allows of the re-transmission of signals into a second cable at a speed not less than that of the siphon recorder worked in the usual way. The special form of curb sender mentioned, termed the "Interpolator," has been devised so as to secure the correct re-transmission of any given number of consecutive elements of a letter which are of the same sign, for when signals are received at the end of a long cable the relay arm will not return to its zero position between consecutive elements of the same sign, but will remain on the respective contact surface during the whole time occupied by such consecutive elements. The instrument consists of two cams, the form of which regulates the components of the curbed signal, one cam being for the dot element and the other for the dash element, which by their sequence give the letter signals; these cams, by means of clutches controlled by the relay, are mechanically rotated by clockwork, the speed of rotation being approximately adjusted to the rate of transmission of a single element, so that the requisite number of consecutive elements is transmitted corresponding to the duration of contact of the relay arm with the side controlling that particular element. By a modification of this apparatus the message, instead of being immediately re-transmitted into the second cable, can be punched on a paper slip, which can be inserted in the usual way into an automatic transmitter, so as to send either cable or Morse signals. Fig. 34 shows the effect of the interpolator in dissecting the consecutive elements of any letter combination. Another instrument (see Brit. Pat. No. 18,261 of 1898) is what may be termed a magnifier, since signals so small as to be almost unreadable on direct record are rendered perfectly legible. The recorder coil is connected mechanically to a second similar coil, which is suspended between the poles of a laminated magnet, so that the motions of the two are similar. This magnet is excited by an alternating current, and the current induced in the second coil is after rectification sent through an ordinary siphon recorder. As the direction and intensity of this induced current are a function of the position of the second coil in its field, and as this position is determined by its mechanical connexion with the recorder coil, it is evident that, by a suitable choice of the electrical elements of the second coil and its alternating field, the indications on the siphon recorder can be magnified to any reasonable extent.

Magnetic shunt.

By means of a "magnetic shunt" Brown succeeded in increasing the working speed of long submarine cables to the extent of 10 to 15 per cent. The magnetic shunt (which is connected across the receiving instrument) consists of a low resistance coil of some 2000 turns of insulated copper wire, enclosed in a laminated iron circuit, and connected at intervals to a number of terminals so that equal increments of inductance may be obtained. The use of the iron core renders it possible to produce a high inductive effect with a low resistance coil, and thus obtain the necessary slow time constant to which is due the success of this type of magnetic shunt on cable signals. The shunts usually employed with the drum relay (referred to above) have each a resistance of about 30 ohms and an inductance of 20, 30 and 40 henrys respectively. The explanation of the action of the shunt is that all slowly varying currents affect the coil of the receiving instrument and its shunt in inverse proportion to their respective resistances; whereas with the comparatively rapid variations of current used in signalling the coil is forced at the beginning of each element of a signal to take *more*, and at the end of the element *less* of the total arrival current from the cable than would traverse it if the shunt were non-inductive.

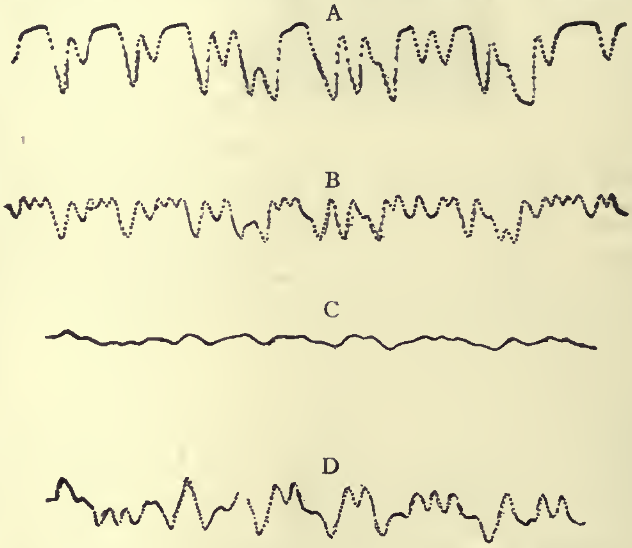


FIG. 34.—Taylor and Dearlove's Interpolator with Brown's Improvements.

A, slip as received on recorder, using ordinary relays for translating on to second cable; B, slip as received on recorder, when interpolator is used at intermediate station, for sending on to second cable; C (four cells through a line, $KR=3\cdot6$), signals with recorder under ordinary conditions; D, all conditions the same as in C, but magnifying relay inserted between the end of the line and the recorder.

Magnetic bridge.

For duplex working a "magnetic bridge" is used. This consists of a low resistance coil of copper wire enclosed in a laminated iron circuit similar to the magnetic shunt already described. The coil, however, is arranged so that the sending current enters an adjustable mid-point in the coil and passes through the two halves of the winding to the ends connected to the cable and artificial line respectively. The receiving instrument is joined up across these ends in the usual manner. The action of this bridge resembles the magnetic shunt in its effect on the received signals, as the direction of the winding is the same throughout its length, and thus the full inductive action is produced for curbing purposes. To the sending currents, however, the bridge offers only apparent ohmic resistance due to the fact that the current entering the mid-point of the winding flows through the two halves or arms in opposite direction, and, owing to the winding being on the same iron core, the mutual inductive effect of the two arms on one another neutralizes the self-induction to the sending currents. The average total inductive value of these bridges to received signals is about 40 henrys, and the coil is so arranged that the arms contain three sections or blocks of winding each, two of which are joined up to strap connexions, and the third divided into small subdivisions to any terminals of which the cross circuit connexions may be affixed. By this arrangement of the coil winding, similar sections can be thrown in or out of circuit with both arms, and also so combined that any amount of inductance suitable to every class of cable may be obtained. The bridge is provided with two adjustments:—(1) a variable "apex,' having several turns of the winding between each stud to permit of the arms being thrown slightly out of balance as a rough compensation for the differences in the cable and artificial line; and (2) an additional "fine" adjustment in one of the arms by which the small daily balance variations may be corrected. As with other duplex systems it is possible to obtain several approximately correct adjustments with the bridge and its accessories, but only one gives a true balance, and careful experiment is required to make sure that this is obtained. The advantage of using the magnetic bridge duplex method is that the maximum current is sent to line or cable, and the receiving system benefits accordingly. (H. R. K.)

Commercial Aspects.

The earliest practical trial of electrical telegraphy was made in 1837 on the London and North Western Railway, and the first public line under the patent of Wheatstone and Cooke was laid from Paddington to Slough on the Great Western Railway in 1843. At first the use of the telegraph was almost entirely confined to railways. The Electric Telegraph Company, formed to undertake the business of transmitting telegrams, was incorporated in 1846. For some time it restricted its operations to constructing and maintaining railway telegraphs and was not commercially successful. Its tariff was 1s. for 20 words within a radius of 50 miles, 1s. 6d. within 100 miles, 5s. if exceeding 100 miles. After about five years great improvements were made in the working of the telegraphs and the industry began to make progress. Telegraphic money orders were established in 1850; a cable was laid between Dover and Calais, and in November 1851 the stock exchanges of London and Paris were able for the first time to compare prices during business hours of the same day; numerous companies were formed, some of which were independent of the railways, and keen competition led to considerable extensions of wires and reduction of tariffs, with the result that a large increase in the volume of business took place. In the period from 1855 to 1868 the number of messages carried annually by all the telegraph companies of the United Kingdom increased from 1,017,529 to 5,781,989, or an average annual increase of 16·36 per cent. During this period the Electric Telegraph Company's average receipts per message fell from 4s. 1½d. to 2s. 0¾d., or just over half, while the number of messages increased nearly fourfold. The working expenses were reduced in a progressively larger ratio, *e.g.* in 1859 the average working expenses were 2s. 7d. per message or more than 65 per cent. of the receipts, while in 1869 they were 1s. 0¼d. per message or only 51 per cent. of the receipts. Much dissatisfaction was felt because the larger towns where competition had been most keen were unduly benefited to the neglect of smaller towns where the business was comparatively less profitable, but it must be remembered that the telegraph lines followed the railways and that many towns were not served owing to their opposition to the railways.

In 1856 the Edinburgh Chamber of Commerce began an agitation for the purchase by the government of the telegraphs, and other chambers of commerce in Great Britain joined the agitation, which was strongly supported by the Press. In 1865 the Postmaster-General (Lord Stanley) commissioned Mr F. T. Scudamore, second secretary to the Post Office, to inquire and report whether the electric telegraph service could be beneficially worked by the Post Office, and whether it would entail any very large expenditure on the Post Office beyond the purchase of the rights. At that time the total number of places supplied with telegraphic communication by all the companies collectively, including railway stations, was 2500, whereas the number of places having postal communications was over 10,000. Under the then existing telegraphic tariff the charge in Great Britain was a shilling for a twenty-word message over a distance not exceeding 100 miles; 1s. 6d. for a like message over distances from 100 to 200 miles; 2s. when exceeding 500 miles. For a message between Great Britain and Ireland the charge ranged from 3s. to 6s.; to Jersey or Guernsey it was 7s. 8d. There were also extra charges under contingent regulations of great complexity, which commonly added 50 per cent. to the primary charge, and frequently doubled it. Mr Scudamore, who was regarded as the author of the bill for the acquisition of the telegraph systems, reported that the charges made by the telegraph companies were too high and tended to check the growth of telegraphy; that there were frequent delays of messages; that many important districts were unprovided with facilities; that in many places the telegraph office was inconveniently remote from the centre of business and was open for too small a portion of the day; that little or no improvement could be expected so long as the working of the telegraphs was conducted by commercial companies striving chiefly to earn a dividend and engaged in wasteful competition with each other; that the growth of telegraphy had been greatly stimulated in Belgium and Switzerland by the annexation of the telegraphs to the Post Offices of those countries and the consequent adoption of a low scale of charges; that in Great Britain like results would follow the adoption of like means, and that the association of the telegraphs with the Post Office would produce great advantage to the public and ultimately a large revenue to the state.

In support of these views he reported that in Belgium in 1863 a reduction of 33 per cent. in the charge had been followed by an increase of 80 per cent. in the number of telegrams, and that in 1886 a reduction of 50 per cent. in the charge had been followed by an increase of 85 per cent. in the traffic; and similar statistics pointing to increase of business consequent on reduction of rates were produced in regard to France, Switzerland and Prussia. The relative backwardness of telegraphy in Great Britain was attributed to high charges made by the companies and to restricted facilities. Some of the complaints against the companies, however, were exaggerated, and the estimates formed of the possible commercial development of telegraphy were optimistic. The basis for these estimates was the experience of other countries, which, however, did not justify the expectation that a large increase of business consequent on reduction of rates could be obtained without serious diminution of profit. The Belgian state telegraphs were started in 1850 and were at first very profitable, but for the years 1866–9 they yielded an average profit of only 2·8 per cent., and subsequently failed to earn operating expenses, the reasons for the steady decline of the profits being the opening of relatively unprofitable lines and offices, increases in wages, and a diminution in growth of the foreign and transit messages which had constituted the most profitable part of the whole business. The Belgian government endeavoured by reducing rates and increasing facilities to stimulate inland telegraphy in the hope of thereby increasing the profits of the department. But these expectations were not realized. Upwards of 100 telegraph offices in Belgium despatched on the average less than one telegram per day, and some offices despatched less than one a month. Similar experience was adduced by the working of the state telegraphs in Switzerland and in France. The profits when earned were derived mainly from foreign messages and transit messages between foreign countries, while the receipts from inland messages did not always cover expenses. In 1868 there were in France over 300 telegraph offices whose average receipts did not exceed £8 per annum. In that year the Swiss government reduced the rate for inland telegrams by one-half, and the traffic immediately doubled, but the cost of carrying on the service increased in a larger ratio.

The experience of the telegraph companies in the United Kingdom, moreover, showed that a uniform rate, irrespective of distance, of 1s. for 20 words, addressed free, was not remunerative in the then state of telegraphy, which made it necessary for messages to be re-transmitted at intervals of about 300 miles. In 1861 the United Kingdom Telegraph Company began a competition with the other companies on the basis of a 1s. rate, and the old-established companies were forced to adopt this rate between all points served by the United Kingdom

Company; but after a trial of four years it was found that a uniform 1s. rate irrespective of distance had not justified itself, and that for any but very short distances the tariff was "utterly unremunerative" notwithstanding a very large increase in volume of business. Even the London District Telegraph Company, which was formed in 1859 for the purpose of transmitting telegraph messages between points in metropolitan London, found that a low uniform rate was not financially practicable. The company began with a tariff of 4d. per 10 words; it soon increased the rate to 6d. for 15 words with an additional porterage charge for delivery beyond a certain distance, and in 1866 the tariff was raised to 1s. The company had 123 m. of line and 83 offices, and in 1865 conveyed over 316,000 messages, but it was not financially successful. Both the telegraph companies and the railway companies had incurred heavy commercial risks in developing the telegraph services of the country and only moderate profits were earned. It cannot justly be said that the companies made large profits while neglecting to develop the services adequately, but it is true that they were not able commercially to comply with many of the demands made upon them by the public. Until speculation took place in anticipation of government purchase, the market prices of the telegraph securities were mostly below par. The stock of the Electric and International Company, the return on which had reached 10 per cent. per annum, however, was valued at about 14 years' purchase of the annual profits. Very little new capital was invested by the telegraph companies about 1865 because of the natural reluctance of the companies to extend the systems under their control so long as a proposal for their acquisition by the state was under consideration. In 1868 the length of electric telegraph lines belonging to the companies was 16,643 m., and of those belonging to the railway companies 4872 m., or a total of 21,515. With regard to the statement that the companies had installed competitive systems and had expended capital needlessly, it was found by the Post Office authorities that in 1865 less than 2000 m. of telegraph lines, and 350 offices out of a total of over 2000, were redundant. The telegraph companies proposed to effect an amalgamation so as to enable the services to be consolidated and extended, and they proposed to submit to various conditions for the protection of the public, such as maximum rates and limitation of dividends, with the provision that new issues of capital should be offered by auction, but public opinion was averse to the proposal. By 1868 both political parties in the House of Commons had committed themselves to the policy of state purchase of the telegraphs.

After much negotiation the basis finally agreed upon between the government and the companies was 20 years' purchase of the profits of the year ended 30th June 1868. The Chancellor of the Exchequer described the terms as "very liberal but not more liberal than they should be under the circumstances," and stated that Mr Scudamore had estimated that £6,000,000 was the maximum price which the government would have to pay, and that the Postmaster-General would obtain from the telegraphs a net annual revenue of £203,000 at least. In addition to the undertakings of the telegraph companies the government had to purchase the reversionary rights of the railway companies which arose out of the circumstance that the telegraph companies for the most part had erected their poles and wires along the permanent way of the railways under leases which in 1868 had still many years to run. The price awarded to the six telegraph companies was £5,733,000. A further £100,000 was paid for the Jersey, Guernsey, Isle of Man and other undertakings, and about £2,000,000 was paid to the railway companies for their reversionary rights, the cost of which had been estimated at £700,000.

The government acquired the perpetual and exclusive wayleaves for telegraph lines over the railways, but the monopoly of the Postmaster-General does not apply to those numerous wires which are required for the protection of life on railways. The telegraphs were transferred to the Post Office on the 5th of February 1870. During the following three years the government spent £500,000 in making good the depreciation suffered by the plant in the transition years of 1868 and 1869, for which allowance had been made in the purchase price, and about £1,700,000 was expended on new plant. During that period 8000 m. of posts, 46,000 m. of wire and about 200 m. of underground pipes were added. The cost of these works had been underestimated, and the report of the Select Committee of the Post Office (Telegraph Department), 1876, states that "the committee have not received any full and satisfactory explanation of the great differences between the estimated expenditure of 1869 and the actual expenditure incurred up to 1876."

The excess expenditure caused the Post Office during two or three years to make temporary application of Savings Banks' balances to telegraph expenditure, an expedient which was disapproved of by both the Treasury and the House of Commons. Probably no more arduous task was ever thrown upon a public department than that imposed on the Post Office by the transfer. The reforms which it was to bring about were eagerly and impatiently demanded by the public. This great operation had to be effected without interrupting the public service, and the department had immediately to reduce and to simplify the charges for transmission throughout the kingdom. It had to extend the hours of business at all the offices; it had to extend the wires from railway stations lying outside of town populations to post offices in the centre of those populations and throughout their suburbs; it had also to extend the wires from towns into rural districts previously devoid of telegraphic communication; it had to effect a complete severance of commercial and domestic telegraphy from that of mere railway traffic, and in order to effect this severance it had to provide the railways with some 6000 m. of wires in substitution for those of which they had been joint users. It had further to provide at low charges for the distribution of news to the Press; it had to facilitate the transmission of money orders by telegram; finally, it had to amalgamate into one staff bodies of men who had formerly worked as rivals upon opposite plans and with different instruments, and to combine the amalgamated telegraph staff with that of the postal service. So zealously was the work of improvement pursued that within little more than six years of the transfer the aggregate extent of road wires in the United Kingdom was already 63,000 m. and that of railway wires 45,000, in all 108,000 m. The number of instruments in the telegraph offices was 12,000. At that date the superintending and managing staffs of the Post Office comprised 590 persons, the staff of the old companies with only about one-third of the traffic having been 534 persons.

The anticipations as to the increase of messages that would result from the reduction of rates were fully realized. The number of messages increased from about 6,500,000 in 1869 to nearly 10,000,000 in 1871 and to 20,000,000 in 1875, but the expectations as to net revenue were not justified by the results. In 1869 Mr Scudamore estimated the operating expenses at 51 to 56 per cent. of the gross revenue. In 1870–1 they were 57 per cent. and in 1871–2, 78 per cent. Since 1873 the capital account has been closed with a total expenditure of £10,867,644, and all subsequent expenditure for extensions, purchase of sites and erection of buildings has been charged against revenue.

There are several reasons for the unsatisfactory financial results apart from the high price paid for the acquisition of the telegraphs. The unprofitable extension of the telegraphs has largely contributed to the loss. Moreover, since 1881 the wages and salaries of the telegraph employees have been increased on several occasions in consequence of political pressure brought to bear on members of parliament; and notwithstanding the protest of the government of the day, the House of Commons in 1883 carried a resolution that the minimum rate for inland telegrams should be reduced to 6d. This involved a large extension of wires to cope with increased traffic. The reduced rate took effect as from the 1st of October 1886.

Another reason assigned by the committee appointed by the Treasury in 1875 "to investigate the causes of the increased cost of the telegraphic service since the acquisition of the telegraphs by the state" is the loss on the business of transmitting Press messages, which has been estimated as at least £300,000 a year. A further cause has been competition offered by the telephone service, but against this the Post Office has received royalties from telephone companies and revenue from trunk telephone lines. These amounted in 1887 to £26,170 and £1312 respectively; in 1897 to £85,289 and £113,294, and in 1907 to £240,331 and £479,639 respectively.

The following table shows the financial results of the business in the year immediately following the purchase of the telegraphs by the state, in the two years preceding and the two years following the introduction of the 6d. tariff, and in the seven financial years from 1900–1907:—

Year.	Number of Messages.	Gross Receipts.	Total Expenditure.	Percentage of Total Expenditure to Gross Receipts.	Net Revenue or Deficiency.	Net Revenue after omitting from Total Expenditure the cost of Sites, Buildings and Telegraph Extensions.	Interest on Stock created for Purchase of Telegraphs.
		£	£		£	£	£
1870–71 *	9,850,177	801,262	462,762	57·75	338,500	342,618	214,500
1883–84	32,843,120	1,789,223	1,808,920	101·10	19,697 Deficiency	330,835	326,417
1884–85†	33,278,459	1,784,414	1,820,764	102·03	36,350 Deficiency	274,271	326,417
1885–86	39,146,283	1,787,264	1,832,401	102·52	45,137 Deficiency	167,915	326,417
1886–87	50,243,639	1,887,159	2,032,632	107·70	145,473 Deficiency	88,484	326,417
1900–01	89,576,961	3,459,353	3,796,994	109·76	337,641 Deficiency	6,861 Deficit	298,860
1901–02	90,432,041	3,570,046	4,221,927	118·26	651,881 Deficiency	169,772 Deficit	298,860
1902–03	92,471,000	3,723,866	4,325,577	116·16	601,711 Deficiency	109,760 Deficit	298,860
1903–04	89,997,000	3,736,115	4,693,898	125·64	957,783 Deficiency	306,108 Deficit	278,483
1904–05	88,969,000	3,920,023	4,839,459	123·45	919,436 Deficiency	160,989 Deficit	271,691
1905–06	89,478,000	4,151,380	4,892,199	117·85	740,819 Deficiency	12,693	271,691
1906–07 (Estimated)	89,493,000	4,369,230	5,021,285	114·92	652,055 Deficiency	214,982	271,691

* 5th February 1870.—Transfer of telegraphs to the state.
† 1st October 1885.—Introduction of sixpenny tariff.

Submarine Telegraphs.—The first commercially successful cable was that laid across the straits of Dover from the South Foreland to Sangatte by T. R. Crampton in 1851, and two years later, after several futile attempts, another was laid between Port Patrick in the south of Scotland and Donaghadee in Ireland. This was followed by various other cables between England and the neighbouring countries, and their success naturally revived the idea which had been suggested in 1845 of establishing telegraphic communication between England and America, though this enterprise, on account of the distance and the greater depth of water, was of a much more formidable character. On the American side Cyrus W. Field acquired a concession which had been granted to F. N. Gisborne for a land line connecting St John's, Newfoundland, and Cape Ray, in the Gulf of St Lawrence, and proceeded himself to get control of the points on the American coast most suitable as landing places for a cable. On the British side the question of constructing an Atlantic cable was engaging the attention of the Magnetic Telegraph Company and its engineer Mr (afterwards Sir) Charles Bright. Visiting England in 1856, Field entered into an agreement with Bright and with John Watkins Brett, who with his brother Jacob had proposed the constructing of an Atlantic cable eleven years previously, with the object of forming a company for establishing and working electric telegraphic communication between Newfoundland and Ireland. The Atlantic Telegraph Company was duly registered in 1856, with a capital of £350,000, the great bulk of which was subscribed in England. The manufacture of the cable, begun early in the following year, was finished in June, and before the end of July it was stowed partly in the American ship "Niagara" and partly in the British ship "Agamemnon," both being war-ships lent for the purpose by their respective governments. The shore end was landed in Valentia Harbour on the 5th of August, and next morning paying out was started by the "Niagara," to which the laying of the first half had been entrusted. For the first few days the operation proceeded satisfactorily, though slowly, but on the afternoon of the 11th, when 380 m. had been laid, the cable snapped, owing to a mistake in the manipulation of the brake, and the ships returned to Plymouth with what remained. Next year, 700 m. of new cable having been made, the attempt was renewed, with the same ships, but on this occasion it was decided to begin paying out in mid-ocean, the two vessels, after splicing together the ends of the cable they had on board, sailing away from each other in opposite directions. They left Plymouth on the 10th of June, but owing to a terrific storm it was not till the 25th that they met at the rendezvous. A splice having been made they started on the 26th, but the cable broke almost immediately. Another splice was made, to be followed, after the "Agamemnon" had paid out about 40 m., by another break. Again the ships returned to the rendezvous and made another splice, and again there was a break after the "Agamemnon" had paid out 146 m., and then the "Agamemnon," after again returning to the meeting-place in the vain hope that the "Niagara" might have returned there also, made for Queenstown, where she found her consort had arrived nearly a week previously.

Although a good deal of cable had been lost, enough remained to connect the British and American shores, and accordingly it was determined to make another attempt immediately. To this end the ships sailed from Queenstown on the 17th of July, and having spliced the cable in mid-ocean, started to pay it out on the 29th. The "Niagara" landed her end in Trinity Bay, Newfoundland, on the 5th of August, while on the same day the "Agamemnon" landed hers at Valentia. The electrical condition of the cable was then excellent, but unfortunately the electrician in charge, Wildman Whitehouse, conceived the wrong idea that it should be worked by currents of high potential. For nearly a week futile attempts were made to send messages by his methods, and then a return was made to the weak currents and the mirror galvanometers of Sir William Thomson (Lord Kelvin) which had been employed for testing purposes while the cable was being laid. In this way communication was established from both sides on the 16th of August, but it did not continue long, for the insulation had been ruined by Whitehouse's treatment, and after the 20th of October no signals could be got through.

The next attempt at laying an Atlantic cable was made in 1865, the necessary capital being again raised in England. It was determined that the work should be done by a single ship, and accordingly the "Great Eastern" was chartered. She started from Valentia at the end of July, but fault after fault was discovered in the cable and the final misfortune was that on the 2nd of August, when nearly 1200 m. had been paid out, there was a break, and all the efforts made to pick up the lost portion proved unavailing. Next year the attempt was renewed. The Atlantic Telegraph Company was reconstituted as the Anglo-American Telegraph Company with a capital of £600,000 and sufficient cable was ordered not only to lay a line across the ocean but also to complete the 1865 cable. The "Great Eastern" was again employed, and leaving the south-west coast of Ireland on the 13th of July she reached Trinity Bay a fortnight later, without serious mishap. She then steamed eastwards again, and on the 13th of August made her first attempt to recover the lost cable. This, like many subsequent ones, was a failure, but finally she succeeded on the 2nd of September, and having made a splice completed the laying of the cable on the 8th of September. These two cables did not have a very long life, that of 1865 breaking down in 1877 and that of 1866 in 1872, but by the later of these dates four other cables had been laid across the Atlantic, including one from Brest to Duxbury, Mass. It was stated by Sir Charles Bright in 1887 that by that date 107,000 m. of submarine cable had been laid, while ten years later it was computed that 162,000 nautical miles of cable were in existence, representing a capital of £40,000,000, 75 per cent. of which had been provided by the United Kingdom. Among the men of business it was undoubtedly Sir John Pender (1815–1896) who contributed most to the development of this colossal industry, and to his unfailing faith in their ultimate realization must be ascribed the completion of the first successful Atlantic cables. The submarine cables of the world now have a length exceeding 200,000 nautical miles, and most of them have been manufactured on the Thames.

The monopoly conferred upon the Postmaster-General by the Telegraph Act 1869 was subsequently extended to telephony and wireless telegraphy, but it does not extend to submarine telegraphy. The submarine telegraphs are mainly controlled by companies, the amount of issued capital of the existing British telegraph companies (twenty-four in number) being £30,447,191, but a certain number of lines are in government hands. Thus on the 31st of March 1889 the undertaking of the Submarine Telegraph Company was purchased by the governments concerned. France and Great Britain jointly acquired the cables between Calais and Dover, Boulogne and Folkestone, Dieppe and Beachy Head, Havre and Beachy Head, Piron, near Coutances, and Vieux Châteaux (St Heliers, Jersey). Belgium and Great Britain became joint-proprietors of the cables between Ramsgate and Ostend and Dover and De la Panne (near Furnes). The two cables to Holland and one of the cables to Germany were already the property of Great Britain, and the German Union Company's cable to Germany was purchased by the German government. The offices of the Submarine Company in London, Dover, Ramsgate, East Dean and Jersey were purchased by the Post Office, as well as the cable ship; and the staff, 370 in number, was taken over by the government. The capital amount laid out by Great Britain was £67,163, and on 1st April the new business was begun with a uniform rate to France, Germany, Holland and Belgium of 2d. a word, with a minimum of 10d.

In 1890 Liverpool was placed in direct telegraphic communication with Hamburg and Havre, and London with Rome. The following year an additional cable was laid from Bacton, in Norfolk, to Borkum, in Germany, at the joint expense of the British and German governments. Direct telegraphic communication was thus afforded between London and Vienna. In 1893 a contract was made with the Eastern and South Africa Telegraph Company for the construction, laying and maintenance of a cable from Zanzibar to the Seychelles and Mauritius, a distance of 2210 m., for a subsidy of £28,000 a year for twenty years. In 1894 the Eastern Extension Telegraph Company laid a cable from Singapore to Labuan and Hong Kong, thus duplicating the route and making it an all-British line. The following year the rates to and from East and South Africa were reduced, by negotiation, from charges varying from 7s. 9d. to 8s. 11d. a word to 5s. 2d. or 5s. Government messages were accorded a rate of 2s. 6d., and Press telegrams one of from 1s. 5d. to 1s. 7½d. a word. In 1896 it was arranged to lay two new cables to France and one (for duplex working) to Germany. On the 1st of February 1898 a new cable was laid between Bermuda and Jamaica (via Turks Islands), giving an all-British line to the West Indies, with reduced charges. In 1900 direct telegraph working was established between London and Genoa, and a third cable was laid to South Africa via St Helena and Ascension. In 1896 a committee was appointed to consider the proposal for laying a telegraph cable between British North America and Australasia. The report of the committee, which is dated January 1897, was presented to parliament in April 1899, and dealt with the practicability of the project, the route, the cost and the revenue. The committee was of opinion that the cable should be owned and worked by the governments interested, and that the general direction should be in the hands of a manager in London under the control of a small board at which the associated governments should be represented. The English cable companies urged that state interference with private enterprise was neither justifiable nor necessary, as the rates could be reduced and an alternative cable route to Australia arranged on reasonable terms without it, and that the Cape route would be the best alternative route. The government policy would, they alleged, create an absolute and objectionable monopoly. In the correspondence (*Blue Book*, Ed. 46, 1900) between the Eastern Telegraph Company and the Colonial Office, the company pointed out that Mr Raikes, when Postmaster-General, had stated that "it would be without precedent for the English government itself to become interested in such a scheme in such a way as to constitute itself a competitor with existing commercial enterprises carried on by citizens of the British empire. There would be a very serious question raised, and it would probably extend to other forms of British enterprise." The company further pointed out that Mr L. Courtney (afterwards Lord Courtney), when Secretary of the Treasury, had stated that "it would be highly inexpedient to encourage upon light grounds competition against a company in the position of the Eastern Telegraph Company which has embarked much capital in existing lines"; and that the permanent officials representing the Post Office before the Pacific Cable committee had stated "that there was no precedent for the Imperial Government alone or in association with the Colonies managing or seeking business for a line of this kind." The reply of the Colonial Office contained the following statements of general policy:—"With the progressive development of society the tendency is to enlarge the functions and widen the sphere of action of the central government as well as of the local authorities, and to claim for them a more or less exclusive use of powers, and the performance of services where the desired result is difficult to attain through private enterprise, or where the result of entrusting such powers or services to private enterprise would be detrimental to the public interest, through their being in that event necessarily conducted primarily for the benefit of the undertakers rather than of the public. This tendency is specially manifested in cases where from the magnitude or other conditions of the enterprise the public is deprived of the important safeguard of unrestricted competition. . . . In the case of inland telegraphs and of cable communication with the continent of Europe government control has entirely superseded private companies. Closely analogous to the action of the state in the cases referred to is the action taken by municipal authorities with the authority of the legislature in competing with or superseding private companies for the supply of electric light, gas, water, tramways and other public services. . . . The service which the government and the colonies desire is one which neither the Eastern Telegraph Company nor any other private enterprise is prepared to undertake on terms which can be considered in comparison with the terms upon which it can be provided by the associated governments."

In November 1899 a committee was appointed by the Colonial Office for the further examination of the scheme, and towards the end of 1900 a tender was accepted for the manufacture and laying of a submarine cable between the Island of Vancouver and Queensland and New Zealand for the sum of £1,795,000, the work to be completed by the 31st of December 1902. A board was constituted to supervise the construction and working of the cable, composed of representatives of the several governments, with offices at Westminster. Under the Pacific Cable Act 1901 the capital sum of £2,000,000 was provided in the following proportions:—

United Kingdom, 5/18ths with 3 representatives including the chairman.
Canada, 5/18ths with 2 representatives.
Australia, 6/18ths with 2 representatives.
New Zealand, 2/18ths with 1 representative.

In these proportions the respective contributing governments are responsible for the losses made in the working of the undertaking. The annual expenses of the board include £35,000 for cable repairs and reserve and a fixed payment to the National Debt Commissioners of £77,544 as sinking fund to amortise capital expenditure in fifty years. The deficiency on the working for the year ended 31st March 1907 was £54,924, and the approximate number of messages transmitted during the year was 96,783 with 1,126,940 words. There was in addition a considerable inter-colonial traffic between Australia, New Zealand and the Fijis.

Since the early days of international telegraphy, conferences of representatives of government telegraph departments and companies have been held from time to time (Paris 1865, Vienna 1868, Rome 1871 and 1878, St Petersburg 1875, London 1879, Berlin 1885, Paris 1891, Buda Pesth 1896, London 1903). In 1868 the International Bureau of Telegraphic Administrations was constituted at Berne, and a convention was formulated by which a central office was appointed to collect and publish information and generally to promote the interests of international telegraphy. International service regulations have been drawn up which possess equal authority with the convention and constitute what may be regarded as the law relating to international telegraphy. The total lengths of the land lines of the telegraphs throughout the world in 1907 were 1,015,894 m. aerial, and 11,454 m. underground, and the total lengths of submarine cables of the world were 39,072 nautical miles under government administration and 194,751 nautical miles under the administration of private companies.

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PART II.—WIRELESS TELEGRAPHY

The early attempts to achieve electric telegraphy involved the use of a complete metallic circuit, but K. A. Steinheil of Munich, however, acting on a suggestion given by Gauss, made in 1838 the important discovery that half of the circuit might be formed of the conducting earth, and so discovered the use of the *earth return*, since then an essential feature of nearly every telegraphic circuit. Encouraged by this success, he even made the further suggestion that the remaining metallic portion of the circuit might perhaps some day be abolished and a system of wireless telegraphy established.[1]

Morse.

Morse showed, by experiments made in 1842 on a canal at Washington, that it was possible to interrupt the metallic electric circuit in two places and yet retain power of electric communication (see Fahie, *loc. cit.*, p. 10). His plan, which has been imitated by numerous other experimentalists, was as follows:—On each side of the canal, at a considerable distance apart, metal plates *e e* (fig. 35) were sunk in the water; the pair on one side were connected by a battery B, and the pair on the other by a galvanometer or telegraphic receiver R. Under these circumstances a small portion of the current from the battery is shunted through the galvanometer circuit, and can be used to make electric signals. Morse and Gale, who assisted him, found, however, that the distance of the plates up and down the canal must be at least three or four times the width of the canal to obtain successful results. Numerous investigators followed in Morse's footsteps. James Bowman Lindsay of Dundee, between 1845 and 1854, reinvented and even patented Morse's method, and practically put the plan into operation for experimental purposes across the river Tay. J. W. Wilkins in 1849, and H. Highton in experiments described in 1872, also revived the same suggestion for wireless telegraphy.

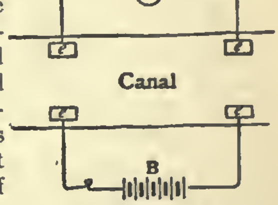

FIG. 35.—Morse's Conduction Method.

Trowbridge.

The invention of the magneto-telephone put into the hands of electricians a new instrument of extraordinary sensitiveness for the detection of feeble interrupted, or alternating, currents, and by its aid J. Trowbridge in 1880, in the United States, made a very elaborate investigation of the propagation of electric currents through the earth, either soil or water (see "The Earth as a Conductor of Electricity," *Amer. Acad. Arts and Sci.*, 1880). He found, as others have done, that if a battery, dynamo or induction coil has its terminals connected to the earth at two distant places, a system of electric currents flows between these points through the crust of the earth. If the current is interrupted or alternating, and if a telephone receiver has its terminals connected to a separate metallic circuit joined by earth plates at two other places to the earth, not on the same equipotential surface of the first circuit, sounds will be heard in the telephone due to a current passing through it. Hence, by inserting a break-and-make key in the circuit of the battery, coil or dynamo, the uniform noise or hum in the telephone can be cut up into periods of long and short noises, which can be made to yield the signals of the Morse alphabet. In this manner Trowbridge showed that signalling might be carried on over considerable distances by electric conduction through the earth or water between places not metallically connected. He also repeated the suggestion which Lindsay had already made that it might be possible to signal in this manner by conduction currents through the Atlantic Ocean from the United States to Europe. He and others also suggested the applicability of the method to the inter-communication of ships at sea. He proposed that one ship should be provided with the means of making an interrupted current in a circuit formed partly of an insulated metallic wire connected with the sea at both ends by plates, and partly of the unlimited ocean. Such an arrangement would distribute a

[1] For a history of the discovery of the earth return, see Fahie, *History of Electric Telegraphy to the Year 1837*, pp. 343–348.

system of flow lines of current through the sea, and these might be detected by any other ships furnished with two plates dipping into the sea at stem and stern, and connected by a wire having a telephone in its circuit, provided that the two plates were not placed on the same equipotential surface of the original current flow lines. Experiments of this kind were actually tried by Graham Bell in 1882, with boats on the Potomac river, and signals were detected at a distance of a mile and a half.

At a later date, 1891, Trowbridge discussed another method of effecting communication at a distance, viz., by means of magnetic induction between two separate and completely insulated circuits. If a primary circuit, consisting of a large coil of wire P (fig. 36), has in circuit a battery B and an interrupter I, and at some distance and parallel to this primary circuit is placed a secondary circuit S, having a telephone T included in it, the interruptions or reversals of the current in the primary circuit will give rise to a varying magnetic field round that circuit which will induce secondary currents in the other circuit and affect the telephone receiver. Willoughby Smith found that it was not necessary even to connect the telephone to a secondary circuit, but that it would be affected and give out sounds merely by being held in the variable magnetic field of a primary circuit. By the use of a key in the battery circuit as well as an interrupter or current reverser, signals can be given by breaking up the continuous hum in the telephone into long and short periods. This method of communication by *magnetic induction* through space establishes, therefore, a second method of wireless telegraphy which is quite independent of and different from that due to *conduction* through earth or water.

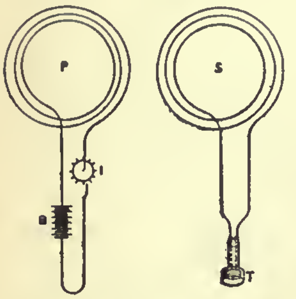

FIG. 36.—Magneto-Induction Method.

Preece.

Sir W. H. Preece, who took up the subject about the same time as Prof. Trowbridge, obtained improved practical results by combining together methods of induction and conduction. His first publication of results was in 1882 (*Brit. Assoc. Report*), when he drew attention to the considerable distance over which inductive effects occurred between parallel wires forming portions of telephonic and telegraphic circuits. Following on this he made an interesting experiment, using Morse's method, to connect the Isle of Wight telegraphically with the mainland, by conduction across the Solent in two places, during a temporary failure of the submarine cable in 1882 in that channel. In subsequent years numerous experiments were carried out by him in various parts of Great Britain, in some cases with circuits earthed at both ends, and in other cases with completely insulated circuits, which showed that conductive effects could be detected at distances of many miles, and also that inductive effects could take place even between circuits separated by solid earth and by considerable distances. A. W. Heaviside in 1887 succeeded in communicating by telephonic speech between the surface of the earth and the subterranean galleries of the Broomhill collieries, 350 feet deep, by laying above and below ground two complete metallic circuits, each about 2½ m. in length and parallel to each other. At a later date other experimentalists found, however, that an equal thickness of sea-water interposed between a primary and secondary circuit completely prevented similar inductive intercommunication. In 1885 Preece and Heaviside proved by experiments made at Newcastle that if two completely insulated circuits of square form, each side being 440 yds., were placed a quarter of a mile apart, telephonic speech was conveyed from one to the other by induction, and signals could be perceived even when they were separated by 1000 yds. The method of induction between insulated primary and secondary circuits laid out flat on the surface of the earth proves to be of limited application, and in his later experiments Preece returned to a method which unites both conduction and induction as the means of affecting one circuit by a current in another. In 1892, on the Bristol Channel, he established communication between Lavernock Point and an island called Flat Holme in that channel by placing at these positions insulated single-wire circuits, earthed at both ends and laid as far as possible parallel to each other, the distance between them being 3·3 m. The shore wire was 1267 yds. long, and that on the island 600 yds. An interrupted current having a frequency of about 400 was used in the primary circuit, and a telephone was employed as a receiver in the secondary circuit. Other experiments in inductive telegraphy were made by Preece, aided by the officials of the British Postal Telegraph Service, in Glamorganshire in 1887; at Loch Ness in Scotland in 1892; on Conway Sands in 1893; and at Frodsham, on the Dee, in 1894. (See *Jour. Inst. Elec. Eng.*, 27, p. 869.) In 1899 experiments were made at Menai Straits to put the lighthouse at the Skerries into communication with the coastguard station at Cemlyn. A wire 750 yds. in length was erected along the Skerries, and on the mainland one of 3½ m. long, starting from a point opposite the Skerries, to Cemlyn. Each line terminated in an earth plate placed in the sea. The average perpendicular distance between the two lines, which are roughly parallel, is 2·8 m. Telephonic speech between these two circuits was found possible and good, the communication between the circuits taking place partly by induction, and no doubt partly by conduction. On the question of how far the effects are due to conduction between the earth plates, and how far to true electromagnetic induction, authorities differ, some being of opinion that the two effects are in operation together. A similar installation of inductive telephony, in which telephone currents in one line were made to create others in a nearly parallel and distant line, was established in 1899 between Rathlin Island on the north coast of Ireland and the mainland. The shortest distance between the two places is 4 m. By stretching on the island and mainland parallel wire circuits earthed at each end, good telephonic communication over an average distance of 6½ m. was established between these independent circuits.

Willoughby Smith.

The difficulty of connecting lightships and isolated lighthouses to the mainland by submarine cables, owing to the destructive action of the tides and waves on rocky coasts on the shore ends, led many inventors to look for a way out of the difficulty by the adoption of some form of inductive or conductive telegraphy not necessitating a continuous cable. Willoughby S. Smith and W. P. Granville put into practice between Alum Bay in the Isle of Wight and the Needles lighthouse a method which depends upon conduction through sea water. (See *Jour. Inst. Elec. Eng.*, 27, p. 938.) It may be explained as follows:—Suppose a battery on shore to have one pole earthed and the other connected to an insulated submarine cable, the distant end of which was also earthed; if now a galvanometer is inserted anywhere in the cable, a current will be found flowing through the cable and returning by various paths through the sea. If we suppose the cable interrupted at any place, and both sides of the gap earthed by connexion to plates, then the same conditions will still hold. Communication was established by this method in the year 1895 with the lighthouse on the Fastnet.[1] A cable is carried out from the mainland at Crookhaven for 7 m., and the outer end earthed by connexion with a copper mushroom anchor. Another earthed cable starts from a similar anchor about 100 ft. away near the shore line of the Fastnet rock, crosses the rock, and is again earthed in the sea at the distant end. If a battery on the mainland is connected through a key with the shore end of the main cable, and a speaking galvanometer is in circuit with the short cable crossing the Fastnet rock, then closing or opening the battery connexion will create a deflection of the galvanometer. A very ingenious call-bell arrangement was devised, capable of responding only to regularly reversed battery currents, but not

[1] See Fahie, *History of Wireless Telegraphy*, p. 170; also 5th Report (1897) of the Royal Commission on Electrical Communication with Lightships and Lighthouses.

to stray "earth currents," and very good signalling was established between the mainland and the rock. Owing to the rough seas sweeping over the Fastnet, the conditions are such that any ordinary submarine cable would be broken by the wearing action of the waves at the rock boundary in a very short time. Another worker in this department of research was C. A. Stevenson, who in 1892 advocated the use of the inductive system pure and simple for communication between the mainland and isolated lighthouses or islands. He proposed to employ two large flat coils of wire laid horizontally on the ground, that on the mainland having in circuit a battery, interrupter and key, and that on the island a telephone. His proposals had special reference to the necessity for connecting a lighthouse on Muckle Flugga, in the Shetlands, and the mainland, but were not carried into effect. Professor E. Rathenau of Berlin made many experiments in 1894 in which, by means of a conductive system of wireless telegraphy, he signalled through 3 m. of water.

Sir Oliver Lodge in 1898 theoretically examined the inductive system of space telegraphy. (See *Jour. Inst. Elec. Eng.*, 27, p. 799.) He advocated and put in practice experimentally a system by which the primary and secondary circuits were "turned" or syntonized by including condensers in the circuits. He proved that when so syntonized the circuits are inductively respondent to each other with a much less power expenditure in the primary circuit than without the syntony. He also devised a "call" or arrangement for actuating an ordinary electric bell by the accumulated effect of the properly tuned inductive impulses falling on the secondary circuit. A very ingenious call-bell or annunciator for use with inductive or conductive systems of wireless telegraphy was invented and described in 1898 by S. Evershed, and has been practically adopted at Lavernock and Flat Holme. (*Id.*, 27, p. 852.)

Lodge.

In addition to the systems of wireless or space telegraphy depending upon conduction through earth or water, and the inductive system based upon the power of a magnetic field created round one circuit to induce, when varied, a secondary current in another circuit, there have been certain attempts to utilize what may best be described as electrostatic induction. In 1885 Edison, in conjunction with Gilliland, Phelps, and W. Smith, worked out a system of communicating between railway stations and moving trains. At each signalling station was erected an insulated metallic surface facing and near to the ordinary telegraph wires. On one or more of the carriages of the trains were placed also insulated metallic sheets, which were in connexion through a telephone and the secondary circuit of an induction coil with the earth or rails. In the primary circuit of the induction coil was an arrangement for rapidly intermitting the current and a key for short-circuiting this primary circuit. The telephone used was Edison's chalk cylinder or electromotograph type of telephone. Hence, when the coil at one fixed station was in action it generated high frequency alternating currents, which were propagated across the air gap between the ordinary telegraph wires and the metallic surfaces attached to one secondary terminal of the induction coil, and conveyed along the ordinary telegraph wires between station and moving train. Thus, in the case of one station and one moving railway carriage, there is a circuit consisting partly of the earth, partly of the ordinary telegraph wires at the side of the track, and partly of the circuits of the telephone receiver at one place and the secondary of the induction coil at the other, two air gaps existing in this circuit. The electromotive force of the coil is, however, great enough to create in these air gaps displacement currents which are of magnitude sufficient to be equivalent to the conduction current required to actuate a telephone. This current may be taken to be of the order of two or three micro-amperes. The signals were sent by cutting up the continuous hum in the telephone into long and short periods in accordance with the Morse code by manipulating the key in the primary circuit. The system was put into practical operation in 1887 on the Lehigh Valley railroad in the United States, and worked well, but was abandoned because it apparently fulfilled no real public want. Edison also patented (U.S.A. *Pat. Spec.*, No. 465971, 14th May 1885) a plan for establishing at distant places two insulated elevated plates. One of these was to be connected to the earth through a telephone receiver, and the other through the secondary circuit of an induction coil in the primary circuit of which was a key. The idea was that variations of the primary current would create electromotive force in the secondary circuit which would act through the air condenser formed by the two plates. It has sometimes been claimed that Edison's proposed elevated plates anticipated the subsequent invention by Marconi of the aerial wire or antenna, but it is particularly to be noticed that Edison employed no spark gap or means for creating electrical high frequency oscillations in these wires. There is no evidence that this plan of Edison's was practically operative as a system of telegraphy.

Edison.

A very similar system of wireless telegraphy was patented by Professor A. E. Dolbear in 1886 (U.S.A. *Pat. Spec.*, No. 350299), in which he proposed to employ two batteries at two places to affect the potential of the earth at those places. At the sending station one battery was to have its positive pole connected to the earth and its negative pole to an insulated condenser. In circuit with this battery was placed the secondary circuit of an induction coil, the primary circuit of which contained a telephone transmitter or microphone interrupter. At the receiving station a telephone receiver was placed in series with another insulated battery, the negative terminal of which was to be in connexion with the earth. There is no evidence, however, that the method proposed could or did effect the transmission of speech or signals between stations separated by any distance. Many other more or less imperfect devices—such as those of Mahlon Loomis, put forward in 1872 and 1877, and Kitsee in 1895—for wireless telegraphy were not within the region of practically realizable schemes.

Space or Radio-Telegraphy by Hertzian Waves.—Up to 1895 or 1896 the suggestions for wireless telegraphy which had been publicly announced or tried can thus be classified under three or four divisions, based respectively upon electrical conduction through the soil or sea, magnetic induction through space, combinations of the two foregoing, and lastly, electrostatic induction. All these older methods have, however, been thrown into the background and rendered antiquated by inventions which have grown out of Hertz's scientific investigations on the production of electric waves. Before the classical researches of Hertz in 1886 and 1887, many observers had noticed curious effects due to electric sparks produced at a distance which were commonly ascribed to ordinary electrostatic or electro-magnetic induction. Thus Joseph Henry (*Scientific Writings*, vol. i. p. 203) noticed that a single electric spark about an inch long thrown on to a circuit of wire in an upper room could magnetize steel needles included in a parallel circuit of wire placed in a cellar 30 ft. below with two floors intervening. Some curious distance-phenomena connected with electric sparks were observed in 1875 by Edison (who referred them to a supposed new "aetheric force"), and confirmed by Beard, S. P. Thompson, E. J. Houston and others.[1] D. E Hughes made some remarkable observations and experiments in or between the years 1879 and 1886 though he did not describe them till some twenty years afterwards. He discovered a fact subsequently rediscovered by others, that a tube of metallic filings, loosely packed, was sensitive to electric sparks made in its vicinity, its electrical resistance being reduced, and he was able to detect effects on such a tube connected to a battery and telephone at a distance of 500 yds.[2]

These distance effects were not understood at the time, or else were referred simply to ordinary induction. Hertz, however, made known in 1887 the experimental proofs that the discharge

[1] See *Telegraphic Journal of London*, vol. iv. pp. 29, 46, 61; *Proc. Phys. Soc. Lond.*, vol. ii. p. 103.

[2] See Fahie, *History of Wireless Telegraphy*, p. 289; also an important letter by D. E. Hughes in *The Electrician*, London, 1899, 43, 40.

of a condenser produces an electric spark which under proper conditions creates an effect propagated out into space as an *electric wave*. He employed as a detector of this wave a simple, nearly closed circuit of wire called a Hertz resonator, but it was subsequently discovered that the metallic microphone of D. E. Hughes was a far more sensitive detector. The peculiar action of electric sparks and waves in reducing the resistance of discontinuous conductors was rediscovered and investigated by Calzecchi Onesti,[1] by Branly,[2] Dawson Turner,[3] Minchin, Lodge,[4] and many others. Branly was the first to investigate and describe in 1890 the fact that an electric spark at a distance had the power of changing loose aggregations of metallic powders from poor to good electric conductors, and he also found that in some cases the reverse action was produced. Lodge particularly studied the action of electric waves in reducing the resistance of the contact between two metallic surfaces such as a plate and a point, or two balls, and named the device a "coherer." He constructed one form of his coherer of a glass tube a few inches long filled with iron borings or brass filings, having contact plates or pins at the end. When such a tube is inserted in series with a single voltaic cell and galvanometer it is found that the resistance of the tube is nearly infinite, provided the filings are not too tightly squeezed. On creating an electric spark or wave in the neighbourhood of the tube the resistance suddenly falls to a few ohms and the cell sends a current through it. By shaking or tapping the tube the original high resistance is restored. In 1894 he exhibited apparatus of this kind in which the tapping back of the tube of filings was effected automatically. He ascribed the reduction of resistance of the mass to a welding or cohering action taking place between the metallic particles, hence the name "coherer." But, as Branly showed, it is not universally true that the action of an electric wave is to reduce the resistance of a tube of powdered metal or cause the particles to cohere. In some cases, such as that of peroxide of lead, an increase of resistance takes place.

Between 1894 and 1896 G. Marconi gave great attention to the improvement of devices for the detection of electric waves.

Marconi. He made his sensitive tube, or improved coherer, as follows:—A glass tube having an internal diameter of about 4 millimetres has sealed into it two silver plugs PP by means of platinum wires WW (fig. 37); the opposed faces of these plugs are perfectly smooth, and are placed within a millimetre of each other. The interspace is filled with a very small quantity of nickel and silver filings, about 95 per cent. nickel and 5 per cent. silver, sufficient to fill loosely about half the cavity between the plugs, which fit tightly into the tube.[5] The tube is then exhausted of its air, and attached to a bone or glass rod as a holder. This form of electric wave detector proved itself to be far more certain in operation and sensitive

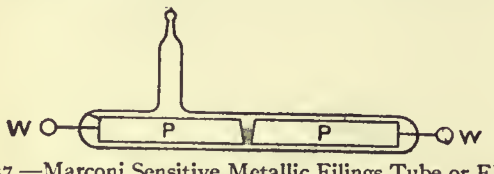

Fig. 37.—Marconi Sensitive Metallic Filings Tube or Electric Wave Detector.

than anything previously invented. The object which Marconi had in view was not merely the detection of electric waves, but their utilization in practical wireless telegraphy. Sir William Crookes had already suggested in 1892 in the *Fortnightly Review* (February 1892) that such an application might be made, but no one had overcome the practical difficulties or actually shown how to do it.

G. Marconi, however, made the important discovery that if his sensitive tube or coherer had one terminal attached to a metal plate lying on the earth, or buried in it, and the other to an insulated plate elevated at a height above the ground, it could detect the presence of very feeble electric waves of a certain kind originating at a great distance. In conjunction with the above receiver he employed a transmitter, which consisted of a large induction or spark coil S having its spark balls placed a few millimetres apart; one of these balls was connected to an earth

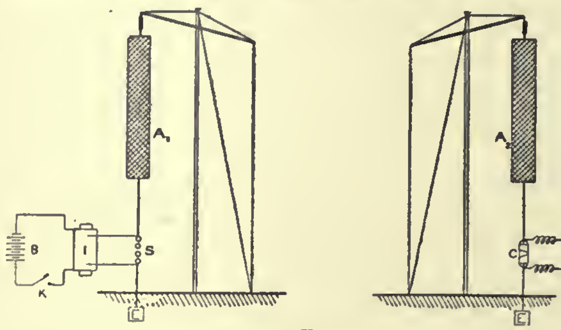

Fig. 38.

plate E and the other to a plate or wire insulated at the upper end and elevated above the surface of the earth. In the primary circuit of the induction coil I he placed an ordinary signalling key K, and when this was pressed for a longer or shorter time a torrent of electric sparks passed between the balls, alternately charging and discharging the elevated conductor A_1 and creating electrical oscillations (see Electro-Kinetics) in the wire. This elevated conductor is now called the *antenna*, *aerial wire*, or *air wire*. At the receiving station Marconi connected a single voltaic cell B_1 and a sensitive telegraphic relay R in series with his tube of metallic filings C, and interposed certain little coils called choking coils. The relay was employed to actuate through a local battery B_2 an ordinary Morse printing telegraphic instrument M. One end of the sensitive tube was then connected to the earth and the other end to an antenna or insulated elevated conductor A_2. Assuming the transmitting and receiving apparatus to be set up at distant stations (see fig. 38[6]), the insulated wires or plates being upheld by masts, its operation is as follows:—When the key in the primary circuit of the induction coil is pressed the transmitting antenna wire is alternately charged to a high potential and discharged with the production of high frequency oscillations in it. This process creates in the space around electric waves or periodic changes in electric and magnetic force round the antenna wire. The antenna wire, connected to one spark ball of the induction coil, must be considered to form with the earth, connected to the other spark ball, a condenser. Before the spark happens lines of electrostatic force stretch from one to the other in curved lines. When the discharge takes place the ends of the lines of electric force abutting on the wire run down it and are detached in the form of semi-loops of electric force which move outwards with their ends on the surface of the earth. As they travel they are accompanied by lines of magnetic force, which expand outwards in ever-widening circles.[7] The magnetic and electric forces are directed alternately in one direction and the other, and at distances which are called multiples of a *wave length* the force is in the same direction at the same time, but in the case of damped waves has not quite the same intensity. The force at any one point also varies cyclically, that is, is varying at any one point

[1] *Nuovo cimento*, series iii. vol. xvii.

[2] *Comptes rendus*, vols. cxi., cxii.; see also *The Electrician*, xl. 87, 91, 166, 235, 333 and 397; xli. 487; xlii. 46 and 527; and xliii. 277.

[3] *Report Brit. Assoc.*, 1892.

[4] Lodge, *Signalling through Space without Wires*, 3rd ed., p. 73, 1899.

[5] See G. Marconi, *Brit. Pat. Spec.*, 12039 of 1896.

[6] Figures 38, 39, 41, 42, 44, 45, 46, 47, 48 and 49 are drawn from Professor J. A. Fleming's *Electric Wave Telegraphy*, by permission of Longmans, Green & Co.

[7] For a more complete account of the nature of an electric wave the reader is referred to Hertz's *Electric Waves*, and to the article Electric Wave. See also *The Principles of Electric Wave Telegraphy*, by J. A. Fleming.

and varying from point to point. This periodic distribution in time and space constitutes an electric wave proceeding outwards in all directions from the sending antenna. If we consider the lines of magnetic force in the neighbourhood of the receiving antenna wire we shall see that they move across it, and thus create in it an electromotive force which acts upon the coherer or other sensitive device associated with it.

Marconi's System of Wireless Telegraphy.—Marconi's system of electric wave telegraphy consists therefore in setting up at the transmitting station the devices just described for sending out groups of damped electric waves of the above kind in long or short trains corresponding to the *dash* or *dot* signals of the Morse alphabet. These trains are produced by pressing the key in the primary circuit of the induction coil for a longer or shorter time and generating a long or short series of oscillatory electric sparks between the spark balls with a corresponding creation of trains of electric waves. At the receiving station he connected, as stated, one end of the sensitive tube to earth and the other to the antenna, and improved and applied a device of Popoff for automatically tapping the tube after each electric impact had rendered it conductive. He caused the relay in series with the sensitive tube to set in action not only a telegraphic instrument but also the electromagnetic tapper, which was arranged so as to administer light blows on the under side of the sensitive tube when the latter passed into the conductive condition. The effect was to print a *dash* or *dot* on a strip of telegraphic paper, according as the incident electric wave train lasted a longer or shorter time. In addition he added certain spark-generating coils across the contacts of the relay and tapper. He thus produced in 1896 for the first time an operative apparatus of electric wave telegraphy. Its simplicity and compactness recommended it immediately for communication between ship and shore and for intermarine communication generally. Marconi's earliest experiments with this apparatus were made in Italy. In 1896 he came to England and gave demonstrations to the British postal telegraph department and other officials. Some of these experiments were made on Salisbury Plain and others in the Bristol Channel between Lavernock and Flat Holm and Bream Down in 1897. Early in 1898 permanent stations were established between Alum Bay and Bournemouth, a distance of 14½ m., where successful results were obtained. Later the Bournemouth station was removed to Poole Harbour, and the Alum Bay station to Niton in the Isle of Wight, the distance being thus increased to 30 m. In December 1898 communication was established by the Marconi method between the East Goodwin lightship and the South Foreland lighthouse; and this installation was maintained for upwards of a year, during which it was the means of saving both life and property. In March 1899 communication was effected by his system between England (South Foreland lighthouse) and France (Wimereux, near Boulogne), a distance of 30 m. He kept up the communication for six months, in all weathers, and found that ordinary commercial messages could be transmitted at the rate of 15 to 20 words a minute. In January 1901 he established communication by his system between the Lizard in Cornwall and Niton in the Isle of Wight, a distance of 200 m. A full account of the development of his system was given by him in an article published in the *Fortnightly Review* for June 1902; see also a paper by him in the *Journ. Inst. Elec. Eng.*, 1899, 28, p. 273. About this time he introduced various improvements into the receiving apparatus. Instead of inserting the sensitive tube between the receiving antenna and the earth, he inserted the primary coil of a peculiar form of oscillation transformer and connected the terminals of the tube to the secondary circuit of the transformer. Lodge had previously suggested the use of transformed oscillations for acting on the coherer (see *British Patent Spec.*, No. 11575 of 1897), but it is not every form of oscillation transformer which is suitable for this purpose.

Marconi's successes and the demonstrations he had given of the thoroughly practical character of this system of electric wave telegraphy stimulated other inventors to enter the same field of labour, whilst theorists began to study carefully the nature of the physical operations involved. It was seen that the effect of the impact of the incident electric waves upon the vertical receiving wire was to create in it electrical oscillations, or in other words, high frequency alternating electric currents, such that whilst the potential variations were a maximum at the top or insulated end of the antenna the current at that point was zero and at the base the potential variation was zero and the current amplitude a maximum. Hence devices for detecting the oscillations in the antenna are merely very sensitive forms of ammeter and voltmeter. It was also recognized that what is required at the transmitting end is the establishment of powerful electric oscillations in the sending antenna, which create and radiate their energy in the form of electric waves having their magnetic force component parallel to the earth's surface and their electric component perpendicular to it.

Transmitting Apparatus.—We now consider the more recent appliances for electric wave telegraphy under the two divisions of transmitting and receiving apparatus. First as regards the transmitting part, one essential element is the *antenna, aerial*, or *air wire*, which may take a variety of forms. It may consist of a single plain or stranded copper wire upheld at the top by an insulator from a mast, chimney or building. The wire may have at the upper end a plate called a "capacity area," electrically equivalent to an extension of the wire, or part of the wire may be bent over and carried horizontally. In many cases multiple antennae are used consisting of many wires arranged in cone or umbrella-rib fashion, or a metal roof or metallic chimney may be employed (see fig. 39). In any case the antenna serves as one surface of a condenser, the other surface of which is the earth. This condenser is charged electrically and then suddenly discharged and violent electrical oscillations are set up in it, that is to say, electricity rushes to and fro between the antenna and the earth. This creates rapid variations in electric and magnetic force round the antenna and detaches energy from it in the form of an electric wave. The antenna has at one moment a static electrical charge distributed upon it, and lines of electric force stretch from it to the surrounding earth. At the next instant it is the seat of an electric current and is surrounded by closed lines of magnetic force. These static and kinetic conditions succeed each other rapidly, and the result is to detach or throw off from the antenna semi-loops of electric force, which move outwards in all directions and are accompanied by expanding circular lines of magnetic force. The whole process is exactly analogous to

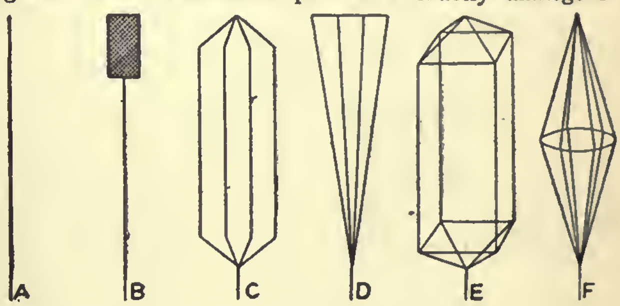

FIG. 39.

the operation by which a violin string or organ pipe creates an air or sound wave. The violin string is first drawn on one side. This strain corresponds to the electrical charging of the antenna. The string is then suddenly released. This corresponds to the electrical discharge of the antenna, and the subsequent string vibrations to the electrical vibrations. These communicate their energy to the surrounding air, and this energy is conveyed away in the form of air waves.

There are three ways in which the antenna may be charged:—

(i) It may be separated from the earth by a pair of spark balls which are connected respectively to the terminals of an induction coil or transformer, or other high tension generator. If these spark balls are set at the right distance, then when the potential difference accumulates the antenna will be charged and at some stage suddenly discharged by the discharge leaping across the spark gap. This was Marconi's original method, and the plan is still used under the name of the direct method of excitation or the plain antenna.

(ii) The antenna may have oscillations excited in it inductively. F. Braun suggested in 1898 that the oscillatory discharge of a Leyden jar should be sent through the primary coil of a transformer and the secondary coil should be interposed between the antenna and an earth connexion.[1] Marconi[2] imparted practical utility to this idea by tuning the two circuits together, and the arrangement now employed is as follows:— A suitable condenser C, or battery of Leyden jars, has one coating connected to one spark ball and the other through a coil of one turn with the other spark ball of a discharger S. These spark balls are connected either to the secondary circuit of an induction coil I, or to that of an alternating current transformer having a secondary voltage of 20,000 to 100,000 volts. Over the coil of one turn is wound a secondary circuit of 5 or 10 turns, of which one end is connected to the earth through a variable inductance and the other end to an antenna or radiating wire A (see fig. 40). These two circuits are so adjusted that the *closed* oscillation circuit, consisting of the condenser, primary coil

[1] See *German Patent* of F. Braun, No. 11578 of 1898, or *British Specification*, No. 1862 of 1899.

[2] See *British Pat. Spec.*, G. Marconi, No. 7777 of 1900.

and spark gap, has the same natural time period of oscillation as the *open* circuit consisting of the antenna, secondary coil and adjustable inductance. When this is the case, if discharges are made across the spark gap oscillations are excited in the closed circuit, and these induce other syntonic oscillations in the antenna circuit. J. A. Fleming devised an arrangement in which a multiple transformation takes place, two oscillation circuits being interlinked inductively, and the last one acting inductively on the open or antenna circuit. J. S. Stone similarly devised a multiple inductive oscillation circuit with the object of forcing on the antenna circuit a single oscillation of definite frequency.[1] In the case of the inductive mode of exciting the oscillations an important quantity is the *coefficient of coupling* of the two oscillation circuits. If L and N are the inductances of any two circuits which have a coefficient of mutual inductance M, then $M/\surd(LN)$ is called the coefficient of coupling of the circuits and is generally expressed as a percentage. Two circuits are said to be closely coupled when this coefficient is near unity and to be loosely coupled if it is very small. It can be shown that if two circuits, both having capacity (C) and inductance (L), are coupled together inductively, then, when oscillations are set up in one circuit, oscillations of two periods are excited in the other differing in frequency from each other and from the natural frequency of the circuit. If the two circuits are in tune so that the numerical product of capacity and inductance of each circuit is the same or $C_1L_1 = C_2L_2 + CL$ and if k is the coefficient of coupling then the natural frequency of each circuit is $n = 1/2\pi\surd(CL)$, and when coupled two oscillations are set up in the secondary circuit having frequencies n_1 and n_2 such that $n_1 = n/\surd(1-k)$ and $n_2 = n/\surd(1+k)$. Since in all cases of

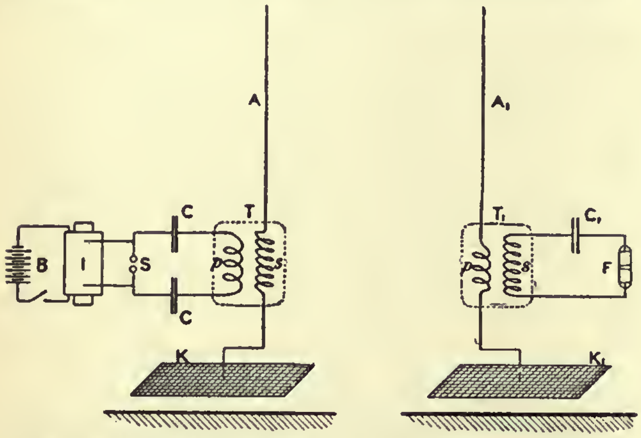

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FIG. 40.

wave motion the wave-length λ is connected with the frequency n and the velocity of propagation v by the relation $v = n\lambda$, it follows that from such an inductively coupled tuned antenna electric waves of two wave-lengths are sent out having lengths λ_1 and λ_2 such that $\lambda_1 = \lambda\surd(1-k)$ and $\lambda_2 = \lambda\surd(1+k)$, where λ is the natural wave-length. It is seen that as the coupling k becomes small these two wave-lengths coalesce into one single wave length. Hence there are advantages in employing a very loose coupling.

(iii) The antenna may be direct-coupled to the closed oscillatory circuit in the manner suggested by F. Braun, A. Slaby and O. Lodge. In this case a closed condenser circuit is formed with a battery of Leyden jars, an inductance coil and a spark gap, and oscillations are excited in it by discharges created across the spark gap by an induction coil or transformer. One end of the inductance coil is connected to the earth, and some other point on the closed condenser circuit to an antenna of appropriate length. When oscillations are created in the closed circuit syntonic oscillations are created in the antenna and electric waves radiated from it (fig. 41). In many cases additional condensers or inductance coils are inserted in various places so that the arrangement is somewhat disguised, but by far the larger part of the electric wave wireless telegraphy in 1907 was effected by transmitters having antennae either inductively or directly coupled to a closed condenser circuit containing a spark gap.

In practical wireless telegraphy the antenna is generally a collection of wires in fan shape upheld from one or more masts or wooden towers. Sometimes the prolongations of these wires are carried horizontally or dipped down so as to form an umbrella antenna (fig. 42). The lower ends of these wires are connected through the secondary coil of an oscillation transformer to an earth plate, or to a large conductor placed on or near the earth called a "balancing capacity." If the direct coupling is adopted then the lower end of the antenna is connected directly to the condenser circuit. The main capacity in this last circuit consists of a battery of Leyden jars or of Leyden panes immersed in oil or some form of air condenser, and the inductance coil or primary circuit of the oscillation transformer consists of a few turns of highly insulated wire wound on a frame and immersed in oil. The oscillations are controlled either by a key inserted in the primary circuit of the exciting induction coil or transformer, or by a key cutting in and out of the primary condensers or throwing inductance in and out of the closed oscillation circuit. In one of these ways the oscillations can be created or stopped at pleasure in the radiating antenna, and hence groups of electric waves thrown off at will.

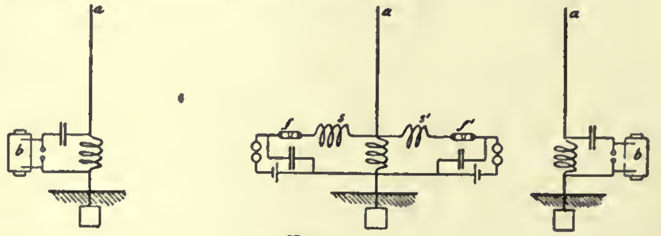

FIG. 41.

Production of Electric Waves of Large Amplitude.—In creating powerful electric waves for communication over long distances it is necessary to employ an alternating current transformer (see TRANSFORMERS) supplied with alternating currents from a low frequency alternator D driven by an engine to charge the condenser (fig. 43). The transformer T_1 has its secondary or high-pressure terminals connected to spark balls S_1, which are also connected by a circuit consisting of a large glass plate condenser C_1 and the primary circuit of an air-core transformer T_2, called an oscillation transformer. The secondary circuit of this last is either connected between an aerial A and the earth E, or it may be again in turn connected to a second pair of spark balls S_2, and these again to a second condenser C_2, oscillation transformer T_2, and the aerial A. In order to produce electric oscillations in the system, the first or alternating current transformer must charge the condenser connected to its secondary terminals, but must not produce a permanent electric arc between the balls. Various devices have been suggested for extinguishing the arc and yet allowing the condenser oscillatory discharge to take place. Tesla effected this purpose by placing the spark balls transversely in a powerful magnetic field. Elihu Thomson blows on the spark balls with a powerful jet of air. Marconi causes the spark balls to move rapidly past each other or causes a studded disk to move between the spark balls. J. A. Fleming devised a method which has practical advantages in both preventing the arc and permitting the oscillatory currents to be controlled so as to make electric wave signals. He inserts in the primary circuit of the alternating

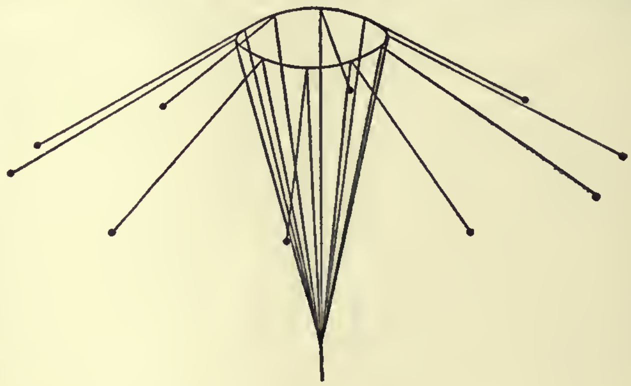

FIG. 42.

current transformers one or more choking or impedance coils R_1, R_2 (fig. 43), called "chokers," which are capable, one or all, of being short-circuited by keys K_1, K_2. The impedance of the primary or alternator circuit is so adjusted that when both the chokers are in circuit the current flowing is not sufficient to charge the condensers; but when one choker is short-circuited the impedance is reduced so that the condenser is charged, but the alternating arc is not formed. In addition it is necessary to

[1] See J. S. Stone, *U.S.A. Pat. Spec.*, Nos. 714756 and 714831.

adjust the frequency so that it has the value of the normal time period of the circuit formed of the condenser and transformer secondary circuit, and thus it is possible to obtain condenser oscillatory discharges free from any admixture with alternating current arc. In this manner the condenser discharge can be started or stopped at pleasure, and long and short discharges made in accordance with the signals of the Morse

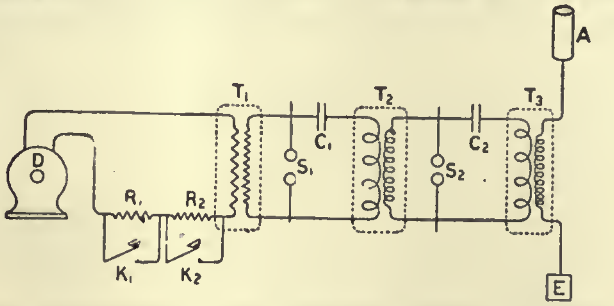

FIG. 43.—Alternate Current Transformer System. (Fleming.)

alphabet by manipulating the short-circuiting key of one of the choking coils (see *British Patent Specs.*, Nos. 18865, 20576 and 22126 of 1900, and 3481 of 1901).

In the case of transmitters constructed as above described, in which the effective agent in producing the electric waves radiated is the sudden discharge of a condenser, it should be noticed that what is really sent out is a train of damped or decadent electric waves. When electric oscillations are set up in an open or closed electric circuit having capacity and inductance, and left to themselves, they die away in amplitude, either because they dissipate their energy as heat in overcoming the *resistance* of the circuit, or because they *radiate* it by imparting wave motion to the surrounding ether. In both cases the amplitude of the oscillations decreases more or less rapidly. Such a sequence of decreasing electric oscillations and corresponding set of waves is called a damped train. In the case of the plain or directly excited antenna the oscillations are highly damped, and each train probably only consists at most of half a dozen oscillations. The reason for this is that the capacity of a simple antenna is very small—it may be something of the order of 0·0002 of a microfarad—and hence the energy stored up in it even under a high voltage is also small. Accordingly this energy is rapidly dissipated and but few oscillations can take place. If, however, the antenna is inductively or directly coupled to a condenser circuit of large capacity then the amount of energy which can be stored up before discharge takes place is very much greater, and hence can be drawn upon to create prolonged or slightly damped trains of waves. Allusion is made below to recent work on the production of undamped trains of electric waves.

Receiving Arrangements.—Before explaining the advantages of such small damping it will be necessary to consider the usual forms of the receiving appliance. This consists of a receiving antenna similar to the sending antenna, and in any wireless telegraph station it is usual to make the one and the same antenna do duty as a receiver or sender by switching it over from one apparatus to the other. The electric waves coming through space from the sending station strike against the receiving antenna and set up in it high frequency alternating electromotive forces. To detect these currents some device has to be inserted in the antenna circuit or else inductively connected with it which is sensitive to high frequency currents. These wave-detecting devices may be divided into two classes: (i) potential operated detectors, and (ii) current operated detectors. The oldest of the class (i) is that generically known as a *coherer*, the construction of which we have already described. The ordinary forms of metallic filings coherer of the Branly type require tapping to bring them back to the high resistance or sensitive condition. Lodge arranged a mechanical tapper for the purpose which continually administered the small blow to the tube sufficient to keep the filings in a sensitive condition. Popoff employed an electromagnetic tapper, in fact the mechanism of an electric bell with the gong removed, for this purpose. Marconi, by giving great attention to details, improved the electromagnetic tapper, and, combining it with his improved form of sensitive tube, made a telegraphic instrument as follows: the small glass tube, containing nickel and silver filings between two silver plugs, was attached to a bone holder, and under this was arranged a small electromagnet having a vibrating armature like an electric bell carrying on it a stem and hammer. This hammer is arranged so that when the armature vibrates it gives little blows to the underside of the tube and shakes up the filings. By means of several adjusting screws the force and frequency of these blows can be exactly regulated. In series with the tube is placed a single voltaic cell and a telegraphic relay, and Marconi added certain coils placed across the spark contacts of the relay to prevent the local sparks affecting the coherer. The relay itself served to actuate a Morse printing telegraph by means of a local battery. This receiving apparatus, with the exception of the Morse printer, was contained in a sheet-iron box, so as to exclude it from the action of the sparks of the neighbouring transmitter. In the early experiments Marconi connected the sensitive tube in between the receiving antenna and the earth plate, but, as already mentioned, in subsequent forms of apparatus he introduced the primary coil of a peculiar form of oscillation transformer into the antenna circuit and connected the ends of the sensitive tube to the terminals of the secondary circuit of this "jigger" (fig. 44). In later improvements the secondary circuit of this jigger was interrupted by a small condenser, and the terminals of the relay and local cell were connected to the plates of this condenser, whilst the sensitive tube was attached to the outer ends of the secondary circuit. Also another condenser was added in parallel with the sensitive tube.

With this apparatus some of Marconi's earliest successes, such as telegraphing across the English Channel, were achieved, and telegraphic communication at the rate of fifteen words or so a minute established between the East Goodwin lightship and the South Foreland lighthouse, also between the Isle of Wight and the Lizard in Cornwall. It was found to be peculiarly adapted for communication between ships at sea and between ship and shore, and a system of regular supermarine communication was put into operation by two limited companies, Marconi's Wireless Telegraph Company and the Marconi International Marine Communication Company. Stations were established on various coast positions and ships supplied with the above-described apparatus to communicate with each other and with these stations. By the end of 1901 this radio-telegraphy had been established by Marconi and his associates on a secure industrial basis.

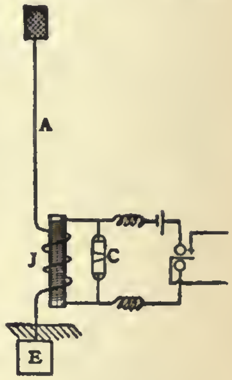

FIG. 44.

Various Forms of Wave Detectors or Receivers.—The numerous adjustments required by the tapper and the inertia of the apparatus prompted inventors to seek for a self-restoring coherer which should not need tapping. Castelli, a petty officer in the Italian navy, found that, if a small drop of mercury was contained in a glass tube between a plug of iron and carbon, with certain adjustments, the arrangement was non-conductive to the current from a single cell but became conductive when electric oscillations passed through it.[1] Hence the following appliance was worked out by Lieutenant Solari and officers in the Italian navy.[2] The tube provided with certain screw adjustments had a single cell and a telephone placed in series with it, and one end of the tube was connected to the earth and the other end to a receiving antenna. It was then found that when electric waves fell on the antenna a sound was heard in the telephone as each wave train passed over it, so that if the wave trains endured for a longer or shorter time the sound in the telephone was of corresponding duration. In this manner it was possible to hear a Morse code dash or dot in the telephone. This method of receiving soon came to be known as the telephonic method. Lodge, Muirhead and Robinson also devised a self-restoring coherer as follows:[3]—A small steel wheel with a sharp edge was kept rotating by clockwork so that its edge continually cut through a globule of mercury covered with paraffin oil. The oil film prevented

[1] See *Electrical Review*, 1902, 51, p. 968.

[2] See "A Royal Institution Discourse," by G. Marconi, *The Electrician*, 1902, 49, p. 490; also *British Pat. Spec.*, No. 18105 of 1901.

[3] See *British Pat. Spec.*, Lodge and others, No. 13521 of 1902.

perfect electrical contact between the steel and mercury for low voltage currents, but when electric oscillations were passed through the junction it was pierced and good electrical contact established as long as the oscillations continued. This device was converted into an electric wave detector as follows:—The mercury-steel junction was acted upon by the electromotive force of a shunted single cell and a siphon recorder was inserted in series. The wheel was connected to a receiving antenna and the mercury to earth or to an equivalent balancing capacity. When electric waves fell on the antenna they caused the mercury-steel junction to become conductive during the time they endured, and the siphon recorder therefore to write signals consisting of short or long deflexions of its pen and therefore notches of various length on the ink line drawn on the strip of telegraphic tape.

An innumerable number of forms of coherer or wave detector depending upon the change in resistance produced at a loose or imperfect contact have been devised. A. Popoff,[1] E. Branly,[2] A. Blondel,[3] O. Lodge[4] and J. A. Fleming[5] invented special forms of the metallic contact or metallic filings sensitive tube. Brown and Neilson,[6] F. J. Jervis-Smith[7] and T. Tommasina[8] tried carbon in various forms. The theory of the action of the coherer has occupied the attention of T. Sundorp,[9] T. Tommasina,[8] K. E. Guthe,[10] J. C. Bose,[11] W. H. Eccles,[12] and Schäfer.[13] For details see J. A. Fleming, *The Principles of Electric Wave Telegraphy and Telephony*, p. 416, 2nd ed. 1910.

The next class of wave or oscillation detector is the magnetic detector depending upon the power of electric oscillations to affect the magnetic state of iron. It had long been known that the discharges from a Leyden jar could magnetize or demagnetize steel needles. J. Henry in the United States in 1842 and 1850 investigated the effect. In 1895 E. Rutherford examined it very carefully, and produced a magnetic detector for electric waves depending upon the power of electric oscillations in a coil to demagnetize a saturated bundle of steel wires placed in it (see *Phil. Trans.*, 1897, 189 A, p. 1). Rutherford used this detector to make evident the passage of an electric or Hertzian wave for half a mile across Cambridge, England. In 1897 E. Wilson constructed various forms of electric wave detector depending on this same principle. In 1902 Marconi invented two forms of magnetic detector, one of which he developed into an electric wave detector of extraordinary delicacy and utility (see *Proc. Roy. Soc.*, 1902, 70, p. 341, or *British Pat. Spec.*, No. 10245 of 1902). In this last form an endless band of hard iron wires passes slowly round two wooden pulleys driven by clockwork. In its course it passes through a glass tube wound over with two coils of wire; one of these is an oscillation coil through which the oscillations to be detected pass, and the other is in connexion with a telephone. Two horse-shoe magnets are so placed (fig. 45) that they magnetize the part of the iron band passing through the coil. Owing to hysteresis the part of the band magnetized is not symmetrically placed with regard to the magnetic poles, but advanced in the direction of motion of the band. When the oscillations pass through the coil they annul the hysteresis and cause a change of magnetism within the coil connected to the telephone. This creates a short sound in the telephone. Hence according as the trains of oscillations are long or short so is the sound heard in the telephone, and these sounds can be arranged on the Morse code into alphabetic audible signals. When used as a receiver for wireless telegraphy Marconi inserted the oscillation coil of this detector in between the earth and a receiving antenna, and this produced one of the most sensitive receivers yet made for wireless telegraphy. Other forms of magnetic detector have been devised by J. A. Fleming,[14] L. H. Walter and J. A. Ewing,[15] H. T. Simon and M. Reich,[16] R. A. Fessenden[17] and others.

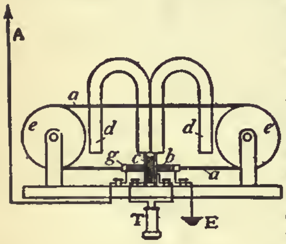

FIG. 45.

[1] A. Popoff, *The Electrician*, 1897, 40, p. 235.
[2] E. Branly, *Comptes rendus*, 1890, 111, p. 785, and *The Electrician*, 1891, 27, p. 221.
[3] A. Blondel, *The Electrician*, 1899, 43, p. 277.
[4] O. Lodge, *The Electrician*, 1897, 40, p. 90.
[5] J. A. Fleming, *Journ. Inst. Elec. Eng. Lond.*, 1899, 28, p. 292.
[6] Brown and Neilson, *Brit. Patent Spec.*, No. 28958, 1896.
[7] F. J. Jervis-Smith, *The Electrician*, 1897, 40, p. 85.
[8] T. Tommasina, *Comptes rendus*, 1899, 128, p. 666.
[9] T. Sundorp, *Wied. Ann.*, 1899, 60, p. 594.
[10] K. E. Guthe, *The Electrician*, 1904, 54, p. 92.
[11] J. C. Bose, *Proc. Roy. Soc. Lond.*, 1900, 66, p. 450.
[12] W. H. Eccles, *The Electrician*, 1901, 47, p. 682.
[13] Schäfer, *Science Abstracts*, 1901, 4, p. 471.
[14] See J. A. Fleming, "A Note on a Form of Magnetic Detector for Hertzian Waves adapted for Quantitative Work," *Proc. Roy. Soc.*, 1903, 74, p. 398.
[15] L. H. Walter and J. A. Ewing, *Proc. Roy. Soc.*, 1904, 73, p. 120.
[16] Simon and Reich, *Elektrotech. Zeits.*, 1904, 22, p. 180.
[17] R. A. Fessenden, *U.S.A. Pat. Spec.*, No. 715043 of 1902.

A third class of electric wave detector depends upon the power of electric oscillations to annul the electrolytic polarization of electrodes of small surface immersed in an electrolyte. If in a vessel of nitric acid are placed a large platinum plate and a platinum electrode of very small surface such as that produced when an extremely fine platinum wire is slightly immersed in the liquid, and if a current from a single voltaic cell is passed through the electrolytic cell so that the fine wire is the anode or positive pole, then the small surface will be polarized or covered with a film of gas due to electrolysis (fig. 46). This increases the resistance of the electrolytic cell. If, however, one electrode of this cell is connected to the earth and the other to a receiving antenna and electric waves allowed to fall on the antenna, the oscillations passing through the electrolytic cell will remove the polarization and temporarily decrease the resistance of the cell. This may be detected by putting a telephone in series with the electrolytic cell, and then on the impact of the electric waves a sound is heard in the telephone due to the sudden increase in the current through it. Such receivers were devised by R. A. Fessenden,[18] W. Schloemilch[19] and others, and are known as electrolytic detectors. Discussions have taken place as to the theory of the operations in them, in which some have advocated a thermal explanation and others a chemical explanation (see V. Rothmund and A. Lessing, *Ann. der Physik*, 1904, 15, p. 193, and J. E. Ives, *Electrical World* of New York, December 1904).

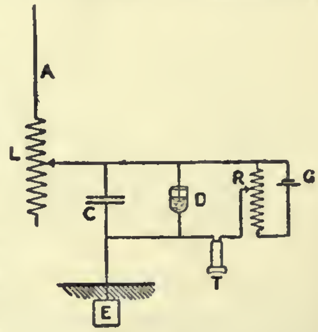

FIG. 46.

A fourth class of electric wave detector comprises the thermal detectors which operate in virtue of the fact that electric oscillations create heat in a fine wire through which they pass. One form such a detector takes is the *bolometer*. If a loop of very fine platinum wire, prepared by the Wollaston process, is included in an exhausted glass bulb like an incandescent lamp, then when electric oscillations are sent through it its resistance is increased. This increase may be made evident by making the loop of wire one arm of a Wheatstone's bridge and so arranging the circuits that the oscillations pass through the fine wire. H. Rubens and Ritter in 1890 (*Wied. Ann.*, 1890, 40, p. 56) employed an arrangement as follows: Four fine platinum or iron wires were joined in lozenge shape, and two sets of these R and S were connected up with two resistances P and Q to form a bridge with a galvanometer G and battery B. To one of these sets of fine wires an antenna A and earth connexion E is added (fig. 47) and when electric waves fall on A they excite oscillations in the fine wire resistance R and increase the resistance, and so upset the balance of the bridge and cause the galvanometer to deflect. Such a bolometer receiver has been used by C. Tissot (*Comptes rendus*, 1904, 137, p. 846) and others as a receiver in electric wave telegraphy.

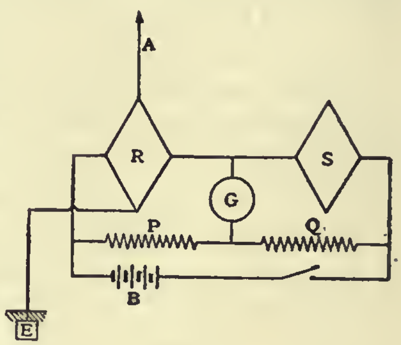

FIG. 47.

Fessenden employed a simple fine loop of Wollaston platinum wire in series with a telephone and shunted voltaic cell, so that when electric oscillations passed through the fine wire its resistance was increased and the current through the telephone suddenly diminished (R. A. Fessenden, *U.S.A. Pat. Spec.*, No. 706742 and No. 706744 of 1902). I. Klemençiç devised a form of thermal receiver depending on thermoelectricity. A pair of fine wires of iron and constantan are twisted together in the middle, and one pair of unlike ends are connected to a galvanometer. If then oscillations are sent through the other pair heat is produced at the junction and the galvanometer indicates a thermoelectric current (*Wied. Ann.*, 1892, 45, p. 78). This thermoelectric receiver was made vastly more sensitive by W. Duddell (*Phil. Mag.*, 1904, 8, p. 91). He passed the oscillations to be detected through a fine wire or strip of gold leaf, and over this, but just not touching, suspended a loop of bismuth-antimony wire by a quartz fibre. This loop hung in a very strong magnetic field, and when one junction was heated by radiation and convection from the heating wire the loop was

[18] See R. A. Fessenden, *U.S.A. Pat. Spec.*, No. 731029, and reissue No. 12115 of 1903.
[19] W. Schloemilch, *Elektrotech. Zeits.*, 1903, 24, p. 959, or *The Electrician*, 1903, 52, p. 250.

traversed by a current and deflected in the field. Its deflexion was observed by an attached mirror in the usual way.

Another form of thermoelectric receiver has been devised by J. A. Fleming (*Phil. Mag.*, December 1906) as follows:—It consists of two glass vessels like test tubes one inside the other, the space between the two being exhausted. Down the inner test tube pass four copper strips having platinum wires at their ends sealed through the glass. In the inner space between the test tubes one pair of these platinum wires are connected by a fine constantan wire about ·02 mm. in diameter. The other pair of platinum wires are connected by a tellurium-bismuth thermo-couple, the junction of which just makes contact with the centre of the fine wire. The outer terminals of this junction are connected to a galvanometer, and when electric oscillations are sent through the fine wire they cause a deflexion of this galvanometer (fig. 48). The thermal detectors are especially useful for the purpose of quantitative measurements, because they indicate the true effective or square root of mean square value of the current or train of oscillations passing through the hot wire. On the other hand, the coherer or loose contact detectors are chiefly affected by the initial value of the electromotive force acting on the junction during the train of oscillations, and the magnetic detectors by the initial value of the current and also to a considerable extent by the number of oscillations during the train. Hence the coherer type of detectors are called potential detectors whilst the thermal are called integral current detectors, the current detectors depending entirely or to some extent upon the damping of the train of oscillations, that is to say, upon the number of oscillations forming a train.

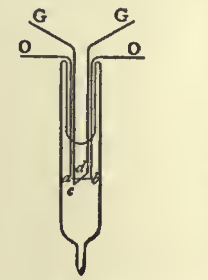

FIG. 48.—Tellurium-bismuth Vacuum Thermal Detector for Electric Oscillations. *a b*, constantan wire; *c d*, thermojunction; G G, galvanometer terminals; O O, antenna and earth terminals.

The fifth type of wave detector depends upon the peculiar property of rarefied gases or vapours which under some circumstances possess a unilateral conductivity. Thus J. A. Fleming invented in 1904 a detector called an oscillation valve or glow lamp detector made as follows:[1] A small carbon filament incandescent lamp has a platinum plate or cylinder placed in it surrounding or close to the filament. This plate is supported by a platinum wire sealed through the glass. Fleming discovered that if the filament is made incandescent by the current from an insulated battery there is a unilateral conductivity of the rarefied gas between the hot filament and the metal plate, such that if the negative terminal of the filament is connected outside the lamp through a coil in which electric oscillations are created with the platinum plate, only one half of the oscillations are permitted to pass, viz., those which carry negative electricity from the hot filament to the cooled plate through the vacuous space. This phenomenon is connected with the fact that incandescent bodies, especially in rarefied gases, throw off or emit electrons or gaseous negative ions.

Such an oscillation valve was first used by Fleming as a receiver for wireless telegraph purposes in 1904 as follows:—In between the receiving antenna and the earth is placed the primary coil of an oscillation transformer; the secondary circuit of this transformer contains a galvanometer in series with it, and the two together are joined between the external negative terminal of the carbon filament of the above-described lamp and the insulated platinum plate. When this is the case oscillations set up in the antenna will cause a continuous current to flow through the galvanometer, the lamp acting as a valve to stop all those electric oscillations in one direction and only permit the opposite ones to pass (fig. 49). Wehnelt discovered that the same effect could be produced by using instead of a carbon filament a platinum wire covered with the oxides of calcium or barium, which when incandescent have the property of copiously emitting negative ions. Another form of receiver can be made depending on the properties of mercury vapour. A highly insulated tube contains a little mercury, which is used as a negative electrode, and the tube also has sealed through the glass a platinum wire carrying an iron plate as an anode. A battery with a sufficient number of cells is connected to these two electrodes so as to pass a current through the mercury vapour, negative electricity proceeding from the mercury cathode to the iron anode. The mercury vapour then possesses a unilateral conductivity, and can be used to filter off all those oscillations in a train which pass in one direction and make them readable on an ordinary galvanometer. In addition to the above gaseous rectifiers of oscillations it has been found that several crystals, such as carborundum (carbide of silicon), hessite, anastase and many others possess a unilateral conductivity and enable us to rectify trains of oscillations into continuous currents which can affect a telephone. Also several contacts, such as that of galena (sulphide of lead) and plumbago, and molybdenite and copper possess similar powers, and can be used as detectors in radio-telegraphy. See G. W. Pierce, *The Physical Review*, July 1907, March 1909, on crystal rectifiers for electric oscillations.

[1] See J. A. Fleming, *Proc. Roy. Soc.*, 1905, 74, p. 746. Also *British Pat. Spec.*, No. 24580 of 1904.

Syntonic Electric Wave Telegraphy.—If a simple receiving antenna as above described is set up with an oscillation-detecting device attached to it, we find that it responds to incident electric waves of almost any frequency or damping provided that the magnetic force of the wave is perpendicular to the antenna, and of sufficient intensity. This arrangement is called a non-syntonic receiver. On the other hand, if a closed oscillation circuit is constructed having capacity and considerable inductance, then oscillations can be set up in it by very small periodic electromotive forces provided these have a frequency exactly agreeing with that of the condenser circuit. This last circuit has a natural frequency of its own which is numerically measured by $1/2\pi\sqrt{(CL)}$, where C is the capacity of the condenser and L is the inductance of the circuit. The problem of syntonic electric wave telegraphy is then to construct a transmitter and a receiver of such kind that the receiver will be affected by the waves emitted by the corresponding or syntonic transmitter, but not by waves of any other wave-length or by irregular electric impulses due to atmospheric electricity. It was found that to achieve this result the transmitter must be so constructed as to send out prolonged trains of slightly damped waves. Electric-radiative circuits like thermal radiators are divided into two broad classes, good radiators and bad radiators. The good electric radiators may be compared with good thermal radiators, such as a vessel coated with lamp black on the outside, and the bad electric radiators to poor thermal radiators, such as a silver vessel highly polished on its exterior. When electric oscillations are set up in these two classes of electric radiators, the first class send out a highly damped wave train and the second a feeble damped wave train provided that they have sufficient capacity or energy storage and low resistance. A radiator of this last class can be constructed by connecting inductively or directly an antenna of suitable capacity and inductance to a nearly closed electric circuit consisting of a condenser of large capacity, a spark gap and an inductance of low resistance. When oscillations are excited in this last circuit they communicate them to the antenna provided this last circuit is *tuned* or syntonized to the closed circuit, and the radiating antenna has thus a large store of energy to draw upon and can therefore radiate prolonged trains of electric waves. The above statements, though correct as far as they go, are an imperfect account of the nature of the radiation from a coupled antenna, but a mathematical treatment is required for a fuller explanation.

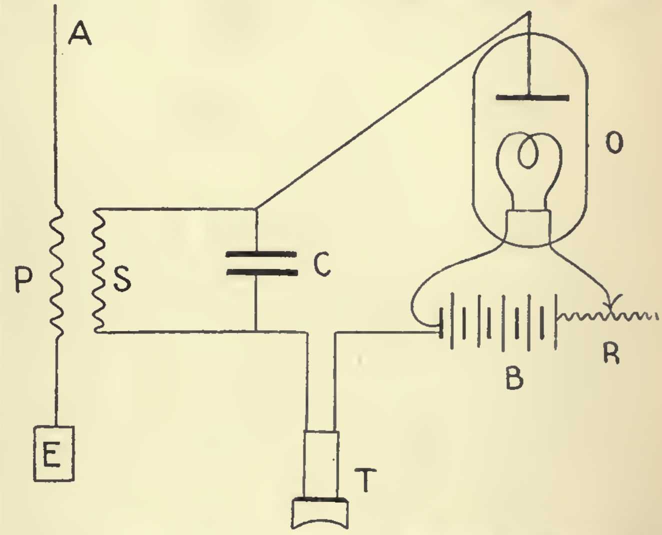

FIG. 49.—A, antenna; P S, jigger or oscillation transformer; C, condenser; O, Fleming oscillation valve; B, working battery; T, telephone; R, rheostat; E, earth-plate.

The success so far achieved in isolating electric wave telegraphic stations has been based upon the principles of electric resonance and the fact that electric oscillations can be set up in a circuit having capacity and considerable inductance by feeble electromotive impulses, provided they are of exactly the natural frequency of the said circuit. We may illustrate the matter as follows: A heavy pendulum possesses inertia and the property of being displaced from a position of rest but tending to return to it. These mechanical qualities correspond to inductance and capacity in electric circuits. Such a pendulum can be set in vigorous vibration even by feeble puffs of air directed against it, provided these are administered exactly in time with the natural period of vibration of the pendulum.

Although inventors had more or less clearly grasped these principles they were first embodied in practice in 1900 by G. Marconi in an operative system of syntonic wireless telegraphy. His transmitter consists of a nearly closed oscillating circuit comprising a condenser or battery of Leyden jars, a spark gap, and the primary coil of an oscillation transformer consisting of one turn of thick wire wound on a wooden frame. Over this primary is wound a secondary circuit of five to ten turns which has one end connected to the earth through a variable inductance coil and the other end to an antenna. These two circuits are syntonized so that the closed or condenser circuit and the open or antenna circuit are adjusted to have, when separate, the same natural electrical time of vibration. The receiving arrangement consists of an antenna which is connected to earth through the primary coil of an oscillation transformer and a variable inductance. The secondary circuit of this transformer is cut in the middle and has a condenser inserted in it, and its ends are connected to the sensitive metallic filings tube or coherer as shown in fig. 50. This receiver therefore, like the transmitter,

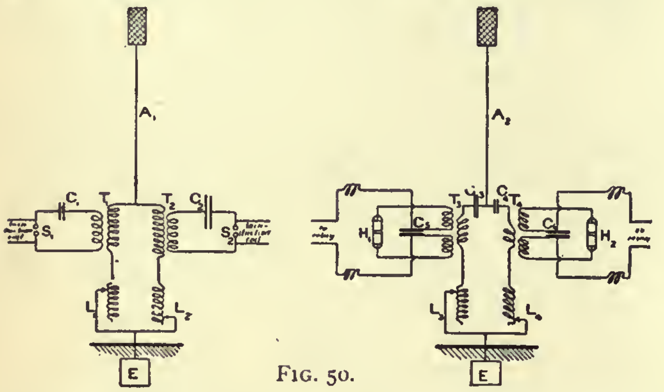

Fig. 50.

consists of an open and a closed electric oscillation circuit inductively connected together; also the two circuits of the receiver must be syntonized or tuned both to each other and to those of the transmitter.[1] When this is done we have a syntonic system which is not easily affected by electric waves of other than the right period or approximating thereto. Marconi exhibited in October 1900 this apparatus in action, and showed that two or more receivers of different tunes could be connected to the same antenna and made to respond separately and simultaneously to the action of separate but tuned transmitters.

A. Slaby in Berlin shortly afterwards made a similar exhibition of syntonic electric wave telegraphy.[2] O. Lodge had previously described in 1897 a syntonic system of electric wave telegraphy, but it had not been publicly seen in operation prior to the exhibitions of Marconi and Slaby.[3] Lodge was, however, fully aware that it was necessary for syntonic telegraphy to provide a radiator capable of emitting sustained trains of waves. His proposed radiator and absorber consisted of two wing-shaped plates of copper, the transmitter plates being interrupted in the centre by a spark gap, and the receiver plates by an inductance coil from the ends of which connexions were made to a coherer. At a later date a syntonic system comprising, as above stated, an antenna directly coupled to a resonant closed circuit was put into operation by Lodge and Muirhead, and much the same methods have been followed in the system known as the *Telefunken* system employed in Germany.

A method of syntonic telegraphy proposed by A. Blondel (*Comptes rendus*, 1900, 130, p. 1383) consisted in creating a syntony not between the frequency of the oscillations in the sender and receiver circuits but between the groups of oscillations constituting the wave trains; but, although other patentees have suggested the same plan, the author is not aware that any success has attended its use in practice. The only other suggested solution of the problem of isolation in connexion with wireless telegraph stations was given by Anders Bull (*Electrician*, 1901, 46, p. 573). Very briefly stated, his method consists in sending out a group of wave trains at certain irregular but assigned intervals of time to constitute the simplest signal equivalent to a dot in the Morse code, and a sequence of such trains, say three following one another, to constitute the dash on the Morse code. The apparatus is exceedingly complicated and can only be understood by reference to very detailed diagrams. (See *Principles of Electric Wave Telegraphy*, by J. A. Fleming, 1906, sect. 13, chap. viii.) By means of the Anders Bull apparatus several messages can be sent out simultaneously from different transmitters and received independently and simultaneously upon corresponding receivers, while no ordinary non-syntonic or other receiver is able either to obscure the messages being sent to the Anders Bull receivers or to interpret those that may be picked up. Although complicated the apparatus seems to work fairly well.

Practical Electric Wave Telegraphy.—At this stage it may be convenient to outline the progress of electric wave telegraphy since 1899. Marconi's success in bridging the English Channel at Easter in 1899 with electric waves and establishing practical wireless telegraphy between ships and the shore by this means drew public attention to the value of the new means of communication. Many investigators were thus attracted into this field of research and invention. In Germany A. Slaby and F. Braun were the most active. Slaby paid considerable attention to the study of the phenomena connected with the production of the oscillations in the antenna. He showed that in a simple Marconi antenna the variations of potential are a maximum at the insulated top and a minimum at the base, whilst the current amplitudes are a maximum at the top earthed end and zero at the top end. He therefore saw that it was a mistake to insert a potential-affected detector such as a coherer in between the base of the antenna and the earth because it was then subject to very small variations of potential between its ends. He overcame the difficulty by erecting a vertical earthed receiving antenna like a lightning rod and attached a lateral extension to it at a yard or two above the earthed end. To the outer end of this lateral wire a condenser was attached and the coherer inserted between the condenser and the earth. The oscillations set up in the vertical antenna excited sympathetic ones in the lateral circuit provided this was of the proper length; and the coherer was acted upon by the maximum potential variations possible. Passing over numerous intermediate stages of development we find that in 1898 Professor F. Braun showed that oscillations suitable for the purposes of electric wave creation in wireless telegraphy could be set up in a circuit consisting of a Leyden jar or jars, a spark gap and an inductive circuit, and communicated to an antenna either by inductive or direct coupling (*Brit. Pat. Spec.*, No. 1862 of 1899). When the methods for effecting this had been worked out practically it finally led to the inventions of Slaby, Braun and others being united into a system called the Telefunken system, which, as regards the transmitter, consisted in forming a closed oscillation circuit comprising a condenser, spark gap and inductance which at one point was attached either directly or through a condenser to the earth or to an equivalent balancing capacity, and at some other point to a suitably tuned antenna. The receiving arrangements comprised also an open or antenna circuit connected directly with a closed condenser-inductance circuit, but in place of the spark gap in the transmitter an electrolytic receiver was inserted, having in connexion with it as indicator a voltaic cell and telephone. In this manner the signals are read by ear. In the same way the arrangements finally elaborated by Lodge and Muirhead consisted of a direct coupled antenna and nearly closed condenser circuit, and a similar receiving circuit containing as a detector the steel wheel revolving on oily mercury which actuated a siphon recorder writing signals on paper tape. Arrangements not very different in general principle were put into practice in the United States by Fessenden, de Forest and others.

Hence it will be seen that the difference between various forms of the so-called spark systems of wireless telegraphy is not very

[1] See G. Marconi, *Brit. Pat. Spec.*, No. 7777 of 1900; also *Journ. Soc. Arts*, 1901, 49, p. 505.

[2] See A. Slaby, *The Electrician*, 1901, 46, p. 475.

[3] See O. Lodge, *Brit. Pat. Spec.*, No. 11575 of 1897.

great. All of them make use of Marconi's antenna in some form both at the transmitting and at the receiving end, all of them make use of an earth connexion, or its equivalent in the form of a balancing capacity or large surface having capacity with respect to the earth, which merely means that they insert a condenser of large capacity in the earth connexion. All of them couple the transmitting antenna directly or inductively to a capacity-inductive circuit serving as a storage of energy, and all of them create thereby electric waves of the same type moving over the earth's surface with the magnetic force of the wave parallel to it. At the receiving station the differences in these systems depend chiefly upon variations in the actual form of the oscillation detector used, whether it be a loose contact or a thermal, electrolytic or magnetic detector.

In July and August 1899 the Marconi system of wireless telegraphy was tried for the first time during British naval manoeuvres, and the two cruisers, "Juno" and "Europa," were fitted with the new means of communication. The important results obtained showed that a weapon of great power had been provided for assisting naval warfare. From and after that time the British Admiralty and the navies of other countries began to give great attention to the development of electric wave telegraphy.

Transatlantic Wireless Telegraphy.—Having found that the principles of resonance could be successfully applied so as to isolate wireless telegraph receivers, Marconi turned his attention to the accomplishment of his great ambition, viz. Transatlantic wireless telegraphy. In January 1901 he telegraphed without difficulty by electric waves from the Isle of Wight to the Lizard, viz. 200 m., and he considered that the time had come for a serious attempt to be made to communicate across the Atlantic. A site for a first Transatlantic electric wave power station was secured at Poldhu, near Mullion in south Cornwall, by the Marconi Company, and plans arranged for an installation. Up to that time an induction coil known as a 10-inch coil had sufficed for spark production, but it was evident that much more power would be required to send electric waves across the Atlantic. Transformers were therefore employed taking alternating electric current from an alternator driven by an oil or steam engine, and these high tension transformers were used to charge condensers and set up powerful oscillations in a multiple antenna. The special electrical engineering arrangements employed at the outset for this first electric wave power station required to create the oscillations of the desired power were designed for Marconi by J. A. Fleming, but the arrangements were subsequently altered and improved by Marconi, one of the most important additions being a form of high-speed rotating disk discharger devised by Marconi by which he was able to immensely increase the speed of signalling. The first antenna employed consisted of 50 bare copper wires 200 ft. long, arranged in fan-shape and upheld between two masts. Subsequently this antenna was enlarged, and four wooden lattice towers were built, 215 ft. high and 200 ft. apart, sustaining a conical antenna comprised of 400 wires (see G. Marconi, *Proc. Roy. Inst.*, 1902, 17, p. 208). This transmitting plant was completed in December 1901, and Marconi then crossed the Atlantic to Newfoundland and began to make experiments to ascertain if he could detect the waves emitted by it. At St John's in Newfoundland he erected a temporary receiving antenna consisting of a wire 400 ft. long upheld by a box kite, and, employing a sensitive coherer and telephone as a receiver, he was able, on December 12, 1901, to hear "S" signals on the Morse code, consisting of three dots, which he had arranged should be sent out from Poldhu at stated hours, according to a preconcerted programme, so as to leave no doubt they were electric wave signals sent across the Atlantic and not accidental atmospheric electric disturbances. This result created a great sensation, and proved that Transatlantic electric wave telegraphy was quite feasible and not inhibited by distance, or by the earth's curvature even over an arc of a great circle 3000 m. in length. In a repetition of this experiment at the end of February 1902 Marconi, on board the s.s. "Philadelphia," received wireless messages printed on the ordinary Morse tape at a distance of 1557 m. from the sending station at Poldhu, and also received the letter "S" at a distance of 2099 m. from the same place. In the course of this voyage he noticed that the signals were received better during the night than the daytime, legible messages being received on a Morse printer only 700 m. by day but 1500 by night.

The appliances in the Poldhu station were subsequently enlarged and improved by Marconi, and corresponding power stations erected at Cape Cod, Massachusetts, U.S.A., and at Cape Breton in Nova Scotia. In 1902 Marconi was able to transmit a large number of messages across the Atlantic, receiving them by means of his magnetic detector. In the same year numerous experiments were tried with the assistance of an Italian battleship, the "Carlo Alberto," lent by the Italian government, and messages were transmitted from Poldhu to Kronstadt, to Spezia, and also to Sydney in Nova Scotia. Doubts having been raised whether the powerful electric waves sent out from these stations would not interfere with the ordinary ship to shore communication, special demonstrations were made by Marconi before the writer, and later before British naval officers, to demonstrate that this was not the case.[1] In 1904 a regular system of communication of press news and private messages from the Poldhu and Cape Breton stations to Atlantic liners in mid-Atlantic was inaugurated, and daily newspapers were thenceforth printed on board these vessels, news being supplied to them daily by electric wave telegraphy. By the middle of 1905 a very large number of vessels had been equipped with the Marconi short distance and long distance wireless telegraph apparatus for intercommunication and reception of messages from power stations on both sides of the Atlantic, and the chief navies of the world had adopted the apparatus. In 1904, during the Russo-Japanese war, war news was transmitted for *The Times* by wireless telegraphy, the enormous importance of which in naval strategy was abundantly demonstrated.

As the power station at Poldhu was then fully occupied with the business of long distance transmission to ships, the Marconi Company began to erect another large power station to Marconi's designs, at Clifden in Connemara on the west coast of Ireland. This station was intended for the Transatlantic service in correspondence with a similar station at Glace Bay in Nova Scotia. It was completed in the summer of 1907, and on the 17th of October 1907 press messages and private messages were sent across the Atlantic in both directions. The station was opened shortly afterwards for public service, the rates being greatly below that then current for the cable service.

The service was, however, interrupted in August 1909 by a fire, which destroyed part of the Glace Bay station, but was re-established in April 1910.

Meanwhile other competitors were not idle. The inventions of Slaby, Braun and others were put into practice by a German wireless telegraph company, and very much work done in erecting land stations and equipping ships. In France the scientific study of the subject was advanced by the work of Blondel, Tissot, Ducretet and others, and systems called the Ducretet and Rochefort set in operation. In the United States the most active workers and patentees at this period were R. A. Fessenden, Lee de Forest, J. S. Stone, H. Shoemaker and a few others. In England, in addition to the Marconi Company, the Lodge-Muirhead Syndicate was formed to operate the inventions of Sir Oliver Lodge and Dr Muirhead.

Directive Telegraphy.—A problem of great importance in connexion with electric wave telegraphy is that of limiting the radiation to certain directions. A vertical transmitting antenna sends out its waves equally in all directions, and these can be equally detected by a suitable syntonic or other receiver at all points on the circumference of a circle described round the transmitter. This, however, is a disadvantage. What is required is some means for localizing and directing a beam of radiation. The first attempts involved the use of mirrors. Hertz had shown that the electric radiation from an oscillator

[1] See J. A. Fleming, *The Principles of Electric Wave Telegraphy* (London, 1906), chap. vii.; also Cantor Lectures on Hertzian wave telegraphy, Lecture iv., *Journ. Soc. Arts*, 1903, or letter to *The Times*, April 14, 1903.

could be reflected and converged by cylindrical parabolic mirrors. He operated with electric waves two or three feet in wave-length. Experiments precisely analogous to optical ones can be performed with somewhat shorter waves. Marconi in his first British patent (No. 12039 of 1896) brought forward the idea of focusing a beam of electric radiation for telegraphic purposes on a distant station by means of parabolic mirrors, and tried this method successfully on Salisbury Plain up to a distance of about a couple of miles. As, however, the wave-length necessary to cover any considerable distance must be at least 200 or 300 ft., it becomes impracticable to employ mirrors for reflection. The process of reflection in the case of a wave motion involves the condition that the wave-length shall be small compared with the dimensions of the mirror, and hence the attempt to reflect and converge electric waves 1000 ft. in length by any mirrors which can be practically constructed would be like attempting optical experiments with mirrors one-hundred-thousandth of an inch in diameter.

Another closely connected problem is that of locating or ascertaining the direction of the sending station. To deal with the latter question first, one of the earliest suggestions was that of J. S. Stone (*U.S.A. Pat. Spec.*, Nos. 716134 and 716135, also reissue No. 12148), who proposed to place two receiving antennae at a distance of half a wave-length apart. If these two were broadside on to the direction of the sending station oscillations in the same phase would be produced in them both, but if they were in line with it then the oscillations would be in opposite phases. It was then proposed to arrange a detector so that it was affected by the algebraic sum of the two oscillations, and by swivelling round the double receiving antennae to locate the direction of the sending station by finding out when the detector gave the best signal. Even if the proposal had been practicable with waves 1000 or 2000 ft. in length, which it is not, it is essentially based upon the supposition that the damping of the waves is negligible. A proposal was made by L. de Forest (*U.S.A. Pat. Spec.*, No. 771818) to employ a receiving antenna consisting of vertical wires held in a frame which could be swivelled round into various positions and used to locate the position of the sending station by ascertaining the position in which the frame must be placed to create in it the maximum oscillatory current. Other inventors had professed to find a solution of the problem by the use of looped receiving antennae or antennae inclined in various directions.

G. Marconi, however, gave in 1906 the first really practical solution of the problem by the use of bent transmitting and receiving antennae. He showed that if an antenna were constructed with a short part of its length vertical and the greater part horizontal, the lower end of the vertical part being earthed, and if oscillations were created in it, electric waves were sent out most powerfully in the plane of the antenna and in the direction opposite to that in which the free end pointed. Also he showed that if such an antenna had its horizontal part swivelled round into various directions the current created in a distant receiver antenna varied with the azimuth, and when plotted out in the form of a polar curve gave a curve of a peculiar figure-of-8 shape.[1] The mathematical theory of this antenna was given by J. A. Fleming (*Proc. Roy. Soc.*, May 1906, also *Phil. Mag.*, December 1906). Marconi also showed that if such a bent receiving antenna was used the greatest oscillations were created in it when its insulated end pointed directly away from the sending station. In this manner he was able to provide means for locating an invisible sending station. F. Braun also gave an interesting solution of the problem of directive telegraphy.[2] In his method three vertical antennae are employed, placed at equidistant distances, and oscillations are created in the three with a certain relative difference of phase. The radiations interfere in an optical sense of the word, and in some directions reinforce each other and in other directions neutralize each other, so making the resultant radiation greater in some directions than others. Very valuable work in devising forms of antennae for directive radio-telegraphy has been done by MM. Bellini and Tosi, who have devised instruments, called radiogonimeters, for projecting radiation in required directions and locating the azimuth of a transmitting station.

Improvements in the Production of Continuous Trains of Electric Waves.—All the above-described apparatus employed in connexion with wireless telegraph transmitters, in which the oscillatory discharge of a condenser is used to create oscillations in an antenna, labours under the disadvantage that the time occupied by the oscillations is a very small fraction of the total time of actuation. Thus, for instance, when using an induction coil or transformer to charge a condenser, it is not generally convenient to make more than 50 discharges per second, but each of these may create a train of oscillations consisting of, say, 20 to 50 waves. Supposing, then, that these waves are 1000 ft. in wave-length, the frequency of the oscillations would by 1,000,000 per second, and accordingly 50 of these waves would be emitted in 1/20,000th part of a second; and if there are 50 groups of waves per second, the total time occupied by the oscillations in a second would only be 1/400th part of a second. In other words, the intervals of silence are nearly 400 times as long as the intervals of activity. It very soon, therefore, became clear to inventors that a very great advantage would be gained if some means could be discovered of creating high frequency oscillations which were not intermittent but continuous. The condenser method of making oscillations is analogous to the production of air vibrations by twanging a harp string at short intervals. What is required, however, is something analogous to an organ pipe which produces a continuous sound.

A method of producing these oscillations devised by Valdemar Poulsen is based upon the employment of what is called a musical arc. W. Duddell discovered in 1900 that if a continuous current carbon arc had its carbon electrodes connected by a condenser in series with an inductance, then under certain conditions oscillations were excited in this condenser circuit which appeared to be continuous. Poulsen immensely improved this process by placing the arc in an atmosphere of hydrogen, coal-gas or some other non-oxidizing gas, and at the same time arranging it in a strong magnetic field.[3] In this way he was able to produce an apparatus which created continuous trains of oscillations suitable for the purposes of wireless telegraphy. The so-called musical arc of Duddell has been the subject of considerable investigation, and physicists are not entirely in accordance as to the true explanation of the mode of production of the oscillations. It appears, however, to depend upon the fact that an electric arc is not like a solid conductor. Increase in the voltage acting upon a solid conductor increases the current through it, but in the case of the electric arc an increase in current is accompanied by a fall in the difference of potential of the carbons, within certain limits, and the arc has therefore been said to possess a negative resistance.[4]

Poulsen's method of producing continuous or undamped electrical waves has been applied by him in radio-telegraphy. The electric arc is formed between cooled copper (positive) and carbon (negative) electrodes in an atmosphere of hydrogen or coal-gas. In recent apparatus, to enable it to be used on board ship, a hydrogeneous spirit is used which is fed drop by drop into the chamber in which the arc is worked. Across the arc is a transverse or radial magnetic field, and the electrodes are connected by an oscillatory circuit consisting of a condenser and inductance. The antenna is connected either directively or inductively with the circuit. At the receiving end are a similar antenna and resonant circuit, and a telephone is connected across one part of the latter through an automatic interrupting device called by Poulsen a "ticker." To send signals the continuous or nearly continuous train of waves must be cut up into Morse signals by a key, and these are then heard as audible signals in the telephone. An important modification of this method enables not only audible signals but articulated words to be transmitted, and gives thus a system of wireless telephony. This has been achieved by employing a microphone transmitter at the sending end to vary the amplitude but not the wave-length of the emitted waves, and at the receiving end using an electrolytic receiver, which proves to be not merely a qualitative but also a quantitative instrument, to make these variations audible on a telephone. The system has already been put into practice in Germany by the *Gesellschaft für drahtlose Telegraphie*, and in the United States by R. A. Fessenden. This last-named inventor has

[1] See G. Marconi, *Proc. Roy. Soc.*, 1906, A 77, p. 413.

[2] F. Braun, *The Electrician*, May 25 and June 1, 1906.

[3] See V. Poulsen, *Brit. Pat. Spec.*, No. 15599 of 1903; also a lecture given in London, November 27, 1906, "On a Method of producing undamped Electrical Oscillations and their employment in Wireless Telegraphy," *Electrician*, 1906, 58, p. 166.

[4] Reference may be made to W. Duddell, "On Rapid Variations in the Current through the Direct Current Arc," *Journ. Inst. Elec. Eng.*, 1900, 30, p. 232; P. Janet, "On Duddell's Musical Arc." *Comptes rendus*, 1902, 134, p. 821; S. Maisel, *Physik. Zeits.*, September 1, 1904, and January 15, 1905, or *L'Éclairage électrique*, 1904, 41, p. 186; J. A. Fleming, *The Principles of Electric Wave Telegraphy*, 1906, p. 73.

employed for the production of the continuous trains of waves a high frequency alternator of his own invention (see *The Electrician*, 1907, 58, pp. 675, 701). Much work has been done on this matter by E. Ruhmer, for which the reader must be referred to his work, *Drahtlose Telephonie*, Berlin, 1907. There is no doubt that the transmission of articulate sounds and speech over long distances without wires by means of electric waves is not only possible as an experimental feat but may perhaps come to be commercially employed. In connexion with this part of the subject a brief reference should also be made to M. Wien's method of impact excitation by employing a form of spark gap which quenches the primary discharge instantly and excites the free oscillations in the antenna by impact or shock.

Instruments and Appliances for making Measurements in Connexion with Wireless Telegraphy.—The scientific study of electric wave telegraphy has necessitated the introduction of many new processes and methods of electrical measurement. One important measurement is that of the wave-length emitted from an antenna. In all cases of wave motion the wave-length is connected with the velocity of propagation of the radiation by the relation $v=n\lambda$, where n is the frequency of the oscillations and λ is the wave-length. The velocity of propagation of electric waves is the same as that of light, viz., about 1000 million feet, or 300 million metres, per second. If therefore we can measure the frequency of the oscillations in an antenna we are able to tell the wave-length emitted. Instruments for doing this are called wave meters and are of two kinds, open circuit and closed circuit. Forms of open circuit wave meter have been devised by Slaby and by Fleming. Slaby's wave meter consists of a helix of non-insulated wire wound on a glass tube. This helix is presented or held near to the antenna, and the length of it shortened until oscillations of the greatest intensity are produced in the helix as indicated by the use of an indicator of fluorescent paper.

Closed circuit wave meters have been also devised by J. Dönitz[1] and by Fleming.[2] In Dönitz's wave meter a condenser of variable capacity is associated with inductance coils of various sizes, and the wave meter is placed near the antenna so that its inductance coils have induced currents created in them. The capacity of the condenser is then altered until the maximum current, as indicated by a hot wire ammeter, is produced in the circuit. From the known value of the capacity in that position and the inductance the frequency can be calculated. The Fleming closed circuit wave meter, called by him a cymometer, consists of a sliding tube condenser and a long helix of wire forming an inductance; these are connected together and to a copper bar in such a manner that by one movement of a handle the capacity of the tubular condenser is altered in the same proportion as the amount of the spiral inductance which is included in the circuit. If, then, a long copper bar which forms part of this circuit is placed in proximity to the transmitting antenna and the handle moved, some position can be found in which the natural time period of the cymometer circuit is made equal to the actual time period of the telegraphic antenna. When this is the case the amplitude of the potential difference of the surfaces of the tubular condenser becomes a maximum, and this is indicated by connecting a vacuum tube filled with neon to the surfaces of the condenser. The neon tube glows with a bright orange light when the adjustments of the cymometer circuit are such that it is in resonance with the wireless telegraph antenna. The scale on the cymometer then shows directly the wave-length and frequency of the oscillations.[3]

An immense mass of information has been gathered on the scientific processes which are involved in electric wave telegraphy. Even on fundamental questions such as the function of the earth interconnexion with it physicists differ in opinion to a considerable extent. Starting from an observation of Marconi's, a number of interesting facts have been accumulated on the absorbing effect of sunlight on the propagation of long Hertzian waves through space, and on the disturbing effects of atmospheric electricity as well as upon the influence of earth curvature and obstacles of various kinds interposed in the line between the sending and transmitting stations.[4]

Electric wave telegraphy has revolutionized our means of communication from place to place on the surface of the earth, making it possible to communicate instantly, and certainly between places separated by several thousand miles, whilst at the same time it has taken a position of the greatest importance in connexion with naval strategy and communication between ships and ships and the shore in time of peace. It is now generally recognized that Hertzian wave telegraphy, or radio-telegraphy, as it is sometimes called, has a special field of operations of its own, and that the anticipations which were at one time excited by uninformed persons that it would speedily annihilate all telegraphy conducted with wires have been dispersed by experience. Nevertheless, transoceanic wireless telegraphy over long distances, such as those across the Atlantic and Pacific oceans, is a matter to be reckoned with in the future, but it remains to be seen whether the present means are sufficient to render possible communication to the antipodes. The fact that it has become necessary to introduce regulations for its control by national legislation and international conferences shows the supremely important position which it has taken in the short interval of one decade as a means of communicating human intelligence from place to place over the surface of the globe. An important International Conference on radio-telegraphy was held in Berlin in 1906, and as a result of its deliberations international regulations have been adopted by the chief Powers of the world. The decisions of the Conference were ratified for Great Britain by the British government on July 1, 1908.

[1] *The Electrician*, 1904, 52, p. 407, or *German Pat. Spec.*, No. 149350.

[2] *Brit Pat. Spec.*, No. 27683 of 1904.

[3] J. A. Fleming, *Phil. Mag.*, 1905 [6], 9, p. 758.

[4] See Admiral Sir H. B. Jackson, F.R.S., *Proc. Roy. Soc.*, 1902, 70, p. 254: G. Marconi, *ib.*, 1902, 70, p. 344.

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TELEMACHUS, in Greek legend (*Odyssey* i.–iv., xv.–xxiv.; Hyginus, *Fab.* 127), son of Odysseus and Penelope. When he reached manhood, he visited Pylos and Sparta to make inquiries about his father, who had been absent for nearly twenty years. On his return, he found that Odysseus had reached home before him. Then father and son, aided by Eumaeus and Philoetius, slew or drove out the suitors of Penelope (see ODYSSEUS). According to later tradition, Telemachus became the husband of Circe and by her the father of Latinus and of a daughter Roma, afterwards the wife of Aeneas. In another story, he married a daughter of Circe, named Cassiphone; having slain his mother-in-law in a quarrel, he was himself killed by his wife. This is the only notice of the death of Telemachus. The foundation of Clusium in Etruria was attributed to him.

TELEMARK, or THELEMARK, a district of southern Norway, wholly comprised in the *amt* (county) of Bratsberg. It covers the uplands and fjelds of the southward projection of the country, having its highest point in the Gaustafjeld (6200 ft.); and contains several large and beautiful lakes, as Nordsjö, Bandaksvand, Tinsjö, Mjösvand and Totakvand. The two first are connected by the Bandaks canal, a fine engineering work giving access from the port of Skien to Dalen at the head of Bandaksvand. From Dalen, which may be reached by road from the railway at Kongsberg (38 miles) a driving road much frequented by travellers runs north-west. It traverses a precipitous wooded gorge, its course in parts hewn out of the rock, and skirts the Börte and Grungedal lakes, follows the Flaathyl river, passes the Vafos and Little Rjukanfos (waterfalls), and Lake Voxli, and culminates at Haukelidsaeter, a station grandly situated among the fjelds at a height of 3085 ft. It rises to the watershed (3715 ft.) and then, leaving the district, descends abruptly with a remarkable winding course to Röldal (58 miles from Dalen), and soon divides, one branch surmounting the Horrebraekke pass and continuing to Odde, the other traversing the beautiful Bratlandsdal. On the Kongsberg-Dalen road is Hitterdal, with a good specimen of the Stavekirke or medieval timber-built church. A divergence from this route may be made by way of Tinsjö to Fosso, where the Maan river forms a fine fall (Rjukanfos) of 415 ft.

TELEOLOGY (Gr. τέλος, end), in philosophy and theology, strictly that branch of study which considers "final causes" as real principles of explanation, *i.e.* which explains things as existing solely as pre-requisites of the results which they produce. More commonly the term is applied to the doctrine that the universe as a whole has been planned on a definite design, or at least that it tends towards some end. The term has been used very loosely, and its meaning has changed considerably. The root idea arises from the analogy of the acts of human beings which are observed to have certain purposes: hence it was natural to assume that the whole sum of existence with its amazing complexity and its orderly progress can be explained only on the assumption of a similar plan devised by a conscious agent. Such a view is essential to any theistic view of the universe which postulates God as the Creator, omniscient and all-good. The modern theory of evolution, on the other hand, has reintroduced a scientific teleology of another type. This is discussed, from the biologist's point of view, in the article ZOOLOGY. Teleology, in this narrower sense, as the study of the adaptation of organic structures to the service of the organisms in which they occur, was completely revolutionized by Darwinism and the research founded on it.

TELEOSTOMES, members of the third sub-class of the class Fishes, being all the fishes in which the skull is invested with membrane bones, viz., the Crossopterygians, the Dipnoans, the Ganoids and the Teleosteans. They may be further defined as fishes with an ossified or cartilaginous skeleton, a lower jaw, gills inserted on the gill-arches, a single gill-opening on each side (exceptionally fused with its fellow on the ventral side), an opercle formed of one or several bones, the body usually covered with scales or bony plates, an air-bladder or lung, at least in the primitive forms, and without copulatory paired organs or "claspers."

The term which designates this sub-class has been adopted by Sir R. Owen, E. D. Cope, and A. S. Woodward in a less comprehensive sense, the Dipneusti being regarded by them as constituting a separate sub-class, and its inventor, C. L. Bonaparte (1838) had proposed it in a more restricted sense, the sturgeons, lophobranchs and plectognaths being excluded. T. Gill (1872) was the first to use it in the acceptation taken in the present article. Whether the Ostracophores should be included among the Teleostomes, as recently proposed by C. T. Regan, is still open to doubt. The sub-class is here divided into four orders, but it is difficult to decide whether, in an ascending series, the Crossopterygians or the Ganoids should be placed first. From the point of view of the evolution of the paired fins, accepting the lateral fin-fold theory as the better supported by the evidence at hand, there is much to say in favour of regarding the Chondrostean Ganoids as the more primitive type. From another point of view the condition of the air-bladder in the existing Crossopterygians appears to represent the earliest form assumed by this important organ, which it seems rational to conclude was originally evolved as an accessory breathing organ and later became transformed into a hydrostatic apparatus (Ganoids and Teleosteans) on the one hand, into a true lung (Dipnoans and Batrachians) on the other. Guided by the second consideration, assuming that the air-bladder of the fossil Crossopterygians conformed to the type known in their recent representatives, and also in deference to palaeontological chronology, whatever it be worth in the present state of our knowledge, we shall begin the series with the Crossopterygians, which pass into the Dipnoans, and then take up the Ganoids, which lead up very gradually to the Teleosteans, the dominant group at the present day. But we do not deny the force of the arguments adduced by Regan in attempting to show that the paired fins of the Chondrostean Ganoids are a nearer approach to the primitive condition than are those of the Crossopterygians. No doubt some day we shall become acquainted with still older Teleostomes, which we may expect to establish the connexion between the two types which in Palaeozoic times have evolved on parallel lines.

ORDER I.—CROSSOPTERYGII

Paired fins, at least the pectorals, lobate, having an endo-skeletal axis more or less fringed with dermal rays. Mandibular arch suspended from the upper segment of the hyoid arch (hyostylic skull). Splenial bone present. No supraoccipital bone. A pair of large jugular plates, sometimes with small lateral plates and an anterior azygous element, developed in the branchiostegal membrane between the mandibular rami. Heart with a contractile, multivalvular conus arteriosus; intestine with a spiral valve; air-bladder with pneumatic duct communicating with the ventral side of the oesophagus.

Maxillary bone large, toothed, bordering the mouth. Bones of the upper surface of the skull mostly paired. Pectoral arch with both clavicle (so-called infra-clavicle) and cleithrum. Ventral fins inserted far back. With few exceptions (tail of Coelacanthidae, dorsal and caudal fins of Polypteridae) the dermal rays of the unpaired fins more numerous than their endo-skeletal supports, a primitive character also found in the lower Ganoids, but disappearing in the higher.

SUB-ORDER I.—OSTEOLEPIDA

(Including the Haplistia, Rhipidistia and Actinistia.) Pectoral fins obtusely or acutely lobate, articulating with the pectoral girdle by a single basal endo-skeletal element. Nostrils on the lower side of the snout. Two dorsal fins.

Families: Osteolepidae, Rhizodontidae, Holoptychidae, Coelacanthidae.

The scales may be rhombic and thickly coated with ganoine (Osteolepidae) or cycloid. The vertebral axis is strongly heterocercal in the Osteolepidae and Holoptychidae, and diphycercal or intermediate between the heterocercal and the diphycercal types in the other families; usually acentrous, sometimes with ring-like calcifications (some of the Rhizodontidae). In the Holoptychidae the pectoral fin is extremely similar to that of the Dipneusti of the family Dipteridae, which they resemble closely in form and scaling. Their teeth are remarkable for their complicated structure, resembling that of the Labyrinthodont Batrachians. A pineal foramen is present between the frontal bones in most of the Rhizodontidae.

The Osteolepidae were mostly moderate-sized fishes, the largest (*Megalichthys*) measuring about 4 ft. in length.

These Crossopterygians first appear in the Lower Devonian, are abundant in the Upper Devonian, Carboniferous and Permian; in later periods they are represented only by the more specialized Coelacanthidae, which appear in the Lower Carboniferous, and persist as late as the Upper Chalk.

SUB-ORDER II.—CLADISTIA

Pectoral fin obtusely lobate, with three basal endo-skeletal elements. Nostrils on the upper side of the snout. A single dorsal fin, formed of a series of detached rays.

A single family: Polypteridae.

The existing Crossopterygians which form this sub-order differ very considerably from the extinct Osteolepida, perhaps quite as much as these differ from the Dipneusti. The ventral fins are not lobate, the vertebral column is well ossified and its termination is of the diphycercal type. Spiracles, covered by bony valves, are present on the upper surface of the head. The dorsal fin is unique among fishes, being formed of detached rays consisting of a spine-like fulcral scale supporting the fringes of the ray; these rays have been regarded, erroneously, as representing so many distinct fins, or "finlets." The scales are bony, rhombic and thickly coated with ganoine.

The Polypteridae are confined to tropical Africa and the Nile, and represented by two genera: *Polypterus* and *Calamichthys*, the former moderately elongate and provided with ventral fins, the latter serpentiform and devoid of ventrals. We now know ten species of *Polypterus*, from the Nile, the Congo, the rivers of West Africa, and lakes Chad, Rudolf and Tanganyika, and one of *Calamichthys*, which inhabits West Africa from the Niger delta to the Chiloango. The largest species of *Polypterus* reach a length of nearly 4 ft. The young are provided with an external opercular gill very similar to the gills of larval salamanders. The air-bladder acts as an accessory breathing organ, although these fishes are not known ever to leave the water. The development is stated by the late J. S. Budgett to be even more Batrachian-like than that of the Dipneusti, but the results of the study of the material collected by him shortly before his death have not yet been published.

Order II.—DIPNEUSTI

Often called Dipnoi, a term proposed for this order by J. Müller in 1845, but which had already been used for the Batrachians (F. Leuckart, 1821) before the discovery of *Lepidosiren*. The substitute Dipneusti (E. Haeckel, 1866) is, therefore, preferable.

Paired fins lobate, or reduced to a jointed endo-skeletal axis. Upper segment of the mandibular arch confluent with the skull (autostylic skull). Praemaxillary and maxillary bones absent, dentary absent or small and toothless; teeth on the palato-pterygoid and splenial bones, sometimes also on the vomers. No supraoccipital bone. Heart trilocular, with a contractile, multivalvular conus arteriosus; intestine with a spiral valve; air-bladder transformed into a single or double lung, opening at the glottis on the ventral side of the pharynx.

The cranial roof-bones include median as well as paired plates, which cannot easily be homologized with those of other Teleostomes; in the older forms, these bones are small and numerous, and, coated with ganoine, appear on the surface of the head, whilst in the later forms they are reduced in number as well as in the degree of ossification, and have sunk below the skin. Pectoral arch with both clavicle and cleithrum. Ventral fins inserted far back. Vertebrae acentrous. Dermal rays of vertical fins much more numerous than their supports, which correspond in number to the neural and haemal arches. Nostrils on the lower side of the snout, the posterior within the mouth. Scales cycloid (almost quadrate in *Sagenodus*, a genus of Ctenodontidae).

Families: Dipteridae, Ctenodontidae, Uronemidae, Ceratodontidae, Lepidosirenidae.

The Dipteridae are heterocercal and have two dorsal fins, as in the Crossopterygian Holoptychidae; in the other families the dorsal fin is elongate and single, and extends to the extremity of the tail, which belongs to the diphycercal type. In the three first families, which are entirely Palaeozoic, ranging from the Devonian to the Permian, the dental plates nearly always exhibit more or less clearly the points of the separate denticles of which, as shown by the development of *Neoceratodus*, they were originally composed, but vomerine teeth, such as exist in the Ceratodontidae and Lepidosirenidae, do not appear to have existed. In the Dipteridae alone the scales were covered with dense, punctate ganoine, which has become much reduced or disappeared entirely in the other members of this order. The two first families had well-developed gular plates.

In the Ceratodontidae, which first appeared in the Trias and have persisted to the present day, the skull is more feebly ossified than in the earlier forms, and this may well be looked upon as a degeneration, since the head of the Triassic *Ceratodus sturi*, whilst exhibiting the same arrangement of bones as in the living form, differs in its higher degree of ossification; and as the dermal rays of the caudal fin also exhibit distinctive features in a fossil of the same period, it is advisable to refer the existing *Ceratodus forsteri* to a distinct genus, which has been named *Neoceratodus* by Castelnau (1876) and *Epiceratodus* by Teller (1891). But there can be no question that *Neoceratodus* is very closely related to *Ceratodus*. Its only known species, *N. forsteri*, variously known as the barramunda, flat-head, and Dawson or Burnett salmon, inhabits the Burnett, Dawson and Mary rivers in Queensland, and was first discovered in 1870. Its anatomy was made known by the memoir of A. Günther, and numerous contributions by T. H. Huxley, E. R. Lankester, J. E. V. Boas, W. B. Spencer and others, whilst its development has been elaborately worked out by R. Semon. This fish, which grows to a length of 6 ft., has the body moderately elongate and compressed, covered with large thin scales, and the paired fins are acutely lobate, consisting of a median jointed axis fringed on each side by a series of radialia supporting fine dermal rays (archipterygium of C. Gegenbaur). Although provided with a lung, which is single, *Neoceratodus* never leaves the water. It feeds on both animal and vegetable matter, the specimens kept in the London Zoological Gardens readily eating lettuce in addition to frogs and bits of raw meat. The early development resembles very closely that of Batrachians, but there are no metamorphoses properly speaking, and at no period does the young possess external gills or a holder or cement organ.

The South American *Lepidosiren* and the tropical African *Protopterus*, which constitute together the family Lepidosirenidae, were discovered long before *Neoceratodus*, the former in 1836, the latter in 1839. These fishes are much more specialized than are the Ceratodontidae; the body is more or less eel-shaped, the scales are thinner, the paired fins are reduced to slender styliform appendages formed of a jointed axis with or without a unilateral fringe of cartilaginous rays bearing fine dermal rays, and the lung is paired. The development is even more Batrachian-like than that of *Neoceratodus*, and the larvae are provided with a cement organ and four (*Lepidosiren*) or five (*Protopterus*) fringed external gills, traces of which may persist throughout life in *Protopterus*. The habits and development of *Lepidosiren* have been investigated by J. Graham Kerr, and those of *Protopterus* by J. S. Budgett. In both the eggs are deposited in nests in the water and the male keeps guard over the eggs and young. The food is both animal and vegetable, as in *Neoceratodus*. During the dry season, *Protopterus* burrows in the mud of drying marshes and, surrounded by a cocoon formed of hardened mucus secreted by glands of the skin, it spends weeks or months in a dormant condition, breathing exclusively by its lungs; dry clay balls containing such cocoons have often been brought over to Europe, and when soaked in water, the *Protopterus* is released in a most lively condition. Three species of *Protopterus* are known from different parts of Africa, the type species being *P. annectens*, an inhabitant of West Africa, from the Senegal to the Niger, and Lake Chad. Of *Lepidosiren* only one species is known, *L. paradoxa*, living in the Amazon and Paraguay basins.

Great uncertainty, and much difference of opinion among palaeichthyologists, still prevail as to the position in the system of a group of Devonian fishes, of which *Coccosteus* and *Dinichthys* are the best-known representatives. Long placed with the Ostracophores is a group instituted by Sir F. McCoy in 1848 under the name of Placodermi; they were removed from their vicinity by A. S. Woodward in 1889, and referred to the Dipnoans as an order which he proposed to call Arthrodira. This view was based mainly on the assumption that the skull was autostylic and that maxillary bones were not developed, and also on the resemblance, previously noticed by J. S. Newberry, between the dentition of *Dinichthys* and that of *Protopterus*. Woodward's proposal has not met with general acceptance, but it is strongly supported by the recent investigations of C. R. Eastman, who has added fresh arguments in favour of the autostylic condition of the skull and the homology of the cranial roof-plates with those of the Dipnoans, the Ceratodontidae in particular. On the other side, B. Dean and L. Hussakof deny such homologies, and even regard the dental mechanism of the Arthrodira as something quite different from the jaws and teeth of other vertebrates, and revert to the view of McCoy in placing the Arthrodira in a group Placodermata, which they regard as a class co-ordinate in rank with such divisions as Cyclostomi and Pisces.

In the present state of our knowledge it is perhaps best to leave the Arthrodira with or near the Dipneusti. They are thus defined by Woodward:—Fishes with both head and trunk armoured, in the more specialized genera the shield of the abdominal region articulating with the head-shield in ginglymoid facettes (Gr. γιγγλυμος, a hinge) which admit of free motion (hence the name *Arthrodira*, joint-neck). No trace of a hyomandibular bone. Jaws paralleled by those of the existing Dipneusti. Notochord persistent. Pectoral fins unknown; ventral fins rudimentary.

Two families: Coccosteidae and Dinichthyidae, from the Devonian of Europe and North America.

Some of the species of *Dinichythys* reached a great size, the head sometimes measuring a metre across.

Order III.—GANOIDEI

Paired fins not lobate. Mandibular arch suspended from the upper segment of the hyoid arch (hyostylic skull). Splenial bone present. No supraoccipital bone. Unpaired fins often with fulcra. Heart with a contractile, multivalvular conus arteriosus; intestine with a spiral valve; air-bladder with pneumatic duct communicating with the dorsal side of the oesophagus.

Sub-order I.—CHONDROSTEI

Pectoral arch with both clavicle and cleithrum. Ventral fins inserted far back, with well-developed endo-skeletal rays (baseosts); dermal rays of the dorsal and anal fins more numerous than their endo-skeletal supports. Heterocercal. Vertebrae acentrous.

Families: Palaeoniscidae, Platysomidae, Catopteridae, Belonorhynchidae, Chondrosteidae, Polyodontidae, Acipenseridae.

In the three first families (Devonian to Jura), the mouth is toothed, praemaxillary bones are present, and the maxillaries are large, the bones of the upper surface of the head are paired, branchiostegal rays are present, and the body is covered with rhomboidal, typically ganoid bony scales. In the fourth family (Trias to Lias), the snout is much elongate, and longitudinal series of scutes extend along the body, one on the back, one on the belly, and one on each side. The Liassic Chondrosteidae show an approach to the sturgeons, and form a sort of connecting link between them and the Palaeoniscidae. The mouth was edentulous, praemaxillary bones were absent, but the maxillary bone was well developed, though small; the membrane bones of the skull were paired;

branchiostegal rays were present; scales were absent, except on the caudal lobe.

In the modern Polyodontidae and Acipenseridae, whose first representatives appear in the Eocene, praemaxillaries are absent and the mouth is edentulous (Acipenseridae) or beset with minute teeth (Polyodontidae), the membrane bones of the skull are more irregular and comprise azygous elements, branchiostegal rays are absent, and the body is naked or covered with small ossifications and longitudinal series of bony scutes, whilst the caudal fin is scaled exactly as in the Palaeoniscidae. Barbels are absent in the Polyodontidae.

In the Polyodontidae, represented by one species, the paddle-fish or spoon-bill (*Polyodon folium*), in the Mississippi, Ohio and Missouri rivers of North America, and by another (*Psephurus gladius*) in the Yang-tse-kiang and Hoang Ho rivers of China, the snout is produced into a very long, spatulate (*Polydon*) or sub-conical (*Psephurus*) appendage, apparently useful in stirring up the mud of the thick waters in which these fishes live, and perhaps a tactile organ compensating the very reduced size of the eyes. *Psephurus gladius* is said to grow to a length of 20 ft. The sturgeons (Acipenseridae) are divided into two genera: *Acipenser*, distributed over the coasts and fresh waters of the temperate parts of the northern hemisphere, and *Scaphirhynchus*, inhabiting North America and Central Asia. About twenty species of *Acipenser* and five of *Scaphirhynchus* are known. The sturgeons are of great value for their flesh, their eggs (caviare) and the isinglass from the air-bladder; several species are migratory, ascending rivers to spawn. The largest species attain a length of 10 to 18 ft.

Sub-order II.—HOLOSTEI

Clavicle proper absent. Ventral fins inserted more or less far back, without or with mere rudiments of endo-skeletal rays; dermal rays of the dorsal and anal fins corresponding to their endo-skeletal supports. Caudal fin of an abbreviate-heterocercal or homocercal type.

Families: Semionotidae, Macrosemiidae, Pycnodontidae, Eugnathidae, Pachycormidae, Lepidosteidae, Aspidorhynchidae, Amiidae.

First appear in the Permian with the Semionotidae, become abundant in the Trias, dominant in the Jurassic, begin to decline in the Cretaceous, and from the Eocene to the present day are reduced to the two families Lepidosteidae and Amiidae, the modern representatives of which inhabit the fresh waters of North America.

In most of the Holostei the scales are bony, rhombic and covered with an enamel-like (ganoine) coating, but there is every gradation between this so-called ganoid type of scaling and the cycloid type exemplified by the Amiidae. Fulcra also disappear in some of the more specialized types. The mouth is always large and toothed, and branchiostegal rays are invariably present; a single gular plate is often present. In the earlier groups the notochord was persistent, with or without annular centra, or with each centrum composed of two elements—pleurocentrum and hypocentrum; these elements remain distinct and alternate in the caudal region of the Amiidae, whilst in the Lepidosteidae the centra are as fully developed as in most Teleosteans, and opisthocoelous or convexo-concave.

The pike-like genus *Lepidosteus* was abundant in Europe in Eocene and Miocene times, and is now represented by three species in eastern North America, Mexico and Cuba. The largest species reaches a length of 10 ft. *Amia*, the bowfin, of similar geological age, is a much smaller fish, not exceeding 2 ft., from the eastern parts of North America. Its air-bladder is cellular and acts as an accessory breathing organ. It deposits its eggs in a sort of nest, which is protected by the male, who for some time accompanies the swarm of young fry and defends them with great courage.

Leedsia problematica, one of the Pachycormidae from the Oxford clay, probably reached a length of 30 ft., and is the largest known Teleostome.

Order IV.—TELEOSTEI

Paired fins non-lobate, the ventrals without baseosts. Mandible suspended from the upper segment of the hyoid arch. Splenial bone absent. Supraoccipital bone present. Heart without muscular conus arteriosus, or with much reduced conus, with one, exceptionally two, rows of valves. Air-bladder, if present, communicating with the dorsal side of the oesophagus or digestive tract, or completely closed.

Sub-order I.—MALACOPTERYGII

Air bladder, if present, with a duct. Opercle well developed. Pectoral arch suspended from the skull; mesocoracoid bone present. Fine without spines, the ventrals abdominal (rarely absent). Anterior vertebrae distinct, without Weberian ossicles.

Families: Pholidophoridae, Archaeomenidae, Oligopleuridae, Leptolepidae, Elopidae, Albulidae, Mormyridae, Hyodontidae, Notopteridae, Osteoglossidae, Pantodontidae, Ctenothrissidae, Phractolaemidae, Saurodontidae, Chirocentridae, Clupeidae, Chanidae, Salmonidae, Alepocephalidae, Stomiatidae, Gonorhynchidae, Cromeriidae.

Unquestionably the most generalized sub-order, having most in common with the Holostean ganoids. The first four families, of Triassic to Cretaceous age, are so closely connected with these Ganoids that their allocation to the Teleosteans must be regarded as provisional. Some of the Pholidophoridae were flying fishes. The Elopidae and Albulidae are also low forms, traced back to the Cretaceous seas, having points in common with the Ganoids (gular plate in the former, conus arteriosus with two rows of valves in the latter). The Mormyridae are among the most extraordinary fishes, and, like the four families which follow in the above list, confined to fresh waters. Other families, like the Chirocentridae, Clupeidae and Salmonidae, are entirely or partly marine, the two last being of great economic importance. The Alepocephalidae and Stomiatidae are restricted to the deep sea.

See Anchovy, Herring, Menhaden, Mormyr, Pilchard, Salmonidae, Shad and Sprat.

Sub-order II.—OSTARIOPHYSI

Air-bladder, if well developed, with a duct. Pectoral arch suspended from the skull; mesocoracoid bone present. Fins without spines, or dorsal and pectoral with a single spine formed by the co-ossification of the segments of an articulated ray. The anterior four vertebrae strongly modified, often co-ossified, and bearing a chain of small bones (so-called Weberian ossicles) connecting the air-bladder with the ear.

Families: Characinidae, Gymnotidae, Cyprinidae, Siluridae, Loricariidae, Aspredinidae.

One of the most natural groups of the class Pisces, as demonstrated by M. Sagemehl in 1885. The Characinidae are the most generalized, although perhaps not directly derived from the Amiid Ganoids, as believed by Sagemehl; they show great variety of form and dentition, and are confined to Central and South America and Africa. The Gymnotidae, which include the so-called electric eel, are closely related to the Characinidae, and occur only in South America. The largest families are the Cyprinidae and Siluridae. With the exception of a few Siluridae, the Ostariophysi are all fresh-water fishes.

Sub-order III.—SYMBRANCHII

Eel-shaped fishes without paired fins, with the pectoral arch free or suspended from the skull, without mesocoracoid bone, and with the anterior vertebrae distinct, without Weberian ossicles. Gill-openings confluent into a single, ventral slit. Air-bladder absent.

Families: Symbranchidae and Amphipnoidae.

Like the Apodes, which they resemble in general appearance, these fishes are no doubt derived from some low type with abdominal ventral fins, but whether from the Malacopterygii or the Haplomi we have as yet no data from which to conclude. Inhabitants of the fresh or brackish waters of south-eastern Asia, tropical America, Australia and Tasmania.

In the cuchia, *Amphipnous cuchia*, the gills are much reduced, and a respiratory air-sac extends on each side of the body behind the head, communicating with the gill-cavity.

Sub-order IV.—APODES

Air-bladder, if present, with a duct. Praemaxillary bones absent; the maxillaries, if present, separated on the median line in front by the coalescent ethmoid and vomer. Pectoral arch, if present, not connected with and remote from the skull; mesocoracoid bone absent. Fins without spines, the ventrals absent. Anterior vertebrae distinct, without Weberian ossicles.

Elongate, serpentiform fishes with naked skin, or with minute scales imbedded in the skin.

Families: Anguillidae, Nemichthyidae, Synaphobranchidae, Saccopharyngidae, Muraenidae.

A large group of aberrant, degraded fishes, heralded by the Cretaceous genus *Urenchelys*, the most generalized of eels. Mostly marine, many bathybial; some living principally in fresh water, but breeding in the sea, like the common eel (see articles Eel and Muraena).

Sub-order V.—HAPLOMI

Air-bladder, if present, with a duct. Opercle well developed. Pectoral arch suspended from the skull; no mesocoracoid bone. Fins usually without, rarely with a few spines; ventrals abdominal, if present. Anterior vertebrae distinct, without Weberian ossicles.

Families: Galaxiidae, Haplochitonidae, Enchodontidae, Esocidae, Dalliidae, Scopelidae, Alepidosauridae, Cetomimidae, Chirothricidae, Kneriidae, Cyprinodontidae, Amblyopsidae, Stephanoberycidae, Percopsidae.

The absence of the mesocoracoid bone distinguishes these fishes from the Malacopterygii, and the presence of a duct to the air-bladder separates them from the Percesoces, to some of which, the Scombresocidae and the Atherinidae, they are linked by the Cyprinodontidae; whilst the Scopelidae are connected with the Berycidae by the Stephanoberycidae.

The type family of this sub-order is that of the Esocidae or pike, inhabitants of the fresh waters of Europe, northern Asia, and North

America. The Galaxiidae are mostly fresh-water fishes and have a wide distribution in the southern hemisphere (southern parts of South America, New Zealand, South Australia and Tasmania, Cape of Good Hope), one species being identical in South America, the Falkland Islands, New Zealand and Tasmania. Their distribution has been regarded as affording support to the theory of an Antarctic continent in Tertiary times. However, several of the species spend part of their life, and even breed, in the sea, whilst others may be regarded as having become more recently adapted to fresh water, so that the argument derived from their range is not so strong as if we had to deal with exclusively fresh-water fishes. The Cyprinodontidae are partly brackish, partly fresh-water fishes, whilst the Scopelidae, which are traced back to the Chalk, are all marine, many being inhabitants of great depths.

Sub-order VI.—HETEROMI

Air-bladder without duct. Opercle well developed, parietal bones separating the frontals from the supraoccipital. Pectoral arch suspended from the supraoccipital or the epiotic, the post-temporal small and simple or replaced by a ligament; no mesocoracoid bone. Ventral fins abdominal, if present.

Families: Dercetidae, Halosauridae, Lipogenyidae, Notacanthidae, Fierasferidae.

Closely related to the Haplomi, but separated chiefly on account of the closed air-bladder. Mostly deep-sea fishes, some of which appeared as early as the Cretaceous period. The genus *Fierasfer* comprises small degraded fishes commensals of Holothurians and bivalve molluscs.

Sub-order VII.—SELENICHTHYES

Air-bladder without duct. Opercle well developed. Pectoral arch suspended from the skull; no mesocoracoid bone. Fins without spines. Ventral fins abdominal, with very numerous (15 to 17) rays.

A very aberrant type, of uncertain affinities. Its only representative is the opah, *Lampris luna*, a large pelagic fish of wide distribution.

Sub-order VIII.—THORACOSTEI

Embracing the Hemibranchii and Lophobranchii, but excluding the Hypostomides (Pegasidae), which the investigations of F. E. Jungersen show to be aberrant mail-cheeked Acanthopterygians.

Air-bladder without duct. Pectoral arch suspended from the skull; no mesocoracoid bone. Ventral fins abdominal, if present. Branchial arches more or less reduced.

Families: Gastrosteidae, Aulorhynchidae, Protosyngnathidae, Aulostomatidae, Fistulariidae, Centriscidae, Amphisilidae, Solenostomidae, Syngnathidae. The two latter families institute the division Lophobranchii, in which the gill-lamellae are enlarged and form rounded lobes.

See articles SEA-HORSE, STICKLEBACK, and PIPE-FISHES.

Sub-order IX.—PERCESOCES

Air-bladder, if present, without duct. Parietal bones separated by the supraoccipital. Pectoral arch suspended from the skull; no mesocoracoid bone. Ventral fins, if present, abdominal, or at least with the pelvic bones not solidly attached to the clavicular arch.

Families: Scombresocidae, Ammodytidae, Atherinidae, Mugilidae, Polynemidae, Chiasmodontidae, Sphyraenidae, Tetragonuridae, Stromateidae, Icosteidae, Ophiocephalidae, Anabantidae.

This series of families connects the Haplomi with the Acanthopterygii. The Percesoces are mostly marine, but the two last families are exclusively fresh-water. Some are inhabitants of great depths, others are pelagic, like the flying-fish (*Exocoetus*).

Sub-order X.—ANACANTHINI

Air-bladder without duct. Parietal bones separated by the supraoccipital; prootic and exoccipital separated by the enlarged opisthotic. Pectoral arch suspended from the skull; no mesocoracoid bone. Ventral fins below or in front of the pectorals, the pelvic bones posterior to the clavicular symphysis and only loosely attached to it by ligament. Fins without spines.

Families: Macruridae, Gadidae, Muraenolepididae.

Nearly all marine. The Macruridae are among the most characteristic fishes of the great depths. The Gadidae include some of the most valuable food-fishes.

Sub-order XI.—ACANTHOPTERYGII

Air-bladder usually without duct. Opercle well developed; supraoccipital in contact with the frontals. Pectoral arch suspended from the skull; no mesocoracoid bone. Ventral fins thoracic or jugular, more or less firmly attached to the clavicular arch. Gill-opening usually large, in front of the base of the pectoral fin.

The character from which this sub-order, the most comprehensive of the whole class, derives its name, viz., the presence of non-articulated, spiny rays in the dorsal and anal fins, is by no means universal, exceptions to the rule being numerous.

Division I. Beryciformes.—Families: Berycidae, Monocentridae, Polymixiidae.

The most primitive of the Acanthopterygians, already well represented in the Chalk. A duct has been observed to be sometimes present between the air-bladder and the digestive tract. All marine, several bathybial.

Division II. Perciformes.—Families: Pempheridae, Serranidae, Anomalopidae, Pseudochromididae, Cepolidae, Hoplognathidae, Sillaginidae, Sciaenidae, Scorpididae, Caproidae, Centrarchidae, Cyphosidae, Lobotidae, Toxotidae, Nandidae, Percidae, Acropomatidae, Gerridae, Lactariidae, Trichodontidae, Pristipomatidae, Sparidae, Mullidae, Latrididae, Haplodactylidae, Chaetodontidae, Drepanidae, Osphromenidae, Acanthuridae, Teuthididae, Embiotocidae, Cichlidae, Pomacentridae, Labridae, Scaridae.

The Percidae, Centrarchidae, Toxotidae, Nandidae, Osphromenidae, Embiotocidae, and Cichlidae are fresh-water fishes, the others are all or nearly all marine. *Aipichthys*, which is included among the Scorpididae, is one of the few Acanthopterygian types known to have existed as early as the Cretaceous period.

See articles CICHLIDS, MULLET, MURRAY COD, PARROT-FISHES, PERCH, PIKE-PERCH, SHEEPSHEAD, WRASSE.

Division III. Scombriformes.—Families: Carangidae, Rhachicentridae, Scombridae, Trichiuridae, Histiophoridae, Xiphiidae, Luvaridae, Coryphaenidae, Bramidae.

Marine fishes, several being pelagic and among the largest Teleosteans and swiftest swimmers. See articles HAIR-TAIL, MACKEREL, PILOT-FISH, SWORD-FISH, TUNNY.

Division IV. Zeorhombi.—Families: Zeidae, Amphistiidae, Pleuronectidae.

Division V. Kurtiformes.—A single family, Kurtidae, with a single genus and species from the Indian and Pacific oceans.

Division VI. Gobiiformes.— A single family, Gobiidae.

Division VII. Discocephali.— A single family, Echeneididae.

The remarkable remoras attach themselves by means of a cephalic disk to boats or to sharks, turtles, cetaceans, and other large swift-swimming animals. They form an isolated group, and have no real affinity with the Scombridae, with which they have long been associated.

Division VIII. Scleroparei.—Families: Scorpaenidae, Hexagrammidae, Comephoridae, Rhamphocottidae, Cottidae, Cyclopteridae, Platycephalidae, Hoplichthyidae, Agonidae, Pegasidae, Triglidae, Dactylopteridae.

The "Mail-cheeked" Acanthopterygians include a great variety of forms, mostly living in the sea, the best known being referred to in the articles FLYING-FISH, GURNARD, LUMP-SUCKER, and MILLER'S-THUMB.

Division IX. Jugulares.—Families: Trachinidae, Percophiidae, Leptoscopidae, Nototheniidae, Uranoscopidae, Trichodontidae, Callionymidae, Gobiesocidae, Blenniidae, Batrachidae, Pholididae, Zoarcidae, Congrogadidae, Ophidiidae, Podatelidae.

Nearly all marine, some deep-sea. *Macrius amissus*, which probably belongs to the Leptoscopidae, measures 5 ft. and is the largest known deep-sea Teleostean. The other members of this division are mostly small, *Anarrhichas* being another exception. The weevers (*Trachinus*) are dangerous stinging fishes.

Division X. Taeniosomi.—Families: Trachypteridae, Lophotidae.

Deep-sea or pelagic fishes, some attaining a large size.

Sub-order XII.—OPISTHOMI

Air-bladder without duct. Opercle well developed, hidden under the skin; supraoccipital in contact with the frontals. Pectoral arch suspended from the vertebral column, far behind the skull; no mesocoracoid bone. Vertical fins with spines. Ventral fins absent.

Eel-shaped fishes standing in the same relation to the Acanthopterygii as do the Apodes to the Malacopterygii. The single family, Mastacembelidae, is possibly derived from the Blenniidae.

Fresh and brackish waters of southern Asia and tropical Africa.

Sub-order XIII.—PEDICULATI

Air-bladder without duct. Opercle well developed, hidden under the skin; supraoccipital in contact with the frontals. Pectoral arch suspended from the skull; no mesocoracoid bone. Ventral fins, if present, jugular. Gill-opening reduced to a foramen situated in or near the axil more or less posterior to the base of the pectoral fin. Body naked or covered with spines or bony tubercles.

Connected with the Acanthopterygii Jugulares through the Batrachidae.

Families: Lophiidae, Ceratiidae, Antennariidae, Gigantactinidae, Malthidae.

Curiously aberrant marine fishes, many bathybial. The best known are the fishing-frog or angler, *Lophius*, and the *Antennarius*, which lives in coral groves or is carried about in mid-ocean among the *Sargassum* weeds.

SUB-ORDER XIV.—PLECTOGNATHI

Air-bladder without duct. Opercular bones more or less reduced; supraoccipital in contact with the frontals; maxillary and praemaxillary bones often firmly united. Pectoral arch suspended from the skull. No ribs. Ventral fins thoracic and much reduced if present; the pelvic bones, if present, more or less co-ossified. Gill-opening much reduced. Body covered with more or less osseous scales, bony scutes, or spines, or naked.

A highly aberrant group, closely connected with the Acanthopterygii through the Acanthuridae.

Division I. Sclerodermi.—Families: Triacanthidae, Triodontidae, Balistidae, Ostraciontidae.

Division II. Gymnodontes.—Families: Tetrodontidae, Diodontidae, Molidae.

The Plectognaths are all marine; the recently discovered Triacanthid *Halimochirurgus*, remarkable for its long, tube-like snout, from the Gulf of Manaar, is the only form of this sub-order which is confined to the deep sea. Although so highly specialized, several forms, such as *Ostracion* (the coffer-fish), *Tetrodon* and *Diodon*, were already represented in the upper Eocene. See FILE-FISH, GLOBE-FISH and SUN-FISH.

For bibliographical references to the Teleostomi, see ICHTHYOLOGY. (G. A. B.)

TELEPATHY (Gr. τῆλε, far, πάθη, feelings), or THOUGHT TRANSFERENCE, the conveyance of thoughts and feelings from mind to mind by other than the ordinary channels of sense. Although the word "telepathy" was first suggested by F. W. H. Myers in 1882, the suggestion had long before been made that the transmission of ideas, images and sensations could be brought about by other than the normally operative motor and sensory apparatus of the body. More than one writer had explained wraiths at the moment of death, clairvoyance and the phenomena of spiritualism by the theory of "brain waves." But it was not until the advent of the Society for Psychical Research that the hypothesis attracted much notice or was backed by carefully collected evidence. As used by the society the term is a mere designation, and implies no hypothesis as to "action at a distance" or the operation of any force not recognized by physical science.

The earliest recorded systematic experiments in thought transference were made in 1871 by the Rev. P. H. and Mrs. Newnham, and were continued for a period of some eight months with marked success; subsequent attempts showed no results of an evidential nature. A few years later the attention of the British Association was called to the subject by Prof. W. F. Barrett, and from 1881 onwards many experiments were made by members of the S.P.R. and others; in fact, the so-called "willing game" was at one time exceedingly popular; the successes, however, depended largely, if not entirely, upon muscle-reading, and usually ceased when there was no contact between agent (the sender of the idea) and percipient (the receiver). The systematic investigation has followed two main lines: (A) experiments on persons, often in the hypnotic state, in which the aim was to transfer selected images, &c., and compare the guesses with the results which chance would give; (B) the collection and examination of records of phenomena such as apparitions at the moment of death and other spontaneous cases in which there is a correspondence between the psychical states of two individuals, usually remote in space from one another. The problems raised by the two cases are entirely different: (1) in A there is seldom any hallucinatory element (see HALLUCINATIONS), in B, though not essential, it is present in a high percentage of cases; (2) what is transferred is in A an image kept before the mind, in B the phantasm of the dying person when that person has prima facie neither endeavoured to transfer this image nor, it may be, even thought of the percipient; (3) the desideratum in A has usually been to exclude normal methods of perception, in B the problem is to show that coincidence will not account for the facts; for, whereas in A the relation of successes to failures is known, in B it is difficult to get statistics and to be sure that an abnormal number of successful cases do not figure in a census. Side by side with direct experimentation, the S.P.R. collected first-hand records of apparitions at or within twelve hours of the moment of death. These, together with a discussion of the experimental evidence, were issued in 1885 under the title of *Phantasms of the Living*. In order to provide a statistical basis for discussion of coincidental apparitions, a census of hallucinations was undertaken by Edmund Gurney, and replies were obtained from over 5000 persons. A defect of the collection in *Phantasms* is that the progressive deterioration of evidence with age is neglected. No narratives are regarded as evidential by the society unless they were reduced to writing less than three years after the event or are based on notes made at the time.

The second systematic attempt to collect material was the census of hallucinations, initiated at the congress of experimental psychology of 1889, and entrusted to Professor Henry Sidgwick. The total number of persons who made returns was 17,000, of whom 1684 asserted that they had once or oftener experienced an hallucination. Analysis of the answers showed that in 350 cases the apparition was recognized; the probability that any person will die on a given day is roughly 1 in 19,000: if therefore chance alone operated, one apparition in 19,000 would coincide with a death; after making all allowances for error, the census committee found that 30 of the 350 recognized apparitions coincided with a death—in other words, cases prima facie telepathic were 440 times more numerous than chance coincidence would give. The committee reported that between deaths and apparitions of dying persons there exists a connexion which is not due to chance alone.

The experimental evidence for telepathy is made up partly of the results of trials where direct transference of thoughts, images or sensations was attempted, partly of successes in hypnotization at a distance; dreams (*q.v.*) also provide some material; and in a small but important class of cases, transitional between wraiths and ordinary experimental cases, the agent has caused his phantasm to appear to the percipient.

Among the chief experimenters may be mentioned Prof. M. Dessoir, Mr Guthrie, Sir Oliver Lodge and Prof. Sidgwick. In experiments conducted by the latter and Mrs Sidgwick at Brighton with numbers as the objects to be guessed, 617 trials were made with the agent and percipients in the same room: the numbers were between ten and ninety, and ninety successes were recorded, the probable total, if chance alone had operated, being eight. In a later series, conducted by Mrs Sidgwick, a similarly high proportion of successes was recorded; but when agent and percipients were in different rooms the results were not above what chance would give. These results were criticised by Prof. Lehmann and others, but were not seriously shaken; it was pointed out that the failure of experiments at a distance might be due to psychological causes rather than to the fact that the increase of distance eliminated the possibility of communication by normal means. In subsequent experiments, however, the successes in no series of any length were so far above chance as to give substantial support to a belief in telepathy.

Experiments in hypnotization at a distance provide some of the most conclusive evidence for telepathy. In 1885 trials were made both by Dr Janet and by Prof. Richet with the same subject. Out of twenty-five experiments the former held that nineteen were complete successes; Prof. Richet secured two successes and four partial successes in nine trials. The most striking point was that the hypnotic trance always coincided with or followed at an interval the attempt to hypnotize the patient; this is a feature of much importance in considering the possibility of coincidence or of auto-suggestion.

It is usually impossible to prove that a dying person has been thinking of the percipient; much less can we show that there was any idea of causing his phantasm to appear. There are, however, a small number of cases in which apparitions, of the agent or some other person, prima facie telepathic, have been produced experimentally. A singularly interesting instance is recorded by Wesermann, who tried the experiment in the early part of the 19th century; he wished to make the phantasm of a lady appear to a lieutenant, who was residing some miles away; at the time of the experiment he was, owing to an unforeseen visit, not alone, and his visitor is said to have seen the apparition also. More recently, in cases recorded in *Phantasms* and the *Census*, the figure of the agent himself has been seen by the percipient.

The so-called reciprocal cases are evidentially of much importance. Each of the two persons concerned appears to receive a telepathic impulse from the other, so that each receives information about the other, or sees his phantasm.

Occasionally telepathic impressions from animals to human beings are reported, but the facts are usually far from well established. Telepathic communication has also been suggested as the explanation of the simultaneous movements of large flocks of birds.

Various theories have been put forward to account for telepathy, but they only agree in the total lack of an experimental basis. Broadly speaking, they are divisible into physical and psychical. Sir W. Crookes suggests that transmission is effected by means of waves of smaller magnitude and greater frequency than those which constitute X rays. Undulations starting from nervous centres are adopted as the explanation by Prof. Flournoy and others. But Myers and others regard the case against a physical explanation as complete. The main difficulty in the way of it is that the strength of the impulse does not seem, in the spontaneous cases, to vary with the distance, as by all physical laws it should. On the other hand, a curious phenomenon has been noted in experiments; if the percipient gaze at an arrow with its head turned to the right, there is a tendency, disproportionately strong if we suppose that chance alone operates, for the arrow to be seen reversed. This fact is, however, more important in all probability for the light which it throws on the mechanism of hallucinations (*q.v.*) than on that of transmission. Telepathy is often invoked as an explanation of the facts of mediumship (see MEDIUM, and POSSESSION); but it seems insufficient to explain them unless we assume for the medium a far greater power of reading other people's minds than experimental evidence has so far shown to exist.

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TELEPHONE (Gr. τῆλε, far, and φώνη, voice). Telephony is the art of reproducing sounds at a distance from their source, and a telephone is the instrument employed in sending or receiving such sounds. The term "telephony" was first used by Philipp Reis of Friedrichsdorf, in a lecture delivered before the Physical Society of Frankfort in 1861.[1] But, although this lecture and Reis's subsequent work received considerable notice, little progress was made until the subject was taken up between 1874 and 1876 by Alexander Graham Bell, a native of Edinburgh, then resident in Boston, Mass., U.S.A. Bell, like Reis, employed electricity for the reproduction of sounds; but he attacked the problem in a totally different manner. This will be better understood if we consider shortly on what the chief characteristics of sound depend.

Characteristics of sound.

The sensation of sound is produced by rapid fluctuation in the pressure of the atmosphere on the tympanum of the ear. If the fluctuations are irregular and non-periodic, the sound is called a noise; if they are cyclic and follow a regular and sufficiently rapid periodic law, the sound is musical. In connexion with the present subject it is important to notice the three characteristics of a musical sound, namely, *pitch*, *loudness* and *quality*. The pitch of a musical sound depends on the number of cycles passed through by the fluctuations of the pressure per unit of time; the loudness depends on the amount or the amplitude of the fluctuation in each cycle; the quality depends on the form or the nature of the fluctuation in each cycle. The necessary condition for a successful system of telephony is the ability to reproduce these characteristics.

Mechanical telephone.

In 1831 Wheatstone by his "magic lyre" experiment showed[2] that, when the sounding-boards of two musical instruments are connected together by a rod of pine wood, a tune played on one will be faithfully reproduced by the other. This only answers, however, for telephoning musical sounds to short distances. Another and somewhat similar example is furnished by what has been variously designated as the "string," "toy," "lovers," and "mechanical" telephone. Two disks of thin metal, or two stretched membranes, each furnished with a mouthpiece, are connected together by a thin string or wire attached at each end to the centres of the membranes. A good example may be made with two cylindrical tin cups; the bottoms form the membranes and the cups the mouthpieces. When the connecting string is held taut and sounds, such as those of ordinary speech, are produced in front of one of the membranes, pulses corresponding to the fluctuations of the atmospheric pressure are transmitted along the string and communicated to the other membrane, which in its turn communicates them to the air, thus reproducing the sound. In both these examples all the three characteristics—pitch, relative intensity, and quality—of sound are reproduced.

Page's discovery.

In July 1837 Dr C. G. Page of Salem, Mass., drew attention to the sound given out by an electromagnet at the instant when the electric circuit is closed or broken, and in October of the same year he discussed, in a short article[3] entitled "Galvanic Music," the musical note produced by rapidly revolving the armature of an electromagnet in front of the poles. Experiments bearing on this subject were subsequently made by a great number of investigators.[4] Page's discovery is of considerable importance in connexion with the theory of action of various forms of telephone, and was a very important feature in the early attempts by Reis to transit music and speech. On the 26th of August 1854 there appeared in *L'Illustration* (Paris) an interesting article by Charles Bourseul on the electric transmission of speech.[5] The writer recommended the use of a flexible plate at the source of sound, which would vibrate in response to the varying pressure of the air, and thus open and close an electric circuit, and of a similar plate at the receiving station, which would be acted on electromagnetically and thus give out as many pulsations as there are breaks in the current. These suggestions were to some extent an anticipation of the work of Reis; but the conditions to be fulfilled before the sounds given out at the receiving station can be similar in pitch, quality and relative intensity to those produced at the transmitting station are not stated, and do not seem to have been appreciated.

Bourseul's suggestions.

Reis's telephone.

In Reis's lecture an apparatus was described which has given rise to much discussion as to priority in the invention of the telephone. The instrument was described in over fifty publications[6] in various countries, and was well known to physicists previous to Bell's introduction of the electric telephone as a competitor with the electric telegraph. Reis caused a membrane to open and close an electric

[1] "Über Telephonie durch den galvanischen Strom," in *Jahresber. d. physikalischen Vereins zu Frankfurt am Main*, 1860–61, p. 57.

[2] See his *Scientific Papers*, p. 47.

[3] See *Silliman's Jour.*, xxxii. 396, and xxxiii. 118.

[4] Marrian, *Phil. Mag.*, 3rd ser., vol. xxv. p. 382; Beatson, *Arch. de l'Élect.*, v. 197; De la Rive, *Treatise on Electricity*, i. 306, also *Phil. Mag.*, 3rd ser., vol. xxxv. p. 422, and *Comp. Rend.*, xx. 1287, xxii. 432; Matteucci, *Arch. de l'Élect.*, v. 389; Guillemin, *Comp. Rend.*, xxii. 264; Wertheim, *Comp. Rend.*, xxii. 336, 544, xxvi. 505, also *Ann. de Chim. et de Phys.*, xxiii. 302, and *Phil. Mag.*, 3rd ser., vol. xxviii. p. 544; Jannair, *Comp. Rend.*, xxiii. 319; Joule, *Phil. Mag.*, 3rd ser., vol. xxv. pp. 76, 225; Laborde, *Comp. Rend.*, l. 692; Poggendorff, *Pogg. Ann.*, lxxxvii. 139, xcviii. 198; Du Moncel, *Exp. de l'Élect.*, ii. 125, iii. 83; and Delesenne, *Bibl. Univ.* (1841), xvi. 406.

[5] See also *Didaskalia: Blätter für Geist, Gemüth, u. Publicität*, Frankfort, No. 232, 28th September 1854; Du Moncel, *Exposé des Applications de l'Électricité* (Paris), ii. 25, ed. 1854; iii. 110, ed. 1856, and *Comp. Rend.*, 26th November 1877.

[6] The English reader may consult—*Jour. Soc. Tel. Eng.*, March 1883; *British Assoc. Rep.*, 1863; *Civ. Eng. and Arch. Jour.*, xxvi. 307; R. M. Ferguson, *Electricity* (London, 1866), p. 257; S. P. Thompson, *Philipp Reis, the Inventor of the Telephone* (London, 1883).

circuit at each vibration, thus transmitting as many electric pulses through the circuit as there were vibrations in the sound. These electric pulses were made to act on an electromagnet at the receiving station, which, in accordance with Page's discovery, gave out a sound of a pitch corresponding to the number of times it was magnetized or demagnetized per second.

Reis's object was to reproduce at a distance not only music but also human speech; but that he did not wholly succeed is clear from the following extract from his lecture:—" Hitherto it has not been possible to reproduce human speech with sufficient distinctness. The consonants are for the most part reproduced pretty distinctly, but not the vowels as yet in an equal degree." Considering the time at which he wrote, Reis seems to have understood very well the nature of the vibrations he had to reproduce, but he failed to comprehend how they could be reproduced by electricity. His fundamental idea—the interruption of the current—was a fatal mistake, which was not at the time properly understood. The suggestion of Bourseul and the experiments of Reis are founded on the idea that a succession of currents, corresponding in number to the successive undulations of the pressure on the membrane of the transmitting instrument, could reproduce at the receiving station sounds of the same character as those produced at the sending station. Neither of them seemed to recognize anything as important except pitch and amplitude, and Reis thought the amplitude was to some extent obtained by the varying length of contact in the transmitting instrument. This might possibly be true to a small extent; but, considering the small capacity of the circuits he used and the nature of his receiving instrument, it is hardly probable that duration of contact sensibly influenced the result. The quality of the sounds was to some extent also reproduced; but, judging from the results of later telephone investigation, it is highly probable that this was due, not to the varying duration, but to the varying firmness of the contact.

Bell's researches.

The next worker at the telephone, and the one to whom the present great commercial importance of the instrument is due, was Bell. His aim was the production, by means of the undulations of pressure on a membrane caused by sound, of an electric current the strength of which should at every instant vary directly as the pressure varied.[1] His first idea seems to have been to employ the vibrations of the current in an electric circuit, produced by moving the armature of an electromagnet included in the circuit nearer to or farther from the poles of the magnet. He proposed to make the armature partake of the vibrations of the atmosphere either by converting it into a suitable vibrator or by controlling its vibrations by a stretched membrane of parchment

In the early trials the armature had the form of a hinged lever of iron carrying a stud at one end, which pressed against the centre of a stretched membrane. Fig. 1 shows the arrangement. M was a membrane stretched by a ring R over the end of a tube T fixed at one side of the frame F. To the opposite side of the frame an electromagnet I was fixed with its axis in line with the tube T, and between the end of the electromagnet and the membrane a hinged armature A was arranged in such a way that its motion could be controlled by the membrane. The instrument was joined in circuit with a battery and another similar instrument placed at a distance; and a continuous current was made to flow through the circuit, keeping the electromagnets energized. The experiments with this form were not successful, and, with the view of making the moving parts as light as possible, he substituted for the comparatively heavy lever armature a small piece of clock spring, about the size of a sixpence, glued to the centre of the diaphragm. The magnet was mounted with its end carrying the coil opposite, and very close to, the centre of the piece of clock spring. This answered sufficiently well to prove the feasibility of the plan, and subsequent experiments were directed to the discovery of the best form and arrangement of the parts. An increase in the size of the iron disk attached to the membrane augmented both the loudness and the distinctness of the sounds, and this finally led to the adoption of a thin iron disk supported round its edge, acting as both membrane and armature (fig. 2). Again, the form of the opening or mouthpiece in front of the membrane exercised considerable influence on the efficiency of the instrument, and it was ultimately ascertained that a small central opening, with a thin air space extending across the face of the membrane, was best. It was also found that comparatively small magnets were sufficient, and that there was no particular virtue in the closed circuit and electromagnet, but that a small permanent magnet having one pole in contact with the end of the core of a short electromagnet, the coil of which was in circuit with the line, but which had no permanent current flowing through it, answered the purpose quite as well.[2] The apparatus thus acted as both a transmitter and a receiver; indeed it is essentially the magneto-receiver which has come into universal use in practical telephony, though for transmission it was soon superseded by forms of microphonic transmitters. One of the latest forms of receiver, known as the double pole, is shown in fig. 3. M and M′ are two permanent magnets; P and P′ are soft iron pole-pieces upon which are placed the electromagnet coils C and C′; D is the diaphragm; I is a soft iron distance piece placed between the magnets at the end remote from the diaphragm; B is the brass body of the instrument, over which is placed a thin ebonite shell S. E is the ear-piece made of ebonite; F is a cap of the same material enclosing the receiver terminals, which are mounted upon the ebonite block G, attached to the distance piece I.

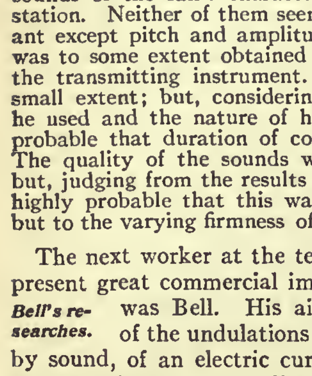

FIG. 1.—Bell's First Telephone (1875); one-fifth full size.

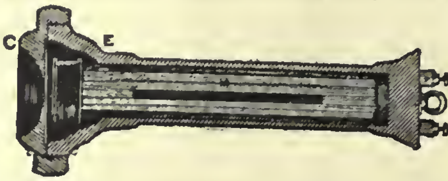

FIG. 2.—Bell's Telephone (1877). M, permanent magnet; E, electromagnet; C, diaphragm; t t_1, terminals.

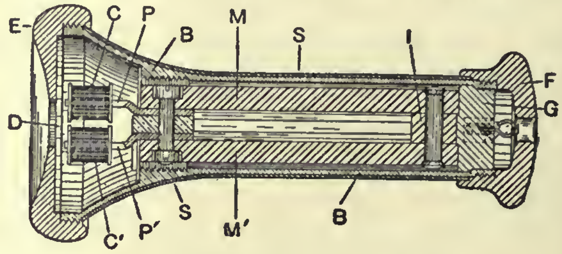

FIG. 3.—Double Pole Receiver.

Edison's instruments.

A telephone transmitter and a receiver on a novel plan were patented in July 1877 by Edison, shortly after the introduction of Bell's instruments. The receiver was based on the change of friction produced by the passage of an electric current through the point of contact of certain substances in relative motion. In one form a drum, mounted on an axis and covered by a band of paper soaked in a solution of caustic potash, was turned under a spring the end of which was in contact through a platinum point with the paper. The spring was attached to the centre of a diaphragm in such a way that, when the drum was turned, the friction between the point of the spring and the paper deflected the diaphragm. The current from the line was made to pass through the spring and paper to the cylinder. Now it had been previously shown by Edison that, when a current was made to pass through an arrangement like that just described, the friction between the paper and the spring was greatly diminished. Hence, when the undulating telephonic currents were made to pass through the apparatus, the constant variation of the friction of the spring caused the deflexions of the diaphragm to vary in unison with the variation of the electric

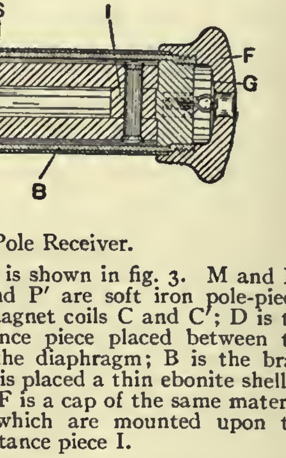

FIG. 4.—Edison's Microphone Transmitter.

[1] See A. G. Bell, " Telephone Researches," in *Journ. Soc. Tel. Eng.*, 31st October 1877.

[2] The extreme smallness of the magnets which might be successfully employed was first demonstrated by Professor Peirce of Brown University, Providence, R.I.

currents, and sounds were given out corresponding in pitch, and also to some extent in quality, with the sounds produced at the transmitting station. A cylinder of chalk was used in some of Edison's later experiments with this receiver.

The transmitter (fig. 4), in an early form, consisted of a cell of insulating material having at its bottom a flat-headed platinum screw G; on the top of G was a layer of carbon powder C, on the top of that a platinum disk D, and above that again, forming the cover of the cell, a disk of ivory B, held in position by a ring E. Resting on the centre of the ivory disk was a small piece of rubber tubing, and this was lightly pressed by the diaphragm A, which was held in place by the mouthpiece M. The varying pressure on A, when a sound was produced near it, caused corresponding variations in the pressure on the carbon powder, and this produced similar variations in its electric resistance.

Elisha Gray's experiments.

Experiments very similar to these of Edison were made by Elisha Gray of Boston, Mass., and described by him in papers communicated to the American Electrical Society in 1875 and 1878. In these experiments the electric current passed through the fingers of the operator's hand, which thus took the place of the spring in Edison's apparatus. The diaphragm was itself used as the rubbing surface, and it was either mounted and rotated or the fingers were moved over it. When the current passed, the friction was felt to increase, and the effect of sending a rapidly undulating current through the arrangement was to produce a sound. The application of this apparatus to the transmission of music was described by Gray.[1]

Dolbear's condenser telephone.

In another form of telephone, brought prominently forward by Professor A. E. Dolbear,[2] the effects were produced by electrostatic instead of electromagnetic forces, as in the Bell telephone. Sir W. Thomson (Lord Kelvin) observed in 1863[3] that when a condenser is charged or discharged, a sharp click is heard, and a similar observation was made by Cromwell F. Varley, who proposed to make use of it in a telegraphic receiving instrument.[4] In Dolbear's instrument one plate of a condenser was a flexible diaphragm, connected with the telephone line in such a way that the varying electric potential produced by the action of the transmitting telephone caused an increased or diminished charge in the condenser. This alteration of charge caused a corresponding change in the mutual attraction of the plates of the condenser; hence the flexible plate was made to copy the vibrations of the diaphragm of the transmitter. It is obvious that this apparatus might be used either as a transmitter or as a receiver, but that the effects must under ordinary circumstances be in either case extremely feeble.

Liquid transmitters of Bell and E. Gray.

It was very early recognized—and, indeed, is mentioned in the first patents of Bell, and in a caveat filed by Elisha Gray in the United States patent office only some two hours after Bell's application for a patent—that sounds and spoken words might be transmitted to a distance by causing the vibrations of a diaphragm to vary the resistance in the circuit. Both Bell and Gray proposed to do this by introducing a column of liquid into the circuit, the length or the resistance of which could be varied by causing the vibrations of the diaphragm to vary the depth of immersion of a light rod fixed to it and dipping into the liquid.

Berliner's microphone transmitter.

On the 4th of April 1877 Émile Berliner filed a caveat in the United States patent office, in which he stated that, on the principle of the variation with pressure of the resistance at the contact of two conductors, he had made an instrument which could be used as a telephone transmitter, and that, in consequence of the mutual forces between the two parts of the current on the two sides of the point of contact, the instrument was capable of acting as a receiver. The caveat was illustrated by a sketch showing a diaphragm with a metal patch in the centre, against which a metal knob was lightly pressed by an adjusting screw. This seems to have been the first transmitter in which it was proposed to use the resistance at the contact of two conductors.

Edison's microphone transmitter.

Almost simultaneously with Berliner, Edison conceived the idea of using a variable resistance transmitter.[5] He proposed to introduce into the circuit a cell containing carbon powder, the pressure on which could be varied by the vibrations of a diaphragm. He sometimes held the carbon powder against the diaphragm in a small shallow cell (from a quarter to half an inch in diameter and about an eighth of an inch deep), and sometimes he used what he describes as a *fluff*, that is, a little brush of silk fibre with plumbago rubbed into it. In another form the plumbago powder was worked into a button cemented together with syrup and other substances. In the specification of the patent applied for on the 21st of July 1877 he showed a sketch of an instrument which consisted of a diaphragm, with a small platinum patch in the centre for an electrode, against which a hard point, made of plumbago powder cemented together with india-rubber and vulcanized, was pressed by a long spring, the pressure of the carbon against the platinum disk being adjusted by a straining screw near the base of the spring. Subsequently he filed an application for a patent in which various forms of springs and weights assisted in maintaining the contacts and otherwise improved the instrument.

Hughes's microphone.

In the early part of 1878 Professor D. E. Hughes, while engaged in experiments upon a Bell telephone in an electric circuit, discovered that a peculiar noise was produced whenever two hard electrodes, such as two wires, were drawn across each other, or were made to touch each other with a variable degree of firmness. Acting upon this discovery, he constructed an instrument which he called a "microphone,"[6] and which consisted essentially of two hard carbon electrodes placed in contact, with a current passing through the point of contact and a telephone included in the same circuit. One of the electrodes was attached to a sounding board capable of being vibrated by sound-waves and the other was held either by springs or weights in delicate contact with it. When the sounding board was spoken to or subjected to sound-waves, the mechanical resistance of the loose electrode, due to its weight, or the spring, or both, served to vary the pressure at the contact, and this gave to the current a *form* corresponding to the sound-waves, and it was therefore capable of being used as a speaking-telephone transmitter.[7]

The next transmitter of note was that introduced by Francis Blake, which came into wide use in the United States of America and other countries. In it the electrodes were of platinum and carbon.

To a frame F (fig. 5) was attached a diaphragm D of thin sheet iron; in front of this was a cover M, M provided with a suitable cavity for directing the sound-waves against the diaphragm. The microphonic arrangement consisted of a spring S, about the hundredth of an inch thick and the eighth of an inch broad, fixed at one end to a lever L, and carrying at its free extremity a brass block W. In one side of W a small disk C of gas carbon was inserted, resting on the hemispherical end of a small platinum pin K, about the twentieth of an inch in diameter, held in position by a thin spring A. The pressure of the carbon on the platinum point could be adjusted by the screw N, which turned the lever about the flexible joint G. The electrical connexions of the instrument as arranged for actual use are also illustrated in the figure. The current circuit went through S, W, C, K, A, and the primary circuit of the induction coil I to the battery B, and thence to S again. This formed a local circuit at the transmitting station. The line of circuit passed through the secondary of the induction coil I to the line, from that to the telephone T at the receiving station,

[1] See George B. Prescott, *The Speaking Telephone* (London, 1879), pp. 151–205.
[2] *Scientific American*, 18th June 1881.
[3] *Electrostatics and Magnetism*, p. 236.
[4] See *Tel. Journ.*, 1st August 1877, p. 178; also Adams, *Journ. Soc. Tel. Eng.*, 1877, p. 476.

[5] See *Journal of the Telegraph*, New York, April 1877; *Philadelphia Times*, 9th July 1877; and *Scientific American*, August 1877.
[6] This term was used by Wheatstone in 1827 for an acoustic apparatus intended to convert very feeble into audible sounds; see his *Scientific Papers*, p. 32.
[7] See *Proc. Roy. Soc.*, xxvii. 362; *Proc. Phys. Soc.*, ii. 255; *Phil. Mag.*, 5th ser., vol. vi. p. 44; W. H. Preece, *Journ. Soc. Tel. Eng.*, vii. 270.

and then either to earth or back to the induction coil by a return line of wire.

Another type of microphone which was used in Europe much more than in the United States was the multiple-contact instrument. In this several microphonic joints were employed.

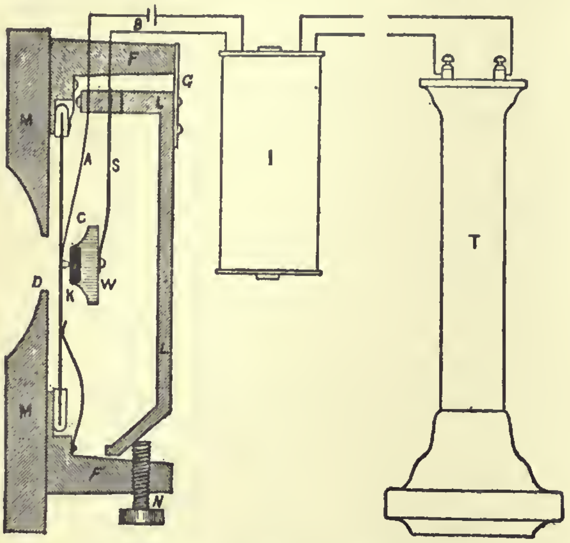

FIG. 5.—Blake's Transmitter.

Thus, in the Crossley transmitter four hard carbon pencils were arranged in a lozenge-shaped figure, the ends of each pencil resting loosely in a small carbon block. These blocks were fastened to a diaphragm of wood. The circuit connexions were such that two adjacent sides of the lozenge were in parallel and two in series. In the Ader transmitter as many as twelve carbon pencils were employed, arranged in a series of two groups with six pencils in parallel in each group. These were supported at their ends in parallel carbon bars, which were carried by a nearly horizontal wooden diaphragm. Such multiple-electrode transmitters give a loud although somewhat harsh sound, and will bear being spoken to very strongly without breaking the circuit.

A type of transmitter which has come to be invaluable in connexion with long-distance telephony, and which has practically superseded all other forms, is the granular carbon transmitter. The earliest instrument of this kind was the Hunnings transmitter, patented in 1878. This was constructed of a shallow box placed in a vertical position, with metallic front and back and insulating sides. The front face was of thin metal, and served as a diaphragm. The box was filled nearly, but not quite full, of granulated hard carbon. The current from the battery used passed from the diaphragm through the granulated carbon to the metallic back of the box. When spoken to the diaphragm vibrated, and thus set the carbon granules into vigorous vibration. The vast number of microphonic contacts present give rise to very strong electrical undulations, and hence to a loud sound.

The chief difficulty with this transmitter, and with various others of later date based upon it, has been the frequent packing of the carbon granules, which renders the instrument inoperative. The difficulty was first satisfactorily overcome in the long-distance transmitter, invented by A. C. White in the laboratory of the American Bell Telephone Company, and commonly known as the "solid back transmitter" (fig. 6).

The microphonic portion of the transmitter is contained in a thin cylindrical box or case of brass A, the inner curved surface of which is covered with an insulating layer of paper. The case is firmly fixed to a "bridge" B with its back or bottom in a vertical position. To the brass bottom of the case is attached a thin disk of polished hard carbon C, which is slightly less in diameter than the brass bottom, so that the carbon disk almost entirely covers this brass back, leaving only a slight annular space around its edge. The front or cover of the case is a similar button of hard polished carbon D, also slightly smaller in diameter than the cylindrical wall of the box. It is attached to a brass disk E, which is fastened to the centre of the diaphragm F by means of a rivet, and is capable of moving to and fro like a plunger when the diaphragm vibrates. A washer of thin flexible mica G concentric with the carbon button is carried by the brass disk, and projecting over the edge of this is held firmly against the rim of the cylindrical wall of the case by an annular brass collar H, which is screwed upon the outer curved surface of this wall. The box is thus entirely closed at the front, while the front carbon disk, which constitutes an electrode, is perfectly free to follow the motions of the diaphragm.

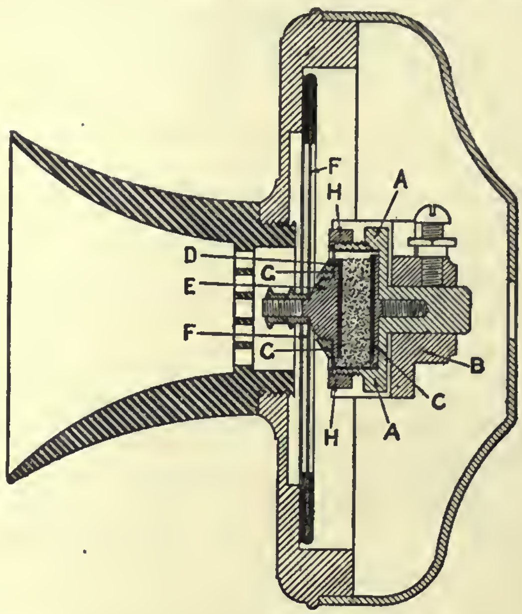

FIG. 6.—Solid Back Transmitter.

The space enclosed between the front and rear faces of the box is filled about three-quarters full of finely granulated hard carbon, which therefore lies in contact with the front and rear carbon disks of the apparatus, and also fills up the space lying between the lower edge of these disks and the curved surface of the case. The current from the battery passes from one of the carbon disks to the other through the particles of granulated carbon which fill the space between them.

The disks and granules constitute a very powerful microphone. The motions impressed upon the carbon granules are very vigorous, and this together with the particular arrangement of the parts of the instrument is effectual in obviating the difficulty from packing which attended the use of earlier forms of granulated carbon transmitters. This instrument has almost entirely displaced all other forms of transmitter.

Subscribers' Organization.—The employment of the telephone as one of the great means of communication requires a definite organization of the subscribers. It is not practicable to connect each subscriber directly to all the others, hence a system of exchanges has been adopted. The territory in which a telephone administration operates is usually divided into a number of local areas, in each of which one or more exchanges are placed. An exchange is a central station to which wires are brought from the various subscribers in its neighbourhood, any two of whom can be put in telephonic communication with each other when the proper pairs of wires are joined together in the exchange.

When the subscribers in a local area exceed a certain number, or when for some other reason it is not convenient or economical to connect all the subscribers in the area to one exchange, it is usual to divide the area into a number of districts in each of which an exchange is placed, and to connect these district exchanges together by means of "junction circuits." In some cases the exchanges are connected together directly; but when the volume of traffic is not sufficient to warrant the adoption of such a course connexions between two exchanges are made through junction centres to which both are connected.

A system of wires, similar to that which connects the district exchanges in an area, links together the various local areas in the territory, and sometimes the territory of one administration with that of another. These inter-area or long-distance lines, called trunk circuits in England, terminate at one exchange in each local area, and between that exchange and the various district exchanges junction circuits are provided for the purpose of connecting subscribers to the trunk lines.

Circuit and Working Arrangements.—The method first employed for working a telephone line was extremely simple. A single line of wire, like an ordinary telegraph line, had a Bell telephone included in it at each end, and the ends were put to earth. Words spoken to the telephone at one end could be heard by holding the telephone to the ear at the other. To obviate the inconvenience of placing the telephone to the mouth and the ear alternately, two telephones were commonly used at each end, joined either parallel to each other or in series. The contrivance most generally adopted for calling attention was a call-bell rung either by a small magneto-electric machine (magneto-generator) or by a battery. The telephone was switched out of circuit when not in use and the bell put in its place, a key being used for throwing the battery into circuit to make the signal. This arrangement is still employed, a hook being attached to the switch lever so that the mere hanging up of the telephone puts the bell in circuit. In some cases when a magneto-generator is employed for calling purposes the coil of the machine is automatically cut out of circuit when it is not in action, and is brought into circuit when the handle is turned by the operation of a centrifugal or other arrangement.

At first it was usual to join the microphone transmitter in the direct circuit. It was soon found that it could only be used to advantage in this way when the total resistance of the circuit, exclusive of the microphone, was small compared with the resistance of the microphone—that is, on very short lines worked with

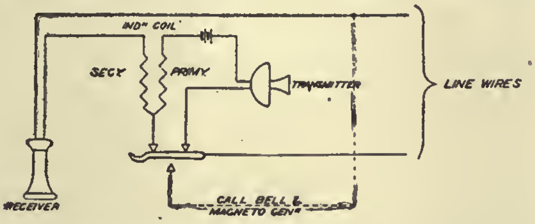

FIG. 7.—Telephone Set with Transmitter in a Local Circuit.

low resistance telephones. The transmitter on long and high-resistance lines worked better by joining, in the manner shown in fig. 7, the microphone, a battery and the primary of an induction coil in a local circuit, and putting the line in circuit with the secondary of the induction coil, which acted as the transmitter. The resistance of the microphone can thus be made a large fraction of the total resistance of the circuit in which it is placed; hence by using considerable currents, small variations in its resistance can be made to induce somewhat powerful currents in the line wire. The requisite energy is derived from the battery.

In the earliest telephone switchboards the lines were connected to vertical conducting strips, across which were placed a series of similar horizontal strips in such a manner that any horizontal could be connected to any line strip by the insertion of a plug into holes provided in the strips for the purpose. Any two lines could be connected together by connecting both to the same horizontal strip.

The next step of importance was the introduction of what was termed the "Standard board." This board was equipped with spring-jacks and annunciators (calling-drops) for the subscribers' lines, and with flexible cords terminating in plugs for connecting purposes. The spring-jack used was a form of switch with two contact springs which pressed against each other, one being connected to the subscriber's line wire and the other to the annunciator, which was also earthed. When a plug was inserted in the spring-jack the connexion between the springs was opened, disconnecting the calling-drop from the line. Each connecting-cord circuit had associated with it a clearing-out drop connected between the cord and earth and a key by means of which the operator's speaking and ringing apparatus could be brought into circuit. When a subscriber called (by turning the handle of his magneto-generator), the shutter of the annunciator associated with his line dropped. This attracted the attention of the attendant, who in response to the call inserted a plug into the spring-jack and connected the speaking apparatus to the circuit by means of the key. Then, having obtained particulars of the subscriber's requirement, the operator connected the second plug to the spring-jack of the wanted subscriber, whom she rang up. When the conversation was finished either of the subscribers could release the shutter of the clearing-out drop by turning his generator handle, and the operator thus notified of the fact removed the plugs and discontinued the connexion.

The single-wire earthed circuits used in the early days of telephony were subject to serious disturbances from the induction caused by currents in neighbouring telegraph and electric light wires, and from the varying potential of the earth due to natural or artificial causes. The introduction of electric tramways caused an enormous increase in disturbances of this class. It was early recognized that a complete metallic circuit would obviate troubles from varying earth potentials, and that if the outgoing and incoming branches of the circuit were parallel and kept, by transposition spiralling, or otherwise, at equal average distances from the disturbing wire, induction effects would likewise be removed. These advantages led to the gradual supersession of the single-wire system until at the present day the all-metallic system is employed almost universally. Since the time when the system first became prominent all switchboards have been arranged for metallic circuits.

Though many types of manually operated switchboards have been brought into use, differing from each other in respect of circuit and working arrangements, yet each of them may be placed in one or other of three main classes according as the system of working is magneto, call-wire, or common battery. The fundamental principle of the magneto system has been described in connexion with the "Standard board."

In a large exchange a number of operators are necessary to attend to calls. Several single switchboards like that described may be employed, each devoted to a certain section of the subscribers, and placed in care of an operator. In these circumstances, when, as frequently will be the case, the person calling desires to be put in communication with a subscriber who belongs to another section, connexions must be established in the office between the two sections; this necessitates additional switchboard arrangements, and also increases the time required to put subscribers in communication with one another. The difficulty was obviated by the introduction of the "multiple switchboard." This board is built up in sections of one or more operators' positions each. All the subscribers' lines are connected in order to jacks on the first two or three or four operators' positions, and these connexions are repeated or "multipled" upon each succeeding similar group of positions. Each subscriber's circuit is further connected to another spring-jack directly associated with the calling-drop. These spring-jacks, known as answering jacks, are distributed along the switchboard, a certain number being terminated upon each position and placed in the care of the operator assigned to that position. Hence this operator, when signalled in the ordinary way, can put any one of these subscribers in connexion with any subscriber whatever, without the necessity of calling upon another operator to make connexions.

Two methods of "multipling" have been much used. In the arrangement first introduced the line wire is connected in series through the various spring-jacks, the circuit finally passing through the answering jack to the calling-drop. This arrangement is liable to give trouble, as disconnexions may arise in the spring-jacks in consequence of the failures of the springs to make contact. Operating mistakes also cause interruptions to conversations, as it is possible, by the insertion of a plug in a multiple jack, to disconnect the circuit between two talking subscribers. To overcome these difficulties the "branching multiple" was introduced. In this arrangement, instead of the circuit being made through the jacks in series, each jack is connected to an independent branch from the main circuit. With the "branching multiple" the "self-restoring drop" was introduced. This apparatus has two coils, one of which, connected across the line, is provided for the purpose of projecting the shutter, while the other is intended for its restoration and is joined in a local circuit arranged to be closed when a plug is inserted in any one of the associated jacks.

It is necessary that the operators working at a multiple board shall be able to ascertain without entering a subscriber's circuit whether the circuit be disengaged. This requirement is usually met by connecting a third or "test" wire to each of the jacks associated with a subscriber's line, and by making the circuit arrangements such that this wire is either disconnected or at earth potential when the line is not in use, and at some potential above or below that of the earth, when the circuit is engaged. With a proper arrangement of the operator's speaking set it is possible, by touching the socket of a jack with the tip of a peg or a special "test" thimble, to determine whether the circuit connected to the jack is in use.

Both the series and the branching methods of multipling are recognized at the present time as standard methods, although the former is only employed in comparatively small exchanges. The magneto system itself is dying out. There are still many magneto exchanges in existence, but when new exchanges are erected only the very smallest are equipped for magneto working, that system having succumbed to the common battery one in the case of all equipments of moderate and large dimensions.

The "call-wire" system has been used to some extent, but it is now obsolete. The feature of the system was the provision of special service circuits, termed call-wires, for purposes of communication between the subscribers and the exchange operators. Each subscriber was given the exclusive use of a circuit as in other systems, and shared a call-wire with a number of other subscribers. Each telephone set was equipped with a special key or switch by means of which the telephone could be transferred from an exclusive line to the call-wire at will. A subscriber desiring a connexion pressed the key and communicated his own number and that of the wanted subscriber to the operator in attendance on the call-wire. Then, when the connexion was made, the originating subscriber rang up the other. At the close of a conversation the originating subscriber again entered the call-wire and requested the operator to take down the connexion. The call-wires were usually equipped with drops in order that the exchange might be called at night when the operators were not listening continuously.

One of the greatest advances made in the development of the art of telephony was the introduction of the "common battery relay system." This advance did not merely remove the primary batteries from the subscribers' stations; it removed also the magneto-generator, and at the same time it modified considerably the conditions governing the exchange operating. The calling-drop of the magneto system was displaced by a relay and a small electric incandescent lamp, and whereas in the older system the calling-drop and the answering jack with which it was associated were some distance apart, the calling-lamp and the answering jack of the newer system were placed in juxtaposition. This alteration improved the operating conditions in three ways. In the first place it increased the visibility of the signalling instrument; in the second place it brought that instrument into the position in which it could most readily catch the operator's eye; and finally it eliminated the effort involved in associating one piece of apparatus with another and in finding that other. Moreover the clearing-out drop of the cord circuit was replaced by an arrangement which included the provision of one signal to be controlled through the agency of a relay by the calling subscriber, and another to be controlled by the person wanted. These supervisory signals took the form of lamps and were placed on the keyboard in positions immediately adjacent to the associated cords. With the adoption of relays the signalling between the subscribers and the exchange became automatic, and, with the introduction of the principle of double and automatic supervision on the cord circuits, it became possible for the operators to tell at any instant the state of a connexion. As a result the time occupied by an operator per call was reduced from 50·77 seconds to 16·63 seconds.

Three fundamental common battery transmission systems have been devised and are shown in figs. 8, 9 and 10. In the Hayes system (fig. 8) a repeating coil is placed in the cord circuit, and when two subscribers are connected together the winding connected to the line of the subscriber who is talking for the time being acts as primary, and the other, which is in the line of the listening subscriber, as secondary.

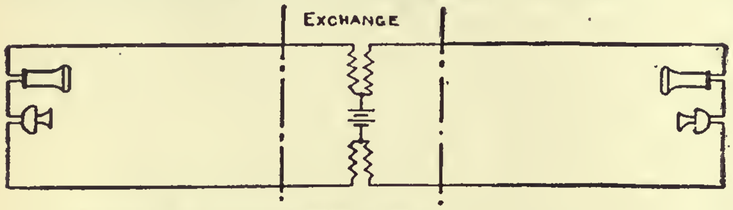

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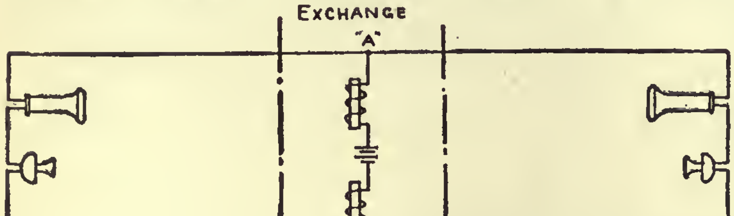
FIG. 8.—Hayes Common Battery System.

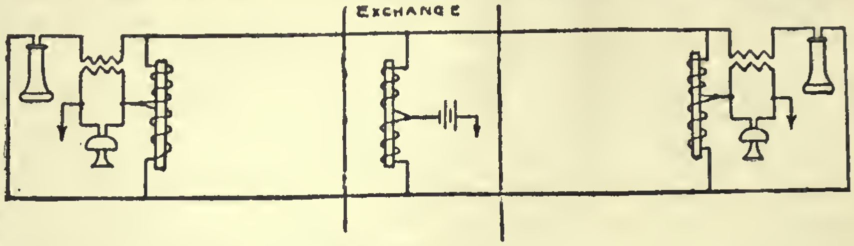
The Stone system (fig. 9) is characterized by the use of impedance coils between the battery and the line wires. When one of two subscribers connected together by this arrangement talks, the



From the *Post Office Electrical Engineers' Journal.*

FIG. 9.—Stone Common Battery System.

variation in resistance of the transmitter spoken into causes a variation of the pressure at the line terminals of the impedance coils, and since those terminals are common to the two circuits the variable E.M.F. operates in the line of the listening subscriber, causing the reproduction of the speech in the latter's receiver. The Stone system, compared with that of Hayes, possesses the



From the *Post Office Electrical Engineers' Journal.*

FIG. 10.—Dean Common Battery System.

disadvantage that one of the conditions affecting the supply of current to any particular subscriber's circuit is the resistance of the

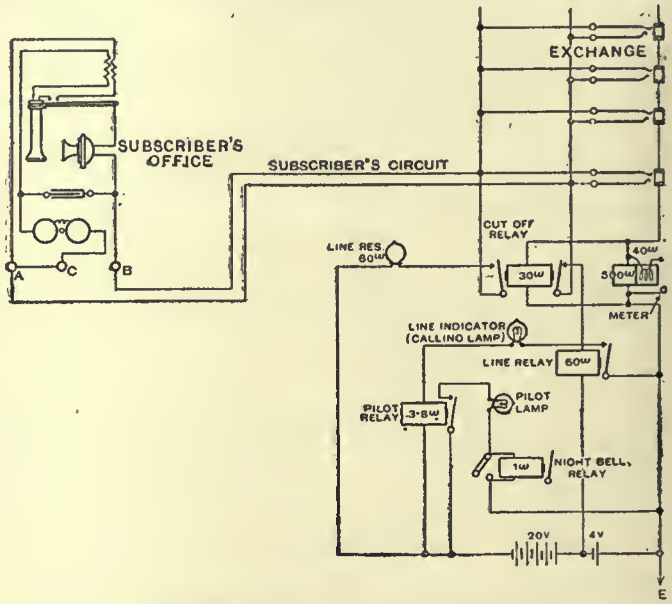
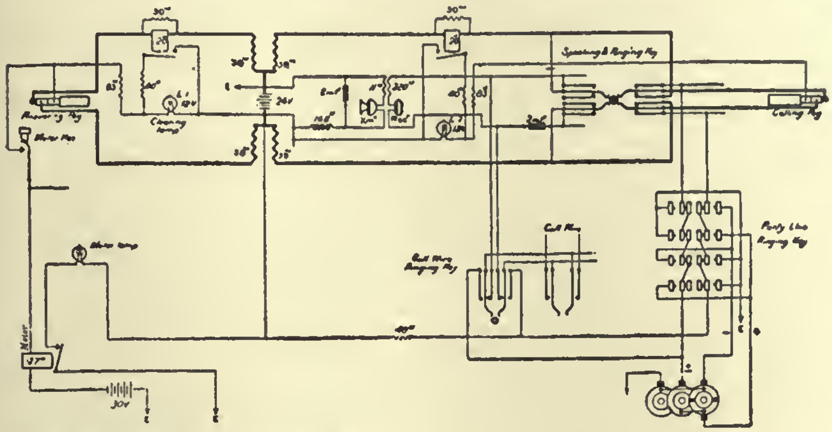


FIG. 11.—Subscriber's Circuit, Common Battery System.

other circuit to which it is connected for the time being. An improvement in this respect has been effected by the insertion of condensers in the cord circuits, coupled with the use of two sets of impedance coils, one set on each side of the condensers.

Dean's method (fig. 10) embodies the idea of supplying current to the transmitters over the line wires in parallel instead of round the loop circuit, as in the other systems referred to. An earth return is used. The transmitter is placed in multiple with the primary winding of an induction coil whose secondary operates in the loop circuit, and consequently when the transmitter is spoken into, a variable E.M.F. is impressed upon the circuit through the medium of the induction coil. The impedance coils shown connected between the battery and the lines and between the latter and the transmitters are joined up non-inductively as regards the transmitter circuits, but inductively as regards the secondary circuits. Figs. 11 and 12 indicate typical subscriber's and connecting-cord circuits as equipped by the Western Electric Company. At the subscriber's station when the receiver is on the hook switch the circuit is through the call-bell and a condenser. The conditions permit of the circulation of the alternating currents of low periodicity, which are used for operating the bells, but in respect of the battery the circuit is open until the subscriber lifts the receiver, when the hook switch, thus released, joins the transmitter with one winding of an induction coil in series across the circuit. A current then flows and in passing round the circuit operates the line relay, with the result that the calling-lamp is lighted. The operator, whose attention is thus attracted, inserts a peg in the jack, then throws over the speaking key of the cord circuit, and having ascertained particulars of the requirement places the other peg of the pair in the nearest multiple jack of the wanted subscriber, whom she proceeds to ring up. In the meantime the calling-lamp has darkened; and each subscriber's line being equipped with a cut-off relay whose function it is to disconnect the calling apparatus while the circuit is in use, the insertion of a peg is immediately followed by the disappearance of the calling signal. The supervisory lamp associated with the peg in the wanted subscriber's jack glows from the time that the peg is inserted until the subscriber responds, when it darkens, in which condition it remains until the subscriber restores the receiver to the hook and causes the lamp to light up again. The other supervisory lamp on the cord circuit is controlled in a similar manner by the subscriber who originated the call, and as that subscriber's telephone is off the hook when the peg is inserted, the lamp is not lighted at all until the subscriber replaces the receiver. When both lamps glow, the operator, who thereby knows that both subscribers have restored their instruments, discontinues the connexion.

A cord circuit, similar in many respects, including the method



From the *Post Office Electrical Engineers' Journal.*

FIG. 12.—Typical Cord Circuit, Western Electric Co.'s System, No. 1 Exchanges.

of operation, but equipped with condensers and impedance coils, in place of the repeating coil, is shown in fig. 13.

In fig. 11 a meter or counter is shown associated with the subscriber's line, and in both figs. 12 and 13 position meters are shown connected to the cord circuits. The operation of these meters is controlled by the operators. The subscriber's meter is joined in multiple with the cut-off relay, and whenever a peg is connected to the circuit a current flows through the meter. This current is small, however, and the meter is not operated until a much larger current is passed through it. Calls are registered by pressing a key, which connects a battery through a position meter of very low resistance to the socket of the line jack, thereby furnishing the necessary energy to the meter. The position meter just mentioned is common to all the cords on one position and records all completed calls handled at the position. Some administrations, in addition to employing the ordinary position meter, use a second one for registering ineffective calls.

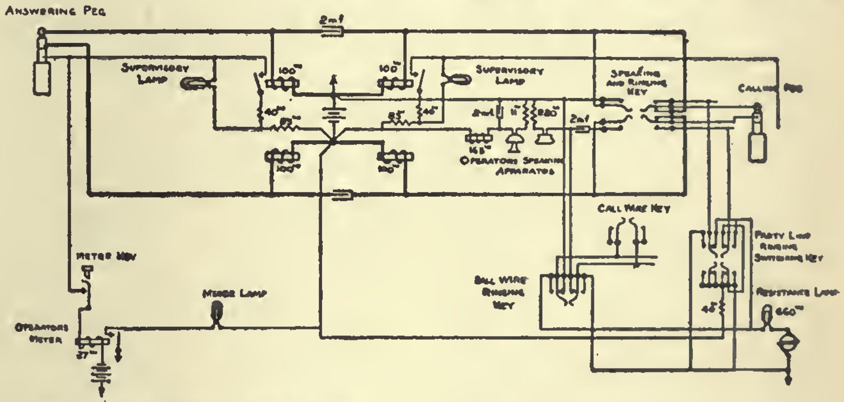
In large towns served by a number of exchanges the junction equipment is an important feature. In many cases from 60 to 80 per cent. of the calls originated at an exchange are for subscribers connected to other exchanges, and in these cases the junction plant forms a considerable fraction of the whole equipment. Moreover each call junctioned is dealt with by at least two operators. The junction circuits connecting two exchanges are invariably divided into two groups, one for traffic from exchange A to exchange B, the other for traffic from B to A. At the outgoing end the circuits are multipled on the subscribers' switchboard, while at the incoming end they terminate in plugs on a special incoming junction switchboard upon which the subscribers' lines are multipled in the usual way.

When a subscriber at exchange A asks for a connexion to a subscriber at B, the operator at A, to whom the request is made, passes the particulars over an order wire to an operator at B. The latter names a disengaged junction circuit, then "tests" the line of the wanted subscriber, and if she finds it free, finally completes the connexion and rings the subscriber. During the progress of these operations the A operator connects the originating subscriber to the junction circuit named by the B operator. There is only one signal on the cord circuit at B, and that signal is controlled by exchange A. Each of the subscribers controls a signal at A, and when either or both of the telephones are replaced, the action is indicated by the lamps there. Control of the call is thus vested in the operator at the originating exchange, at which point the connexion must be severed before a clearing signal can appear at B.

Party Lines.—A circuit which serves more than one subscriber is termed a "party line." It was originally the practice to place the calling apparatus in series in the line circuit, but the effect of the large impedance introduced by the electromagnets of the calling bells was such that not more than two or three persons could be connected without seriously impairing the efficiency of the circuit for speech transmission. An improvement was effected in this respect by the introduction of the "bridging" system, in which the bells possessing high inductance are placed in parallel between the two wires of the circuit. Although the bells are constantly in circuit their high impedance prevents any appreciable interference with the telephonic currents. In America, on farmers' circuits, ten or more stations are frequently connected to one line; but in England ten is practically the maximum. In city districts the modern practice is to restrict the number to four stations per line, and to equip the exchanges and stations for selective ringing. In one arrangement, now in extensive use, each telephone set is fitted with a relay of high inductance which is bridged across the circuit in series with a condenser. When the relay is operated it connects a bell between one of the wires of the circuit and earth, while the bell itself is arranged to respond to current pulsations in one direction only. The four telephones on a circuit are so wired that the relays connect two of the bells between each wire and earth, and further that one of each pair of bells responds to positive and the other to negative pulsations. This system of course requires that the exchange equipment shall include machines capable of delivering a positive pulsating current and a negative pulsating current, besides the usual alternations required for the ringing of ordinary subscribers.

In another party line system a harmonic principle is employed: the ringing machines deliver alternating currents of four frequencies, while each bell is constructed to operate at a particular frequency only. Of the four bells connected to a circuit each responds to a different frequency.

Trunk Line Working.—Trunk or long-distance working is complicated by the necessity for recording all calls. The system of the British Post Office is worked as follows: A subscriber desiring a long-distance connexion calls up his local exchange in the ordinary way, and the operator there, being informed that a trunk connexion is desired, extends the subscriber's line to the Post Office by means of a record circuit. At the Post Office a record operator replies and takes particulars of the connexion, and these are entered upon a ticket. The record operator then removes her speaking apparatus from the circuit, and the local operator, receiving a disconnect signal, severs the connexion at the local exchange. Meanwhile the ticket is conveyed to the position where the lines to the town wanted are terminated. If there be a line free, or when the turn of the call is reached, particulars of the connexion wanted are passed to the distant end, and the trunk operators request the local exchanges to connect the subscribers by means of junction



From the *Post Office Electrical Engineers' Journal.*

FIG. 13.—Typical Cord Circuit, British Insulated Co.'s System.

circuits to the trunk exchanges where the necessary connexions are made between the trunk line and the junctions. The call is controlled by the trunk operators, the junction circuits being equipped in such a manner that the subscribers' signals appear at the trunk exchanges, from which point disconnecting signals are sent automatically to the local exchanges, when the connexions between the trunk and the junction circuits are removed.

The large modern trunk exchanges are equipped with relays and lamps for signalling purposes. "Calculographs" are employed for stamping the time upon the tickets, and there is associated with each trunk circuit a device which lights a lamp as soon as the scheduled limit of the period of conversation is reached.

Particulars of calls are now passed between trunk centres to a great extent over telegraph circuits superposed upon the trunk lines. This arrangement permits particulars of calls to be passed over lines while conversations are in progress.

Automatic Systems.—The idea of automatic telephony is to substitute for the operator of the manual exchange an electro-mechanical or other switching system, which, controlled in its movement by the action of the subscriber, will automatically select, connect and disconnect circuits as desired. Several schemes embodying this idea have been developed, and one of them has been put into extensive operation. Each subscriber's circuit on this system terminates upon the incoming portion of a selector switch, called a first selector, and is multipled upon the outgoing portions of a number of similar switches called connector switches. Only calls originated by a subscriber pass through the selector switch (first selector) provided for his sole use; the calls incoming to him pass through one or other of the various connector switches upon which his circuit is multipled. Each connexion involves the use of three switches, viz., a first selector, a connector switch, and a second selector which is brought into operation between the other two.

The subscribers' lines in an exchange are arranged in groups of 1000, which are divided in turn into sub-groups of 100 each. By means of his first selector the circuit of a calling subscriber is connected to the outgoing end of a junction whose other end terminates upon the incoming portion of a second selector in the thousand group to which the wanted subscriber belongs. The second selector in turn extends the connexion by means of another junction circuit to one of the connector switches in the hundred group wanted, while finally the connector switch completes the connexion. One hundred circuits are connected to the outgoing portion of each switch, and the contacts upon which they terminate are arranged in a number of horizontal rows upon the face of a curved surface, at whose axis a vertical shaft is placed. This shaft, which carries a set of "wipers" connected to the incoming circuit, is susceptible of a vertical and a rotational movement, so that the wipers may be brought, first opposite any particular horizontal series of contacts, and then into actual contact with any particular set in the series. The movements of the shaft are controlled by relays and electro-magnets which operate in response to the action of the subscriber whose telephone is fitted with a calling mechanism which, when the subscriber calls, earths the line a certain number of times for each figure in the number of the wanted subscriber.

Wire Plant.—In suburban and rural districts subscribers are usually served by means of bare wires erected upon wooden or iron poles. As subscribers' lines are invariably short, the smallest gauge of wire possessing the mechanical strength necessary to withstand the stresses to which it may be subjected can be employed, and bronze wire weighing 40 ℔ per mile is commonly used. In large towns telephone distribution by means of open wires is practically impossible, and the employment of cables either laid in the ground or suspended from poles or other overhead supports is necessary.

In the types of cable that were first used, the wires, usually with a cotton insulation, were drawn into lead tubes, and the tubes filled with paraffin or other similar compound, which kept the wires from the injurious effects of any moisture which might penetrate the lead tube. This form of cable has been superseded by a type with paper insulation. The separate wires are surrounded only with a loose covering of specially prepared paper, which furnishes abundant insulation. In the manufacture of the cable the wires are first enclosed in the paper, which is applied sometimes longitudinally and sometimes spirally. The conductors are then twisted in pairs with definite lays. These pairs are laid up symmetrically into cables, each layer being protected with an additional covering of paper and all adjacent layers revolving with an opposite twist. The cable is then placed in an oven, and, after all moisture has been driven off, it is passed through a lead press whence it emerges protected by a continuous lead pipe. The electrostatic capacity of a cable of this type is low, and its dimensions are small, the external diameter of a cable containing 1600 ten-℔ conductors being only 2¾ in. The conductors used for subscribers' circuits are of copper weighing from 10 to 20 ℔ per mile. Junction circuits are usually made up of 20 or 40 ℔ conductors.

When a number of cables follow the same route, they are generally laid in conduits made up of earthenware or cement ducts; iron pipes are used when the number of cables is small. Manholes are placed at intervals in the line of ducts to facilitate the drawing in and jointing of the cables, and surface boxes are placed in the footways for distributing purposes. Various methods of making the connexions between the large main cables and the subscribers are in use. In one system the main cables terminate in large air-tight iron boxes placed in the manholes. There, the large cables divide into a number of small cables, which are carried along the footways in pipes and are tapped at suitable points to serve subscribers. Another method of distribution, largely adopted, is to run the lead cables into the interior of blocks of buildings, and to terminate them there in iron boxes from which the circuits are distributed to the surrounding buildings by means of rubber-covered wires run along the walls. Aerial distribution from distributing poles is a method frequently adopted. In this case the cables terminate upon the poles, the connexions between the cable wires and the open wires being made with rubber-covered leads.

The introduction in 1883 of the hard-drawn copper wire of high conductivity invented in 1877 by T. B. Doolittle was of the greatest importance in rendering the use of long lines practicable, and it is universally employed for such service. Wire weighing between 150 and 400 ℔ per mile is generally used. The New York-Chicago line, built in 1892, is of wire 165 millimetres in diameter (No. 8 Birmingham), weighing 435 ℔ per mile and having a resistance of 2·05 ohms per mile. Speech has been habitually transmitted for business purposes over a distance of 1542·3 m., viz., over the lines of the American Telegraph and Telephone Company from Omaha to Boston. Conversation has been carried on over 2200 m. of No. 8 line.

As no practical process of telephone relaying has been devised, it is extremely important that the character of the line should be such as to favour the preservation of the strength and form of the telephone current. In circuits possessing high resistance and capacity and low inductance per mile, telephonic currents are rapidly attenuated, and the higher the frequency the more rapid is the attenuation. Moreover, as the velocity of propagation is a function of the frequency, there is distortion of the complex waves. Oliver Heaviside showed mathematically that uniformly-distributed inductance in a telephone line would diminish both attenuation and distortion, and that if the inductance were great enough and the insulation resistance not too high the circuit would be distortionless, while currents of all frequencies would be equally attenuated. Following up this idea, Professor M. I. Pupin showed that by placing inductance coils in circuit, at distances apart of less than half the length of the shortest component wave to be transmitted, a non-uniform conductor could be made approximately equal to a uniform conductor. Many circuits have been "loaded" in the manner proposed by Pupin during recent years, especially in underground cables, and it has been found in practice that the transmission value of these when loaded is approximately from three to four times their value unloaded. Open aerial long-distance lines have also been loaded, but not to the same extent. The introduction of inductance coils into such circuits renders them more susceptible to trouble from atmospheric electricity and more sensitive to leakage variations.

In consequence of their high capacity, the attenuation constant of submarine cables is high, and only a small number of cables, of comparatively short length, are in use for telephonic purposes. Attempts have been made to improve submarine cables in this respect, and in 1906 a short cable "loaded" with Pupin coils was laid across Lake Constance. The problem, however, of constructing a deep-sea cable satisfactorily, with suitable inductance coils inserted at short distances apart, is a difficult one, and one which it cannot be said has been solved. (H. R. K.)

Commercial Aspects.—The records of the telephone industry in Great Britain during the thirty years from 1877 to 1907 form an instructive chapter in the industrial history of the country. The aspects which stand out most prominently in this history are: (*a*) The vacillation of successive governments due to the conflicting policies adopted from time to time to protect the telegraph revenues of the Post Office and to avoid the suppression of an enterprise which was becoming a public necessity and yielding substantial royalties to the Postmaster-General. (*b*) The obstructive use made by the local authorities of their power to veto underground wayleaves. (*c*) The remarkable success achieved by the National Telephone Company, despite these obstacles, in developing an extensive organization and a profitable business.

The chief events in chronological order are:—

1876. Graham Bell's telephone patent was granted for the United Kingdom.

1877. Edison's telephone patent was granted for the United Kingdom.

1878. Professor D. E. Hughes invented the microphone, but did not apply for letters patent. The Telephone Company, Limited, was formed to acquire Bell's patent. During the passage of the Telegraph Bill 1878 through parliament the Postmaster-General endeavoured, without success, to insert a clause declaring that the term "telegraph" included "any apparatus for transmitting messages or other communications with the aid of electricity, magnetism, or any other like agency."

1879. The Edison Telephone Company of London was formed. Both the Bell and the Edison Companies opened negotiations with the Post Office for the sale of their patents to the government, but without success. The Edison Company announced its intention to start telephone business in London, and the Postmaster-General instituted proceedings against the company for infringement of his monopoly rights under the Telegraph Act 1869.

1880. The two companies amalgamated as the United Telephone Company Ltd. Mr Justice Stephen decided (*Attorney-General* v. *Edison Telephone Company*, 6 Q.B.D., 244) that the telephone was a telegraph, and that telephone exchange business could not legally be carried on except by the Postmaster-General or with his consent. The decision covered also future invention in regard to "every organized system of communication by means of wires according to any preconcerted system of signals."

1881. The company's appeal against the decision was withdrawn, the Postmaster-General agreeing to grant licences for restricted areas of about 5 m. in London and about 2 m. in the provinces. The licences merely condoned the infringement of the Telegraph Act 1869, and did not confer powers to erect poles and wires on, or to place wires under, any highway or private property. The licensee was precluded from opening public call offices and from laying trunk lines from one town to another. The licences were for 31 years, expiring in 1922, without any provision for purchase or compensation, and were subject to the payment of a minimum royalty to the Post Office of 10 per cent. of the gross revenues. The United Telephone Company confined its operations to London; subsidiary companies were formed to operate in the provinces. The Post Office at the same time established several telephone exchanges in provincial towns so as to enable the Postmaster-General "to negotiate with the telephone companies in a satisfactory manner for licences."

1882. The Postmaster-General (Mr Fawcett) declared that he would issue no more licences unless the licensees agreed to sell telephones to the Post Office. As a result only eight companies out of over seventy that had applied obtained or accepted licences.

1883. The Post Office proposed to engage in active competition with the telephone companies, but the Treasury at that time opposed this policy on the ground that the state should at most be ready to supplement and not to supersede private enterprise.

1884. The licences within restricted areas having proved unsuitable for the growing business, public opinion appealed to the Post Office to issue new licences applicable to the whole country. All limitations of areas were removed and licensees were allowed to open public call offices but not to receive or deliver written messages, and they were allowed to erect trunk wires. The royalty of 10 per cent. was continued. The Post Office reserved the right to compete either directly or by granting other licences, and it was under no obligation to grant wayleaves. The new licences were to terminate in 1911 without any provision for purchase or compensation in that year, but with the option to the government to purchase the plant of the licensees in 1890, 1897, or 1904 at a price to be determined by arbitration. The United Telephone Company asked parliament for rights of way in streets but was refused, and its only right to place overhead wires was obtained by private wayleaves.

1885. The United Telephone Company again applied unsuccessfully for right to lay wires underground.

1888. The application of the company for permission to lay wires in streets was again refused.

1889. After the withdrawal of the restriction against the companies erecting trunk wires it became evident that the development of the telephone services throughout the country would be facilitated by complete intercommunication and uniformity of systems, and that economies could be effected by concentration of management. The various companies therefore amalgamated as the National Telephone Company.

1890. The government had the option to buy out the companies under the licences of 1884, but did not exercise it. The Bell telephone patents expired. The National Telephone Company applied to the London County Council for permission to lay wires underground and continued efforts till 1899 to obtain this power, but without success.

1891. The duke of Marlborough, in the name of the New Telephone Company, inaugurated a campaign for cheaper telephone services, but the New Telephone Company was subsequently merged in the National Telephone Company.

1892. The National Telephone Company again applied to parliament for powers to lay wires underground; public discontent with inadequate telephone services was expressed, and at the same time the competition of the telephone with the Post Office telegraph became more manifest. The government again changed its policy. It compelled the companies to sell their trunk wires to the Post Office, leaving the local exchanges in the hands of the companies. It also expressed willingness that the companies should have rights of way in the streets.

1893. The National Telephone Company again applied to parliament for power to lay wires underground, but was refused.

1894. The draft agreement between the government and the National Telephone Company to carry out the policy of 1892 was submitted to parliament and led to much discussion. Local authorities (particularly London and Glasgow) refused to permit the company to lay wires underground.

1895. A select committee of the House of Commons (with Mr Arnold Morley, Postmaster-General, as chairman) was appointed "to consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licences to local authorities or otherwise." The committee was not unanimous and made no report, but merely submitted to the House the evidence it had taken.

1896. The trunk wires were transferred to the Post Office in pursuance of the policy of 1892, but for all practical purposes the local authorities had vetoed the permission of the government to the company to lay wires underground.

1897. The government had an option to purchase the plant of the company under the licences of 1884, but did not exercise it. The corporation of Glasgow having persisted in its efforts to obtain a licence, the Treasury appointed Sheriff Andrew Jameson (afterwards Lord Ardwall) a special commissioner to hold a local inquiry in Glasgow to report whether the telephone service in that city was adequate and efficient and whether it was expedient to grant the corporation a licence. The commissioner reported that the service was adequate but not efficient; that the rates were reasonable but that the corporation was responsible for unreasonably withholding facilities, thus rendering the service inefficient; that it was inexpedient to grant the corporation a licence because the funds of a city ought not to be applied for the benefit of a limited class of citizens; that delay and waste would result from two systems in one area and would increase the difficulties of the government in 1911; and that the corporation had not proved it could work the licence without placing a burden on the rates.

1898. The policy of the government was again changed; Mr R. W. Hanbury, Financial Secretary to the Treasury and representative in the House of Commons of the Postmaster-General, advocated the granting of licences to local authorities. A select committee was appointed with Mr Hanbury as chairman to consider "whether the telephone service is calculated to become of such general benefit as to justify its being undertaken by municipal and other local authorities, and if so under what conditions." The committee reported (9th August) that the telephone service was not likely to become of general benefit "so long as the present practical monopoly in the hands of a private company shall continue." The committee considered that the Post Office was not prevented either by legal agreement or by good faith from limiting or ending the monopoly of the company, and that competition appeared to be both expedient and necessary in order to extend and popularize the service and to avoid the danger that a purchase of the company's undertaking at an inflated price might be forced upon the government. While considering that a really efficient Post Office service would afford the best means for securing such competition, it recommended that general, immediate and effective competition should at once be undertaken either by the Post Office or by local authorities. The Association of Municipal Corporations passed resolutions on the 28th of April that "the subject of telephonic supply should be treated as an imperial and not as a local one, and that the Postmaster-General should have the sole control of the telephone system," and "that in the event of the Postmaster-General not taking over the telephone service it should be competent for municipal and other local authorities to undertake such services within areas composed of their own districts or combination of such districts."

1899. In pursuance of the report of the select committee, 1898, the Telegraph Act 1899 was passed to enable the Post Office to develop its telephone exchange business, for which a loan of £2,000,000 was sanctioned, and to empower local authorities, subject to certain conditions, to enter upon telephone business. The licence of the National Telephone Company was extended so as to be co-extensive with that of a competitive licence for any locality on condition that the company should afford intercommunication with the telephone systems of the new licensees. In short, all-round competition was authorized, and the Post Office decided to establish a telephone system in London in competition with the company.

1900. The Telegraph Act 1899, while providing for intercommunication between the telephone systems of the local authorities and the company, did not give the Post Office the right to demand intercommunication between its exchanges and those of the company. The Post Office co-operated with the London County Council to put difficulties in the way of the company which had placed wires underground in London with the consent of the local road authorities. In February the Postmaster-General applied for an injunction to restrain the company from opening any street or public road within the county of London without the consent of the Postmaster-General and the London County Council, which injunction was granted in July.

1901. The government policy of 1899 was abandoned in London, the Post Office making an agreement with the company in regard to the London business. The company consented to free intercommunication between its subscribers and those of the Post Office, and undertook to charge rates identical with those charged by the Post Office. The Postmaster-General on the other hand agreed to provide underground wires for the company on a rental, and agreed to buy in 1911 the company's plant in London at the cost of construction less allowance for repairs and depreciation.

1904. The government had option to purchase the company's provincial plant under the licence of 1884. Negotiations took place, but no agreement was reached.

1905. The government contracted to buy the company's plant in 1911, thus in effect annulling the act of 1899 which had failed to accomplish its object of establishing all-round competition.

By 1907 altogether 59 local authorities had examined the proposition of establishing telephone systems after 1899, and licences were granted to local authorities at Brighton, Belfast, Chard, Glasgow, Grantham, Huddersfield, Hull, Portsmouth, Swansea, Tunbridge Wells, Oldham, Scarborough and Hartlepool, but only six municipalities proceeded with the business. Glasgow opened its exchange in March 1901, Tunbridge Wells in May 1901, Portsmouth in March 1903, Brighton in October 1903, Swansea in November 1903 and Hull in October 1904. The Tunbridge Wells and Swansea municipal undertakings were subsequently sold to the National Telephone Company, and the Glasgow and Brighton undertakings to the Post Office. Hull and Portsmouth were the only municipal telephone systems working in 1907.

The effect of the unsettled policy of the Post Office until 1905 and of the difficulties created by the local authorities was that the National Telephone Company was never able to do its best to develop the enterprise on the most efficient lines. In 1885 there were only 3800 telephone subscribers in London and less than 10,000 in the rest of the United Kingdom, and telephonic services were available in only about 75 towns, while in the same year the American Bell Telephone Company had over 134,000 subscribers. The removal in 1884 of the prohibition against the erection of trunk lines at once enabled considerable expansion to take place. Within six years the services had been extended to 400 towns with about 55,000 subscribers. Large as this progress was it would have been much greater if the Telephone Company had been granted adequate powers to put wires underground and thus instal a complete metallic circuit in place of the single wire, earth-return, circuit which it was constrained to employ. Subsequently the progress was still greater. In 1906 there were 30,551, equal to 7·2 per cent., more telephone stations in the United Kingdom than in the ten European countries of Austria, Hungary, Belgium, Denmark, Holland, Italy, Norway, Portugal, Russia, Sweden and Switzerland, having a combined population of 288 millions as against a population of 42 millions in the United Kingdom. Apart from France, Germany and Switzerland, there was no European country that had as many telephones working as London. That city, with a population of 6 millions, had nearly as many telephones as the whole of Sweden with about the same population, or as the whole of France, with a population of 39 millions. The only European country which can be compared with the United Kingdom in telephone development is Germany. With a population of 58 millions there are 10·2 telephones per 1000 of the population in that country compared with 10·15 in Great Britain and Ireland. The development of telephony in the United States of America is much greater than anywhere else; on the 1st of January 1907, 5 per cent. of the population were telephone subscribers.

Tariffs.—Telephone business is characterized by two features: (1) that the capital account is never closed, and (2) that the costliness of the service increases with the size of the undertaking. The original method of charging adopted in Great Britain took the telephone instrument as the unit, charging a fixed annual rental independent of the amount of use to which the instrument was put. The study of telephone economics showed that the proper basis for charging was the "message-mile," on the theory that the user should pay according to the facilities offered and the extent to which he made use of them. In a large city, where several interconnected exchanges have to be built and thousands of subscribers are put into communication with each other, the service is at once more costly and more valuable than in a small town with a few hundred subscribers accommodated in one exchange. Differences not only in the size of towns, but in the arrangement and character of the population, make each district a telephone problem by itself, and nullify close comparisons between telephone rates and telephone efficiencies in different areas and different countries. But the tendency is towards a system of charging a moderate sum to cover the rent of the instrument and an additional fee per message. For instance, in the county of London, the telephone tariff is £5 per annum plus 1d. per call within the county and 2d. per call outside the county. Subscribers outside the county of London pay only £4 in annual subscription and 1d. per call to subscribers on the same exchange and 2d. per call to subscribers on other exchanges. In each case the minimum annual amount for message fees is £1, 10s. The alternative is given of an unlimited service ("flat rate") at £17 per annum. In the provinces the unlimited service costs only £7, 10s. for subscribers within half a mile of the exchange, £1, 5s. being charged for every additional quarter of a mile or fraction thereof. The toll or message rates are £3, with 1d. per call, with a minimum of £1, 10s. As the cost of the service varies in proportion to the amount of use, the toll rate is more scientific, and it has the further advantage of discouraging the unnecessary use of the instrument, which causes congestion of traffic at busy hours and also results in lines being "engaged" when serious business calls are made. The tariff for unlimited use has to be made very high to cover the cost of the additional burdens thrown upon the service, and it only works economically to the individual subscriber who has an exceptionally large number of calls originating from his instrument. The message-rate system equalizes the charges according to the service rendered. Another method of charge, known as the "measured service rate," is designed to make the subscriber pay in proportion to the quality and quantity of the service he takes. It is widely used in America, and was introduced into Great Britain in 1907. The subscriber pays a fixed annual rent which covers a certain number of free outward calls, say 500; additional calls he purchases in advance in blocks of several hundred at so much per hundred, the price being reduced as the number increases.

For subscribers who desire the telephone for occasional use, the party-line system has been devised, whereby several telephones are connected to one line leading to the exchange. In London a two-line party service costs £3 per annum, the message fees being 1d. per call to subscribers within the county and 2d. per call to those outside it, with a minimum of £3. The fee charged for the use of public telephone call offices is 2d. per message.

The trunk line service is charged for on rates which vary from 3d. (for 25 m.) up to 1s. (for 100 m.) for a three minutes' conversation between 6 a.m. and 8 p.m. For every 40 m. above 100 m. an additional 6d. per conversation is charged. A reduction has been made in the charges for trunk calls at night, and calls for single periods of three minutes are allowed at half the ordinary rates between 7 p.m. and 7 a.m. A call between London and Liverpool, which ordinarily costs 2s., can be made for 1s. between those hours. The growth of traffic on this basis has been considerable, and the arrangement has proved of advantage to the public, as it provides cheap facilities at times which are convenient for social conversation.

Telephone subscribers may telephone ordinary messages to any post office which may be reached through the local exchange system, or by means of the trunk wires, in order that the messages may be written down and forwarded as telegrams or express letters or ordinary letters. Subscribers to exchanges may also make arrangements to have all telegrams (except Press telegrams) addressed to them delivered by telephone instead of messenger. Telephone subscribers may also obtain the services of an express messenger by telephoning to the nearest post office connected with the exchange.

National Telephone Company.—The issued share and debenture capital of the company on the 31st of December 1907 was:—

15,000 6% 1st preference shares of £10 each	£150,000
15,000 6% 2nd preference shares of £10 each	150,000
250,000 5% 3rd preference shares of £5 each	1,250,000
6% preferred stock	2,225,000
Deferred stock	3,366,425
71,715 new shares of £5 each	358,575
	£7,500,000
3½% debenture stock	2,000,000
4% debenture stock	1,716,593
	£11,216,593

The company has a reserve fund of £2,467,707, the major part of which is invested in the business. The gross income for the year 1907 amounted to £2,702,228, of which £257,920 was paid to the Post Office in respect of royalties. The working expenses amounted to £1,530,093 or 62·6 per cent. of the net income, leaving a profit for the year of £914,216.

At the time of the formation of the various telephone companies the enterprises were regarded as speculative, and much of the capital was raised at a discount. The business subsequently proved profitable, good dividends were paid, and the securities for the most part commanded a premium in the market. After the consolidation of the companies in 1889–1890 the profits declined, patent rights had expired, material reductions were made in the rates for telephone services, and considerable replacements of plant became necessary, the cost of which was charged to revenue.

Agreement of 1905.—By this agreement the Postmaster-General agreed to purchase all plant, land and buildings of the National Telephone Company in use at the date of the agreement or constructed after that date in accordance with the specification and rules contained in the agreement, subject to the right of the Postmaster-General to object to take over any plant not suited to his requirements. The price is to be fixed by the Railway and Canal Commissioners as arbitrators on the basis of the "then value," exclusive of any allowance for past or future profits or any compensation for compulsory sale or other consideration. In those cases in which the company's licence has been extended beyond 1911 (Glasgow to 1913, Swansea to 1926, Brighton to 1926 and Portsmouth to 1926) the Postmaster-General will buy the unexpired licence with allowance for goodwill. The Postmaster-General agreed also to buy the private wire plant of the company at a value based upon three years' purchase of the net profits on the average of the three years ending 31st of December 1911. The Postmaster-General also agreed to lay underground wires for the company at an annual rental of £1 per mile of double wire in any local area in which the company was operating, but not in areas in which the municipalities had established exchanges. Free intercommunication was established by the agreement between the subscribers of the company and those of the Post Office, and a scale of charges was adopted or arranged to be agreed as binding on both the Post Office and the company. The late Mr W. E. L. Gaine, general manager of the company, stated before the Select Committee that in the view of the directors the bargain was a hard one, because it gave no consideration in respect of the goodwill of the great business, with its gross income of over £2,000,000 per annum and its net revenue of over £750,000, which the company had built up. The company had had to pay for all the experiments and mistakes which are inherent in the launching and development of any new industry. It had paid the Post Office in royalties already £1,848,000, and the Post Office under the agreement would step into the business in 1911 by merely paying for the plant employed. The Association of Municipal Corporations and the London County Council, on the other hand, considered the terms of purchase to be too favourable to the company. The London County Council, according to the statement of its comptroller, was disturbed by the hope expressed by the manager of the company, that the holders of the company's ordinary shares would obtain the par value of their shares in 1911. Inasmuch as the debenture stocks and preference shares would have to be redeemed in 1911 at premiums ranging from 3 to 5 per cent., the state would have to pay the company £253,000 in excess of the total of the outstanding securities in order to enable the ordinary shares to receive par, and in the council's view this payment would diminish the probability of the Post Office being able to afford a substantial reduction in the telephone charges.

Post Office Telephones.—The number of trunk wire centres open on the 31st of March 1907 was 533, and the total number of trunk circuits was 2043, containing about 73,000 m. of double wire. The capital expenditure on the purchase and development of the trunk wire system amounted to £3,376,252. The total number of conversations which took place over the trunk wires during the year 1906–1907 was 19,803,300. The gross revenue derived from the trunk services was £480,658, being an average of 5·82d. per conversation. The total number of subscribers to the Post Office provincial exchanges on the 31st of March 1907 (excluding those in Glasgow and Brighton) was 10,010, and the number of telephones rented was 12,006. The Glasgow system included 11,103 subscribers' lines with 12,964 telephones, and the Brighton system contained 1542 subscribers' lines with 1884 telephones. The sum received by the Post Office as rental in respect of private wires was £183,000. The years' working of the whole telephone system of the Post Office showed a balance of £451,787 after payment of the working expenses, while the estimated amount required to provide for depreciation of plant and interest at 3 per cent. on the total expenditure of £7,252,000 was £432,726.

The number of telephones connected with the Post Office system in the metropolitan area on the 31st of March 1907 was 41,236, and additional subscribers were being connected at the rate of about 150 a week. There were 425 post office call-offices in the London area. The length of underground pipes which had been laid in the metropolitan area for telephone purposes was 2030 m. Cables containing 317,789 m. of wire had been laid, including 69,066 m. rented by the National Telephone Company. The average cost of constructing an exchange circuit in the metropolitan area (including the installation of telephone instruments and of exchange apparatus, but excluding the provision of spare plant) has been £33. Taking into account the whole system (including spare plant of all kinds), the capital expenditure per station (*i.e.* per telephone connected with an exchange) stands at less than £50.

International Telephone Lines.—The Anglo-French telephone service, which was opened between London and Paris in April 1891, was extended to the principal towns in England and France on the 11th of April 1904. The service has since been extended to certain other English provincial towns; and the Anglo-Belgian telephone service has similarly been extended. There are now four circuits between London and Paris, one between London and Lille, and two between London and Brussels, the last carrying an increasing amount of traffic. Experiments have been made in telephonic communication between London and Rome by way of Paris. It was found possible to exchange speech when the conditions were exceptionally favourable; but in spite of the partial success of the experiment, a public service between the two capitals is not at present practicable.

References.—*Reports of Select Committee on Telephone and Telegraph Wires* (1885), of *Select Committee on Telegraph Bill* (1892), of *Joint Committee of the House of Lords and the House of Commons on Electric Powers* (*Protective Clauses*) (1893), of *Select Committee on Telephone Service* (1895), of *Select Committee on Telephones* (1898), and of *Select Committee on Post Office* (*Telephone*) *Agreement* (1905); *Treasury Minutes* (1892 and 1899); *Annual Reports of the Postmaster-General; Report to the Treasury by Sheriff Andrew Jameson on Glasgow Telephone Enquiry* (1897); H. R. Meyer, *Public Ownership and the Telephone in Great Britain* (London, 1907); E. Garcke, *Manual of Electrical Undertakings* (1896–1908). (E. Ga.)

TELESCOPE, an optical instrument employed to view distant objects. The term "photographic telescope" has been applied to instruments employed to record the appearance of celestial objects by photography. The word was coined by Demiscianus, a Greek scholar, at the request of Federigo Cesi, founder of the *Accademia dei Lincei*, from the Greek τῆλε, far, and σκοπευν, to see. It was used by Galileo as early as 1612, and came into English use much later, when it supplanted *trunk* and *cylinder*, the terms hitherto used to denote the telescope.

History

The credit of the discovery of the telescope has been a fruitful subject of discussion. Thus, because Democritus announced that the Milky Way is composed of vast multitudes of stars, it has been maintained that he could only have been led to form such an opinion from actual examination of the heavens with a telescope. Other passages from the Greek and Latin authors have similarly been cited to prove that the telescope was known to the ancients. But, as has been remarked by Dr Robert Grant (*History of Physical Astronomy*, p. 515), we are no more warranted in drawing so important a conclusion from casual remarks, however sagacious, than we should be justified in stating that Seneca was in possession of the discoveries of Newton because he predicted that comets would one day be found to revolve in periodic orbits. William Molyneux, in his *Dioptrica Nova* (1692), p. 256, declares his opinion that Roger Bacon (who died *c.* 1294) "did perfectly well understand all kinds of optic glasses, and knew likewise the method of combining them so as to compose some such instrument as our telescope." He cites a passage from Bacon's *Opus Majus*, p. 377 of Jebb's edition, 1733, translated as follows:—

"Greater things than these may be performed by refracted vision. For it is easy to understand by the canons above mentioned that the greatest objects may appear exceedingly small, and the contrary, also that the most remote objects may appear just at hand, and the converse; for we can give such figures to transparent bodies, and dispose them in such order with respect to the eye and the objects, that the rays shall be refracted and bent towards any place we please, so that we shall see the object near at hand or at any distance under any angle we please. And thus from an incredible distance we may read the smallest letters, and may number the smallest particles of dust and sand, by reason of the greatness of the angle under which we see them. . . . Thus also the sun, moon and stars may be made to descend hither in appearance, and to be visible over the heads of our enemies, and many things of the like sort, which persons unacquainted with such things would refuse to believe."

Molyneux also cites from Bacon's *Epistola ad Parisiensem*, "Of the Secrets of Art and Nature," chap. 5:—

"Glasses or diaphanous bodies may be so formed that the most remote objects may appear just at hand, and the contrary, so that we may read the smallest letters at an incredible distance, and may number things, though never so small, and may make the stars also appear as near as we please."

These passages certainly prove that Bacon had very nearly, if not perfectly, arrived at theoretical proof of the possibility of constructing a telescope and a microscope; but his writings give no account of the trial of an actual telescope, nor any detailed results of the application of a telescope to an examination of the heavens. It has been pointed out by Dr Robert Smith, in his *Complete System of Opticks*, that Bacon imagines some effects of telescopes which cannot be performed by them, and his conclusion is that Bacon never actually looked through a telescope.

Giambattista della Porta, in his *Magia Naturalis*, printed in 1558, makes the following remarkable statement:—

"If you do but know how to join the two (viz., the concave and the convex glasses) rightly together, you will see both remote and near objects larger than they otherwise appear, and withal very distinct."

Wolfius infers from this passage that its author was the first actual constructor of a telescope, and it appears not improbable that by happy accident Porta really did make some primitive form of telescope which excited the wonder of his friends. Here, however, his interest in the matter appears to have ceased, and he was unable either to appreciate the importance of his discovery or to describe the means by which the object was attained. Kepler, who examined Porta's account of his concave and convex lenses by desire of his patron the emperor Rudolph, declared that it was perfectly unintelligible. Poggendorff (*Gesch. der Physik*, p. 134) throws considerable doubt on the originality of Porta's statement.

Thomas Digges, in his *Stratiolicus*, p. 359, published in 1579, states that his father, Leonard Digges,

"among other curious practices had a method of discovering by perspective glasses set at due angles all objects pretty far distant that the sun shone upon, which lay in the country round about,"

and that this was by the help of a manuscript book of Roger Bacon of Oxford, who he conceived was the only man besides his father who knew it. There is also the following passage in the *Pantometria* (bk. i. chap. 21) of Leonard Digges [1] (originally published by his son Thomas in 1571, and again in 1591):—

"Marvellous are the conclusions that may be performed by glasses concave and convex, of circular and parabolic forms, using for multiplication of beams sometime the aid of glasses transparent, which, by fraction, should unite or dissipate the images or figures presented by the reflection of other."

He then describes the effects of magnification from a combination of lenses or mirrors, adding:—

"But of these conclusions I minde not here to intreate, having at large in a volume [2] by itselfe opened the miraculous effects of perspective glasses."

It is impossible to discredit the significance of these quotations, for the works in which they occur were published more than twenty years before the original date claimed for the discovery of the telescope in Holland.

But it is quite certain that previous to 1600 the telescope was unknown, except possibly to individuals who failed to see its practical importance, and who confined its use to "curious practices" or to demonstrations of "natural magic." The practical discovery of the instrument was certainly made in Holland about 1608, but the credit of the original invention has been claimed on behalf of three individuals, Hans Lippershey and Zacharias Jansen, spectacle-makers in Middelburg, and James Metius of Alkmaar (brother of Adrian Metius the mathematician).

Descartes, in his treatise on *Dioptrics* (1637), attributes the discovery to Metius "about thirty years ago," whilst Schyraelus de Rheita, a Capuchin friar, in his *Oculus Enoch et Eliae* (Antwerp, 1645), gives the credit to Lippershey about 1609. Peter Borel, physician to the king of France, published at The Hague, in 1655, a work *De Vero Telescopii Inventore*. He was assisted in its preparation by William Borel, Dutch envoy at the court of France, and the latter declares, as the result of patient investigation, that Jansen and his father were the real inventors of the telescope in 1610, and that Lippershey only made a telescope after hints accidentally communicated to him of the details of Jansen's invention. But the most trustworthy information on the subject is to be got from the researches of J. H. van Swinden.[3] Briefly summarized, this evidence is as follows. In the library of the university of Leyden, amongst the MSS. of Huygens there is an original copy of a document (dated 17th October 1608) addressed to the states-general by Jacob Andrianzoon (the same individual who is called James Metius by Descartes), petitioning for the exclusive right of selling an instrument of his invention by which distant objects appear larger and more distinct. He states that he had discovered the instrument by accident when engaged in making experiments, and had so far perfected it that distant objects were made as visible and distinct by his instrument as could be done with the one which had been lately offered to the states by a citizen and spectacle-maker of Middelburg. Among the acts of the states-general preserved in the government archives at The Hague, Van Swinden found that on 2nd October 1608 the assembly of the states took into consideration the petition of Hans Lippershey, spectacle-maker, a native of Wesel and an inhabitant of Middelburg, inventor of an instrument for seeing at a distance. On 4th October a committee was appointed to test the instrument, and on the 6th of the same month the assembly agreed to give Lippershey 900 florins for his instrument. Further, on the 15th December of the same year they examined an instrument invented by Lippershey at their request to see with both eyes, and gave him orders to execute two similar instruments at 900 florins each; but, as many other persons had knowledge of this new invention to see at a distance, they did not deem it expedient to grant him an exclusive privilege to sell such instruments. The dates of these documents dispose effectually of Borel's statement that Lippershey borrowed the ideas of Jansen in 1610. They also prove that, whilst Metius was in possession of a telescope, with which he may have experimented, about the time when Lippershey presented his application for patent rights, yet he makes no pretension that Lippershey borrowed the invention from him. The conclusion is that Lippershey was the first person who independently invented the telescope, and at the same time made the instrument known to the world. The common story is that Lippershey, happening one day, whilst holding a spectacle-lens in either hand, to direct them towards the steeple of a neighbouring church, was astonished, on looking through the nearer lens, to find that the weathercock appeared nearer and more distinct. He fitted the lenses in a tube, in order to adjust and preserve their relative distances, and thus constructed his first telescope. But doubt may be thrown on this traditional account owing to the further statement that the image of the weathercock so viewed was seen turned upside down. All the original Dutch telescopes were composed of a convex and a concave lens, and telescopes so constructed do not invert. The inverting telescope, composed of two convex lenses, was a later invention; still it is not impossible that the original experiment was made with two convex lenses.

Telescopes seem to have been made in Holland in considerable numbers soon after the date of their invention, and rapidly found their way over Europe. Sirturus, in his *De Telescopio* (1618), states that "a Frenchman proceeded to Milan in the month of May 1609 and offered a telescope for sale to Count di Fuentes"; and Lorenzi Pigorna writes,[4] under date 31st August 1609, that "Galileo had been appointed lecturer at Padua for life on account of a perspective like the one which was sent from Flanders to Cardinal Borghese." Simon Marius, the German astronomer, appears to have made astronomical observations in 1609 with a telescope which he procured from Holland, and Professor S. P. Rigaud of Oxford found from the MSS. of Harriot, the mathematician, that he had been making astronomical observations with a Dutch telescope as early as July 1609. Galileo, in his *Nuncius Sidereus*, states that, happening to be in Venice about the month of May 1609, he heard that a Belgian had invented a perspective instrument by means of which distant objects appeared nearer and larger, and that he discovered its construction by considering the effects of refraction. In his *Saggiatore* Galileo states that he solved the problem of the construction of a telescope the first night after his return to Padua from Venice, and made his first telescope next day by fitting a convex lens in one extremity of a leaden tube and a concave lens in the other one. A few days afterwards, having succeeded in making a better telescope than

[1] He died about 1570. His son alludes to his untimely death in the preface to the *Pantometria*.

[2] There is no further trace of this volume.

[3] See Dr G. Moll of Utrecht, in *Journ. Roy. Inst.*, vol. i., 1831.

[4] *Lettre d' Uomini Illustri*, p. 112 (Venice, 1744).

the first, he took it to Venice, where he communicated the details of his invention to the public, and presented the instrument itself to the doge Leonardo Donato, sitting in full council. The senate, in return, settled him for life in his lectureship at Padua and doubled his salary, which was previously 500 florins and which then became treble that which any of his predecessors had enjoyed. Galileo may thus claim to have invented the telescope independently, but not till he had heard that others had done so. In fact the time was ripe; and, as often happens in similar circumstances, only a hint was necessary to complete the latent chain of thought. Galileo devoted all his time to improving and perfecting the telescope. Knowing the theory of his instrument, and possessed of much practical skill, coupled with unwearied patience, he conquered the difficulties of grinding and polishing the lenses, and soon succeeded in producing telescopes of greatly increased power. His first telescope magnified three diameters; but he soon made instruments which magnified eight diameters, and finally one that magnified thirty-three diameters.[1] With this last instrument he discovered in 1610 the satellites of Jupiter, and soon afterwards the spots on the sun, the phases of Venus, and the hills and valleys on the moon. He demonstrated the rotation of the satellites of Jupiter round the planet, and gave rough predictions of their configurations, proved the rotation of the sun on its axis, established the general truth of the Copernican system as compared with that of Ptolemy, and fairly routed the fanciful dogmas of the philosophers. These brilliant achievements, together with the immense improvement of the instrument under the hands of Galileo, overshadowed in a great degree the credit due to the original discoverer, and led to the universal adoption of the name of the Galilean telescope for the form of the instrument invented by Lippershey.

Kepler first explained the theory and some of the practical advantages of a telescope constructed of two convex lenses in his *Catoptrics* (1611). The first person who actually constructed a telescope of this form was the Jesuit Christoph Scheiner, who gives a description of it in his *Rosa Ursina* (1630). William Gascoigne was the first who practically appreciated the chief advantages of the form of telescope suggested by Kepler, viz., the visibility of the image of a distant object simultaneously with that of a small material object placed in the common focus of the two lenses. This led to his invention of the micrometer and his application of telescopic sights to astronomical instruments of precision (see MICROMETER). But it was not till about the middle of the 17th century that Kepler's telescope came into general use, and then, not so much because of the advantages pointed out by Gascoigne, but because its field of view was much larger than in the Galilean telescope. The first powerful telescopes of this construction were made by Huygens, after much labour, in which he was assisted by his brother. With one of these, of 12-ft. focal length, he discovered the brightest of Saturn's satellites (Titan) in 1655, and in 1659 he published his *Systema Saturnium*, in which was given for the first time a true explanation of Saturn's ring, founded on observations made with the same instrument. The sharpness of image in Kepler's telescope is very inferior to that of the Galilean instrument, so that when a high magnifying power is required it becomes essential to increase the focal length. G. D. Cassini discovered Saturn's fifth satellite (Rhea) in 1672 with a telescope of 35 ft., and the third and fourth satellites in 1684 with telescopes made by Campani of 100- and 136-ft. focal length. Huygens states that he and his brother made object-glasses of 170 and 210 ft. focal length, and he presented one of 123 ft. to the Royal Society of London. Adrien Auzout (d. 1691) and others are said to have made telescopes of from 300 to 600 ft. focus, but it does not appear that they were ever able to use them in practical observations. James Bradley, on 27th December 1722, actually measured the diameter of Venus with a telescope whose object-glass had a focal length of 212¼ ft. In these very long telescopes no tube was employed, and they were consequently termed *aerial telescopes*. Huygens contrived some ingenious arrangements for directing such telescopes towards any object visible in the heavens—the focal adjustment and centring of the eye-piece being preserved by a braced rod connecting the object-glass and eye-piece. Other contrivances for the same purpose are described by Philippe de la Hire (*Mém. de l'Acad.*, 1715) and by Nicolaus Hartsoeker (*Miscel. Berol.*, 1710, vol. i. p. 261). Telescopes of such great length were naturally difficult to use, and must have taxed to the utmost the skill and patience of the observers. One cannot but pay a passing tribute of admiration to the men who, with such troublesome tools, achieved such results.

Reflecting Telescopes.—Until Newton's discovery of the different refrangibility of light of different colours, it was generally supposed that object-glasses of telescopes were subject to no other errors than those which arose from the spherical figure of their surfaces, and the efforts of opticians were chiefly directed to the construction of lenses of other forms of curvature. James Gregory, in his *Optica Promota* (1663), discusses the forms of images and objects produced by lenses and mirrors, and shows that when the surfaces of the lenses or mirrors are portions of spheres the images are curves concave towards the objective, but if the curves of the surfaces are conic sections the spherical aberration is corrected. He was well aware of the failures of all attempts to perfect telescopes by employing lenses of various forms of curvature, and accordingly proposed the form of reflecting telescope which bears his name. But Gregory, according to his own confession, had no practical skill; he could find no optician capable of realizing his ideas, and after some fruitless attempts was obliged to abandon all hope of bringing his telescope into practical use. Newton was the first to construct a reflecting telescope. When in 1666 he made his discovery of the different refrangibility of light of different colours, he soon perceived that the faults of the refracting telescope were due much more to this cause than to the spherical figure of the lenses. He over-hastily concluded from some rough experiments (*Optics*, bk. i. pt. ii. prop. 3) "that all refracting substances diverged the prismatic colours in a constant proportion to their mean refraction"; and he drew the natural conclusion "that refraction could not be produced without colour," and therefore "that no improvement could be expected from the refracting telescope" (*Treatise on Optics*, p. 112). But, having ascertained by experiment that for all colours of light the angle of incidence is equal to the angle of reflexion, he turned his attention to the construction of reflecting telescopes. After much experiment he selected an alloy of tin and copper as the most suitable material for his specula, and he devised means for grinding and polishing them. He did not attempt the formation of a parabolic figure on account of the probable mechanical difficulties, and he had besides satisfied himself that the chromatic and not the spherical aberration formed the chief faults of previous telescopes. Newton's first telescope so far realized his expectations that he could see with its aid the satellites of Jupiter and the horns of Venus. Encouraged by this success, he made a second telescope of 6½-in. focal length, with a magnifying power of 38 diameters, which he presented to the Royal Society of London in December 1671. A third form of reflecting telescope was devised in 1672 by Cassegrain (*Journal des Sçavans*, 1672). No further practical advance appears to have been made in the design or construction of the instrument till the year 1723, when John Hadley (best known as the inventor of the sextant) presented to the Royal Society a reflecting telescope of the Newtonian construction, with a metallic speculum of 6-in. aperture and 62⅝-in. focal length, having eye-pieces magnifying up to 230 diameters. The instrument was examined by Pound and Bradley, the former of whom reported upon it in *Phil. Trans.*, 1723, No. 378, p. 382. After remarking that Newton's telescope "had lain neglected these fifty years," they stated that Hadley had sufficiently shown "that this noble invention does not consist

[1] This last power could not be exceeded with advantage in this form of telescope till after the invention of the achromatic object-glass.

in bare theory." They compared its performance with that of the object-glass of 123-ft. focal length presented to the Royal Society by Huygens, and found that Hadley's reflector

"will bear such a charge as to make it magnify the object as many times as the latter with its due charge, and that it represents objects as distinct, though not altogether so clear and bright. . . . Notwithstanding this difference in the brightness of the objects, we were able with this reflecting telescope to see whatever we have hitherto discovered with the Huygenian, particularly the transits of Jupiter's satellites and their shadows over his disk, the black list in Saturn's ring, and the edge of his shadow cast on his ring. We have also seen with it several times the five satellites of Saturn, in viewing of which this telescope had the advantage of the Huygenian at the time when we compared them; for, being in summer, and the Huygenian telescope being managed without a tube, the twilight prevented us from seeing in this some of these small objects which at the same time we could discern with the reflecting telescope."

Bradley and Molyneux, having been instructed by Hadley in his methods of polishing specula, succeeded in producing some telescopes of considerable power, one of which had a focal length of 8 ft.; and, Molyneux having communicated these methods to Scarlet and Hearn, two London opticians, the manufacture of telescopes as a matter of business was commenced by them (Smith's *Opticks*, bk. iii. ch. 1). But it was reserved for James Short of Edinburgh to give practical effect to Gregory's original idea. Born at Edinburgh in 1710 and originally educated for the church, Short attracted the attention of Maclaurin, professor of mathematics at the university, who permitted him about 1732 to make use of his rooms in the college buildings for experiments in the construction of telescopes. In Short's first telescopes the specula were of glass, as suggested by Gregory, but he afterwards used metallic specula only, and succeeded in giving to them true parabolic and elliptic figures. Short then adopted telescope-making as his profession, which he practised first in Edinburgh and afterwards in London. All Short's telescopes were of the Gregorian form, and some of them retain even to the present day their original high polish and sharp definition. Short died in London in 1768, having realized a considerable fortune by the exercise of his profession.

Achromatic Telescope.—The historical sequence of events now brings us to the discovery of the achromatic telescope. The first person who succeeded in making achromatic refracting telescopes seems to have been Chester Moor Hall, a gentleman of Essex. He argued that the different humours of the human eye so refract rays of light as to produce an image on the retina which is free from colour, and he reasonably argued that it might be possible to produce a like result by combining lenses composed of different refracting media.[1] After devoting some time to the inquiry he found that by combining lenses formed of different kinds of glass the effect of the unequal refrangibility of light was corrected, and in 1733 he succeeded in constructing telescopes which exhibited objects free from colour. One of these instruments of only 20-in. focal length had an aperture of $2\frac{1}{2}$ in. Hall was a man of independent means, and seems to have been careless of fame; at least he took no trouble to communicate his invention to the world. At a trial in Westminster Hall about the patent rights granted to John Dollond (Watkin *v.* Dollond),[2] Hall was admitted to be the first inventor of the achromatic telescope; but it was ruled by Lord Mansfield that "it was not the person who locked his invention in his scrutoire that ought to profit for such invention, but he who brought it forth for the benefit of mankind."[3] In 1747 Leonhard Euler communicated to the Berlin Academy of Sciences a memoir in which he endeavoured to prove the possibility of correcting both the chromatic and the spherical aberration of an object-glass. Like Gregory and Hall, he argued that, since the various humours of the human eye were so combined as to produce a perfect image, it should be possible by suitable combinations of lenses of different refracting media to construct a perfect object-glass. Adopting a hypothetical law of the dispersion of differently coloured rays of light, he proved analytically the possibility of constructing an achromatic object-glass composed of lenses of glass and water. But all his efforts to produce an actual object-glass of this construction were fruitless—a failure which he attributed solely to the difficulty of procuring lenses worked precisely to the requisite curves (*Mem. Acad. Berlin*, 1753). Dollond admitted the accuracy of Euler's analysis, but disputed his hypothesis on the grounds that it was purely a theoretical assumption, that the theory was opposed to the results of Newton's experiments on the refrangibility of light, and that it was impossible to determine a physical law from analytical reasoning alone (*Phil. Trans.*, 1753, p. 289). In 1754 Euler communicated to the Berlin Academy a further memoir, in which, starting from the hypothesis that light consists of vibrations excited in an elastic fluid by luminous bodies, and that the difference of colour of light is due to the greater or less frequency of these vibrations in a given time, he deduced his previous results. He did not doubt the accuracy of Newton's experiments quoted by Dollond, because he asserted that the difference between the law deduced by Newton and that which he assumed would not be rendered sensible by such an experiment.[4] Dollond did not reply to this memoir, but soon afterwards he received an abstract of a memoir by Samuel Klingenstierna, the Swedish mathematician and astronomer, which led him to doubt the accuracy of the results deduced by Newton on the dispersion of refracted light. Klingenstierna showed from purely geometrical considerations, fully appreciated by Dollond, that the results of Newton's experiments could not be brought into harmony with other universally accepted facts of refraction. Like a practical man, Dollond at once put his doubts to the test of experiment, confirmed the conclusions of Klingenstierna, discovered "a difference far beyond his hopes in the refractive qualities of different kinds of glass with respect to their divergency of colours," and was thus rapidly led to the construction of object-glasses in which first the chromatic and afterwards the spherical aberration were corrected (*Phil. Trans.*, 1758, p. 733).

We have thus followed somewhat minutely the history of the gradual process by which Dollond arrived independently at his invention of the refracting telescope, because it has been asserted that he borrowed the idea from others. Montucla,

[1] The same argument was employed by Gregory more than fifty years previously, but had been followed by no practical result. The lens of the human eye is not achromatic.

[2] At a meeting of the Royal Astronomical Society held on 9th May 1886 a legal document, signed by Chester Moor Hall, was presented by R. B. Prosser of the Patent Office to the society. On the same occasion A. C. Ranyard made the following interesting statement respecting Hall:—

"Some years ago very little was known about Moor Hall. It was known that, about seven years after the patent for making achromatic object-glasses was granted to Dollond, his claim to the invention was disputed by other instrument-makers, amongst them by a Mr Champness, an instrument-maker of Cornhill, who began to infringe the patent, alleging that John Dollond was not the real inventor, and that such telescopes had been made twenty-five years before the granting of his patent by Mr Moor Hall. John Dollond, to whom the Copley medal of the Royal Society had been given for his invention, was the dead, and his son brought an action for infringing the patent against Champness. There is no report of the case, but the facts are referred to in the reports of subsequent cases. It appears that workmen who had been employed by Mr Moor Hall were examined, and proved that they had made achromatic object-glasses as early as 1733. Dollond's patent was not set aside, though the evidence with regard to the prior manufacture was accepted by Lord Mansfield, who tried the case, as having been satisfactorily proved . . . Mr Hall was a bencher of the Inner Temple, and was alive at the time of the action. He was a man of some property, and is spoken of on his tombstone as an excellent lawyer and mathematician. He was not a fellow of the Royal Society, but must certainly have known of the gift of the Copley medal to Dollond. It is very curious the conflicting evidence we have to reconcile, but I think the balance of evidence is in favour of there having been a prior invention of achromatic object-glasses before the date of Dollond's patent" (*Astron. Register*, May 1886; see also the *Observatory* for same date).

[3] *Gentleman's Magazine*, 1790, part ii. p. 890.

[4] For a good account of this controversy, see Dr H. Servus, *Geschichte des Fernrohrs*, p. 77 seq. (Berlin, 1886).

in his *Histoire des Mathématiques* (pp. 448–449), gives the following footnote, communicated to him by Lalande:—

"Ce fut Chestermonhall" (an obvious misprint for Chester Moor Hall) "qui, vers 1750, eut l'idée des lunettes achromatiques. Il s'adressoit à Ayscough[1] qui faisoit travaillir Bass. Dollond ayant eu besoin de Bass pour un verre que demandoit le duc d'Yorck, Bass lui fit voir du crown-glass et du flint-glass. Hall donna une lunette à Ayscough, qui la montra à plusieurs personnes; il en donna la construction à Bird, qui n'en tint pas compte. Dollond en profita. Dans le procès qu'il y eut entre Dollond et Watkin, au banc du roi, cela fut prouvé; mais Dollond gagna, parce qu'il étoit le premier qui eût fait connoître les lunettes achromatiques."

It is clearly established that Hall was the first inventor of the achromatic telescope; but Dollond did not borrow the invention from Hall without acknowledgment in the manner suggested by Lalande. His discovery was beyond question an independent one. The whole history of his researches proves how fully he was aware of the conditions necessary for the attainment of achromatism in refracting telescopes, and he may be well excused if he so long placed implicit reliance on the accuracy of experiments made by so illustrious a philosopher as Newton. His writings sufficiently show that but for this confidence he would have arrived sooner at a discovery for which his mind was fully prepared. It is, besides, impossible to read Dollond's memoir (*Phil. Trans.*, 1758, p. 733) without being impressed with the fact that it is a truthful account, not only of the successive steps by which he independently arrived at his discovery, but also of the logical processes by which these steps were successively suggested to his mind.

The triple object-glass, consisting of a combination of two convex lenses of crown glass with a concave flint lens between them, was introduced in 1765 by Peter, son of John Dollond, and many excellent telescopes of this kind were made by him.

The limits of this article do not permit a further detailed historical statement of the various steps by which the powers of the telescope were developed. Indeed, in its practical form the principle of the instrument has remained unchanged from the time of the Dollonds to the present day; and the history of its development may be summed up as consisting not in new optical discoveries but in utilizing new appliances for figuring and polishing, improved material for specula and lenses, more refined means of testing, and more perfect and convenient methods of mounting.

About the year 1774 William Herschel, then a teacher of music in Bath, began to occupy his leisure hours with the construction of specula, and finally devoted himself entirely to their construction and use. In 1778 he had selected the *chef-d'oeuvre* of some 400 specula which he made for the celebrated instrument of 7-ft. focal length with which his early brilliant astronomical discoveries were made. In 1783 he completed his reflector of $18\frac{7}{10}$ in. aperture and 20-ft. focus, and in 1789 his great reflector of 4-ft. aperture and 40-ft. focal length. The fame of these instruments was rapidly spread by the brilliant discoveries which their maker's genius and perseverance accomplished by their aid. The reflecting telescope became the only available tool of the astronomer when great light grasp was requisite, as the difficulty of procuring disks of glass (especially of flint glass) of suitable purity and homogeneity limited the dimensions of the achromatic telescope. It was in vain that the French Academy of Sciences offered prizes for perfect disks of optical flint glass. Some of the best chemists and most enterprising glass-manufacturers exerted their utmost efforts without succeeding in producing perfect disks of more than $3\frac{1}{2}$ in. in diameter. All the large disks were crossed by striae, or were otherwise deficient in the necessary homogeneity and purity. The subsequent history of the development of the art of manufacturing glass disks for telescopic objectives will be found in the article Glass: § *Optical*.

Instruments, &c.

We proceed to give an account of the methods and principles of construction of the various kinds of telescopes, and to describe in detail special typical instruments, which, owing to the work accomplished by their aid or the practical advances exemplified in their construction, appear most worthy of record or study.

[1] Ayscough was an optician in Ludgate Hill, London.

Refracting Telescope

In its simplest form the telescope consists of a convex objective capable of forming an image of a distant object and of an eye-lens, concave or convex, by which the image so formed is magnified. When the axis of the eye-lens coincides with that of the object-glass, and the focal point of the eye-lens is coincident with the principal focus of the object-lens, parallel rays incident upon the object-glass will emerge from the eye-piece as parallel rays. These, falling in turn on the lens of the human eye, are converged by it and form an image on the retina.

Fig. 1 shows the course of the rays when the eye-lens is convex (or positive), fig. 2 when the eye-lens is concave (or negative). The former represents Kepler's, the latter Lippershey's or the Galilean telescope. The magnifying power obviously depends on the proportion of the focal length of the object-lens to that of the eye-lens, that is,

$$\text{magnifying power} = F/e,$$

where F is the focal length of the object-lens and e that of the eye-lens. Also the diameter of the pencil or parallel rays emerging from the eye-lens is to the diameter of the object-lens inversely as the magnifying power of the telescope. Hence one of the best methods of determining the magnifying power of a telescope is to measure the diameter of the emergent pencil of rays, after the telescope has been adjusted to focus upon a star, and to divide the diameter of the object-glass by the diameter of the emergent pencil. If we desire to utilize all the parallel rays which fall upon an object-glass it is necessary that the full pencil of emerging rays should enter the observer's eye. Assuming with Sir William Herschel that the normal pupil of the eye distends to one-fifth of an inch in diameter when viewing faint objects, we obtain the rule that the minimum magnifying power which can be efficiently employed is five times the diameter of the object-glass expressed in inches.[2]

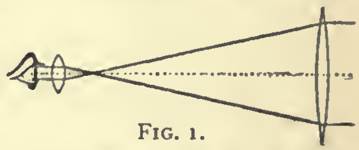


Fig. 1.

The defects of the Galilean and Kepler telescopes are due to the chromatic and spherical aberration of the simple lenses of which they are composed. The substitution of a positive or negative eye-piece for the simple convex or concave eye-lens, and of an achromatic object-glass for the simple object-lens, transforms these early forms into the modern achromatic telescope. The Galilean telescope with a concave eye-lens instead of an eye-piece still survives as the modern opera-glass, on account of its shorter length, but the object-glass and eye-lens are achromatic combinations.

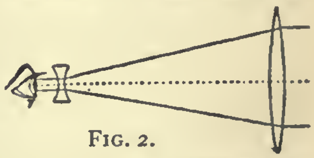


Fig. 2.

(D. Gi.)

Telescope Objectives.[3]—In spite of the improvements in the manufacture of optical glass (see Glass) practically the same crown and flint glasses as used by John Dollond in 1758 for achromatic objectives are still used for all the largest of the modern refracting telescopes.

It has long been known that the spectra of white or solar light yielded by ordinary crown and flint glasses are different: that while two prisms of such glasses may be arranged to give exactly the same angular dispersion between two Fraunhofer

[2] In the case of short-sighted persons the image for very distant objects (that is, for parallel rays) is formed in front of the retina; therefore, to enable such persons to see distinctly, the rays emerging from the eye-piece must be slightly divergent; that is, they must enter the eye as if they proceeded from a comparatively near object. For normal eyes the natural adaptation is not to focus for quite parallel rays, but on objects at a moderate distance, and practically, therefore, most persons do adjust the focus of a telescope, for most distinct and easy vision, so that the rays emerge from the eye-piece very slightly divergent. Abnormally short-sighted persons require to push in the eye-lens nearer to the object-glass, and long-sighted persons to withdraw it from the adjustment employed by those of normal sight. It is usual, however, in computations of the magnifying power of telescopes, for the rays emerging from the eye-piece when adjusted for distinct vision to be parallel.

[3] For the methods of grinding, polishing and testing lenses, see Objective.

lines, such as C and F, yet the flint glass prism will show a relative drawing out of the blue end and a crowding together of the red end of the spectrum, while the crown prism shows an opposite tendency. This want of proportion in the dispersion for different regions of the spectrum is called the "irrationality of dispersion"; and it is as a direct consequence of this irrationality, that there exists a secondary spectrum or residual colour dispersion, showing itself at the focus of all such telescopes, and roughly in proportion to their size. These glasses, however, still hold the field, although glasses are now produced whose irrationality of dispersion has been reduced to a very slight amount. The primary reason for this retention is that nothing approaching the difference in dispersive power between ordinary crown glass and ordinary dense flint glass (a difference of 1 to $1\frac{2}{3}$) has yet been obtained between any pair of the newer glasses. Consequently, for a certain focal length, much deeper curves must be resorted to if the new glasses are to be employed; this means not only greater difficulties in workmanship, but also greater thickness of glass, which militates against the chance of obtaining large disks quite free from striae and perfect in their state of annealing. In fact, superfine disks of over 15 in. aperture are scarcely possible in most of the newer telescope glasses. Moreover the greater depths of the curves (or "curvature powers") in itself neutralize more or less the advantages obtained from the reduced irrationality of dispersion. When all is taken into consideration it is scarcely possible to reduce the secondary colour aberration at the focus of such a double object-glass to less than a fourth part of that prevailing at the focus of a double objective of the same aperture and focus, but made of the ordinary crown and flint glasses.

The only way in which the secondary spectrum can be reduced still further is by the employment of *three* lenses of three different sorts of glass, by which arrangement the secondary spectrum has been reduced in the case of the Cooke photo visual objective to about 1/20th part of the usual amount, if the whole region of the visible spectrum is taken into account. It is possible to construct a triple objective of two positive lenses enclosing between them one negative lens, the two former being made of the same glass. For relatively short focal lengths a triple construction such as this is almost necessary in order to obtain an objective free from aberration of the 3rd order, and it might be thought at first that, given the closest attainable degree of rationality between the colour dispersions of the two glasses employed, which we will call crown and flint, it would be impossible to devise another form of triple objective, by retaining the same flint glass, but adopting two sorts of crown instead of only one, which would have its secondary spectrum very much further reduced. Yet such is the rather surprising fact. But it can be well illustrated in the case of the older glasses, as the following case will show.

The figures given are the partial dispersions for ordinary crown and ordinary extra dense flint glasses, styled in Messrs Schott's catalogue of optical glasses as 0·60 and 0·102 respectively, having refractive indices of 1·5179 and 1·6489 for the D ray respectively, and $(\mu_D-1)/(\mu_F-\mu_C)=60{\cdot}2$ and 33·8 respectively to indicate their dispersive powers (inverted), $=\nu$.

	C to F		A to D		D to F		F to G	
0·60	·00860	* 1·000	·00533	* ·643	·00605	* ·703	·00487	* ·566
0·102	·01919	1·000	·01152	·600	·01372	·714	·01180	·615
	·02779	1·000	·01685	·613	·01977	·711	·01667	·600

The $\Delta\mu$ from C to F being taken as unity in each case, then the $\Delta\mu$'s for the other regions of the spectrum are expressed in fractions $\Delta\mu$ (C to F) and are given under the asterisks. Let it be supposed that two positive lenses of equal curvature powers are made out of these two glasses, then in order to represent the combined dispersion of the two together the two $\Delta\mu$'s for each spectral region may be added together to form $\Delta'\mu$ as in the line below, and then, on again expressing the partial $\Delta'\mu$ in terms of $\Delta'\mu$ (C to F) we get the new figures in the bottom row beneath the asterisks. We find that we have now got a course of dispersion or degree of rationality which very closely corresponds to that of an ordinary light flint glass, styled 0·569 in Schott's catalogue, and having μ_D 1·5738 and $(\mu_D-1)/(\mu_F-\mu_C) = 41{\cdot}4 = \nu$, the figures of whose course of dispersion are as below:—

Light Flint Glass 0·569.

C to F		A′ to D		D to F		F to G	
·01385	1·000	·00583	·615	·00987	·713	·00831	·600

Hence it is clear that if the two positive lenses of equal curvature power of 0·60 and 0·102 respectively are combined with a negative lens of light flint 0·569, then a triple objective, having no secondary spectrum (at any rate with respect to the blue rays), may be obtained.

But while an achromatic combination of 0·60 and 0·102 alone will yield an objective whose focal length is only 1·28 times the focal length of the negative or extra dense flint lens, the triple combination will be found to yield an objective whose focal length is 73 times as great as the focal length of the negative light flint lens. Hence impossibly deep curvatures would be required for such a triple objective of any normal focal length. This case well illustrates the much closer approach to strict rationality of dispersion which is obtainable by using two different sorts of glass for the two positive lenses, even when one of them has a higher dispersive power than the glass used for the negative lens.

It is largely to this principle that the Cooke photo visual objective of three lenses (fig. 3) owes its high degree of achromatism. This form of objective has been successfully made up to $12\frac{1}{2}$ in. clear aperture. The front lens is made of baryta light flint glass

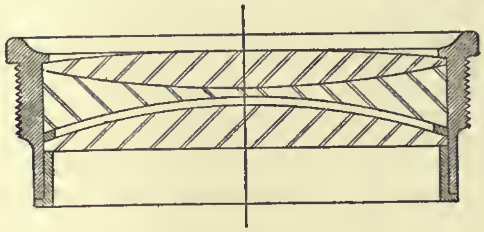


FIG. 3.

(0·543 of Schott's catalogue) and the back lens of a crown glass, styled 0·374 in Schott's older lists.

The table gives their partial dispersions for six different regions of the spectrum also expressed (in brackets below) as fractional parts of the dispersion from C to F.

	C to F	A to C	D to F	E to F	F to G′	F to H
0·543 $\mu_D =$ 1·564 ν = 50·7	·01115 (1·0000)	·00374 (·3354)	·00790 (·7085)	·00369 (·3309)	·00650 (·5830)	·01322 (1·1857)
0·374 $\mu_D =$ 1·511 ν = 60·8	·00844 (1·0000)	·00296 (·3507)	·00593 (·7026)	·00274 (·3247)	·00479 (·5675)	·00976 (1·1564)

Since the curvature powers of the positive lenses are equal, the partial dispersions of the two glasses may be simply added together, and we then have:—

[0·543+0·374]

C to F	A to C	D to F	E to F	F to G′	F to H
·01959 (1·0000)	·00670 (·3420)	·01383 (·7059)	·00643 (·3282)	·01129 (·5763)	·02298 (1·1730)

The proportions given on the lower line may now be compared with the corresponding proportional dispersions for borosilicate flint glass 0·658, closely resembling the type 0·164 of Schott's list, viz.:—

[0·658 ($\mu_D = 1{\cdot}546$) $\nu = 50{\cdot}1$]

C to F	A to C	D to F	E to F	F to G′	F to H
1·0000	·3425	·7052	·3278	·5767	1·1745

A slight increase in the relative power of the first lens of 0·543 would bring about a still closer correspondence in the rationality, but with the curves required to produce an object-glass of this type of 6 in. aperture and 108 in. focal length a discrepancy of 1 unit in the 3rd decimal place in the above proportional figures would cause a linear error in the focus for that colour of only about ·025 in., so that the largest deviation implied by the tables would be a focus for the extreme violet H ray about ·037 longer than the normal. It will be seen, then, that the visual and photographic foci are now merged in one, and the image is practically as achromatic as that yielded by a reflector.

Other types of triple object-glasses with reduced secondary spectra have recently been introduced. The extension of the image away from the axis or size of field available for covering a photographic plate with fair definition is a function in the first place of the ratio between focal length and aperture, the longer focus having the greater relative or angular covering power, and in the second a function of the curvatures of the lenses, in the sense that the objective must be free from coma at the foci of oblique pencils or must fulfil the sine condition (see ABERRATION).

Eye-pieces.—The eye-pieces or oculars through which, in case of visual observations, the primary images formed by the objective are viewed, are of quite secondary importance as regards definition in the central portion of the field of view. If an eye-piece blurs the definition in any degree in the centre of the field it must be very badly figured indeed, but the definition towards the edge of the field, say at 20° away from the centre of the apparent field of view, depends very intimately upon the construction of the eye-piece. It must be so designed as to give as flat an image as is possible consistently with freedom from astigmatism of oblique pencils. The mere size of the apparent field of view depends upon obtaining the oblique pencils of light emerging from it to cross the axis at the great possible angle, and to this end the presence of a field-lens is indispensable, which is separated from the eye-lens by a considerable interval.

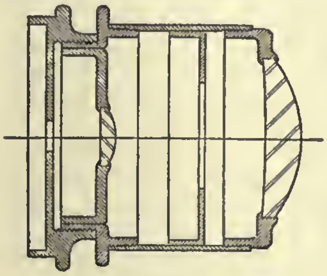


FIG. 4.

The earlier arrangement of two lenses of the Huygenian eye-piece (see MICROSCOPE) having foci with ratio of 3 to 1, gives a fairly large flat field of view approximately free from distortion of tangential lines and from coma, while the Mittenzwey variety of it (fig. 4) in which the field-lens is changed into a meniscus having radii in about the ratio of +1 to −9 gives still better results, but still not quite so good as the results obtained by using the combination of two convexo-plane lenses of the focal ratio 2 to 1.

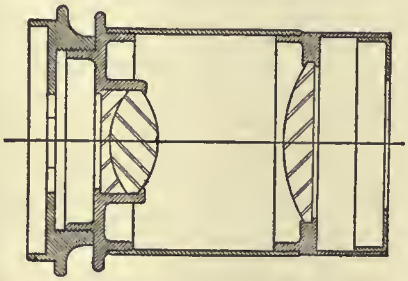


FIG. 5.

In the Ramsden eye-piece (see MICROSCOPE) the focal lengths of the two plano-convex lenses are equal, and their convexities are turned towards one another. The field-lens is thus in the principal focal plane of the eye-lens, if the separation be equal to $\frac{1}{2}(f_1+f_2)$. This is such a practical drawback that the separation is generally $\frac{2}{3}$ths or $\frac{3}{4}$ths of the theoretical, and then the primary image viewed by the eye-piece may be rather outside the field-lens, which is a great practical advantage, especially when a reticule has to be mounted in the primary focal plane, although the edge of the field is not quite achromatic under these conditions.

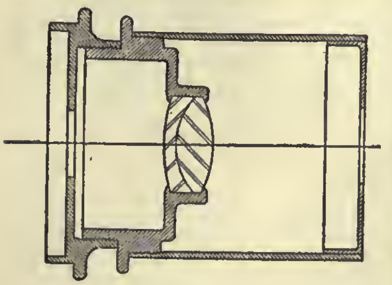


FIG. 6.

Kellner Eye-piece.—In order to secure the advantage of the principal focal plane of the eye-piece being well outside of the field-lens and at the same time to obtain a large flat field of view with oblique achromatism and freedom from coma and distortion, there is no better construction than the modified Kellner eye-piece (fig. 5) such as is generally used for prismatic binoculars. It consists of a plano-convex field-lens of crown glass and an approximately achromatic eye-lens, some distance behind it, consisting of an equi-convex crown lens cemented to a concavo-plane flint lens, the latter being next to the eye.

There are also other eye-pieces having the field-lens double or achromatic as well as the eye-lens.

In cases where it is important to get the maximum quantity of light into the eye, the field-lens is discarded and an achromatic eye-lens alone employed. This yields a very much smaller field of view, but it is very valuable for viewing feeble telescopic objects and very delicate planetary or lunar details. Zeiss and Steinheil's monocentric eye-pieces and the Cooke single achromatic eye-piece (fig. 6) are examples of this class of oculars. (H. D. T.)

Reflecting Telescope.

The following are the various forms of reflecting telescopes:—

Gregorian. The Gregorian telescope is represented in fig. 7. A A and B B are concave mirrors having a common axis and their concavities facing each other. The focus of A for parallel rays is at F, that of B for parallel rays at f—between B and F. Parallel rays falling on A A converge at F, where an image is formed; the rays are then reflected from B and converge at P, where a second and more enlarged image is formed. Gregory himself

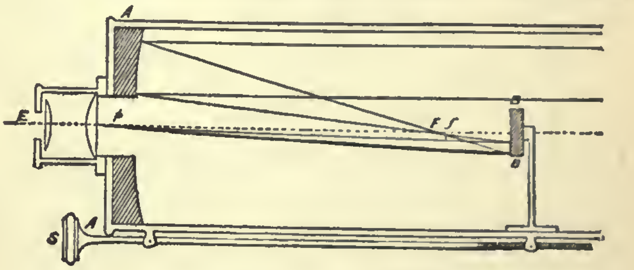


FIG. 7.—Gregorian Telescope.

showed that, if the large mirror were a segment of a paraboloid of revolution whose focus is F, and the small mirror an ellipsoid of revolution whose foci are F and P respectively, the resulting image will be plane and undistorted. The image formed at P is viewed through the eye-piece at E, which may be of the Huygenian or Ramsden type. The focal adjustment is accomplished by the screw S, which acts on a slide carrying an arm to which the mirror B is attached. The practical difficulty of constructing Gregorian telescopes of good defining quality is very considerable, because if spherical mirrors are employed their aberrations tend to increase each other, and it is extremely difficult to give a true elliptic figure to the necessarily deep concavity of the small speculum. Short appears to have systematically conquered this difficulty, and his Gregorian telescopes attained great celebrity. The use of the Gregorian form is, however, practically abandoned in the present day. The magnifying power of the telescope is $=Ff/ex$, where F and f are respectively the focal lengths of the large and the small mirror, e the focal length of the eye-piece, and x the distance between the principal foci of the two mirrors ($=Ff$ in the diagram) when the instrument is in adjustment for viewing distant objects. The images are erect.

Cassegrain. The Cassegrain telescope differs from the Gregorian only in the substitution of a convex hyperboloidal mirror for a concave ellipsoidal mirror as the small speculum. This form has two distinct advantages: (1) if spherical mirrors are employed their aberrations have a tendency to correct each other; (2) the instrument is shorter than the Gregorian, *caeteris paribus*, by twice the focal length of the small mirror. Fewer telescopes have been made of this than perhaps of any other form of reflector; but in comparatively recent years the Cassegrain has acquired importance from the fact of its adoption for the great Melbourne telescope, and from its employment in the 60-in. reflector of the Mount Wilson Solar Observatory (see below). For spectroscopic purposes the Cassegrain form has peculiar advantages, because in consequence of the less rapid convergence of the rays after reflection from the convex hyperboloidal mirror, the equivalent focus can be made very great in comparison with the length of the tube. This permits the employment of a spectroscope furnished with a collimator of long focus. The magnifying power is computed by the same formula as in the case of the Gregorian telescope.

Newtonian. The Newtonian telescope is represented in Fig. 8. A A is a concave mirror whose axis is $a\ a$. Parallel rays falling on A A converge on the plane mirror B B, and are thence reflected at right angles to the axis, forming an image in the focus of the eye-piece E. The surface of the large mirror should be a paraboloid of revolution, that of the small mirror a true optical plane. The magnifying power is $=F/e$. This form is employed in the construction of most modern reflecting telescopes. A glass prism of total reflection is sometimes substituted for the plane mirror.

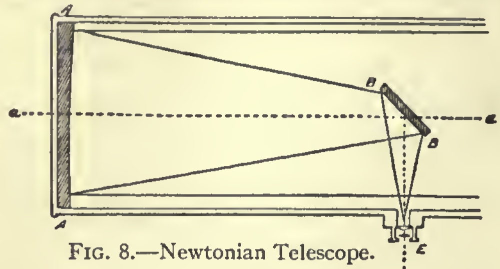


FIG. 8.—Newtonian Telescope.

The Herschelian or front view reflector is represented in fig. 9. A A is a concave parabolic mirror, whose axis *a c* is inclined to the axis of the tube *a b* so that the image of an object in the focus of the mirror may be viewed by an eye-piece at E, the angle *b a c* being equal to the angle *c a* E. This form was adopted by the elder Herschel to avoid the loss of light from reflection in the small mirror of the Newtonian telescope. The front view telescope, however, has hardly been at all employed except by the Herschels. But at the same time none but the Herschels have swept the whole sky for the discovery of faint nebulae; and

Herschelian.

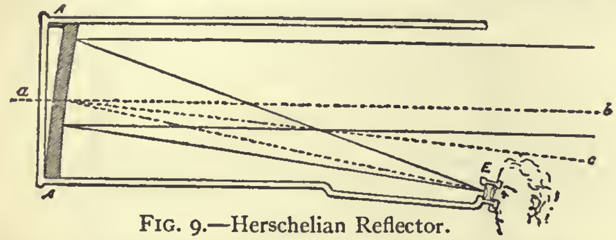


FIG. 9.—Herschelian Reflector.

probably no other astronomers have worked for so many hours on end for so many nights as they did, and they emphasize the easy position of the observer in using this form of instrument.

Construction of Specula.

The composition of metallic specula in the present day differs very little from that used by Sir Isaac Newton. Many different alloys have been suggested, some including silver, nickel, zinc or arsenic; but that which has practically been found best is an alloy of four equivalents of copper to one of tin, or the following proportions by weight: copper 252, tin 117·8. Such speculum metal is exceedingly hard and brittle, takes a fine white polish, and when protected from damp has little liability to tarnish. The process of casting and annealing, in the case of the specula of the great Melbourne telescope, was admirably described by Dr Robinson in *Phil. Trans.*, 1869, 159, p. 135. Shaping, polishing and figuring of specula are accomplished by methods and tools very similar to those employed in the construction of lenses. The reflecting surface is first ground to a spherical form, the parabolic figure being given in the final process by regulating the size of the pitch squares and the stroke of the polishing machine.

Soon after Liebig's discovery of a process for depositing a film of pure metallic silver upon glass from a salt of silver in solution, Steinheil (*Gaz. Univ. d'Augsburg*, 24th March 1856), and later, independently, Foucault (*Comptes Rendus*, vol. xliv., February 1857), proposed to employ glass for the specula of telescopes, the reflecting surface of the glass speculum to be covered with silver by Liebig's process. Those silver-on-glass specula are now the rivals of the achromatic telescope, and it is not probable that many telescopes with metal specula will be made in the future. The best speculum metal and the greatest care are no guarantee of freedom from tarnish, and, if such a mirror is much exposed, as it must be in the hands of an active observer, frequent repolishing will probably be necessary. This involves refiguring, which is the most delicate and costly process of all. Every time, therefore, that a speculum is repolished, the future quality of the instrument is at stake; its focal length will probably be altered, and thus the value of the constants of the micrometer also have to be redetermined. Partly for these reasons the reflecting telescope with metallic mirror has never been a favourite with the professional astronomer, and has found little employment out of England.[1] In England, in the hands of the Herschels, Rosse, Lassell and De la Rue it has done splendid service, but in all these cases the astronomer and the instrument-maker were one. The silver-on-glass mirror has the enormous advantage that it can be resilvered with little trouble, at small expense, and without danger of changing the figure. Glass is lighter, stiffer, less costly and easier to work than speculum metal. Silvered mirrors have also some advantage in light grasp over those of speculum metal, though, aperture for aperture, the former are inferior to the modern object-glass. Comparisons of light grasp derived from small, fresh, carefully silvered surfaces are sometimes given which lead to illusory results, and from such experiments Foucault claimed superiority for the silvered speculum over the object-glass. But Sir David Gill found from experience and careful comparison that a silvered mirror of 12-in. aperture, mounted as a Newtonian telescope (with a silvered plane for the small mirror), when the surfaces are in fair average condition, is equal in light grasp to a first-rate refractor of 10-in. aperture, or area for area as 2 : 3. This ratio will become more equal for larger sizes on account of the additional thickness of larger object-glasses and the consequent additional absorption of light in transmission.

[1] There is a noteworthy exception in the case of the 18-in. speculum-metal mirror employed by Sir William Huggins at Tulse Hill, with which a large part of his remarkable and important series of astro-spectroscopic results have been obtained. So far as we know, this mirror has never been repolished since its first installation in 1870, and still retains its admirable surface. One of Short's mirrors, made about 1760 or 1770, of 6-in. aperture, now in the possession of Sir William Huggins, has surfaces which still retain their original perfection although they have never been repolished.

Mounting of Telescopes.

The proper mounting of a telescope is hardly of less importance than its optical perfection. Freedom from tremor, ease and delicacy of movement and facility of directing the instrument to any desired object in the heavens are the primary qualifications. Where accurate differential observations or photographs involving other than instantaneous exposures have to be made, the additional condition is required that the optical axis of the telescope shall accurately and automatically follow the object under observation in spite of the apparent diurnal motion of the heavens, or in some cases even of the apparent motion of the object relative to neighbouring fixed stars.

Our limits forbid a historical account of the earlier endeavours to fulfil these ends by means of motions in altitude and azimuth, nor can we do more than refer to mountings such as those employed by the Herschels or those designed by Lord Rosse to overcome the engineering difficulties of mounting his huge telescope of 6 ft. aperture. Both are abundantly illustrated in most popular works on astronomy, and it seems sufficient to refer the reader to the original descriptions.[2]

We pass, therefore, directly to the equatorial telescope, the instrument *par excellence* of the modern extra-meridian astronomer. The article TRANSIT CIRCLE describes one form of mounting in which the telescope is simply a refined substitute for the sights or pinules of the old astronomers. The present article contains a description of the mounting of the various forms of the so-called zenith telescope. In its simplest form the mounting of an equatorial telescope consists of an axis parallel to the earth's axis, called "the polar axis"; a second axis at right angles to the polar axis called "the declination axis"; and the telescope tube fixed at right angles to the declination axis.

In Fig. 10 A A is the polar axis; the telescope is attached to the end of the declination axis; the latter rotates in bearings which are attached to the polar axis and concealed by the telescope itself. The telescope is counterpoised by a weight attached to the opposite end of the declination axis. The lower pivot of the polar axis rests in a cup-bearing at C, the upper bearing upon a strong metal casting M M attached to a stone pier S. A vertical plane passing through A A is therefore in the meridian, and the polar axis is inclined to the horizon at an angle equal to that of the latitude of the place of observation. Thus, when the declination axis is horizontal the telescope moves in the plane of the meridian by rotation on the declination axis only. Now, if a graduated circle B B is attached to the declination axis, together with the necessary verniers or microscopes V V for reading it (see TRANSIT CIRCLE), so arranged that when the telescope is turned on the declination axis till its optical axis is parallel to A A the vernier reads 0° and when at right angles to A A 90°, then we can employ the readings of

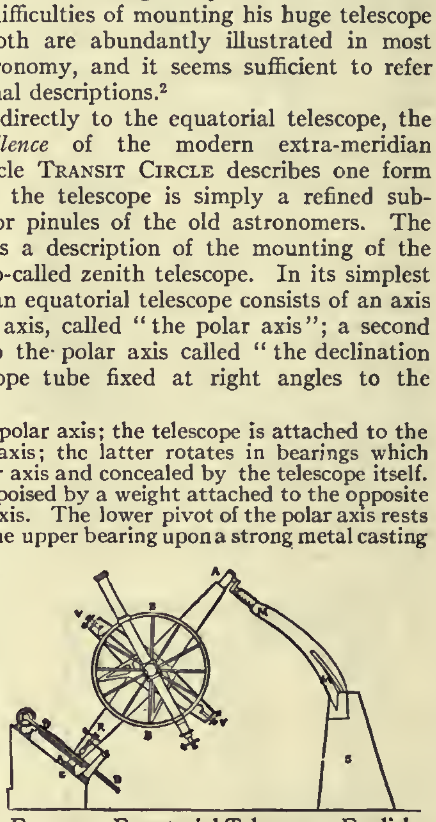


FIG. 10.—Equatorial Telescope. English form.

[2] Herschel, *Phil. Trans.*, 1795, 85, p. 347; Rosse, *Phil. Trans.* 1840, p. 503; 1861, p. 681.

this circle to measure the polar distance of any star seen in the telescope, and these readings will also be true (apart from the effects of atmospheric refraction) if we rotate the instrument through any angle on the axis A A. Thus one important attribute of an equatorially mounted telescope that, if it is directed to any fixed star, it will follow the diurnal motion of that star from rising to setting by rotation of the polar axis only. If we now attach to the polar axis a graduated circle D D, called the "hour circle," of which the microscope or vernier R reads 0^h when the declination axis is horizontal, we can obviously read off the hour angle from the meridian of any star to which the telescope may be directed at the instant of observation. If the local sidereal time of the observation is known, the right ascension of the star becomes known by adding the observed hour angle to the sidereal time if the star is west of the meridian, or subtracting it if east of the meridian. Since the transit circle is preferable to the equatorial for such observations wherein great accuracy is required, the declination and hour circles of an equatorial are employed, not for the determination of the right ascensions and declinations of celestial objects, but for directing the telescope with ease and certainty to any object situated in an approximately known position, and which may or may not be visible to the naked eye, or to define approximately the position of an unknown object. Further, by causing the hour circle, and with it the polar axis, to rotate by clockwork or some equivalent mechanical contrivance, at the same angular velocity as the earth on its axis, but in the opposite direction, the telescope will, apart from the effects of refraction, automatically follow a star from rising to setting.

Types of Equatorials.—Equatorial mountings may be divided into six types. (A) The pivots or bearings of the polar axis are placed at its extremities. The declination axis rests on bearings attached to opposite sides of the polar axis. The telescope is attached to one end of the declination axis, and counterpoised by a weight at the other end, as in fig. 10. (B) The polar axis is supported as in type A; the telescope is placed between the bearings of the declination axis and is mounted symmetrically with respect to the polar axis; no counterpoise is therefore requisite. (C) The declination axis is mounted on the prolongation of the upper pivot of the polar axis; the telescope is placed at one end of the declination axis and counterpoised by a weight at the other end. (D) The declination axis is mounted on a forked piece or other similar contrivance attached to a prolongation of the upper pivot of the polar axis; the telescope is mounted between the pivots of the declination axis. (E) The eye-piece of the telescope is placed in the pivot of the polar axis; a portion or the whole of the axis of the telescope tube coincides with the polar axis. (F) The telescope is fixed and the rays are reflected along its axis from an external mirror or mirrors. Mountings of types A and B—that is, with a long polar axis supported at both ends—are often called the "English mounting," and type C, in which the declination axis is placed on the extension of the upper pivot of the polar axis, is called the "German mounting," from the first employment of type C by Fraunhofer. A description of some of the best examples of each type will illustrate their relative advantages or peculiarities.

Type A.—Fig. 10 may be taken as a practical example of the earlier equatorials as made by Troughton in England and afterwards by Gambey for various Continental observatories. In the *Phil. Trans.* for 1824 (part 3, pp. 1–412) will be found a description by Sir John Herschel and Sir James South of the equatorial telescope which they employed in their measurements of double stars. The polar axis was similar in shape to that of fig. 10 and was composed of sheets of tinned iron. In Smyth's celebrated Bedford telescope the polar axis was of mahogany. Probably the best example of this type of mounting applied to a refractor is that made by the elder Cooke of York for Fletcher of Tarnbank; the polar axis is of cast iron and the mounting very satisfactory and convenient, but unfortunately no detailed description has been published. In recent years no noteworthy refractors have been mounted on this plan; but type A has been chosen by Grubb for the great Melbourne reflector, of 48-in. aperture, with marked ingenuity of adaptation to the peculiar requirements of the case. Fig. 11 shows the whole instrument on a small scale with the telescope directed to the pole, and the hour circle set 6^h from the meridian.

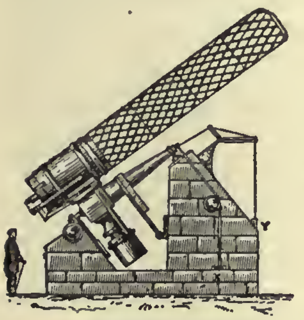


FIG. 11.—Melbourne Reflector.

Great Melbourne telescope.

Type B.—The most important examples of type B are Airy's equatorial at Greenwich (originally made to carry a telescope of 13-in. aperture, but now fitted with a telescope by Grubb of 28-in. aperture), and the photographic equatorials of 13-in. aperture employed at Paris and other French observatories, of which the object-glasses were made by the brothers Henry and the mountings by Gautier of Paris.

These instruments have done admirable work in connexion with the great international undertaking, the *Carte du Ciel.* The general construction will be understood from fig. 12. The double polar axis is composed of hollow metal beams of triangular section. The hour circle has two toothed circles cut upon it, one acted upon by a worm screw mounted on the pier and driven by clockwork, the other by a second worm screw attached to the polar axis, which can be turned by a handle in the observer's hand and thus a slow movement can be given to the telescope in right ascension independently of the clock. Slow motion in declination can be communicated by a screw acting on a long arm, which latter can be clamped at pleasure to the polar axis. An oblong metallic box fitted with pivots, whose bearings are attached to the triangular beams, forms the tube for two parallel telescopes; these are separated throughout their length by a metallic diaphragm. The chromatic aberration of the object-glass of one of these telescopes is corrected for photographic rays, and the image formed by it is received on a highly sensitive photographic plate. The other telescope is corrected for visual rays and its image is formed on the plane of the spider-lines of a filar micrometer. The peculiar form of the tube is eminently suited for rigid preservation of the relative parallelism of the axes of the two telescopes, so that, if the image of a certain selected star is retained on the intersection of two wires of the micrometer, by means of the driving clock, aided by small corrections given by the observer in right ascension and declination (required on account of irregularity in the clock movement, error in astronomical adjustment of the polar axis, or changes in the star's apparent place produced by refraction), the image of a star will continue on the same spot of the photographic film during the whole time of exposure. In these telescopes the photographic object-glass has an aperture of 13 in. and the visual object-glass of 10 in. Both telescopes have the same focal length, viz. 11·25 ft., so that, in the image produced, 1 mm. is = $1'$ of arc. An excellent mounting of type B, made by T. Cooke & Sons of York, has been employed by Franklin Adams for making his maps of the sky.

FIG. 12.—Paris Observatory Instrument.
After an illustration in *La Nature*, by permission of Masson et Cie.

Type C.—Many more telescopes have been made of type C than of any other, and this form of mounting is still most generally employed for the mounting of modern refractors. Fraunhofer's *chef-d'oeuvre*, the great Dorpat refractor, made for Otto Struve about 1820, had a mounting of this type, and was the first equatorial of any importance to be provided with clockwork. The instrument, shown in fig. 13, is described in detail by Struve (*Beschreibung des auf der Sternwarte zu Dorpat befindlichen grossen Refractors von*

Fraunhofer, Dorpat, 1825), and was an enormous advance upon all previous telescopes for micrometric research. In the hands of Struve results were obtained by it which in combined quality and quantity had never before been reached. Its success was such that the type of Fraunhofer's telescope became stereotyped for many years not only by Fraunhofer's successors but throughout Germany. When, twelve years afterwards, Struve ordered the 15-in. refractor for the new observatory at Pulkovo, the only important change made by Fraunhofer's successors was, at Struve's suggestion, the substitution of a stone pier for the wooden stand in the original instrument.

Both the Dorpat and the Pulkovo refractors are defective in rigidity, especially in right ascension. The declination circle is most inconvenient of access, and slow motion in declination can only be effected when the instrument is clamped by a long and inconvenient handle; so that, practically, clamping in declination was not employed. The slow motion in right ascension is defective, being accomplished in the Dorpat refractor by changing the rate of the clock, and in the Pulkovo refractor by a handle which, when used, affects very injuriously the rate of the clock for the time being. Struve's skill as an observer was such that he used to complete the bisection on the fixed wire of the micrometer by a pressure of the finger on the side of the tube—a method of proved efficiency in such hands, but plainly indicative of the want of rigidity in the instrument and of the imperfection of the slow motions (see MICROMETER).

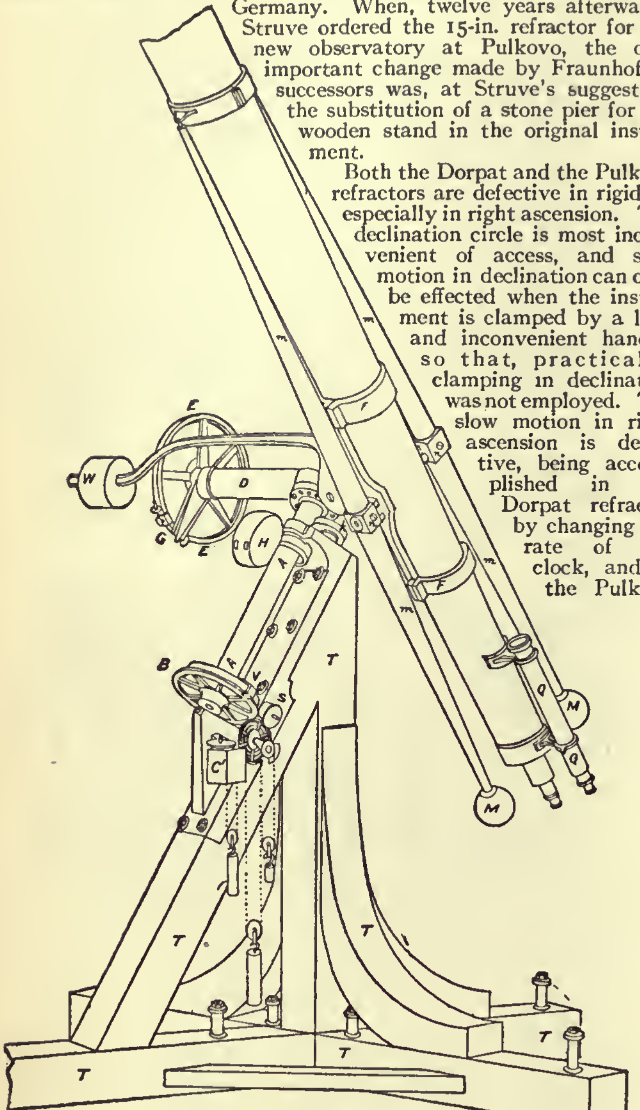


FIG. 13.—Dorpat Refractor.

The driving circle is also much too small, so that a very slight mechanical freedom of the screw in the teeth involves a large angular freedom of the telescope in right ascension, while its position at the lower end of a too weak polar axis tends to create instability from torsion of that axis. Strange to say, the wooden tube long retained its place in German telescope-mountings.

About 1840 a great advance was made by the Repsolds of Hamburg in the equatorial mounting of the Oxford heliometer. The driving circle was greatly increased in diameter and placed at the upper end of the polar axis, and both the polar and declination axes were made much stronger in proportion to the mass of the instrument they were designed to carry. (A figure of the instrument is given in the Oxford *Observations* for 1850.) About 1850 Thomas Cooke of York began his career as a maker of equatorial telescopes. The largest example of his work is the refractor of 24-in. aperture, originally made for the private observatory of Robert Stirling Newall at Gateshead, Northumberland, and afterwards presented by him to the University Observatory, Cambridge. Cooke's mounting is admirable for its symmetry and simplicity of design, its just apportioning of strength, and a general suitability of means to ends.

It is not a little curious that the obvious improvement of transferring the declination axis as well as the declination-clamp to the telescope end of the declination axis was so long delayed; we can explain the delay only by the desire to retain the declination circle as a part of the counterpoise. We believe the first important equatorials in which the declination was read from the eye-end were the 15-in. by Grubb and the 6-in. by Cooke, made for the observatory of Lord Crawford (Lord Lindsay) at Dun Echt, Aberdeenshire, about 1873. The plan is now universally adopted. Telescopes of such dimensions can be conveniently directed to any object by the circles without the observer being under the necessity to climb a special ladder. But when much larger instruments are required the hour circle becomes inaccessible from the floor, and means have to be devised for reading both circles from the eye-end. This was first accomplished by Grubb in the great refractor of 27-in. aperture which he constructed for the Vienna observatory, represented in section in fig. 14. The observer's eye is applied to the small telescope E, which (by means of prisms numbered 1, 2, 3, 4) views the vernier attached to the cross-head simultaneously with the hour circle attached to the upper end of the polar axis. Light to illuminate the vernier and circle is thrown from the lamp L upon prism 4 by the prisms 6 and 5. Prism 1 is in the axis of the declination circle and always reflects rays along that axis, whatever the position of the telescope may be, whilst the prisms 2, 3, 4, 5 and 6 are attached to the cross-head and therefore preserve their relative positions to each other. Through the eye-piece of the bent[1] telescope E′ another hour circle attached to the lower end of the polar axis can be seen; thus an assistant is able to direct the telescope by a handle at H to any desired hour angle. A slight rotatory motion of the telescope E on its axis enables the vernier of the declination circle to be read through prism 1. The leading features of this fine instrument represent those of all Grubb's large telescopes. The mode of relieving the friction of the declination axis is similar to that employed in the Melbourne telescope and in the account of the Vienna telescope published by Grubb. The end friction of the polar axis is relieved by a ring of conical rollers shown in section beside the principal figure.

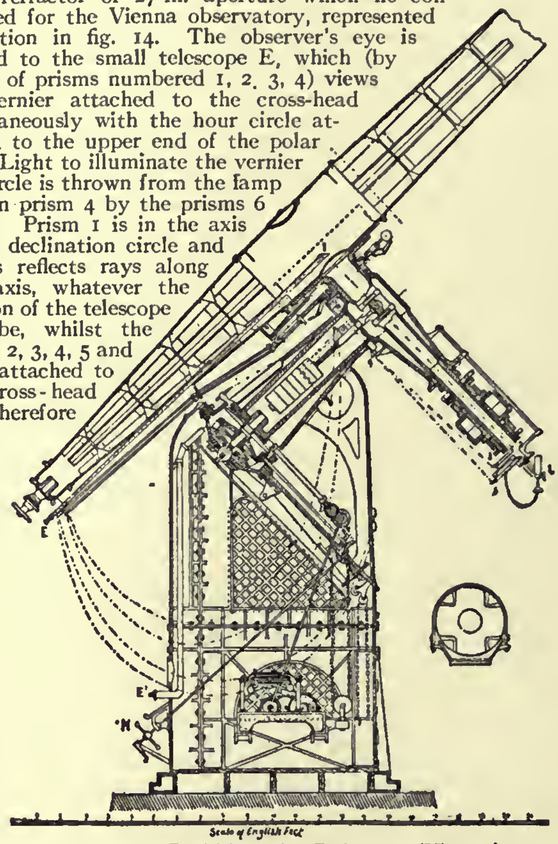


FIG. 14.—Grubb's 27-in. Refractor (Vienna).

From this point we must condense farther description into critical remarks on a few typical modern instruments.

Repsolds' small equatorial.

(1) *Telescopes of Moderate Size for Micrometric Research Only.*—Fig. 15 shows the mounting of the 8-in. refractor, of 9-ft. focal length, at the private observatory of Dr Engelmann, Leipzig. The object-glass is by Messrs Clark of Cambridge, Mass., the mounting by the Repsolds of Hamburg. The declination circle reads from the eye-end, and four handles for clamping and slow motion in right ascension and declination are situated near the observer's hands. The tube is of sheet steel, light, stiff, and free from tremor. The eye-end carries the micrometer with an illuminating apparatus similar to that described under MICROMETER. The lamp near the eye-end illuminates the field or the wires at pleasure, as well as the position circle of the micrometer and the declination circle; a separate lamp illuminates the hour circle. An excellent feature is the short distance between the eye-piece and the declination axis, so that

[1] In the bent telescope refracting prisms are employed at the corners to change the direction of the rays.

the observer has to follow the eye-end in a comparatively small circle; another good point is the flattening of the cast-iron centre-piece of the tube so that the flange of the declination axis is attached as near to the axis of the telescope tube as is consistent with free passage of the cone of rays from the object-glass. The substitution of small incandescent electric lamps is an improvement now universally adopted.

(2) *Telescopes for General Purposes.*—The modern equatorial should, for general purposes, be capable of carrying spectroscopes of considerable weight, so that the proportional strength of the axes and the rigidity of the instrument have to be considerably increased. The original mounting of the Washington refractor of 26-in. aperture and 32½-ft. focal length (described in *Washington Observations*, 1874, App. 1) was in these respects very defective, the polar and declination axes being only 7 in. in diameter.

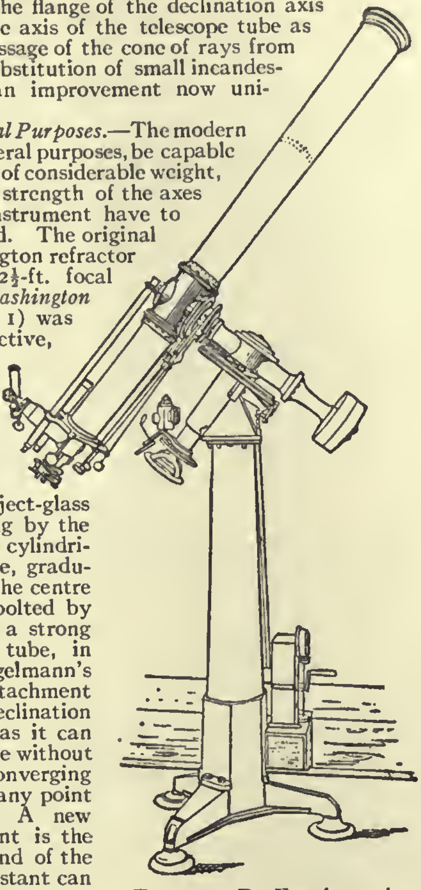


FIG. 15.—Dr Engelmann's 8-in. Refractor.

The great Pulkovo refractor (fig. 16) erected in 1885 is of 30-in. aperture and 45-ft. focal length. The object-glass is by Clark, the mounting by the Repsolds. The tube is cylindrical, of riveted steel plate, graduated in thickness from the centre to its extremities, and bolted by very powerful flanges to a strong short cast-iron central tube, in which, as in Dr Engelmann's telescope (fig. 15), the attachment to the flange of the declination axis is placed as close as it can be to the axis of the tube without interfering with rays converging from the object-glass to any point in the field of view. A new feature in this instrument is the platform at the lower end of the polar axis, where an assistant can view the hour circle by one eye-piece and the declination circle by another (looking up the perforated polar axis), and where he can also set the telescope to any hour angle by one wheel, or to any declination by a second, with the greatest ease. The observer at the eye-end can also read off the hour and declination circles and communicate quick or slow motions to the telescope both in right ascension and declination by conveniently placed handles. The eye end presents an appearance too complicated to be figured here; it has a micrometer and its illumination for the position circle, a micrometer head, and a bright or dark field, clamps in right ascension and declination and quick and slow motion in the same, a finder, microscopes for reading the hour and declination circles, an illuminated dial showing sidereal time and driven by an electric current from the sidereal clock, and counter weights which can be removed when a spectroscope or other heavy appliance is added. All these, although making up an apparently complicated apparatus, are conveniently

Pulkovo refractor.

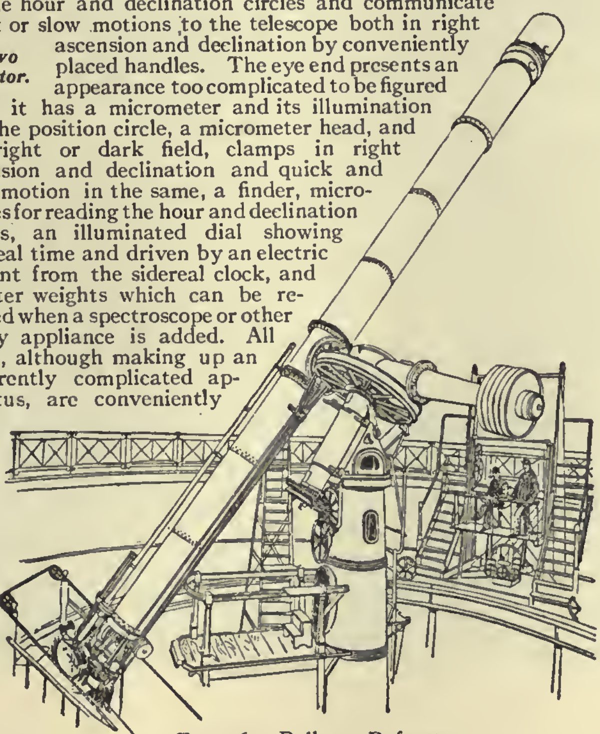


FIG. 16.—Pulkovo Refractor.

arranged, and are all necessary for the quick and easy working of so large an instrument. We have the authority of Otto Struve for stating that in practice they are all that can be desired. There is in this instrument a remarkably elegant method of relieving the friction of the polar axis. Let A A (fig. 17) be a section of the polar axis; it is then easy to adjust the weight P attached to its lower end so that the centre of gravity X of the whole moving parts of the instrument shall be in the vertical (V V) of a line passing through the apex of the hollowed flange $p\ q$ at q, which flange forms part of the polar axis. If now a wheel W is forced up against q with a pressure equal to the weight of the moving part of the instrument, the whole weight of the moving part would rest upon W in unstable equilibrium; or if a pressure R, less than W, is employed, we have the end friction on the lower bearing removed to an extent $=$ R sin ϕ, and the friction on the bearings of the upper pivot removed to the extent of F cos ϕ,—where ϕ is the latitude of the place. The wheel W is therefore mounted on a guided rod, which is forced upwards by suitable levers and weights, and this relief of pressure is precisely proportional to the pressure on the respective bearings. The Repsolds find it unnecessary to relieve the friction of the declination axis.

In such large telescopes it becomes a matter of the first importance to provide means of convenient access to the eye-end of the instrument. This the Repsolds have done in the Pulkovo telescope by means of two platforms, as shown in fig. 16. These platforms are capable of easy motion so that the astronomer may be conveniently situated for observing an object at any azimuth or altitude to which the telescope may be directed. For the great refractor more recently erected at Potsdam, Messrs Repsold arranged a large platform mounted on a framework which is moved in azimuth by the dome, so that the observer on the platform is always opposite the dome-opening. This framework is provided with guides on which the platform, whilst preserving its horizontality, is raised and lowered nearly in an arc of a circle of which the point of intersection of the polar and declination axes is the centre. The rotation of the dome, and with it the platform-framework, is accomplished by means of electric motors, as also is the raising and lowering of the platform on its framework. The current is supplied by accumulators, and the switch-board is attached to the platform in a position convenient for use by the astronomer or his assistant.

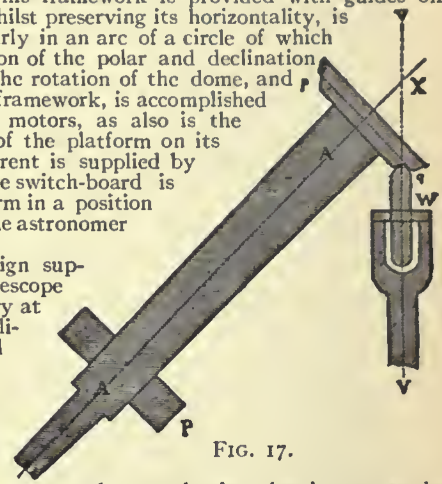


FIG. 17.

In the original design supplied for the 36-in. telescope of the Lick Observatory at Mount Hamilton, California, Grubb suggested that the whole floor, 70 ft. in diameter, should be raised and lowered by water power, under control of the observer by means of electric keys which act on secondary mechanism that in turn works the valves and reversing gear of the water engines. Other water engines, similarly connected, with keys at the observer's hands, rotate the dome and perform the quick motions in right ascension and declination. (An illustration showing these arrangements appeared in *The Engineer* of July 9, 1886.) Grubb's suggestion of the "rising floor" was adopted, although his original plans for the mounting were not carried out; the construction of the mounting, dome, floor, &c., having been entrusted to Messrs Warner & Swasey of Cleveland, Ohio, U.S.A. It has been contended that it is undesirable to move so great a mass as a floor when a platform alone is required to carry the observer. But a floor, however heavy, suspended by three wire ropes and properly balanced over large, well-mounted pulleys, requires an amount of energy to work it which does not exceed that required to operate a platform of moderate dimensions, and there is a freedom, a safety and a facility of working with a complete floor which no partial platform can give. A floor can be most satisfactorily operated by hydraulic means, a platform cannot be so well worked in this way. The best floor mounting we know of is that designed by O. Chadwick for the Victoria Telescope of the Cape Observatory. An account of it will be found in the *History and Description of the Cape Observatory*. This floor can be raised at the rate of 1 ft. per second or as slowly as the observer desires—whilst in all the large platforms we have seen (Potsdam and Paris), the rate of shift is tedious and time-consuming.

The largest refracting telescope in active use is the Yerkes telescope, with an object-glass of 40-in. diameter by Alvan Clark & Son of Cambridge, U.S.A., and with a mounting, dome and rising floor by Warner & Swasey of Cleveland, Ohio, U.S.A. The reader will gather a good general idea of the design from fig. 16. The eye-end is shown on the plate, fig. 25.

The chief defect in equatorial mountings of type C is that in general they are not capable of continued observing much past the meridian without reversal. This is an unquestionable drawback when long exposures near the meridian are required. By the

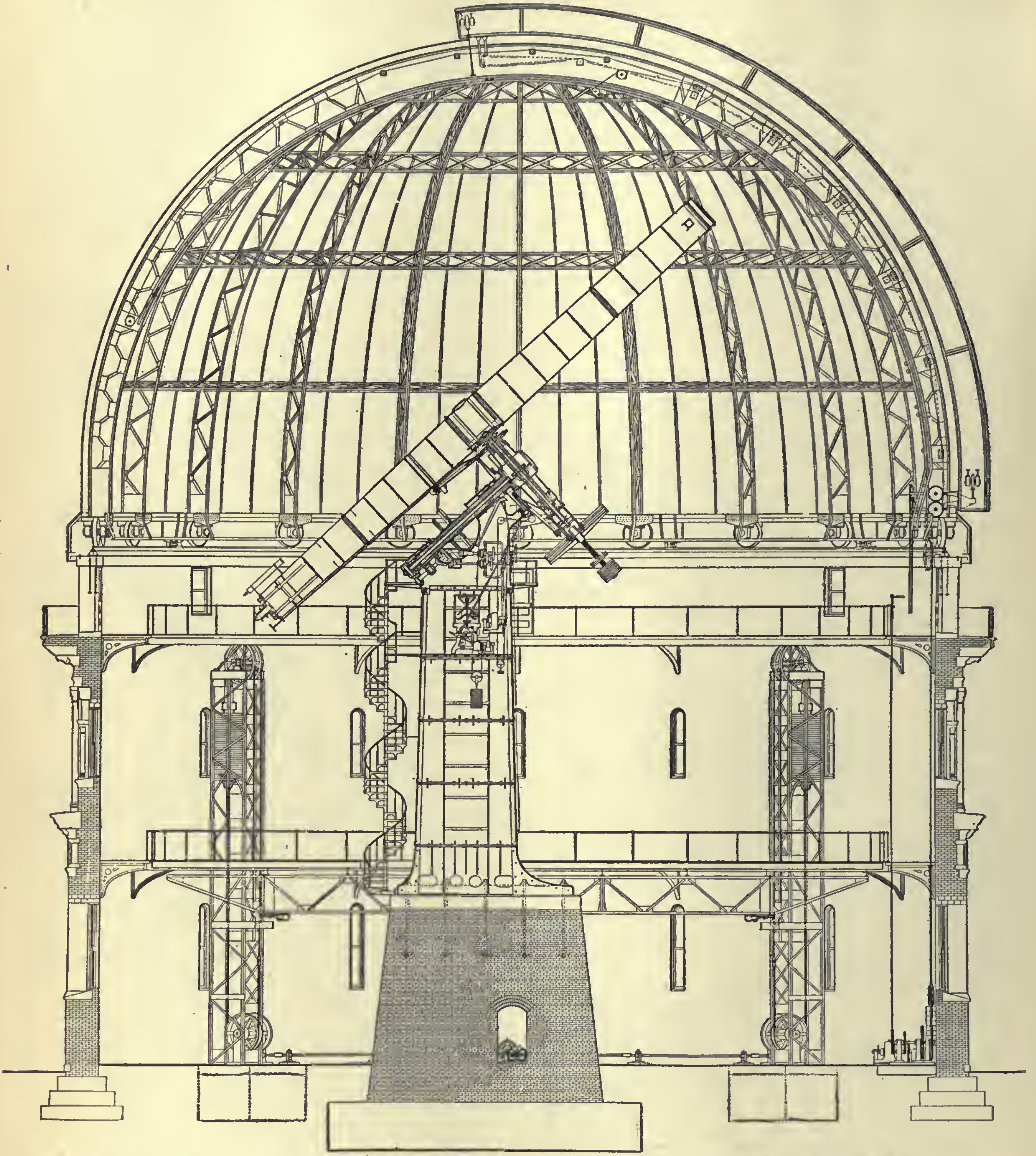

DESIGNED AND CONSTRUCTED BY
WARNER & SWASEY
CLEVELAND OHIO. U.S.A.
1897
40 INCH TELESCOPE
90 FT. DOME AND 75 FT. ELEVATING FLOOR
FOR THE YERKES OBSERVATORY

FIG. 18.

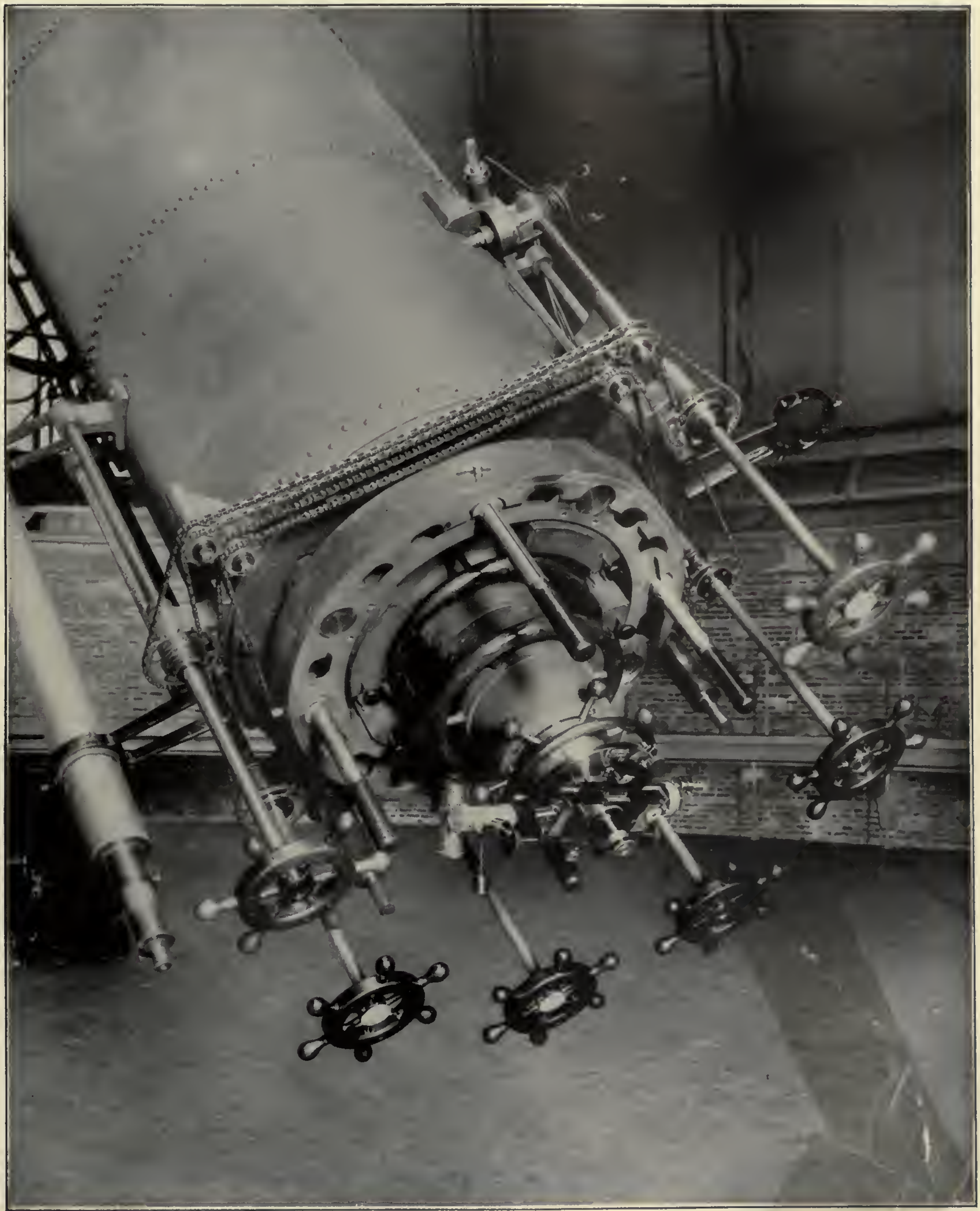


FIG. 25.—EYE END OF 40″ YERKES TELESCOPE.

use of an overhanging polar axis the difficulty can be overcome; it has been successfully adopted by Repsolds for their astrographic equatorials of 13-in. aperture and 11·25-ft. focus, and on a much smaller scale by Warner & Swasey for the Bruce telescope of 10-in. aperture and 50-in. focus, made for the Yerkes Observatory. The

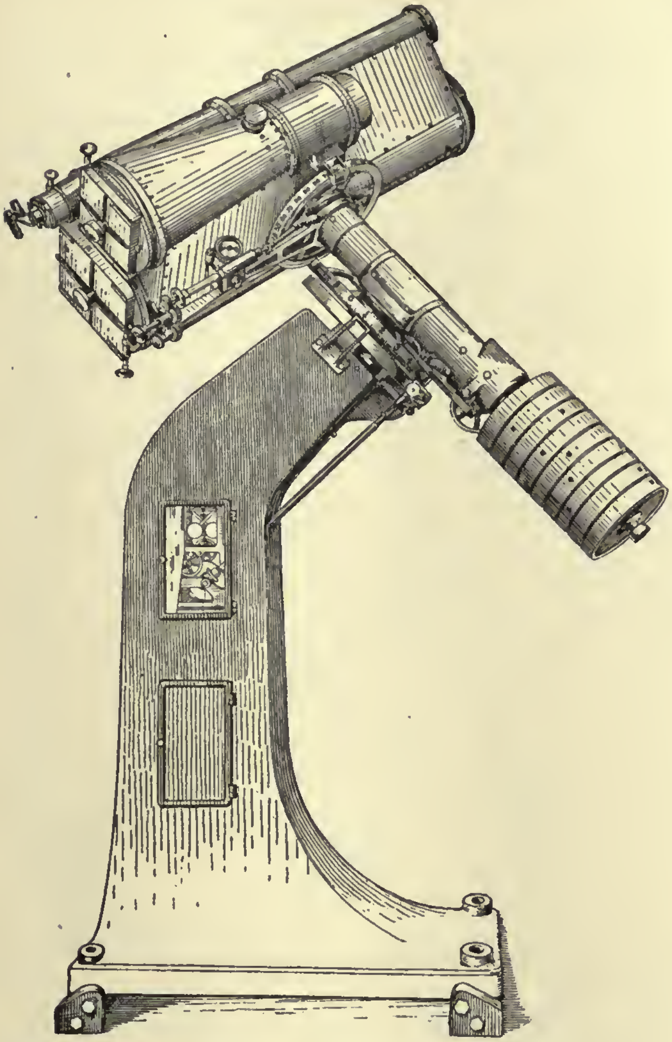


FIG. 19.—Bruce Telescope, made for the Yerkes Observatory.

From Professor Hale's *The Study of Stellar Evolution*, by permission of the University of Chicago Press.

latter is shown in fig. 19. Stability in this method of mounting can only be secured by excessive weight and rigidity in the support of the overhanging axis. In the case of the Victoria telescope (24-in. aperture and 22½-ft. focus) mounted at the Cape of Good Hope on this plan, it has been found necessary to add supporting stays where great rigidity is required, and thus to sacrifice continuous circum-meridian motion for stars between the zenith and the elevated pole.

Type D.—The first important equatorial of type D was the 4-ft. reflecting telescope of Lassell (*Mem. R.A.S.*, xxxvi. 1–4), and later Lord Rosse's 36-in. reflecting telescope at Birr Castle (*Phil. Trans.*, clxxi. 153), and A. Common's 36-in. reflecting telescope mounted by him at Ealing (*Mem. R.A.S.*, xlvi. 173–182). In Lassell's instrument (a reflector of the Newtonian type) the observer is mounted in the open air on a supplementary tower capable of motion in any azimuth about the centre of motion of the telescope, whilst an observing platform can be raised and lowered on the side of the tower. In Lord Rosse's instrument (also of the Newtonian type) the observer is suspended in a cage near the eye-piece, and the instrument is used in the open air. Common's telescope presents many ingenious features, especially the relief-friction by flotation of the polar axis in mercury, and in the arrangements of the observatory for giving ready access to the eye-piece of the telescope.

Type C seems indeed to be the type of mounting most suitable for reflecting telescopes, and this form has been adopted for the 60-in. reflector completed by G. W. Ritchey, under the direction of Professor G. E. Hale, for the Mount Wilson Solar Observatory. The instrument is shown in fig. 20, and its design is unquestionably the most perfect yet proposed for modern astrophysical research.

The declination axis is here represented by what are practically the trunnions or pivots of the tube, resting in bearings which are supported by the arms of a very massive cast-iron fork bolted to the upper end of the polar axis. This axis is a hollow forging of nickel steel, of which the accurately turned pivots rest on bearings attached to cast-iron uprights bolted upon a massive cast-iron base plate. The base plate rests upon levelling screws which permit the adjustment of the polar axis to be made with great precision. The combined overhanging weight of the cast-iron fork, the mirror and tube is so great, that without a very perfect relief-friction system the instrument could not be moved in right ascension with any approach to practical ease. But a hollow steel float, 10 ft. in diameter, is bolted to the upper end of the polar axis just below the fork. This float dips into a tank filled with mercury so that practically the entire instrument is floated by the mercury, leaving only sufficient pressure on the bearings to ensure that the pivots will remain in contact with them. The 60-in. silver-on-glass mirror (weighing about one ton) rests at the lower end of the tube on a support-system consisting of a large number of weighted levers which press against the back of the glass and distribute the load. Similar weighted levers around the circumference of the mirror provide the edge support. The telescope is moved in right ascension and declination by electric motors controlled from positions convenient for the observer. The driving clock moves the telescope in right ascension by means of a worm-gear wheel, 10 ft. in diameter, mounted on the polar axis.

The 60-in. mirror is of 25-ft. focus, but for certain classes of work it is desirable to have the advantage of greater focal length. For this purpose the telescope can be used in the four different ways shown in fig. 21.

(1) As a Newtonian reflector, fig. 21 (*a*), the converging rays from the 60-in. mirror being reflected to the side of the tube where

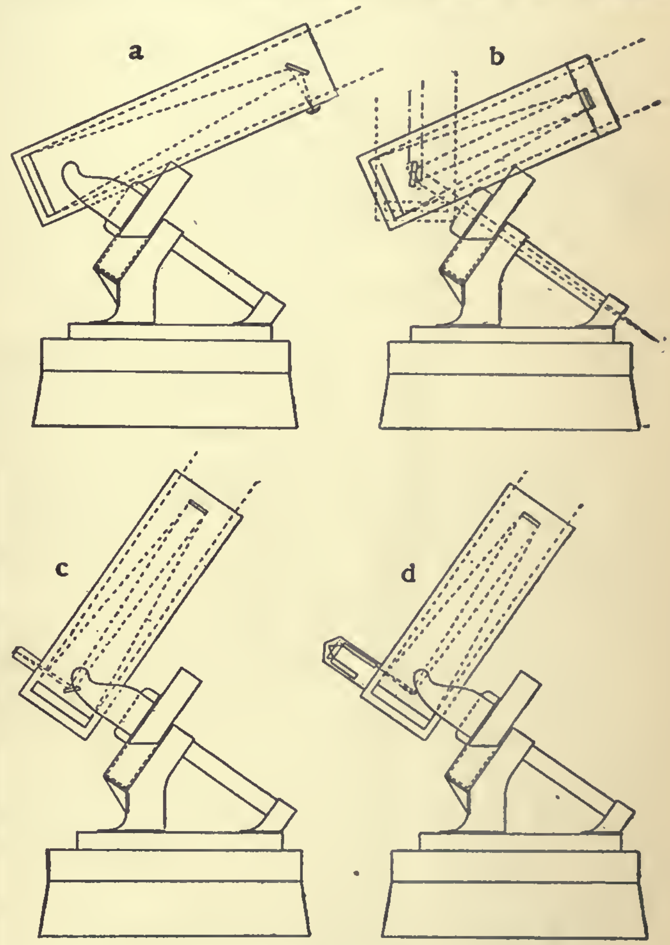


FIG. 21.

From Professor Hale's *The Study of Stellar Evolution*, by permission of the University of Chicago Press.

the image is formed, and where it may be photographed or viewed with an eye-piece. In this case the image is formed without secondary magnification and the focal length is 25 ft.

(2) As a Cassegrain reflector, fig. 21 (*b*), in which case the upper section of the tube bearing the plane mirror is removed and a shorter section substituted for it. This latter carries a hyperboloidal

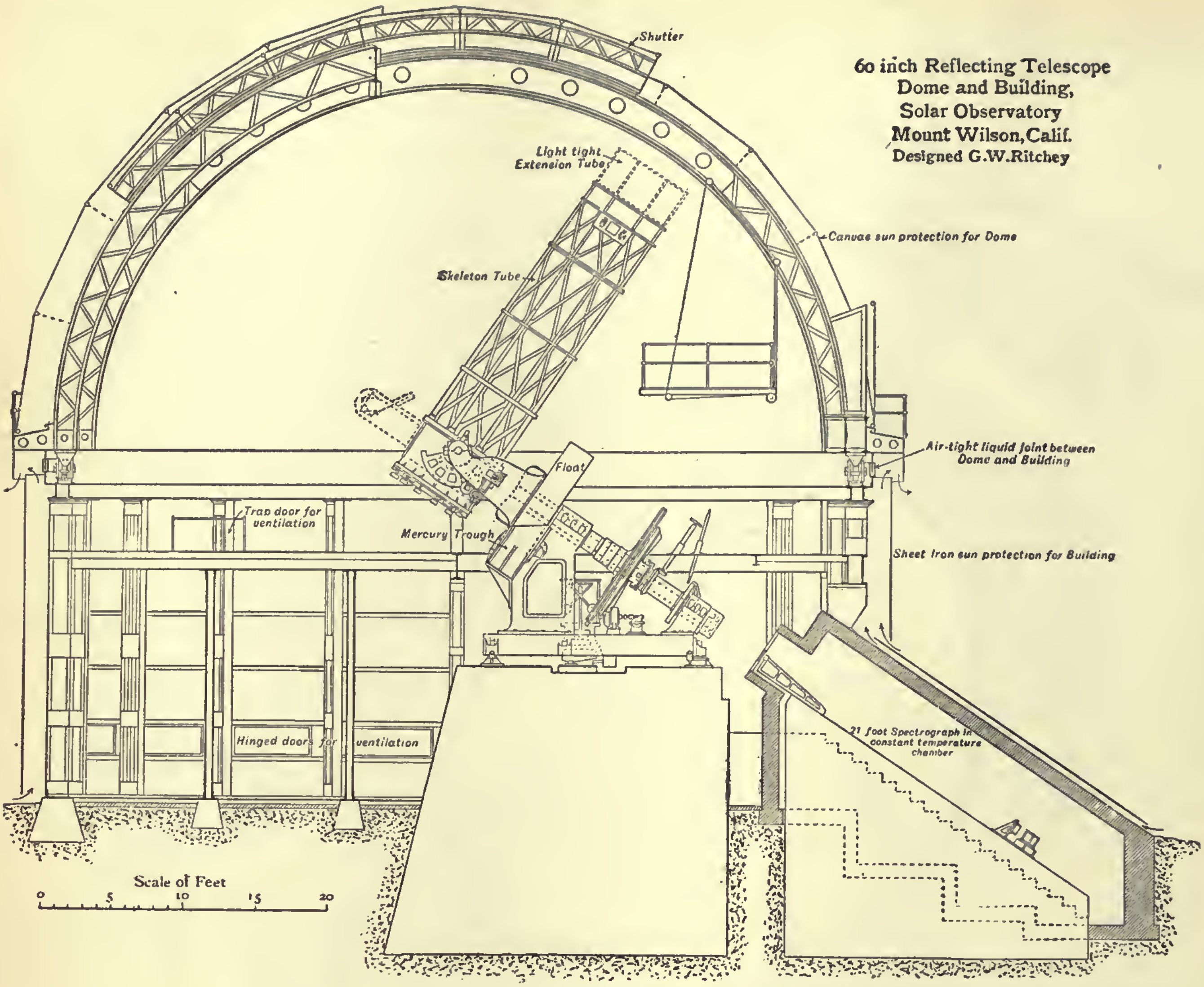


FIG. 20.

From Professor Hale's *The Study of Stellar Evolution*, by permission of the University of Chicago Press.

mirror, which returns the rays towards the centre of the large mirror and causes them to converge less rapidly. They then meet a small plane mirror supported at the point of intersection of the polar and declination axes, whence they are reflected down through the hollow polar axis as shown in fig. 2, and come to focus on the slit of the powerful spectroscope that is mounted on a pier in the chamber of constant temperature as shown in fig. 20. In this case the equivalent focal length is 150 ft.

(3) As a Cassegrain reflector, for photographing the moon, planets or very bright nebulae on a large scale, as shown in fig. 21 (*c*), with an equivalent focal length of 100 ft.

(4) As a Cassegrain reflector, for use with a spectroscope mounted in place of the photographic plate, fig. 21 (*d*); in this case a convex mirror of different curvature is employed, the equivalent focus of the combination being 80 ft.

Loewy's equatorial coudé.

Type E.—In the *Comptes Rendus* for the year 1883, vol. 96, pp. 735–741, Loewy gives an account of an instrument which he calls an "equatorial coudé," designed (1) to attain greater stability and so to measure larger angles than is generally possible with the ordinary equatorial; (2) to enable a single astronomer to point the telescope and make observations in any part of the sky without changing his position; (3) to abolish the usual expensive dome, and to substitute a covered shed on wheels (which can be run back at pleasure), leaving the telescope in the open air, the observer alone being sheltered. These conditions are fulfilled in the manner shown in fig. 22. E P is the polar axis, rotating on bearings at E and P. The object-glass is at O, the eye-piece at E. There is a plane mirror at M, which reflects rays converging from the object-glass to the eye-piece at E. A second mirror N, placed at 45° to the optical axis of the object-glass, reflects rays from a star at the pole; but by rotating the box which contains this mirror on the axis of its supporting tube T a star of any declination can be observed, and by combining this motion with rotation of the polar axis the astronomer seated at E is able to view any object whatever in the visible heavens, except circumpolar stars near lower transit. An hour circle attached to E P and a declination circle attached to the box containing the mirror N, both of which can be read or set from E, complete the essentials of the instrument. There must be a certain loss of light from two additional reflections; but that could be tolerated for the sake of other advantages, provided that the mirrors could be made sufficiently perfect optical planes. By making the mirrors of silvered glass, one-fourth of their diameter in thickness, the Henrys have not only succeeded in mounting them with all necessary rigidity free from flexure but have given them optically true plane surfaces, notwithstanding their large diameters, viz., 11 and 15·7 in. Sir David Gill tested the equatorial coudé on double stars at the Paris Observatory in 1884, and his last doubts as to the practical value of the instrument were dispelled. He has never seen more perfect optical definition in any of the many telescopes he has employed, and certainly never measured a celestial object in such favourable conditions of physical comfort. The easy position of the observer, the convenient position of the handles for quick and slow motion, and the absolute rigidity of the mounting leave little to be desired. In a much larger

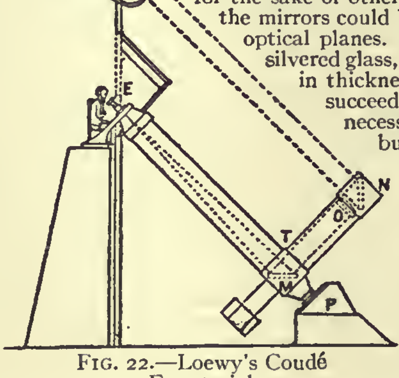


FIG. 22.—Loewy's Coudé Equatorial.

instrument of the same type subsequently mounted at Paris, and in like instruments of intermediate size mounted at other French observatories, the object-glass is placed outside the mirror N, so that both the silvered mirrors are protected from exposure to the outer air.

A modification of Loewy's equatorial coudé has been suggested by Lindemann (*Astr. Nachr.*, No. 3935); it consists in placing both the mirrors of Loewy's "equatorial coudé" at the top of the polar axis instead of the lower end of it. By this arrangement the long cross tube becomes unnecessary, and neither the pier nor the observatory obstruct the view of objects above the horizon near lower transit as is the case in Loewy's form. The reflected rays pass down the tube from the direction of the elevated pole instead of upward towards that pole. The observer is, therefore, at the bottom of the tube instead of the top and looks upward instead of downward. The drawbacks to this plan are (1) the necessarily large size of the upper pivot (viz. the diameter of the tube) and of the lower pivot (which must be perforated by a hole at least equal in diameter to the photographic field of the telescope), conditions which involve very refined arrangements for relief of friction, and (2) the less comfortable attitude of looking upward instead of downward. The plan, however, would be a very favourable one for spectroscopic work and for the convenient installation of an underground room of constant temperature. The difficulties of relief friction could probably be best overcome by a large hollow cylinder concentric with the polar axis fixed near the centre of gravity of the whole instrument and floated in mercury, on the plan adopted in the Mount Wilson 60-in. reflector already described, but in this case the floating cylinder would be below and not above the upper bearing.

The Grubb equatorial at Cambridge.

In 1884 Sir Howard Grubb (*Phil. Trans. R. Dub. Soc.*, vol. iii. series 2, p. 61) proposed a form of equatorial telescope of which an excellent example was erected at Cambridge (Eng.) in 1898. The instrument in some respects resembles the equatorial coudé of Loewy, but instead of two mirrors there is only one. A flanged cast-iron box, strongly ribbed and open on one side, forms the centre of the polar axis. One pivot of the polar axis is attached to the lower end of this box, and a strong hollow metal cone, terminating in the other pivot, forms the upper part of the polar axis. The declination axis passes through the two opposite sides of the central box. Upon an axis concentric with the declination axis is carried a plane mirror, which is geared so as always to bisect the angle between the polar axis and the optical axis of the telescope. If then the objective tube is directed to any star, the convergent beam from the object-glass is received by the plane mirror from which it is reflected upwards along the polar axis and viewed through the hollow upper pivot. Thus, as in the equatorial coudé, the observer remains in a fixed position looking down the polar tube from above. He is provided with quick and slow motions in right ascension and declination, which can be operated from the eye-end, and he can work in a closed and comfortably heated room. A large slot has to be cut in the cone which forms the upper part of the polar axis, in order to allow the telescope to be pointed nearer to the pole than would otherwise be possible; even so stars within 15° of the pole cannot be observed. An illustrated preliminary description of the instrument is given by Sir Robert Ball (*Mon. Not. R.A.S.*, lix. 152). The instrument has a triple photo-visual Taylor object-glass of 12½ in. aperture and 19·3-ft. focal length.

Type F.—In all the previously described types of telescope mounting the axis of the instrument is either pointed directly at the object or to the pole; in the latter case the rays from the star under observation are reflected along the polar axis by a mirror or mirrors attached to or revolving with it. Equatorials of types A, B, C and D have the advantage of avoiding interposed reflecting surfaces, but they involve inconveniences from the continual motion of the eye-piece and the consequent necessity for providing elaborate observing stages or rising floors. In those of type E the eye-piece has a fixed position and the observer may even occupy a room maintained at uniform temperature, but he must submit to a certain loss of light from one or more reflecting surfaces, and from possible loss of definition from optical imperfection or flexure of the mirror or mirrors. In all these types the longer the telescope and the greater its diameter (or weight) the more massive must be the mounting and the greater the mechanical difficulties both in construction and management.

But if it be possible to mount a fixed telescope by which a solar or stellar image can be formed within a laboratory we give the following advantages:—(1) There is no mechanical limit to the length of the telescope; (2) the clockwork and other appliances to move the mirror, which reflects the starlight along the axis, are much lighter and smaller than those required to move a large telescope; (3) the observer remains in a fixed position, and spectroscopes of any weight can be used on piers within the laboratory; and (4) the angular value of any linear distance on a photographic plate can be determined by direct measurement of the distance of the photographic plate from the optical centre of the object-glass. The difficulty is that the automatic motion of a single mirror capable of reflecting the rays of any star continuously along the axis of a fixed horizontal telescope, requires a rather complex mechanism owing to the variation of the angle of reflexion with the diurnal motion.

The Paris refractor (1900).

Foucault appears to have been the first to appreciate these advantages and to face the difficulty of designing a siderostat which, theoretically at least, fulfils the above-mentioned conditions. A large siderostat, constructed by Eichens after Foucault's design, was completed in 1868—the year of Foucault's death. It remained at the Paris Observatory, where it was subsequently employed by Deslandres for solar photography. The largest refracting telescope yet made, viz., that constructed by Gautier for the Paris exhibition of 1900, was arranged on this plan (type F), the stars' rays being reflected along the horizontal axis of a telescope provided with visual and with photographic object-glasses of 49-in. diameter and nearly 200-ft. focal length. Up to 1908 neither the optical qualities of the images given by the object-glasses and reflecting plane nor the practical working of the instrument, have, so far as we know, been submitted to any severe test. It is, however, certain that the Foucault siderostat is not capable, in practice, of maintaining the reflected image in a constant direction with perfect uniformity on account of the sliding action on the arm that regulates the motion of the mirror; such an action must, more or less, take place by jerks. There are farther inconveniences in the use of such a telescope, viz., that the image undergoes a diurnal rotation about the axis of the horizontal telescope, so that, unless the sensitive plate is also rotated by clockwork, it is impossible to obtain sharp photographs with any but instantaneous exposures. In the spectroscopic observation of a single star with a slit-spectroscope, this rotation of the image presents no inconvenience, and the irregular action of a siderostat on Foucault's plan might be overcome by the following arrangement:—

A B (fig. 23) is a polar axis, like that of an equatorial telescope, rotating in twenty-four hours by clockwork. Its lower extremity terminates in a fork on which is mounted a mirror C D, capable of turning about A on an axis at right angles to A B, the plane of the mirror being parallel to this latter axis. The mirror C D is set at such an angle as to reflect rays from the star S in the direction of the polar axis to the mirror R and thence to the horizontal telescope T.

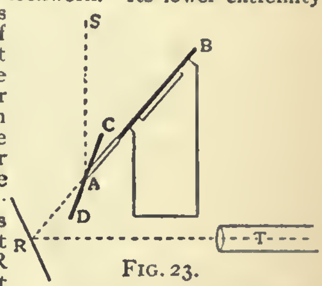


FIG. 23.

The mirrors of Lindemann's equatorial coudé reflecting light downwards upon the mirror R would furnish an ideal siderostat for stellar spectroscopy in conjunction with a fixed horizontal telescope.

Coelostat.—If a mirror is mounted on a truly adjusted polar axis, the plane of the mirror being parallel to that axis, the normal to that mirror will always be directed to some point on the celestial equator through whatever angle the axis is turned. Also, if the axis is made to revolve at half the apparent diurnal motion of the stars, the image of the celestial sphere, viewed by reflection from such a moving mirror, will appear at rest at every point—hence the name *coelostat* applied to the apparatus. Thus, any fixed telescope directed towards the mirror of a properly adjusted coelostat in motion will show all the stars in the field of view at rest; or, by rotating the polar axis independently of the clockwork, the observer can pass in review all the stars visible above the horizon whose declinations come within the limits of his original field of view. Therefore, to observe stars of a different declination it will be necessary either to shift the direction of the fixed telescope, keeping its axis still pointed to the coelostat mirror, or to employ a second mirror to reflect the rays from the coelostat mirror along the axis of a fixed telescope. In the latter case it will be necessary to provide means to mount the coelostat on a carriage by which it can be moved east and west without changing the altitude or azimuth of its polar axis, and also to shift the second mirror so that it may receive all the light from the reflected beam. Besides these complications there is another drawback to the use of the coelostat for general astronomical work, viz., the obliquity of the angle of reflection, which can never be less than that of the declination of the star, and may be greater to any extent. For these reasons the coelostat is never likely to be largely employed in general astronomical work, but it is admirably adapted for spectroscopic and bolometric observations of the sun, and for use in eclipse expeditions. For details of the coelostat applied to the Snow telescope—the most perfect installation for spectroheliograph and bolometer work yet erected—see *The Study of Stellar Evolution* by Prof. G. E. Hale, p. 131.

The Zenith Telescope

The zenith telescope is an instrument generally employed to measure the difference between two nearly equal and opposite zenith distances. Its original use was the determination of geographical latitudes in the field work of geodetic operations; more recently it has been extensively employed for the determination of variation of latitude, at fixed stations, under the auspices of the International Geodetic Bureau, and for the astronomical determination of the constant of aberration. The instrument is shown in its most recent form in fig. 24. A is a sleeve that revolves very freely and without shake on a vertical steel cone. This cone is mounted on a circular base *b* which rests on three levelling screws, two of which are visible in the figure. The sleeve carries a cross-piece on its upper extremity to which the bearings of the horizontal axis *c* are attached. A reversible level *d* rests on the accurately turned pivots of this axis. The telescope is attached to one end of this axis and a counterpoise *e* to the other. The long arm *f* serves to clamp the telescope in zenith distance and to communicate slow motion in zenith distance when so clamped. On the side of the telescope opposite to the horizontal axis is attached a graduated circle *g*, and, turning concentrically with this circle, is a framework *h*, to which the readers and verniers of the circle are fixed. This frame carries two very sensitive levels, *k* and *l*, and the whole frame can be clamped to the circle *g* by means of the clamping screw *m*.

The object-glass of the telescope is, of course, attached by its cell to the upper end of the telescope tube. Within the focus of the

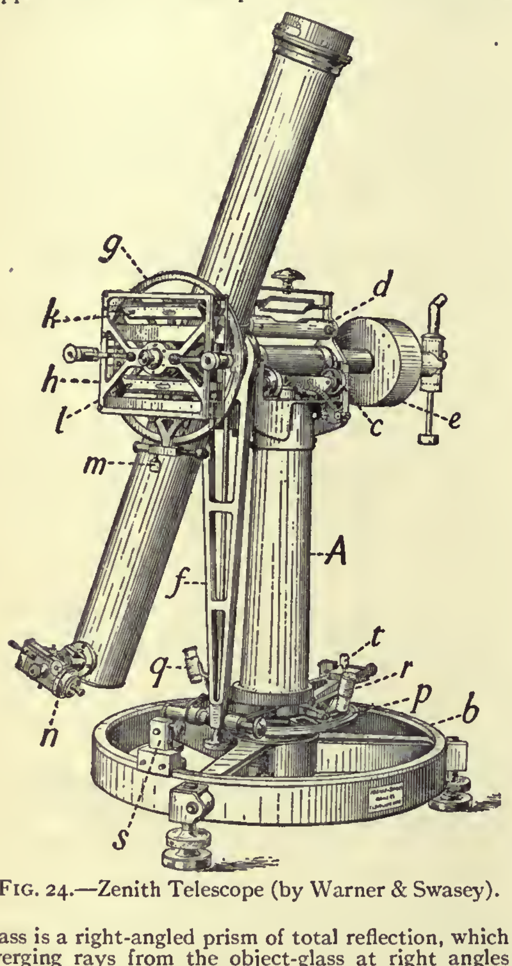


Fig. 24.—Zenith Telescope (by Warner & Swasey).

object-glass is a right-angled prism of total reflection, which diverts the converging rays from the object-glass at right angles to the axis of the telescope, and permits the observing micrometer *n* to be mounted in the very convenient position shown in the figure. A small graduated circle *p* concentric with A is attached to the circular base *b* and read by the microscopes *q r*, attached to *a*. The instrument is thus a theodolite, although, compared with its other dimensions, feeble as an apparatus for the measurement of absolute altitudes and azimuths, although capable of determining these co-ordinates with considerable precision.

In practice the vertical circle is adjusted once for all, so that when the levels *k* and *l* are in the centre of their run, the verniers read true zenith distances. When the instrument has been set up and levelled (either with aid of the cross level *d*, or the levels *k* and *l*), the reading of the circle *p* for the meridional position of the telescope is determined either by the method of transits in the meridian (see Transit Circle), or by the observation of the azimuth of a known star at a known hour angle. This done, the stops *s* and *t* are clamped and adjusted so that when arm *r* comes in contact with the screw of stop *t* the telescope will point due north, and when in contact with *s*, it will point due south, or vice versa. A pair of stars of known declination are selected such that their zenith distances, when on the meridian, are nearly equal and opposite, and whose right ascensions differ by five or ten minutes of time. Assuming, for example, that the northern star has the smaller right ascension, the instrument is first, with the aid of the stop, placed in the meridian towards the north; the verniers of the graduated circle *g* are set to read to the reading $\phi-\frac{1}{2}(\delta_n+\delta_s)$ where ϕ is the approximate latitude of the place and δ_n, δ_s the declinations of the northern and southern star respectively; then the level frame *h* is turned till the levels *k* and *l* are in the middle of their run, and there clamped by the screw *m*, aided in the final adjustment by the adjoining slow motion screw shown in the figure. The telescope is now turned on the horizontal axis till the levels read near the centres of these scales and the telescope is clamped to the arm *f*. When the star enters the field of view its image is approximately bisected by the spider web of the micrometer *n*, the exact bisection being completed in the immediate neighbourhood of the meridian. The readings of the levels *k* and *l* and the reading of the micrometer-drum are then entered, and the observation of the northern star is complete. Now the instrument is slowly turned towards the south, till the azimuth arm is gently brought into contact with the corresponding stop *s*, care being taken not to touch any part of the instrument except the azimuth arm itself. When the southern star enters the field the same process is repeated.

Suppose now, for the moment, that the readings of the levels *k* and *l* are identical in both observations, we have then, in the difference between the micrometer readings north and south, a measure of the difference of the two zenith distances expressed in terms of the micrometer screw; and, if the "value of one revolution of the micrometer screw" is known in seconds of arc we have for the resulting latitude

$$\phi=\tfrac{1}{2}\{(\zeta_n-\zeta_s)+(\delta_n+\delta_s)\},$$

where $\zeta_n-\zeta_s$ is the difference of the micrometer readings converted into arc—it being assumed that increased micrometer readings correspond with increased zenith distance of the star.

If between the north and south observation there is a change in the level readings of the levels *k* and *l*, this indicates a change in the zenith distance of the axis of the telescope. By directing the telescope to a distant object, or to the intersection of the webs of a fixed collimating telescope (see Transit Circle), it is easy to measure the effect of a small change of zenith distance of the axis of the telescope in terms both of the level and of the micrometer screw, and thus, *if the levels are perfectly sensitive and uniform in curvature and graduation*, to determine the value of one division of each level in terms of the micrometer screw. The value of "one revolution of the screw in seconds of arc" can be determined either by observing at transit the difference of zenith distance of two stars of known declination in terms of the micrometer screw, the instrument remaining at rest between their transits; or by measuring at known instants in terms of the screw, the change of zenith distance of a standard star of small polar distance near the time of its greatest elongation.

The reason why two levels are employed is that sometimes crystals are formed by the decomposition of the glass which cause the bubble to stick at different points and so give false readings. Two levels are hardly likely to have such causes of error arise at exactly corresponding points in their run, and thus two levels furnish an independent control the one on the other. Also it is impossible to make levels that are in every respect perfect, nor even to determine these errors for different lengths of bubble and at different readings with the highest precision. The mean of two levels therefore adds to the accuracy of the result.

Attempts have been made to overcome the difficulties connected with levels by adopting the principle of Kater's floating collimator (*Phil. Trans.*, 1825 and 1828). On this principle the use of the level is abolished, the telescope is mounted on a metallic float, and it is assumed that, in course of the rotation of this float, the zenith distance of the axis of the telescope will remain undisturbed, that is, of course, after the undulations, induced by the disturbance of the mercury, have ceased.

S. C. Chandler in 1884 constructed an equal altitude instrument on this principle, which he called the almucantar, and he found that after disturbance the telescope recovered its original zenith distance within $\frac{1}{20}$ of a second of arc. R. A. Sampson at Durham (*Monthly Notices R.A.S.* lx. 572) and H. A. Howe (*Ast. Jahrb.* xxi. 57) have had instruments constructed on the same general principle. It is, however, obviously impossible to apply a micrometer with advantage to such instruments, because to touch such an instrument, in order to turn a micrometer screw, would obviously set it into motion. The almucantar was therefore used only to observe the vertical transits of stars in different azimuths over fixed horizontal webs, without touching the telescope.

By the use of photography, however, it is possible to photograph the trail of a star as it transits the meridian when the telescope is directed towards the north, and another trail be similarly photographed when the telescope is directed towards the south. The interval between the true trails, measured at right angles to the direction of the trails, obviously corresponds to the difference of zenith distance of the two stars. This principle has been applied with great completeness and ingenuity of detail by Bryan Cookson to the construction of a "photographic floating zenith telescope," which he has erected at Cambridge (Eng.) and applied to an investigation of the change of latitude and a determination of the constant of refraction. A description of the instrument, and some preliminary results obtained by it, is given by him (*Monthly Notices R.A.S.*, lxi. 314). [D. Gi.]

TELESIA [mod. Telese], a town of the Samnites, 24 m. N.W. from Beneventum. It possesses remains of walls in *opus reticulatum*, of a total length of over a mile; two inscriptions of the Republican period record the erection of towers. The remains of baths (*Thermae Sabinianae*) and of an amphitheatre still exist: and the city was supplied with water by an aqueduct. There are sulphur springs in the vicinity, which may have supplied the baths.

TELESILLA, Greek poetess, a native of Argos, one of the so-called nine lyric muses. According to the traditional story, when Cleomenes, king of Sparta, invaded the land of the Argives in 510 B.C., and slew all the males capable of bearing arms, Telesilla, dressed in men's clothes, put herself at the head of the women and repelled an attack upon the city of Argos. To commemorate this exploit, a statue of the poetess, in the act of putting on a helmet, with books lying at her feet, was set up in the temple of Aphrodite at Argos. The festival *Hybristica* or *Endymatia*, in which men and women exchanged clothes, also celebrated the heroism of her female compatriots. Herodotus (vi. 76) does not refer to the intervention of Telesilla, but mentions an oracle which predicted that the female should conquer the male, whence the tradition itself may have been derived. Further, the statue seen by Pausanias may not have been intended for Telesilla; it would equally represent Aphrodite, in her character as wife of Ares and a warlike goddess (the books, however, seem out of place). The *Hybristica*, again, was most probably a religious festival connected with the worship of some androgynous divinity. Of Telesilla's poems only two lines remain, quoted by the grammarian Hephaestion, apparently from a Parthenion, or song for a chorus of maidens.

See Pausanias ii. 20, 8; Plutarch, *De Virtut. Mulierum*, 8; Clement of Alexandria, *Stromata*, iv. 19, p. 522; Bergk, *Poetae Lyrici Graeci*, iii.; and especially Macan, *Herodotus iv.–vi.*, i. 336 foll. and notes.

TELESIO, BERNARDINO (1509–1588), Italian philosopher and natural scientist, was born of noble parentage at Cosenza near Naples in 1509. He was educated at Milan by his uncle, Antonio, himself a scholar and a poet of eminence, and afterwards at Rome and Padua. His studies included all the wide range of subjects, classics, science and philosophy, which constituted the curriculum of the Renaissance savants. Thus equipped, he began his attack upon the medieval Aristotelianism which then flourished in Padua and Bologna. Resigning to his brother the archbishopric of Cosenza, offered to him by Pope Pius IV., he began to lecture at Naples and finally founded the academy of Cosenza. In 1563, or perhaps two years later, appeared his great work *De Rerum Natura*, which was followed by a large number of scientific and philosophical works of subsidiary importance. The heterodox views which he maintained aroused the anger of the Church on behalf of its cherished Aristotelianism, and a short time after his death his books were placed on the Index.

Telesio was the head of the great South Italian movement which protested against the accepted authority of abstract reason, and sowed the seeds from which sprang the scientific methods of Campanella and Bruno, of Bacon and Descartes, with their widely divergent results. He, therefore, abandoned the purely intellectual sphere and proposed an inquiry into the data given by the senses, from which he held that all true knowledge really comes. Instead of postulating matter and form, he bases existence on matter and force. This force has two opposing elements: heat, which expands, and cold, which contracts. These two processes account for all the diverse forms and types of existence, while the mass on which the force operates remains the same. The harmony of the whole consists in this, that each separate thing develops in and for itself in accordance with its own nature while at the same time its motion benefits the rest. The obvious defects of this theory, (1) that the senses alone cannot apprehend matter itself, (2) that it is not clear how the multiplicity of phenomena could result from these two forces, and (3) that he adduced no evidence to substantiate the existence of these two forces, were pointed out at the time by his pupil, Patrizzi (see article on PATRIZZI, FRANCESCO). Moreover his theory of the cold earth at rest and the hot sun in motion was doomed to disproof at the hands of Copernicus. At the same time, the theory was sufficiently coherent to make a great impression on Italian thought. When Telesio went on to explain the relation of mind and matter, he was still more heterodox. Material forces are, by hypothesis, capable of feeling; matter also must have been from the first endowed with consciousness. For consciousness exists, and could not have been developed out of nothing. Again, the soul is influenced by material conditions; consequently the soul must have a material existence. He further held that all knowledge is sensation ("non ratione sed sensu") and that intelligence is, therefore, an agglomeration of isolated data, given by the senses. He does not, however, succeed in explaining how the senses alone can perceive difference and identity. At the end of his scheme, probably in deference to theological prejudices, he added an element which was utterly alien, namely, a higher impulse, a soul superimposed by God, in virtue of which we strive beyond the world of sense. The whole system of Telesio shows lacunae in argument, and ignorance of essential facts, but at the same time it is a forerunner of all subsequent empiricism, scientific and philosophical, and marks clearly the period of transition from authority and reason to experiment and individual responsibility. Beside the *De Rerum Natura*, he wrote *De Somno*, *De his quae in aere fiunt*, *De Mari*, *De Cometis et Circulo Lacteo*, *De usu respirationis*, &c.

TELESPHORUS, bishop of Rome from about 126 till about 137. St Irenaeus says that he suffered martyrdom.

TELFORD, THOMAS (1757–1834), British civil engineer, was the son of a shepherd, and was born at Westerkirk in Eskdale, Dumfriesshire, on the 9th of August 1757. From early childhood he was employed as a herd, occasionally attending the parish school of Westerkirk, where his quickness and diligence helped to make up for his lack of opportunity. On being apprenticed, at the age of fifteen, to a stonemason at Langholm, he found leisure not only to gain an acquaintance with Latin, French and German, but to gratify his literary tastes by a wide variety of reading. In his early manhood he was much given to the writing of verse: a poem of some length on Eskdale appeared in 1784 in the *Poetical Museum*, published at Hawick; under the signature of "Eskdale Tam" he contributed verses to Ruddiman's *Weekly Magazine;* and he addressed an epistle in rhyme to Burns, which was published in James Currie's *Life* of the poet. In 1780 Telford went to Edinburgh, where he was employed in the erection of houses in the "new" town, and occupied much of his spare time in learning architectural drawing. Proceeding to London two years later, he found employment in the erection of Somerset House. Having in 1784 superintended the erection of a house for the commissioner at Portsmouth dockyard, he next repaired the castle of Sir W. Pulteney, member for Shrewsbury, who conceived such a high opinion of his talents that he got him made surveyor of public works for the county of Salop. In 1793 he was appointed engineer of the Ellesmere canal, for which he built the Chirk and Pont-y-Cysyllte aqueducts, and this work established his reputation as a canal engineer. He was consulted in 1806 by the king of Sweden regarding the construction of the Göta Canal, and, his plans having been adopted, he visited the country in 1810 to superintend some of the more important excavations. In the early years of the 19th century the question of improving the communications in the Highlands of Scotland engaged the attention of the government, and Telford was commissioned to report on the matter. In consequence of his recommendations, he was appointed engineer for the Caledonian Canal, which was begun in 1804 and forms one of the largest but by no means the most useful of his undertakings, and also for the construction of 920 miles of roads, a great part through very difficult country. Of the numerous bridges built in this line of roads mention may be specially made of that across the Tay at Dunkeld. Subsequently he was employed on the improvement of the road between Carlisle and Glasgow, which was undertaken as a result of a parliamentary inquiry in 1814, and he was then entrusted with the execution of another scheme, of equal magnitude and importance with that in the Highlands of Scotland, for a system of roads through the more inaccessible parts of Wales, which involved the erection of the magnificent suspension bridge across the Menai Straits, begun in 1820, and the Conway Bridge, begun in 1822. While his fame rests chiefly on his road and canal engineering, and the erection of the numerous bridges and aqueducts which this involved, he also did good work in harbour construction. The fisheries and industries of Scotland benefited by the improvements he effected at many of the harbours on the east coast; he constructed the St Katherine's Docks, London (finished in 1828); and his last piece of professional work was a plan for the improvement of Dover harbour. Other achievements of his later years were the drainage of the north level of the eastern Fen district, an area of 48,000 acres, and erection of the Dean Bridge, Edinburgh, and of the Broomielaw Bridge, Glasgow. He died on the 2nd of September 1834 in London, and was buried in Westminster Abbey.

Telford was never married. For twenty-one years he lived at the Salopian coffee-house, afterwards the Ship Hotel, Charing Cross, whence he removed to 24 Abingdon Street. He was a fellow of the Royal Societies of London and of Edinburgh, and was annually elected president of the Institution of Civil Engineers from its foundation. He received the Swedish order of knighthood of Gustavus Vasa.

See Telford's *Memoirs*, written by himself and edited by John Rickman (1838); also Smiles's *Lives of the Engineers*.

TÉLIGNY, CHARLES DE (*c.* 1535–1572), French soldier and diplomat, belonged to a respected Huguenot family of Rouerque, and received an excellent training in letters and arms at the house of Coligny. He was employed on several peace missions; he represented the Protestants before the king, and was entrusted by Condé with the presentation of his terms to the queen-mother in 1567, and in the following year he assisted at the conference at Châlons and signed the peace of Longjumeau, which was destined to be of short duration. On the outbreak of war, he took part in the siege of Poitiers, directed an unsuccessful attack on Nantes, fought bravely under Coligny at Moncontour, and participated in the negotiations ending in the treaty of Saint-Germain (8th of August 1570). In 1571 he retired to La Rochelle and married Louise de Coligny, but was speedily recalled to Paris to serve on the bi-partisan commission of adjustment. Although he won the special favour of Charles IX., he was one of the first victims in the massacre of St Bartholomew's Day (24th of August 1572). His remains were taken to the Castle of Téligny in 1617, but eight years later were thrown into the river by the bishop of Castres.

TELL, WILLIAM. The story of William Tell's skill in shooting at and striking the apple which had been placed on the head of his little son by order of Gessler, the tyrannical Austrian bailiff of Uri, is so closely bound up with the legendary history of the origin of the Swiss Confederation that they must be considered together. Both appear first in the 15th century, probably as results of the war for the Toggenburg inheritance (1436–50); for the intense hatred of Austria, greatly increased by her support of the claims of Zürich, favoured the circulation of stories which assumed that Swiss freedom was of immemorial antiquity, while, as the war was largely a struggle between the civic and rural elements in the Confederation, the notion that the (rural) Schwyzers were of Scandinavian descent at once separated them from and raised them above the German inhabitants of the towns.

The Tell story is first found in a ballad the first nine stanzas of which (containing the story) were certainly written before 1474. There is no mention made of the names of the bailiff or of his master, or of the hat placed on a pole. Tell is called "the first Confederate," and his feat is treated as the real and only reason why the Confederation was formed and the tyrants driven out of the land. It is probably to this ballad that Melchior Russ of Lucerne (who began his *Chronicle* in 1482) refers when, in his account (from Justinger) of the evil deeds of the bailiffs in the Forest districts, he excuses himself from giving the story. He goes on to narrate how Tell, irritated by his treatment, stirred up his friends against the governor, who seized and bound him and was conveying him by boat to his castle on the lake of Lucerne, when a storm arose, and Tell, by reason of his great bodily strength, was, after being unbound, given charge of the rudder on his promise to bring the boat safely to land. He steers it towards a shelf of rock, called in Russ's time Tell's Platte, springs on shore, shoots the bailiff dead with his crossbow, and goes back to Uri, where he stirs up the great strife which ended in the battle of Morgarten. In these two accounts, which form the basis of the Uri version of the origin of the Confederation, it is Tell and Tell only who is the actor and the leader. We first hear of the cruelties of Austrian bailiffs in the Forest districts in the *Bernese Chronicle* of Conrad Justinger (1420). No names or details are given, and the dates are different in the two recensions of the *Chronicle* as "olden days before Bern was founded" (*i.e.* before 1191) and 1260. Several details, but only one name, are added in the *De Nobilitate et Rusticitate Dialogus* (cap. 33) of Felix Hemmerli, a canon of Zürich, who wrote it after 1451 and before 1454; in this last year he was imprisoned by the Schwyzers, whom he had repeatedly insulted and attacked in his books. According to him the men of Schwyz and of Unterwalden were the first to rise, those of Uri following suit much later But neither Justinger nor Hemmerli makes any allusion to Tell or his feat.

The Tell story and the "atrocities" story are first found combined in a MS. known as the *White Book of Sarnen*. They are contained in a short chronicle written between 1467 and 1476, probably about 1470, and based on oral tradition. Many details are given of the oppressions of the bailiffs: we hear of Gessler, of the meeting of Stoupacher of Schwyz, Fürst of Uri, and a man of Nidwalden at the Rütli,- -in fact, the usual version of the legend. To give an instance of tyranny in Uri, the author tells us the story of the refusal of "der Thäll" to do reverence to the hat placed on a pole, of his feat of skill, and of his shooting the bailiff, Gessler, from behind a bush in the "hollow way" near Küssnacht. Tell is represented as being one of those who swore at the Rütli to drive out the oppressors; but the narrative of his doings is merely one incident in the general movement which began quite independently of him. The chronology is very confused, but the events are placed after Rudolf's election to the empire in 1273. This is the only account in which Tell is called "der Thäll," which name he himself explains by saying, "If I were sharp (*witzig*) I should be called something else and not der Tall," *i.e.* the simpleton or slow-witted man. (It is worthy of notice that the same meaning is attributed to the name of Tokko, the hero of a similar legend in Gheysmer's abridgment of the *Historia Danica* of Saxo Grammaticus, which may, somehow, have influenced the Swiss version.) The only other known instances of the Uri version of the legend relating to the origin of the Confederation are the Latin hexameters of Glareanus (1515), in which Tell is compared to Brutus as "assertor patriae, vindex ultorque tyrannum," and the *Urnerspiel* (composed in 1511–12), a play acted in Uri, in which Russ's version is followed, though the bailiff, who is unnamed, but announces that he has been sent by Albert of Austria, is slain in the "hollow way." Tell is the chief of the Rütli leaguers, and it is his deed which is the immediate occasion of the rising against the oppressors, which is dated in 1296. Mutius (1540) is the latest writer who, in his description of the origin of the Confederation, does not mention Tell and his act. The two stories are now firmly bound together; the version contained in the *White Book* is the accepted one, though small additions in names and dates are often made.

The task of filling up gaps, smoothing away inconsistencies, rounding off the tale, was accomplished by Giles Tschudi (*q.v.*), whose recension was adopted, with a few alterations, by Johannes von Müller in his *History of the Confederation* (1780). In the final recension of Tschudi's *Chronicle* (1734–36), which, however, differs in many particulars from the original draft still preserved at Zürich, we are told how Albert of Austria, with the view of depriving the Forest lands of their ancient freedom, sent bailiffs (among them Gessler) to Uri and Schwyz, who committed many tyrannical acts, so that finally on

8th November 1307, at the Rütli, Werner von Stauffacher of Schwyz, Walter Fürst of Uri, Arnold von Melchthal in Unterwalden, each with ten companions, among whom was William Tell, resolved on a rising to expel the oppressors, which was fixed for New Year's Day 1308. A few days later (November 18) the Tell incident takes place (described according to the *White Book* version), and on the appointed date the general rising. Tschudi thus finally settled the date, which had before varied from 1260 to 1334. He utterly distorts the real historical relations of the Three Lands, though he brings in many real historical names, their owners being made to perform historically impossible acts, and introduces many small additions and corrections into the story as he had received it. In particular, while in his first draft he speaks of the bailiff as Gryssler—the usual name up to his time, except in the *White Book* and in Stumpff's *Chronicle* of 1548—in his final recension he calls him Gessler, knowing that this was a real name. Later writers added a few more particulars,—that Tell lived at Bürglen and fought at Morgarten (1598), that he was the son-in-law of Fürst and had two sons (early 18th century), &c. Johannes von Müller (1780) gave a vivid description of the oath at the Rütli by the three (Tell not being counted in), and threw Tschudi's version into a literary form, adding one or two names and adopting that of Hermann for Gessler, calling him of "Bruneck." Schiller's play (1804) gave the tale a world-wide renown.

The story was, on the ground of want of evidence, regarded as suspicious by Guilliman in a private letter of 1607, and doubts were expressed by the brothers Iselin (1727 and 1754) and by Voltaire (1754); but it was not till 1760 that the legend was definitely attacked, on the ground of its similarity to the story of Tokko (see below), in an anonymous pamphlet by Freudenberger, a Bernese pastor. This caused great stir; it was publicly burnt by order of the government of Uri, and many more or less forged proofs and documents were produced in favour of Tell. The researches of J. E. Kopp (*Urkunden zur Geschichte d. eidgenössischen Bünde*, 2 parts, 1835 and 1851, and *Geschichte der eidgenössischen Bünde*, vol. ii., 1847), first cleared up the real early history of the league, and overthrew the legends of the *White Book* and Tschudi. Since then many writers have worked in the same direction. Vischer (1867) has carefully traced out the successive steps in the growth of the legend, and Rochholz (1877) has worked out the real history of Gessler as shown in authentic documents. The general result has been to show that a mythological marksman and an impossible bailiff bearing the name of a real family have been joined with confused and distorted reminiscences of the events of 1245–47, in which the names of many real persons have been inserted and many unauthenticated acts attributed to them. Th. von Liebenau has, however, shown (in an article reprinted from the *Katholische Schweizerblätter* in the *Bollettino Storico della Svizzera Italiana* for 1899) that in 1283 the Emperor Rudolf of Habsburg gave the right of receiving the tolls for escort over the St Gotthard Pass to his sons, the dukes of Austria. The levying of these tolls gave rise to various disputes between the men of Uri and the bailiffs of the dukes of Austria, and by 1319 (if not already in 1309) the claim to levy them was silently given up. These facts show (what could not hitherto be proved) that at the time when legend places the rising of Uri, Tell exploit, &c., the dukes of Austria really had disputes with Uri.

The story of the skilful marksman who succeeds in striking some small object placed on the head of a man or child is very widely spread: we find it in Denmark (Tokko), Norway (two versions), Iceland, Holstein, on the Rhine, and in England (William of Cloudesley). How it came to be localized in Uri we do not know; possibly, through the story of the Scandinavian colonization of Schwyz, the tale was fitted to some real local hero.

The alleged proofs of the existence of a real William Tell in Uri in the 14th century break down hopelessly. (1) The entries in the parish registers are forged. (2) As to the Tell chapels—(*a*) that in the "hollow way" near Küssnacht was not known to Melchior Russ and is first mentioned by Tschudi (1572). (*b*) That on Tell's Platte is first mentioned in 1504. The document which alleges that this chapel was built by order of a "landsgemeinde" held in 1388, at which 114 men were present who had been personally acquainted with Tell, was never heard of till 1759. The procession in boats to the place where the chapel stands may be very old, but is not connected with Tell till about 1582. (*c*) The chapel at Bürglen is known to have been founded in 1582. Other documents and statements in support of the Tell story have even less claim to credit. It has been pointed out above that with two exceptions the bailiff is always called Gryssler or Grissler, and it was Tschudi who popularized the name of Gessler, though Grissler occurs as late as 1765. Now Gessler is the name of a real family, the history of which from 1250 to 1513 has been worked out by Rochholz, who shows in detail that no member ever played the part attributed to the bailiff in the legend, or could have done so, and that the Gesslers could not have owned or dwelt at the castle of Küssnacht; nor could they have been called Von Bruneck.

In the *Urnerspiel* the name of the bailiff's servant who guarded the hat on the pole is given as Heintz Vögely, and we know that Friedrich Vögeli was the name of one of the chief military officers of Peter von Hagenbach, who from 1469 to 1474 administered for Charles the Bold, duke of Burgundy, the lands (Alsace, &c.) pledged to him by Sigismund of Habsburg. Now Hagenbach is known to have committed many cruelties like those attributed to the bailiffs in the legend, and it has been plausibly conjectured that his case has really given rise to these stories, especially when we find that the Confederates had a hand in his capture and execution, that in a document of 1358 Hagenbachs and Gesslers appear side by side as witnesses, and that the Hagenbachs had frequent transactions with the Habsburgs and their vassals.

In general see two excellent works by Franz Heinemann, *Tell-Iconographie*, Lucerne, 1902 (reproductions, with text, of the chief representations of Tell in art from 1507 onwards), and *Tell-Bibliographie* (including that of Schiller's play), published in 1908 at Bern.

Among the vast number of books and pamphlets on the Tell story, the two most to be recommended are W. Vischer, *Die Sage von der Befreiung der Waldstätte* (Leipzig, 1867), and E. L. Rochholz, *Tell und Gessler*, with a volume of documents 1250–1513 (Heilbronn, 1877). Convenient summaries of the controversy will be found in any modern book on Swiss history, and more particularly in G. von Wyss, *Über d. Gesch. d. drei Länder—Uri, Schwyz, u. Unterwalden —in den Jahren* 1212–1315 (Zürich, 1858); Alf. Huber, *Die Waldstätte bis zur festen Begründung ihrer Eidgenossenschaft, mit einem Anhange über die geschichtliche Stellung des Wilh. Tell* (Innsbruck, 1861); Albert Rilliet, *Les Origines de la Confédération Suisse, histoire et légende* (Geneva, 2nd edition, 1869); and S. Baring-Gould, *Curious Myths of the Middle Ages*, ch. v. (new edition, London, 1884).

The setting up in 1895 in the market-place in Altdorf of a fine statue (by the Swiss sculptor Richard Kissling) of Tell and his son, and the opening in 1899 just outside Altdorf of a permanent theatre, wherein Schiller's play is to be represented every Sunday during the summer months, show that the popular belief in the Tell legend is still strong, despite its utter demolition at the hands of a succession of scientific Swiss historians during the 19th century. A. Gisler of Altdorf (in his book, *Die Tellfrage*, Bern, 1895) has also made an attempt to rehabilitate it from the purely historical point of view. He is well acquainted with all the researches that have been made, but tries to save Tell's refusal to do reverence to the hat, his leap from the boat in the lake, and his slaying of the bailiff in the "hollow way." To effect the rescue of these incidents, he boldly admits the forgeries in the registers, abandons all the traditional dates, throws over Tschudi's account, and regards the shooting by Tell of the apple from his son's head as an "ornamental addition" to the tale. Save a mention of the Tell chapel on "Tellsplatte" in 1504 (the first known before was that by Tschudi in 1572), and a proof that the pilgrimages to Bürglen and Steinen had nothing to do with "St Kümmerniss," as her images are preserved in the *parish churches* of those villages, whereas the pilgrims go to the *chapels* therein, he brings forward no new evidence. His book is a striking proof that the popular Tell legend cannot claim the support of authentic history, while his attempt to find room for the atrocities of the wicked bailiffs elsewhere than at Altdorf consists only in suggesting an intricate series of possibilities, none of which are supported by any positive evidence.

In his pamphlet *Die Sagen v. Tell u. Stauffacher* (Basel, 1899) August Bernoulli, and in his elaborate *Geschichte d. Schweiz. Politik* (vol. i. Frauenfeld, 1906) J. Schollenberger, have applied the same sort of method, but without attaining any greater degree of historical success. (W. A. B. C.)

TELL EL AMARNA, the name now given to a collection of ruins and rock tombs in Upper Egypt near the east bank of the Nile, 58 m. by river below Assiut and 190 m. above Cairo. The ruins are those of Ekhaton (Akhet-Aton), a city built *c.* 1360 B.C. by Akhenaton (Amenophis IV.) as the new capital of his empire (in place of Thebes) when he abandoned the worship of Ammon and devoted himself to that of Aton, *i.e.* the sun (see EGYPT: *History*, § *Ancient*). Shortly after the death of Akhenaton the court returned to Thebes, and the city, after an existence of perhaps only twenty years—of fifty years at the utmost—was abandoned. Not having been inhabited since, the lines of the streets and the ground-plans of many buildings can still be traced. The chief ruins are those of the royal palace and of the House of the Rolls; there are scanty remains of the great temple. In the palace are four pavements of painted stucco work in fair preservation. They were discovered in 1891–92 by Prof. Flinders Petrie (see his *Tell el Amarna*, 1894). In the Rolls House were discovered in 1887 by the fellahin some 300 clay tablets inscribed with cuneiform characters. They are letters and state documents addressed to Amenophis IV. and his father, from the kings of Babylon, Assyria, &c., and from the Egyptian governors in Syria and neighbouring districts. The greater part of them were purchased for the Berlin Museum, but a large number were secured for the British Museum. Their contents proved invaluable for the reconstruction of the history, social and political, of Egypt and Western Asia during that period.

Hewn out of the sides of the hills which close in on the east the plain on which Ekhaton stood are two groups of tombs; one group lies 1½ m. N.E., and the other 3 m. S. of the city. The tombs, all of which belong to the time of Akhenaton, are full of interesting scenes in the peculiar style of the period, accompanied by hymns to the sun god. The most important tomb is, perhaps, that of Meri-Ra, high priest of the sun, which has a façade nearly 100 ft. long and two large chambers. On one of the walls of the main chamber is depicted the scene, now well known, in which a blind choir of harpists and singers celebrate the arrival of the court at the temple. In the early centuries of Moslem rule in Egypt the northern tombs were inhabited by Copts, one tomb, that of Pa-Nehesi, being turned into a church. In a ravine opening into the plain between the north and south tombs, and some seven miles from the city, is a tomb supposed to be that of Akhenaton.

The tombs and the great stelae sculptured on the cliffs which mark the bounds of the city of Akhet-Aton have been the object of special study by N. de G. Davies on behalf of the Archaeological Survey of Egypt. The results, with numerous plates and plans, are embodied in a series of memoirs, *Rock Tombs of El Amarna* (six parts, 1903–8).

For the tablets see *Tell el Amarna Tablets in the British Museum* (1892); C. Bezold, *Oriental Diplomacy; the transliterated text of the Cuneiform Despatches discovered at Tell el Amarna* (1893); *The Tel el Amarna Letters* (English translation by M. Winckler, Berlin, 1896); J. A. Knudtzon, *Die El-Amarna Tafeln* (Leipzig, 1907–9); W. M. F. Petrie, *Syria and Egypt from the Tell el Amarna Letters* (1898).

TELLER, WILHELM ABRAHAM (1734–1804), German Protestant divine, was born at Leipzig on the 9th of January 1734. His father, Romanus Teller (1703–1750), was a pastor at Leipzig, and afterwards became professor of theology in the university. He edited the earlier volumes of a *Bibelwerk* (19 vols., 1749–70) which was designed as an adaptation for German readers of the exegetical works of Andrew Willet, Henry Ainsworth, Symon Patrick, Matthew Poole, Matthew Henry and others. Wilhelm Abraham studied philosophy and theology in the university of his native town. Amongst the men whose influence mainly determined his theological position and line of work was J. A. Ernesti. Teller's writings present rationalism in its course of development from biblical supernaturalism to the borders of deistical naturalism. His first learned production was a Latin translation of Benjamin Kennicott's *Disserlation on the State of the Printed Hebrew Text of the Old Testament* (1756), which was followed the next year by an essay in which he expounded his own critical principles. In 1761 he was appointed pastor, professor of theology and general superintendent in the university of Helmstedt. Here he pursued his exegetical, theological and historical researches, the results of which appeared in his *Lehrbuch des christlichen Glaubens* (1764). This work caused some commotion, as much by the novelty of its method as by the heterodoxy of its matter, and more by its omissions than by its positive teaching, though everywhere the author seeks to put theological doctrines in a decidedly modern form. In 1767 Teller, whose attitude had made his position at Helmstedt intolerable, was glad to accept an invitation from the Prussian minister for ecclesiastical affairs to the post of provost of Kölln, with a seat in the supreme consistory of Berlin. Here he found himself in the company of the rationalistic theologians of Prussia—F. S. G. Sack (1738–1817), Johann Joachim Spalding (1714–1804) and others —and became one of the leaders of the rationalistic party, and one of the chief contributors to C. F. Nicolai's *Allgemeine Deutsche Bibliothek*. Teller was not long in making use of his freer position in Berlin. In 1772 appeared the most popular of his books, *Wörterbuch des Neuen Testamentes zur Erklärung der christlichen Lehre* (6th ed., 1805). The object of this work was to recast the language and ideas of the New Testament and give them the form of 18th-century illuminism. The author maintains that the Graeco-Hebraic expressions must not be interpreted literally, but explained in terms intelligible to the modern mind. By this lexicon Teller had put himself amongst the most advanced rationalists, and his opponents charged him with the design of overthrowing positive Christianity altogether. In 1786 the author became a member of the Berlin Academy of Sciences. The "Wöllner edict" of July 9, 1788, for the enforcement of Lutheran orthodoxy, and Teller's manly action, as member of the consistorial council, in defiance of it (cf. his *Wohlgemeinte Erinnerungen*, 1788), led the Prussian government to pass upon him the sentence of suspension for three months, with forfeiture of his stipend. He was not, however, to be moved by such means, and (1792) issued his work *Die Religion der Vollkommeneren*, an exposition of his theological position, in which he advocated at length the idea, subsequently often urged, of "the perfectibility of Christianity,"—that is, of the ultimate transformation of Christianity into a scheme of simple morality, with a complete rejection of all specifically Christian ideas and methods. This book represents the culminating point of German illuminism, and is separated by a long process of development from the author's *Lehrbuch*. In the same year he published his *Anleitung zur Religion überhaupt und zum Allgemeinen des Christenthums besonders; für die Jugend höherer und gebildeler Stände aller Religionsparteien*. Teller died on the 9th of December 1804. Besides his contributions to the *Allgemeine Deutsche Bibliothek*, he edited a popular and practically useful *Magazin für Prediger* (1792–1801).

See W. Gass, *Geschichte der protestantischen Dogmatik*, iv. pp. 206–222; P. Wolff, art. in Herzog-Hauck, *Realencyklopädie* (ed. 1907); Heinrich Döring, *Deutsche Kanzelredner des 18ten und 19ten Jahrh.*, p. 506 seq.; Edward Pusey, *Causes of the Late Rationalistic Character of German Theology* (1828), p. 150; and cf. the article in the *Allgemeine Deutsche Biographie.*

TELLICHERRY, a seaport of British India, in the Malabar district of Madras, between Cannanore and the French settlement of Mahe. Pop. (1901) 27,883. It is a healthy and picturesque town, built upon a group of wooded hills running down to the sea, and is protected by a natural breakwater of rock. The town with its suburbs occupies about 5 sq. m., and was at one time defended by a strong mud wall. The old fort still stands to the north of the town. The East India Company established a factory here in 1683 for the pepper and cardamom trade. For two years (1780–82) the town withstood a siege by Hyder's general, and in the subsequent wars with Mysore Tellicherry was the base of operations for the ascent of the Ghats from the west coast. The town is a busy centre of export trade in coffee, coco-nut produce, spices and sandal-wood. The Basel Protestant mission has a station here. The municipality manages the Brennen college founded in 1862.

TELLURIUM [Symbol Te, atomic weight 127·5 (O=16)], a chemical element, found to a certain extent in nature in the uncombined condition, but chiefly in combination with other metals in the form of tellurides, such, for example, as sylvanite, black tellurium, and tetradymite. Small quantities are occasionally met with in iron pyrites, and hence tellurium is found with selenium in the flue dust, or chamber deposits of sulphuric acid works. Tellurium was first recognized as a distinct element in 1798 by M. H. Klaproth. It may be obtained by heating tellurium bismuth with sodium carbonate, lixiviating the fused mass with water, filtering, and exposing the filtrate to air, when the tellurium is gradually precipitated as a grey powder (J. J. Berzelius). J. Farbaky (*Zeit. angew. Chem.*, 1897, p. 11) extracts the element from black tellurium as follows:—The ore is boiled with concentrated sulphuric acid, the solution diluted, hydrochloric acid added and the tellurium (together with selenium) precipitated by sulphur dioxide and the process repeated when a purer tellurium is obtained. B. Brauner (*Monats.*, 1889, 10, p. 414) recommends the following method for the purification. The crude element is treated with aqua regia and then evaporated with an excess of hydrochloric acid, the solution diluted and the tellurium precipitated by a current of sulphur dioxide. The precipitated tellurium is then fused with potassium cyanide, the melt extracted with water and the element precipitated by drawing a current of air through the solution and finally distilled in a current of hydrogen.

Tellurium is a brittle silvery-white element of specific gravity 6·27. It melts at 452° C. and boils at 478° C. (F. Krafft, *Ber.*, 1903, 36, p. 4344). When heated in a current of hydrogen it sublimes in the form of brilliant prismatic crystals. An amorphous form is obtained when tellurium is precipitated from its solutions by sulphur dioxide, this variety having a specific gravity 6·015. When heated in air, tellurium burns, forming the dioxide TeO_2. The element is insoluble in water, but dissolves in concentrated sulphuric acid forming a deep red solution.

Like sulphur and selenium, tellurium combines directly with hydrogen to form *telluretted hydrogen*, TeH_2, an extremely objectionable smelling and highly poisonous gas, which was first prepared by Sir H. Davy in 1810. It is best obtained by decomposing metallic tellurides with mineral acids. It is soluble in water, the solution gradually decomposing with deposition of tellurium; it also decomposes on exposure to light. It burns, and also, like sulphuretted hydrogen, precipitates many metals from solutions of their salts. It may be liquefied, the liquid boiling at 0° C., and on further cooling, it solidifies, the solid melting at −48° C. Many tellurides of metals have been examined by C. A. Tibbals (*Jour. Amer. Chem. Soc.*, 1909, 31, p. 902) who obtained the sodium and potassium tellurides by the direct union of their component elements and others from these by precipitation. The tellurides of the alkali metals immediately decompose on exposure to air, with liberation of tellurium. Two chlorides are known, the *dichloride*, $TeCl_2$, and the *tetrachloride*, $TeCl_4$. They are both obtained by passing chlorine over tellurium, the product being separated by distillation (the tetrachloride is the less volatile). The dichloride is an amorphous, readily fusible, almost black solid. It is decomposed by water with formation of tellurium and tellurous acid: $2TeCl_2+3H_2O=Te+H_2TeO_3+4HCl$. The tetrachloride is a white crystalline solid which is formed by the action of chlorine on the dichloride or by sulphur chloride on the element. It melts at 224° C. and is exceedingly hygroscopic. Water decomposes it with formation of tellurous acid and other products. It combines directly with sulphur trioxide to form a complex of composition $TeCl_4 \cdot 2SO_3$. The tetrabromide similarly gives $TeOBr_2 \cdot 2SO_3$ (W. Prandtl, *Zeit. anorg. Chem.*, 1909, 62, p. 237). Iodides are also known.

Two oxides of the element are definitely known, viz., the *dioxide*, TeO_2, and the *trioxide*, TeO_3, whilst a *monoxide*, TeO, has also been described. The dioxide is formed by burning tellurium in air or by warming it with nitric acid. It is a colourless crystalline solid which readily fuses to a yellow liquid. The trioxide is an orange-coloured solid which is formed when telluric acid is strongly heated. *Tellurous acid*, H_2TeO_3, is obtained when the tetrachloride is decomposed by water, or on dissolving tellurium in nitric acid and pouring the solution into water. It is a colourless solid and behaves as a dibasic acid. The alkaline tellurites are soluble in water. It also gives rise to super-acid salts, such as $KHTeO_3 \cdot H_2TeO_3$; $K_2TeO_3 \cdot 3TeO_2$. *Telluric acid*, H_2TeO_4, is obtained in the form of its salts when tellurium is fused with potassium carbonate and nitre, or by the oxidizing action of chlorine on a tellurite in alkaline solution. The free acid may be obtained by decomposing the barium salt with sulphuric acid and concentrating the solution, when a crystalline mass of composition $H_2TeO_4 \cdot 2H_2O$ separates. It is also formed when the dioxide is oxidized by hydrogen peroxide in caustic potash solution (A. Gutbier, *Zeit. anorg. Chem.*, 1904, 40, p. 260), and perhaps best of all by oxidizing tellurium with a mixture of nitric and chromic acids. It crystallizes in prisms, which lose their water of crystallization at 160° C. The tellurates of the alkali metals are more or less soluble in water, those of the other metals being very sparingly or almost insoluble in water. Some tellurates exist in two forms, a colourless form soluble in water and acids, and a yellow form insoluble in water and acids. An oxychloride of tellurium has been described, but the investigations of V. Lenher (*Jour. Amer. Chem. Soc.*, 1909, 31, p. 20) seem to negative its existence.

A considerable amount of work has been done on determinations of the atomic weight of tellurium, the earlier results giving the value 128. According to its position in the periodic classification of the elements one would expect its atomic weight to be less than that of iodine, instead of approximately equal, and on this account many efforts have been made to isolate another element from tellurium compounds, but none have as yet been successful. Recent investigations of the atomic weight are due to G. Gallo (*Atti. R. Acad. Lincei*, 1905 (iv.), 14, pp. 1, 23, 104), who, by a determination of the electrochemical equivalent of the element, arrived at the value 127·61; A. Gutbier (*Ann.*, 1905, 342, p. 266) by reduction of the dioxide obtained 127·6; Marckwald, by determining the ratio of telluric acid to tellurium dioxide, obtained 126·85; H. B. Baker (*Jour. Chem. Soc.*, 1907, 91, p. 1849), by determining the ratio of tellurium dioxide to oxygen and by analysis of tellurium tetrabromide, obtained 127·60, and V. Lenher (*Jour. Amer. Chem. Soc.*, 1909, 31, p. 20), by heating the double salt, $TeBr_4 \cdot 2KBr$, first in chlorine and finally in a current of hydrochloric acid to convert it into potassium chloride, obtained the value 127·55. P. E. Browning and W. R. Flint (*Amer. J. Sci.*, 1909 (iv.), 28, p. 347) claim to have separated two substances (of atomic weights 126·49 and 128·85 respectively) from tellurium, by fractional precipitation of tellurium chloride with water, but in the opinion of H. B. Baker this would seem to point to the fact that the tellurium used was insufficiently purified, since his work showed that there was no difference between the first and last fractions (see *Chem. Soc. Ann. Rep.*, 1909, 6, p. 39). Marckwald (*Ber.*, 1903, 36, p. 2662) showed that the Joachimsthal pitchblende yields tellurium and a minute quantity of the strongly radioactive polonium which is precipitated by bismuth (see RADIOACTIVITY).

TELUGU, one of the five great Dravidian languages. The word is probably derived from Trilinga (=the three *lingas* of Siva), a name for the old Hindu kingdom of Andhra. It was at one time called by Europeans "Gentoo," from a Portuguese word meaning Gentile. The Telugu-speaking peoples are partly subjects of the nizam of Hyderabad and partly under British rule, beginning north of Madras city and extending N.W. to Bellary, where Telugu meets Kanarese, and N.E to near Orissa. They are taller and fairer than the Tamils, otherwise they are of typical Dravidian features. They are an enterprising people, good farmers and skilful seamen. They formed the greater part of the early Madras or "coast" army, whence sepoys even in Bengal were formerly called *telingas*. In 1901 the number of speakers of Telugu in all India was nearly twenty-one millions.

TEMBU (Ama-Tembu), popularly called Tambookies; one of the most powerful of Kaffir tribes, who have given their name to Tembuland, a division of Cape Colony which lies south-west of Griqualand East. In Kaffir genealogy they hold an honourable position, being traditionally descended from Tembu, elder brother of Xosa, from whom most "Kaffirs" claim descent (see KAFFIRS).

TEMENOS (Gr. *τέμενος*, *τέμνειν*, to cut), the Greek term in archaeology given to a piece of land which forms the enclosure of a temple, or sanctuary.

TEMESVÁR, the capital of the county of Temes, Hungary, 188 m. S.E. of Budapest by rail. Pop. (1900) 53,033. It lies on the navigable Béga canal and on the river Béga, and consists of the inner town, formerly strongly fortified, and of four outlying suburbs. Several parks have been laid out on the site of the broad glacis which formerly separated Temesvár from its suburbs, which are now united with it by broad avenues. Temesvár is the seat of a Roman Catholic and a Greek Orthodox bishop. Amongst its principal buildings are the Roman Catholic cathedral, built (1735–57) by Maria Theresa; the Greek Orthodox cathedral; a castle built by Hunyady Janos in 1442, now used as an arsenal; the town and county hall, the museum and large barracks. In the principal square rises a Gothic column, 40 ft. high, erected by the Emperor Francis Joseph in 1851 to commemorate the successful resistance of the town to the siege of 107 days laid by the Hungarian revolutionary army in 1849. Temesvár is the most important centre of commerce and industry of south Hungary, and carries on a brisk trade in grain, flour, spirits and horses. Its industrial establishments include factories for tobacco, cloth, matches, leather, artificial manure, besides breweries and distilleries.

Temesvár is an old town, and although destroyed by the Tatars in 1242, it was a populous place at the beginning of the 14th century, and was strongly fortified by King Charles Robert of Anjou, who resided here several years. The Hunyady family had also their residence here. In 1514 the peasant leader, Stephan Dozsa, was defeated by the Transylvanian voivod, John Zápolya, near Temesvár, captured and executed. Unsuccessfully besieged by the Turks in 1552, it was captured by them in the following year after a heroic resistance. It remained in their hands until 1716, when it was liberated by Prince Eugene of Savoy. New strong fortifications were erected, and the town grew steadily in importance, serving as the capital of the whole Banat. It endured another siege in 1849, when it resisted successfully the attacks of a Hungarian revolutionary army.

TEMPE, VALE OF, the ancient name (*i.e.* "cleft," from Gr. *τέμνειν*, to cut) of a narrow valley in N. Thessaly, through which the river Peneus (mod. Salambria) reaches the sea. The valley, which the Greeks were accustomed to associate with rural delights, is a chasm, cloven in the rocks, the fable tells us, by the trident of Poseidon, between Olympus and Ossa; but though it possesses every element of the sublime, yet its features are soft and beautiful, from the broad winding river, the luxuriant vegetation, and the glades that at intervals open out at the foot of the cliffs. It is about four miles and a half long, and towards the middle of the pass, where the rocks are highest, the precipices in the direction of Olympus fall so steeply as to bar the passage on that side; but those which descend from Ossa are the loftiest, for they rise in many places not less than 1500 ft. from the valley. Owing to the length and narrowness of the ravine, it was a position easily defended, but still it offered a practicable entrance to an invading force; a number of castles (of which the ruins still exist) were built at different times at the strongest points. Tempe was sacred to Apollo, to whom a temple was erected on the right bank. Every ninth year a sacred mission proceeded to the valley to pluck the laurel for the chaplets for the Pythian games. Owing to its widespread fame, the name Tempe was given also to the valley of the Velinus near Reate (Italy) and that of the Helorus in Sicily.

TEMPER (from Lat. *temperare*, to mingle or compound in due proportion, to qualify, rule, regulate, to be moderate, formed from *tempus*, time, fit or due season), to blend, modify, or qualify by mixing, to combine in due proportions, hence to restrain, calm. A specific application of the word is to the bringing of steel or other metal to a proper hardness and elasticity (see METAL and IRON AND STEEL). The word is also used as a substantive, especially in the transferred sense of disposition or frame of mind, generally with some qualifying epithet, but when used absolutely signifying a hasty, passionate temper, or display of such.

TEMPERA (the Italian term), or DISTEMPER, a method of painting in which solid pigments are employed, mixed with a water medium,[1] in which some kind of gum or gelatinous substance is dissolved to prevent the colours from scaling off. Tempera is also called in Italy *fresco a secco*, as distinguished from *fresco buono*, or true fresco, painted on freshly laid patches of stucco. Various media have been used for tempera work, such as the glutinous sap of the fig and other trees, various gums which are soluble in water, and size made by boiling down fish-bones, parchment and animals' hoofs. A mixture of egg and vinegar has also been found to make a good medium, especially when it is desirable to apply the colours in considerable body or *impasto*. For the nature and history of painting in tempera and fresco, see PAINTING.

TEMPERANCE. The word "temperance," which strictly means moderation, has acquired a particular meaning in connexion with intoxicating liquor, and it is here used in that limited sense. The "temperance question" is the equivalent in English of *l'alcoolisme* and *Alkoholismus* in French and German-speaking countries respectively; it embraces all the problems that arise in connexion with the use or abuse of alcoholic drink. This usage has arisen from the practice of societies formed for the purpose of suppressing or reducing the consumption of such liquors, and calling themselves Temperance Societies. Their activity is often spoken of as the Temperance Movement, though that term properly covers very much wider ground.

Historical.—Ever since man in some distant age first discovered that process of fermentation by which sugar is converted into alcohol and carbonic acid, and experienced the intoxicating effects of the liquor so produced, there has been, in a sense, a temperance question. The records of the ancient Oriental civilizations contain many references to it, and from very remote times efforts were made by priests, sages or law-givers in India, Persia, China, Palestine, Egypt, Greece and Carthage to combat the vice of drunkenness. But the evil appears never to have been so great or the object of so much attention in the ancient world as in Western countries and our own era. Two circumstances mainly differentiate the modern problem; one is the use of distilled waters or spirits as a beverage, and the other the climatic conditions prevailing in the more northern latitudes which are the home of Western civilization. The intoxicating drinks used by the ancients were wines obtained from grapes or other fruits and beers from various kinds of grain. These products were not confined to the East, but were known to the ancient civilizations of Mexico and Peru and even to primitive peoples who used the sugar-containing juices and other substances indigenous in their country. In the time of the Romans the barbarians in the north of Europe used fermented liquors made from honey (mead), barley (beer) and apples (cider) in place of grape-wine. All such drinks produce intoxication if taken in sufficient quantity; but their action is so much slower and less violent than that of distilled spirits that even their abuse did not give rise to any opposition that can properly be called a movement, and the distinction has repeatedly formed the basis of legislation in several countries down to this day. Extremists now place all alcohol-containing drinks under the same ban, but fermented liquors are still generally held to be comparatively innocuous; nor can any one deny that there is a difference. It is safe to say that if spirits had never been discovered the history of the question would have been entirely different. The distillation of essences from various substances seems to have been known to the ancients and to have been carried on by the Arabians in the dark ages; but potable spirits were not known until the 13th century. The distilled essence of wine or *aqua vitae* (brandy) is mentioned then as a new discovery by Arnoldus de Villa Nova, a chemist and physician, who regarded it, from the chemical or medical point of view, as a divine product. It probably came into use very gradually, but once the art of distillation had been mastered it was extended to other alcoholic substances in countries where wine was not grown. Malt, from which beer had been made from time immemorial, was naturally used for the

[1] Hence it used to be called "water-work"; see Shakespeare, *Hen. IV.*, part ii. act ii. sc. 1.

purpose, and then gin or Geneva spirits and whisky or usquebagh (Irish for "water of life") were added to grape brandy; then came corn brandy in the north and east of Europe, rum from sugar canes in the Indies, potato spirit, and eventually, as the process was perfected, rectified ethyl alcohol from almost anything containing sugar or starch.

The concentrated form of alcohol, thus evolved, for a long time carried with it the prestige of a divine essence from the middle ages when chemistry was a mysterious art allied to all sorts of superstitions. It had potent properties and was held to possess great virtue. This view is embodied in the name "water of life," and was at one time universally held; traces of it still linger among the very ignorant. Ardent spirit seemed particularly desirable to the habitants of the cold and damp regions of northern Europe, where the people took to it with avidity and imbibed it without restraint when it became cheap and accessible. That happened in England, as related in the article on LIQUOR LAWS, in the early part of the 18th century; and out of the frightful results which followed there eventually arose the modern Temperance Movement. The legislature had been busy with the liquor traffic for more than two centuries previously, but its task had been the repression of disorder; the thing was a nuisance and had to be checked in the interests of public order. It is significant that though drunkenness had been prevalent from the earliest times, the disorder which forced legislative control did not make its appearance until after the introduction of spirits; but they were not cheap enough to be generally accessible until the home manufacture of gin was encouraged towards the end of the 17th century, and consequently their use did not cause visible demoralization on a large scale until then. When, however, the spirit bars in London put up signboards, as related by Smollett, inviting people to be "drunk for one penny" and "dead drunk for 2d.," with "straw for nothing" on which to sleep off the effects, the full significance of unlimited indulgence in spirits became visible. Speaking in the House of Lords in 1743 Lord Lonsdale said:—

> "In every part of this great metropolis whoever shall pass along the streets will find wretchedness stretched upon the pavement, insensible and motionless, and only removed by the charity of passengers from the danger of being crushed by carriages or trampled by horses or strangled with filth in the common sewers. . . . These liquors not only infatuate the mind but poison the body; they not only fill our streets with madness and our prisons with criminals, but our hospitals with cripples. . . . Those women who riot in this poisonous debauchery are quickly disabled from bearing children, or produce children diseased from their birth."

The latter part of this quotation is particularly interesting because it proves the participation of women in public drunkenness at this period and shows that the physical ruin caused by excess and its national consequences were then for the first time recognized. It was the first step towards the inauguration of the Temperance Movement in the sense of a spontaneous and conscious effort on the part of the community as distinguished from the action of authority responsible for public decency. The need was only realized by degrees. Intemperance was one of many questions which we can now see were struggling into existence during the latter half of the 18th century, to become the subject matter of "social reform" in the 19th. Like the majority of them it was a question of bodily welfare, of health. A breach had been made in the unthinking traditional belief in the virtue of alcoholic liquor by the experiences referred to; and medical thought, as soon as it began to busy itself with health as distinguished from the treatment of disease, took the matter up. In 1804 Dr Trotter of Edinburgh published a book on the subject, which was an expansion of his academic thesis written in 1788; Dr Benjamin Rush of Philadelphia, a distinguished American physician and politician, who had studied in Edinburgh and London, wrote a striking paper on the same subject in the same year; and very soon after this the organized Temperance Movement was set on foot in the United States, where the habit of spirit-drinking had been transplanted from the British Islands.

Temperance Organization.—In 1808 a temperance society was founded at Saratoga in the state of New York, and in 1813 the Massachusetts Society for the Suppression of Intemperance made its appearance. These seem to have been the earliest organizations, though the device of a pledge of abstinence had been introduced in 1800. The movement made rapid progress mainly under the influence of the Churches. In 1826 the American Society for the Promotion of Temperance was founded in Boston, and by 1833 there were 6000 local societies in several states with more than a million members. The campaign was for the most part directed against the use of spirits only, and the proposal to include all alcoholic drinks in the pledge of abstinence, though adopted by a few societies, was rejected in 1833 by the American Society, but accepted in 1836 and retained ever since.

In Europe the earliest organizations were formed in Ireland. A temperance club is said to have been started at Skibbereen in 1818, and others followed; but it was in 1829 that the organized movement began to make effectual progress with the formation of the Ulster Temperance Society. By the end of that year there were twenty-five societies in Ireland and two or three in Scotland. In 1830 the movement spread to Yorkshire and Lancashire, and supported a newspaper called the *Temperance Societies' Record*, according to which there were then 127 societies with 23,000 paying members and 60,000 associated abstainers. In 1831 the British and Foreign Temperance Society was founded in London with the Bishop of London (Blomfield) for president and Archbishop Sumner for one of the vice-presidents. This important society, of which Queen Victoria became patron on her accession in 1837, came to an end in 1850, when the whole cause was under an eclipse. At the time it was formed temperance meant abstinence from spirits, as at first in the United States; but very soon afterwards the more drastic form of total abstinence began to be urged in the north of England and acquired the name of teetotalism from "tee-total," a local intensive for "total." It led to strife in the societies and damaged the cause, which suffered in public estimation from the intemperance of some of its advocates. The early promise of the movement was not fulfilled; it ceased to grow after a few years and then declined, both in the United Kingdom and in the United States. The most remarkable episode in the temperance campaign at this period was the mission of the Rev. Theobald Mathew of Cork, commonly known as Father Mathew, the greatest of all temperance missionaries. He travelled through Ireland in the years 1838–42 and everywhere excited intense enthusiasm. People flocked to hear him and took the pledge in crowds. In 1841 the number of abstainers in Ireland was estimated to be 4,647,000, which is more than the entire population to-day. In three years the consumption of spirits fell from 10,815,000 to 5,290,000 gallons. This was not all due to Father Mathew, because great depression and distress prevailed at the same time, but he unquestionably exercised an extraordinary influence. In 1843 he went to England, where he had less, though still great, success, and in 1850 to America. He died in 1856, by which time the cause had fallen into a depressed state in both countries. In the United States a flash of enthusiasm of a similar character, but on a smaller scale, known as the Washingtonian movement, had appeared about the same time. It was started in Baltimore by a knot of reformed drunkards in 1840 and was carried on by means of public meetings; many societies were formed and some half-million persons took the pledge, including many reformed drunkards. But the public grew weary of the agitation and enthusiasm died down. The decline of moral suasion and of the societies was followed by a tendency to have recourse to compulsion and to secure by legislation that abstinence from alcoholic drinks which the public would not voluntarily adopt or would not maintain when adopted. In 1845 a law prohibiting the public sale of liquor was passed in New York State but repealed in 1847; in 1851 state prohibition was adopted in Maine (see LIQUOR LAWS). The same tendency was manifested in England by the formation in 1853 of the United Kingdom Alliance "to procure the total and immediate legislative suppression of the traffic in intoxicating liquors as beverages."

Since that time the organized movement has embraced both elements, the voluntary and the compulsory, and has combined the inculcation of individual abstinence with the promotion of legislation for the reduction or suppression of the traffic. On the whole the latter has predominated, particularly in the United States, where organized agitation has for more than half a century made temperance a political question and has produced the various experiments in legislation of which an account is given in the article on LIQUOR LAWS. In 1869 a National Prohibition Party was formed. In Great Britain the political element has been less predominant but sufficiently pronounced to form a distinguishing feature between the early and more enthusiastic stage of temperance agitation, which after lasting some twenty years suffered a reaction, and the later one, which began between 1860 and 1870 and made way more gradually. In addition to combining the moral and the political elements the modern movement is characterized by the following features: (1) international organization, (2) organized co-operation of women, (3) juvenile temperance, (4) teaching of temperance in schools and elsewhere, (5) scientific study of alcohol and inebriety.

(1) International organization appears to have been started by the Order of Good Templars, a society of abstainers formed in 1851 at Utica in New York State. It spread over the United States and Canada, and in 1868 was introduced into Great Britain. Some years later it was extended to Scandinavia, where it is very strong. Temperance societies had previously existed in Norway from 1836 and in Sweden from 1837; these seem to be the earliest examples on the continent of Europe. The Good Templar organization has spread to several other European countries, to Australasia, India, South and West Africa and South America. There are several other international societies, and international congresses have been held, the first in 1885 at Antwerp. A World's Prohibition Conference was held in London in 1909. It was attended by about 300 delegates from temperance societies in nearly all parts of the world, and resulted in the foundation of an International Prohibition Federation, which embraces every country in Europe with three or four minor exceptions, the United States, Mexico, Argentina, the British self-governing Dominions, India, China, Japan, Palestine, Tunisia and Hawaii. The formation of this body indicates the growth of the most uncompromising form of antagonism to the liquor traffic. Its object is the total abolition of the legalized traffic throughout the world.

(2) The organization of women, which has also become international, dates from 1874, when the National Women's Christian Temperance Union was founded at Cleveland in the United States. In 1907 it had branches in every state in the Union and in about 10,000 towns and villages with an aggregate membership of 350,000. It employs all means, educational and social as well as political, but it has exercised great influence in promoting that drastic legislation which characterizes the United States. It has also taken up many other questions relating to women, in addition to temperance, and has adopted the badge of a white ribbon. About the year 1883 Miss Frances Willard, who had been the moving spirit of the Union, carried the organization of women into other lands and formed the World's Woman's Christian Temperance Union, which now possesses branches in some fifty countries with a total membership of half a million. It has held several conventions in America and Europe and circulated a polyglot petition, said to be the largest on record, which has been presented to a large number of sovereigns and other heads of states. There are several other female organizations in the United Kingdom.

(3) The inclusion of children in temperance organization goes back to 1847, when a society was formed at Leeds, in Yorkshire, of juvenile abstainers who had taken the pledge; it took the name of Band of Hope. The practice spread, and in 1851 a Band of Hope Union was formed. There are now a number of such unions, for the United Kingdom, Scotland, Ireland and separate counties in England; the Bands of Hope are said to number 15,000 in all. There are also several other juvenile organizations, some of which are branches of the adult societies. By far the largest is the juvenile section of the Church of England Temperance Society, which has 485,888 members (1910). Children's societies in the United States are usually called the Loyal Temperance Legion, but there are some Bands of Hope also. On the continent of Europe juvenile organizations exist in several countries and notably in Sweden and Belgium (*sociétés scolaires*).

(4) The teaching of temperance in schools, which has become a great feature of the moral propaganda, was begun by private effort in 1852, when the late Mr John Hope inaugurated a regular weekly visitation of day-schools in Edinburgh. In 1875 at the invitation of the National Temperance League, the late Sir Benjamin Richardson wrote his *Temperance Lesson Book*, which was adopted by many schools as a primer. In 1889 school-teaching by travelling lecturers was taken up by the United Kingdom Band of Hope Union, and the example was followed by many other societies. The Band of Hope Unions in England alone have spent over £3000 a year for the last twenty years in itinerant lectures; object-lessons on the nature and effects of alcoholic drinks are given to children in the higher standards. The Church of England Temperance Society carries on similar work in diocesan schools, and examines the children in the subject of temperance; in 1909 it had in use 6000 lantern slides for lectures, and set 7598 examination papers. The voluntary temperance teaching having grown continuously and become very extensive, has led to action by central education authorities. In 1906 the Board of Education in Ireland made "Hygiene and Temperance" a compulsory subject in the public schools. In 1909 the Board of Education for England issued a syllabus of temperance teaching, the adoption of which in elementary schools is optional. In Scotland also courses of teaching in hygiene and temperance are permissive and have been adopted by many local educational authorities. In the United States compulsory teaching is of much longer standing and more advanced. The question was first taken up by the Women's Christian Temperance Union (see above) in 1879; it was believed that by teaching the physiological effects of alcohol to all children the problem of intemperance would be effectually "solved," and a systematic political campaign was planned and carried out for the purpose of obtaining compulsory legislation to give effect to this idea. The campaign was successful in New York in 1884, in Pennsylvania in 1885 and subsequently in other states. Laws have now been passed in every state and territory, making anti-alcohol teaching part of the curriculum in the public schools, and tobacco is usually included. The manner of teaching has given rise to much controversy and opposition. Temperance is taught in connexion with physiology and hygiene, but the promoters of the movement insisted that prominence should be given to it and that the text-books should be adapted accordingly. Consequently a class of text-books came into use which were offensive to men of science and well-educated teachers because they contained false statements and absolute nonsense. The effect of forcing teachers to teach what they knew to be untrue was very unfortunate, and in some states the laws have undergone revision. With regard to other countries the practice varies greatly. School-teaching is compulsory in Canada, except in Quebec and Prince Edward Island, where it is permissive; in France since 1902; in Sweden since 1892, and in Iceland. It is recognized by authority but optional in Australia, South Africa, some provinces of India, Belgium, Finland, Denmark, Norway, Germany, Austria-Hungary and Switzerland. The movement in favour of school-teaching is continuously and generally advancing.

(5) The scientific study of the physiology and pathology of alcohol is a very large subject in itself. As has been shown above, the pioneers of the temperance movement were medical men; and though the Churches soon became the chief moving force, doctors have always exercised an influence, and in more recent times since people learnt to bow down to the name of Science there has been a marked tendency to have recourse to scientific authority for arguments and support, of which the teaching of temperance as a branch of physiology or hygiene is an illustration. At the same time the increasing interest taken in all questions relating to health has directed the attention of scientific investigators to this subject, while advancing knowledge of physiology, pathology and chemistry in general and improved means of investigation have enabled them to pursue it in various directions. Consequently a large amount of research has been devoted to alcohol and its effects both by experimentation on animals and plants and by observation of the morbid conditions set up in human beings by excessive and long-continued indulgence in alcoholic drinks. Another field of inquiry which has been actively worked is the statistical study of drink in relation to nationality, occupation, disease, insanity, mortality, longevity, crime, pauperism and other aspects of social life. In London there is a society, consisting chiefly of medical men, for the scientific study of inebriety; it holds periodical meetings at which papers are read and discussed. But the subject is being worked at in every country, and a vast mass of information has been accumulated. An attempt will be made later on to summarize the more important results of this activity. There is no doubt that it has exercised a strong influence on public opinion and on the whole in the direction of temperance. A great change of attitude has taken place and is still going on. The ill-effects of excessive drinking, especially of distilled spirits, have long been recognized, but the tendency now is to question whether any alcohol-containing drinks are of any value at all and to deny any valid distinction between distilled and fermented liquors. Medical abstinence societies have been formed in England, Germany, Belgium, Holland, Norway, Sweden and Denmark.

Present State of the Movement.—No comprehensive data are available for estimating the numerical strength of the temperance organizations or the number of abstainers at the present time; but the *Alliance Year Book* contains a directory of societies, which at least give some idea of the wide distribution of the movement. The following summary figures are extracted from the list; they relate to distinct organizations, exclusive of branches and sub-sections, having for their object the promotion of individual abstinence or of legislation: The United Kingdom, 62; Australasia, 11; Canada, 2; South Africa, 3; India, 2; United States, 10; Austria-Hungary, 8; Belgium, 2; Denmark, 5; France, 4; Germany, 12; Holland, 6; Sweden, 6; Switzerland, 11. The figures are no doubt very imperfect and must not be taken in any way to represent the relative strength of temperance organizations in the several countries. The list for the United Kingdom is much more complete than for the other countries. The *Alliance Year Book* indeed gives the names of 130 organizations in the United Kingdom connected in some way with temperance work; but these include local branches, juvenile sections, insurance companies, orphanages and so on. An attempt has been made to pick out the temperance societies as ordinarily understood; but some of those included are merely committees for promoting particular pieces of legislation, and on the other hand bodies like the Salvation Army and the Church Army, which do a great deal of temperance work but are not primarily and principally engaged in it, have been omitted. Altogether the subject is full of confusion and not susceptible of exact statement. The number of societies is no guide to the number of individuals, for many persons belong to several organizations. There can be little doubt that the organized movement is numerically strongest in the United States and next strongest in the United Kingdom, but no reliable estimates can be made.

Some of the British societies call for particular notice. The two principal ones are the Church of England Temperance Society and the United Kingdom Alliance. The latter, founded in 1853, is the chief fighting political organization, having total prohibition of the liquor traffic for its object; its income is about £12,000 a year. The Church of England Temperance Society is much the largest of the British societies. It was founded in 1862 and reconstituted in 1873 on a dual basis of total abstinence and general

Consumption per Head of Population

Countries.	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Wine in Gallons.															
United Kingdom	0·39	0·38	0·37	0·35	0·37	0·40	0·39	0·41	0·41	0·38	0·37	0·36	0·33	0·28	0·27
Russia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Norway	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Denmark	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Germany	0·57	1·01	1·89	1·43	1·06	2·29	1·34	0·77	1·03	1·45	1·14	1·14	1·61	1·74	1·61
France	23·0	21·0	31·0	24·0	18·0	29·0	22·0	22·0	31·0	40·0	34·0	24·0	22·0	40·0	33·9
Belgium	0·90	0·84	0·75	0·86	0·90	1·03	0·86	0·88	0·90	1·01	1·03	1·01	1·08	0·95	1·03
Holland	0·44	0·44	0·44	0·42	0·42	0·42	0·40	0·40	0·40	0·37	0·37	0·37	0·35	0·35	0·40
Switzerland	..	..	..	16·0	14·0	17·0	15·0	14·0	14·0	21·0	15·0	15·0	14·3	9·5	..
Italy	26·0	23·0	21·0	17·0	16·0	19·0	18·0	21·0	20·0	22·0	29·0	27·0	24·6	26·2	18·5
Austria	2·2	2·4	3·5	3·1	3·3	2·9	2·6	3·3	3·3	4·0	4·0	4·0	3·5	4·0	4·2
United States	0·36	0·40	0·27	0·25	0·22	0·44	0·23	0·30	0·32	0·31	0·52	0·40	0·44	0·35	..
Canada	0·11	0·10	0·10	0·09	0·09	0·09	0·09	0·08	0·09	0·09	0·09	0·09	0·09	0·10	0·10
Australia	1·09	1·01	0·95	1·14	1·26	1·42	1·21	1·00	0·74	1·22	1·38	1·11	1·48	1·24	1·27
New Zealand	0·17	0·17	0·17	0·14	0·13	0·14	0·15	0·15	0·15	0·15	0·16	0·16	0·15	0·14	0·13
Beer in Gallons.															
United Kingdom	30·2	29·8	29·6	29·5	29·6	30·8	31·3	31·8	32·6	31·6	30·8	30·3	29·7	28·8	27·7
Russia	0·70	0·70	0·62	0·67	0·84	0·92	0·94	0·89	0·97	0·94	0·92	0·89	1·05	1·03	..
Norway	4·8	4·5	4·6	4·4	3·9	3·6	3·9	4·8	5·1	5·0	4·4	3·9	3·1	2·9	3·0
Sweden	6·8	6·8	7·0	7·3	7·8	9·3	9·9	11·0	12·8	12·4	13·3	12·5	12·9	11·6	..
Denmark	..	17·9	18·5	19·1	19·1	20·2	20·8	20·8	22·0	21·7	21·1	20·8	20·2	20·5	20·5
Germany	23·2	23·7	23·9	23·5	25·5	25·5	27·1	27·3	27·5	27·5	27·3	25·5	25·7	25·7	26·3
France	4·8	5·3	5·3	4·8	5·1	5·3	5·3	5·5	5·7	5·9	8·1	8·1	7·7	8·1	7·5
Belgium	39·2	39·8	40·0	40·3	42·2	43·6	44·4	45·5	46·9	48·2	48·2	47·1	47·7	48·2	48·8
Holland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Switzerland	10·6	11·0	11·4	11·2	12·5	13·9	14·7	15·4	15·4	14·7	13·4	13·6	14·3	14·3	..
Italy	0·18	0·13	0·12	0·10	0·11	0·10	0·11	0·12	0·13	0·14	0·15	0·16	0·17	0·20	0·22
Austria	7·5	8·4	8·8	9·0	9·2	9·9	9·9	9·9	9·9	9·9	9·9	9·5	9·2	9·5	9·0
United States	12·6	13·5	12·8	12·6	13·2	12·4	13·3	12·7	13·3	13·5	14·6	15·0	15·2	15·4	16·8
Canada	3·8	3·6	3·5	3·5	3·4	3·6	3·5	3·9	4·1	4·4	4·7	5·1	4·8	5·0	5·4
Australia	11·7	10·6	9·1	9·0	10·2	11·0	11·4	11·7	11·8	12·6	12·4	12·4	11·8	11·3	11·3
New Zealand	7·8	7·6	7·7	7·4	7·4	7·9	8·2	8·4	8·6	9·1	9·4	9·2	9·5	9·5	9·2
Spirits in Gallons.															
United Kingdom	1·03	1·03	0·98	0·97	1·00	1·02	1·03	1·04	1·09	1·11	1·09	1·05	0·99	0·95	0·91
Russia	0·89	0·89	0·89	0·95	0·92	0·89	0·92	0·92	1·00	0·97	0·92	0·92	1·00	0·95	..
Norway	0·70	0·62	0·68	0·73	0·66	0·44	0·42	0·48	0·62	0·64	0·64	0·64	0·62	0·62	0·51
Sweden	1·28	1·30	1·30	1·34	1·34	1·39	1·45	1·56	1·63	1·67	1·65	1·52	1·43	1·34	1·36
Denmark	2·67	2·79	2·90	2·71	2·79	2·86	2·71	2·60	2·77	2·58	2·69	2·69	2·50	2·44	2·42
Germany	1·67	1·67	1·69	1·69	1·63	1·67	1·63	1·63	1·69	1·67	1·63	1·61	1·54	1·54	1·43
France	1·68	1·74	1·65	1·54	1·55	1·59	1·63	1·79	1·75	1·77	1·33	1·24	1·35	1·50	1·37
Belgium	1·87	1·85	1·83	1·83	1·94	1·63	1·72	1·63	1·63	1·80	1·89	1·61	1·01	1·14	1·10
Holland	1·72	1·72	1·69	1·69	1·65	1·65	1·61	1·58	1·54	1·58	1·56	1·54	1·50	1·50	1·43
Switzerland	1·19	1·21	1·19	1·08	1·08	1·12	1·14	1·17	1·12	1·06	0·92	0·95	0·99	1·01	..
Italy	0·28	0·29	0·21	0·24	0·19	0·21	0·23	0·21	0·22	0·24	0·24	0·24	0·25	0·28	0·29
Austria	1·98	2·20	1·98	1·98	1·98	1·98	1·98	1·98	2·20	1·98	1·98	1·98	1·98	1·98	1·98
United States	1·24	1·27	1·12	0·95	0·84	0·85	0·93	0·98	1·04	1·09	1·13	1·22	1·23	1·21	1·26
Canada	0·74	0·71	0·76	0·76	0·69	0·65	0·75	0·56	0·69	0·71	0·76	0·80	0·83	0·95	0·94
Australia	1·13	0·97	0·68	0·75	0·73	0·82	0·78	0·79	0·83	0·89	0·97	0·84	0·79	0·87	0·96
New Zealand	0·70	0·71	0·70	0·65	0·63	0·64	0·66	0·66	0·69	0·72	0·76	0·75	0·75	0·76	0·73

anti-intemperance. Its objects are (1) the promotion of habits of temperance, (2) the reformation of the intemperate; (3) the removal of the causes which lead to intemperance. Thus it embraces both the moral and the legislative spheres, but the former takes first place; and this was emphasized in 1909 by the inauguration of a "forward movement" in spiritual activity. On the legislative side the society supports measures of reform rather than prohibition, and particularly reduction of licences and popular control of the traffic. Its activity is many-sided; it carries on an extensive publication department and educational courses, police court and prison gate missions, missions to seamen, travelling vans, and inebriate homes, of which there are 4 for women and 1 for men. It works locally through 36 diocesan branches, of which the aggregate expenditure in 1909 was £41,353, exclusive of the central office. It has Church temperance societies in Scotland and Ireland affiliated to it, as are the missions to seamen, and it has given birth to a temperance mission for railway workers and a Church benefit society. Its comparative moderation contrasts strongly with the extreme views of many temperance bodies. One of its departments is a semi-teetotal association, which was founded separately in 1903, but came under the society in 1904; the members pledge themselves to abstain from alcoholic liquor between meals. This department, which revives an old form of pledge, has been very successful; it is found that members frequently go on to take the full pledge. The total membership of the Church of England Temperance Society in 1909 was 636,233, thus distributed:—General section, 35,901; total abstainers, 114,444; juvenile members, 485,888. The enormous number of juvenile members is significant. The numerical strength of the temperance societies in general, which is often greatly exaggerated, seems to be largely made up by the juvenile contingents, so far as information is available. Other noteworthy British societies are the Royal Army Temperance Association and the Royal Naval Temperance Society. The special liability of soldiers and sailors to intemperance makes the work of these bodies particularly valuable, and it is strongly supported by the king and many officers of the greatest distinction. Very striking results have been obtained in the army. Twenty-five per cent of the Home Forces and 42 per cent. of the Indian army belong to the association; and the movement is growing. In the navy 25,000 men have joined the Temperance Society.

Like other propagandist causes of the day the temperance movement is supported by an enormous output of literature, including books, pamphlets, leaflets and periodicals. The *Alliance Year Book* gives a list of the latter. It names over 40 in the United Kingdom; the great majority are penny monthly magazines, but three societies conduct weekly journals—namely, the Church of England Temperance Society (*Temperance Chronicle*), United Kingdom Alliance (*Alliance News*) and the International Order of Good Templars (*Good Templars' Watchword*). Several Nonconformist churches have weekly papers in which temperance work is specially noted, as in the *War Cry*, the journal of the Salvation Army. For other countries the number of journals is given as follows:—Australasia, 10 (one weekly); Canada, 7 (3 weekly); India, 5; South Africa, 2; U.S.A. 15 (2 weekly); Austria, 2; Belgium, 2; Denmark, 1; France, 2; Germany, 8; Holland, 2; Italy, 1; Norway, 2; Russia, 1; Sweden, 7; Switzerland, 3. The list is no doubt imperfect. In the United States newspapers of all kinds are many times more numerous than in the United Kingdom, and the American *Prohibition Year Book* names 21 "leading" prohibition papers, of which 16 are weekly and 1 daily. There are probably hundreds of temperance journals in the United States.

Effect of the Temperance Movement.—The organized agitation against the abuse and even the use of alcoholic liquors thus briefly described is a very interesting feature of social life in the present state of civilization; but when a serious attempt is made to ascertain its results the inquiry is found to be beset with difficulty. It has no doubt been largely instrumental in procuring the varied mass of legislation described in the article on LIQUOR LAWS, particularly in the United States, the United Kingdom and Scandinavia; and these laws are in a sense results. Ardent advocates of legislation, who are always apt to substitute the means for the end, point to them with satisfaction. Those who demand prohibition regard its adoption by this or that community as an end in itself and a proof of "progress"; more moderate reformers view the reduction of public-houses in the same light. Facts of this kind can be stated with precision, but they go a very little way. The real point is not the law or the number of houses, but the habits of the people, and what we want to know is the effect on them of legislation, of organization, moral persuasion and the other influences that go to make up the Temperance Movement. To this question no clear or general answer can be given. There is a good deal of information about the United Kingdom, where the subject has been much more fully studied than anywhere else, and about Norway and Sweden, but for other countries valid data are lacking to show whether intemperance has increased or diminished. The fullest statistical evidence available relates to the consumption of drink.

Consumption of Drink.

International Statistics.—In 1906 a return was published by the British Board of Trade giving the production and consumption of alcoholic beverages in different countries for the years 1891–1905. The table on p. 581 is compiled from it. Information is also given in the returns for Spain, Portugal, the Balkan States and South Africa, but it is very imperfect and has therefore been omitted.

The only considerable movement during the 15 years covered by the table is a marked increase in the consumption of beer. It has occurred in some measure in the following countries:—Russia, Sweden, Denmark, France, Belgium, Switzerland, Italy, Austria, United States, Canada, Australia, New Zealand. The rise is notably large in Sweden, France, Switzerland, United States and Canada; and the upward movement has been particularly steady since 1898 in the United States, Canada and New Zealand. Exceptions are the United Kingdom and Norway, in both of which the consumption has fallen largely and steadily since 1899. In Germany it has also fallen somewhat since 1900, but not so steadily, and over the whole period it has risen in that country. It is impossible to connect these various movements either with legislation or with temperance organization. If the fall in Norway is ascribed to them, it must be pointed out that they are much more directed against spirits than against beer in that country, and the consumption of spirits shows no such movement, having risen since 1897. No one who has studied the subject in the different countries affected can doubt that the general rise is due to the introduction and growing popularity of the light beers originally brewed in Germany and Austria, and commonly called "lager." This is notably the case in France, Belgium, Sweden and North America. It is an instance of the force of popular taste. The increase in beer has not been accompanied by a corresponding reduction of other alcoholic liquor. Wine might be left out of account in this connexion. It is largely consumed only in countries where it is extensively grown, namely, in France, Italy and Switzerland, out of the countries enumerated. The consumption is very irregular and dependent mainly on the abundance of the crop. But the tendency of wine has also been to rise; it has risen in France, Belgium, Italy, Austria, the United States and Australia. With regard to spirits, the only general movement is that consumption has fallen in most European countries since 1900. But this does not appear to be compensatory to the rise of beer, which extends over the whole period and went on when spirits were rising too. Exceptions to the downward movement of spirits since 1900 are offered by the United States and Canada, and to a less extent by Russia, Italy and Norway. The only country in which all classes of drink have steadily fallen is the United Kingdom; this singular fact will be discussed presently, but its peculiarity should be noted here in connexion with other countries.

Attempts have been made to express the total consumption of each country in terms of alcohol by allowing a certain percentage of spirit for wine and beer and reducing all three to a common denominator. The calculation yields a simple and uniform measure of comparison and permits the classification of the countries in the order of their alcoholic consumption; but it must be regarded as a somewhat arbitrary estimate, because the strength of both wine and beer varies considerably. The *Brewers' Almanack* gives the following table based on the returns quoted above:—

Consumption of Alcohol at Proof Strength in Gallons. Annual Average per Head, 1901–5.

	Wine.	Beer.	Spirits.	Total.
France	7·70	0·63	1·36	9·69
Italy	6·27	..	0·26	6·53
Belgium	0·25	3·84	1·35	5·44
Switzerland	3·35	1·11	0·96	5·42
Spain	4·62	..	..	4·62
Portugal	4·27	..	..	4·27
Austria	0·97	1·23	2·06	4·26
Germany	0·36	2·08	1·75	4·19
Denmark	..	1·64	2·54	4·18
United Kingdom	0·08	2·35	0·99	3·42
Hungary	0·97	0·12	1·89	2·98
United States	0·11	1·23	1·21	2·55
Sweden	..	1·00	1·46	2·46
Australia	0·32	0·94	0·88	2·14
Holland	0·09	..	1·50	1·59
New Zealand	..	0·74	0·69	1·43
Canada	..	0·40	0·85	1·25
Russia	..	..	0·95	0·95
Cape	..	0·12	0·75	0·87
Norway	..	0·25	0·60	0·85
Natal	..	0·05	0·37	0·42
Newfoundland	..	0·02	0·34	0·36

Apart from the gaps in the information, which speak for themselves, allowance must be made for other defects. In no case is the nominal consumption per head a valid index to the relative temperateness of different peoples unless other conditions are fairly equal. The distribution of the drinking has to be taken into account, and this is conditioned by the age and sex constitution of the population and by the habits of the people. A country in which every person except infants takes a minute quantity of drink at every meal every day will have a far larger consumption per head and yet may be far more temperate than one in which a large proportion of the population takes none at all and the drinking is concentrated in regard to both time and person. The Portuguese and Spaniards, for instance, are more temperate than any of the nations below them on the list; drunkenness is never seen in Portugal and in the south of Spain (the bishop of Birmingham has publicly borne testimony to the sobriety even of such a large seaport as Barcelona). The aggregate consumption is brought up to a comparatively high level by the national practice of drinking a little wine freely diluted with water, a beverage which contains less alcohol than many "temperance" drinks. In like manner the French and Italians, whose high place is due to wine, are more sober than most of the nations ranged below them. The writer has made extensive inquiries on this head in France. There is drunkenness, to which Zola's *l'Assommoir* bears testimony, but outside Paris and the seaports it is rare. Employers of labour in all the principal industrial centres, including the mining districts of the north, agree on this point. The very high position of Belgium is mainly due to a prodigious consumption of beer, which is explained by the general practice of giving it to children. On the other hand, drunkenness is exceedingly prevalent in Russia, which is near the bottom of the list, and is due to the consumption of vodka. The comparatively small amount per head put down in the returns may, if it is correct, be explained by the very large proportion of children in the population. The opposite condition is illustrated by Western Australia, which has a consumption per head nearly thrice that of any other Australian province. These instances will show the conditions that must be taken into account in making international comparisons and the fallacy of measuring national sobriety by consumption per head.

Consumption in United Kingdom.—Statistics of consumption for a longer period of time than that covered by the table given above are available for the United Kingdom, the United States and Scandinavia, and they are of particular interest because these are the countries in which the Temperance Movement has been most active and productive of most legislation. The United Kingdom is distinguished by being the only country in the list which shows a distinct fall in the consumption of all three kinds of liquor since 1899. To estimate the significance of this interesting fact it must be placed in historical perspective. The following table, compiled from the official returns, gives the annual average consumption per head in decennial periods from 1831 to 1890, and subsequently for each year to 1909. No continuous record of beer was kept until after 1856.

United Kingdom:

Average Annual Consumption per head in Gallons.

Year.	Wine.	Beer.	Spirits.
1831–40	0·26	. .	1·11
1841–50	0·23	. .	0·94
1851–60	0·23	23·5	1·01
1861–70	0·42	27·5	0·94
1871–80	0·51	31·5	1·17
1881–90	0·38	27·7	0·99
1891	0·39	30·1	1·03
1892	0·38	29·7	1·03
1893	0·36	29·5	0·98
1894	0·35	29·4	0·96
1895	0·37	29·6	1·00
1896	0·40	30·8	1·02
1897	0·40	31·4	1·03
1898	0·41	31·9	1·04
1899	0·41	32·7	1·08
1900	0·42	32·2	1·18
1901	0·36	31·4	1·10
1902	0·35	30·6	1·01
1903	0·37	30·2	1·03
1904	0·31	29·5	0·99
1905	0·27	28·4	0·93
1906	0·27	27·9	0·91
1907	0·28	27·8	0·91
1908	0·27	27·6	0·90
1909	0·25	26·4	0·87

It will be observed that the consumption has oscillated up and down during the whole period of 79 years. More spirits were drunk in 1831–40 than in the three following decades, and more wine than in the two following decades. The decennial period of greatest consumption was 1871–80; and the highest points reached were: wine, 0·56 gal. in 1876; beer, 34·0 gals. in 1874; spirits, 1·29 gals. in 1875. Since then the consumption has always been lower, though with fluctuations. The up and down movement is always associated with the state of trade, and the connexion is well marked in the last ten years. The progressive fall is striking, particularly in regard to beer, which is the staple drink of the people; but the period is too short to warrant the inference that it represents a permanent movement which will continue. The fluctuations shown by the decennial table given above suggest the probability of a subsequent rise with a revival of trade. Chronic depression and unemployment have prevailed in many industries since 1900, and these conditions always cause a diminished consumption. Nevertheless they do not fully account for the movement here shown, because the fall in consumption has been progressive, whereas the state of trade has fluctuated considerably; the curves do not coincide. Some other factor has been at work, and there is reason to think that it is a gradual change in the habits of the people. The facts of consumption agree with much other evidence in pointing to this conclusion. The expenditure in drink is not so high as it used to be in the past, whether periods of prosperity or adversity are taken. The calculation of annual expenditure prepared for the United Kingdom Alliance, and commonly called the National Drink Bill, points to that conclusion. It is based on an arbitrary estimate of the cost of drink to the consumer and must not be taken to represent established facts; but it has some comparative value. The following table gives this calculation for the last 26 years:—

National Drink Bill, United Kingdom.

Year.	Total Expenditure.	Expenditure per head.	Year.	Total Expenditure	Expenditure per head.
	£	£ s. d.		£	£ s. d.
1884	144,734,214	4 1 0¼	1897	174,365,372	4 7 6¾
1885	141,039,141	3 18 3¾	1898	176,967,349	4 8 0¾
1886	140,550,126	3 17 4¾	1899	185,927,227	4 11 8
1887	142,784,438	3 18 0¼	1900	184 881,196	4 10 4¼
1888	142,426,153	3 17 2¾	1901	181,788,245	4 7 8¼
1899	151,064,035	4 1 3¼	1902	179,499,817	4 5 6¾
1890	159,542,700	4 5 1½	1903	174,445,271	4 2 4
1891	161,765,291	4 5 7¼	1904	168,987,165	3 18 11¾
1892	161,527,717	4 4 9¼	1905	164,167,941	3 15 11½
1893	159,020,709	4 2 8¾	1906	166,425,911	3 16 3
1894	158,932,134	4 1 11½	1907	167,016,200	3 15 9
1895	163,133,935	4 3 4½	1908	161,060,482	3 12 3¾
1896	170,426,467	4 6 4½	1909	155,162,485	3 8 11½

The table begins and ends in two periods of marked depression, with one of marked prosperity in between; but it is to be noted that in the earlier term of depression, although it was very acute, the expenditure never sank so low as in the later one. During the four lowest years (1885–88) the mean expenditure was nearly 4s. a head more than in the five lowest years (1905–9). At the other end of the scale the high-water mark in the table, which is the year 1899, shows an expenditure of £4, 11s. 8d.; but the previous high-water mark comparable with it, namely 1876, showed an expenditure of £5, 1s. 9d., when calculated on the same basis. The figures, therefore, rather confirm than contradict the general belief that the people have grown more temperate during the last 30 or 40 years. With regard to the expression "national drink bill," which tacitly suggests so much money thrown away on drink, it must be remembered that a large proportion is devoted to public purposes and would have to be found in some other way. In the year ending March 1909 the trade paid a direct contribution of £37,404,575 to the national exchequer in excise and customs duties, in addition to income-tax and local taxation; all this comes back to the public pocket. Then it also maintains directly and indirectly a population reckoned at 2,000,000. The net amount spent on drink which might have been saved and spent on other things is not more than a third of the total sum.

The United States.—The movement in the United States has been totally different. The figures below are taken from the statistical abstract of the U.S. government as quoted in the *American Prohibition Year Book.* The figures, it may be noticed, differ widely throughout from those given for the same years in the Board of Trade returns of international consumption quoted on p. 581. The discrepancy is too great and too constant to admit of any explanation, but that the two sets of returns are calculated from different bases. It illustrates the defects of these statistics and the need of caution in using them. The American figures show a far larger consumption in the United States than the English.

The most noticeable fact here shown is the continuous and large increase in the consumption of beer. Every year shows a rise down to 1908, when for the first time in 70 years a fall was recorded. It was continued in 1909, and being accompanied by a fall in spirits and wine also is no doubt mainly attributable to the financial state of the country. Down to 1880 beer was to a considerable extent taking the place of spirits, the consumption of which had previously been very high; but after that the steady increase in beer was not accompanied by a reverse movement in spirits; and from 1896 to 1907 all three kinds of liquor rose together, though not with equal steadiness. The rising consumption of beer has been accompanied by an enormous increase in home production, the capital invested in breweries having risen from 4 million dollars in 1850 to 515 million dollars in 1905. The consumption of spirits is at a much higher level than in the United Kingdom, and two considerations add greatly to the significance of the fact—one is that drinking takes place more between meals and less at them, and the other that it is more confined to men. Women, other than prostitutes,

Consumption per head in Gallons, United States.

Year ending June 30.	Spirits.	Wine.	Malt.	Total.
1840	2·52	0·29	1·36	4·17
1850	2·23	0·27	1·58	4·08
1860	2·86	0·35	3·22	6·43
1870	2·07	0·32	5·31	7·70
1880	1·27	0·56	8·26	10·08
1882	1·40	0·49	10·03	11·92
1884	1·48	0·37	10·74	12·60
1886	1·28	0·45	11·20	12·92
1888	1·26	0·61	12·80	14·67
1890	1·40	0·46	13·66	15·53
1892	1·49	0·43	15·17	17·10
1894	1·34	0·32	15·32	16·96
1896	1·01	0·27	15·84	17·12
1898	1·12	0·28	15·96	17·36
1900	1·28	0·39	16·01	17·68
1901	1·33	0·37	16·20	17·90
1902	1·36	0·63	17·49	19·48
1903	1·46	0·48	18·04	19·98
1904	1·48	0·53	18·28	20·35
1905	1·45	0·42	18·50	20·38
1906	1·52	0·55	20·19	22·26
1907	1·63	0·67	21·24	23·53
1908	1·44	0·60	20·98	23·02
1909	1·37	..	19·79	..

do not frequent the bar as they do in the United Kingdom, and children not at all. The expenditure in drink, so far as it can be calculated, has fluctuated somewhat, but shows a general tendency to rise. The following table has been prepared by Mr G. B. Waldron, an American statistician. It is taken from the *Prohibition Year Book*, with the American currency converted into English on the basis of 4s. to the dollar, omitting fractions of a penny, for purposes of comparison with the British statistics given above.

Annual Drink Bill, United States.

Year.	Total Expenditure.	Expenditure per head.			Year.	Total Expenditure.	Expenditure per head.		
	£	£	s.	d.		£	£	s.	d.
1878	90,655,754	1	18	1	1898	208,312,573	2	17	1
1888	163,617,545	2	14	7	1899	214,137,995	2	17	8
1889	168,176,169	2	14	11	1900	234,445,322	3	1	5
1890	180,529,173	2	17	8	1901	243,999,598	3	2	10
1891	195,916,560	3	1	4	1902	269,556,728	3	8	3
1892	202,978,872	3	2	4	1903	282,122,043	3	10	2
1893	215,896,634	3	5	1	1904	292,735,706	3	11	7
1894	204,924,298	3	0	7	1905	293,180,332	3	10	6
1895	194,189,466	2	16	4	1906	321,604,383	3	16	4
1896	192,418,995	2	14	9	1907	351,461,570	4	1	11
1897	198,640,711	2	15	6	1908	335,167,639	3	16	11

Comparison with the British table shows at a glance an opposite movement in the two countries. While expenditure has steadily fallen in the United Kingdom since 1899, it has as steadily risen in the United States; and whereas in 1888 the expenditure in the former was 41 per cent. higher than in the latter, the two had drawn equal in 1906 and since then have changed places. Moreover the different system of taxation brings back a much larger proportion of the whole expenditure into the exchequer in the United Kingdom (see LIQUOR LAWS). The comparison is of much interest in view of the very different laws and regulations under which the trade is conducted in the two countries. It may be objected that the statistics are merely estimates, but both sets are put forward by the advocates of prohibition and are of equal authority, so that they hold good for comparison.

Norway and Sweden.—The statistics for these countries are imperfect, because there is no record of wine, and in recent years the use of spirits has been supplemented or replaced to a considerable extent by artificial wines heavily loaded with spirits. But, as they stand, the statistics derive special interest from the peculiar conditions under which the traffic is conducted. The Scandinavian company system was started in Sweden in 1865 and in Norway in 1871 (see LIQUOR LAWS).

Consumption per head in Litres, Norway.

Year.	Bränvin.	Beer.
1851–60	5·9	..
1861–70	4·6	..
1871–80	5·2	18·2
1881–90	3·2	16·0
1891	3·7	21·7
1892	3·2	20·6
1893	3·5	20·8
1894	3·8	19·8
1895	3·5	17·7
1896	2·3	16·2
1897	2·2	17·8
1898	2·6	21·6
1899	3·3	23·2
1900	3·4	22·7
1901	3·4	20·0
1902	3·4	17·8
1903	3·2	14·1
1904	3·3	13·1
1905	2·7	13·7

Consumption per head in Litres, Sweden.

Year.	Bränvin.	Beer.
1856–60	9·5	..
1861–70	9·7	10·9
1871–80	10·9	16·1
1881–90	7·5	21·9
1891	6·4	30·9
1892	6·5	30·8
1893	6·7	31·6
1894	6·9	33·0
1895	6·9	35·5
1896	7·2	42·4
1897	7·5	45·0
1898	8·0	50·0
1899	8·3	58·1
1900	8·5	56·4
1901	8·4	60·4
1902	7·8	56·6
1903	7·4	58·7
1904	6·9	52·8
1905	7·0	..

The difference between these contiguous countries is remarkable. The consumption of spirits has always been much higher in Sweden than in Norway. In the old days before any legislation the estimated consumption was in Sweden 46 litres (1829) and in Norway 16 litres (1833) a head. In recent years, under the company system, the figures for both countries are vastly less, but the Swedish consumption has hardly ever been less than double the Norwegian and sometimes three times as great. This difference, observed over a long period before regulation and after, points to different conditions and national habits; but such constant differentiating factors hardly explain the strikingly dissimilar movements shown by the tables. Both countries are obviously affected by the state of trade. The high-water mark of spirit-drinking in modern times for both was the same period, 1874–76, as noted above for the United Kingdom; Sweden then averaged 12·4 litres a head and Norway 6·6. Both show also the influence of the 1900 boom in trade and the subsequent decline. But in Sweden the increase of beer-drinking, which in 1871–80 was less than in Norway, has been enormous. If the two drinks are put together it cannot be said that the consumption in Sweden was appreciably less in 1896–1905 than in 1871–80, whereas in Norway it was distinctly less. This may in part be explained by the substitution of the made wine, called laddevin, to which reference has already been made. The marked fall in the consumption of spirits which occurred in 1896–98 is attributed to this cause (Rowntree and Sherwell); the importation of wine rose from 2,320,300 litres in 1891–94 to 5,876,750 litres in 1898. Subsequently importation was checked by heavier duties and reduced consumption followed. In 1886–90 the quantity consumed per head in litres averaged 0·88; in 1896–1900 it was 2·49, with a maximum of 2·75 in 1898; in 1905 it had fallen again to 0·88 (Pratt).

A careful study of the foregoing statistics of consumption in the three countries—United Kingdom, United States and the Scandinavian peninsula—which have paid most attention to the problem and have for a long period applied forcible but widely different methods of control, does not permit any confident conclusion upon the comparative merits of any particular system. The United States, in whose multitudinous liquor laws prohibition plays the most prominent part, has most conspicuously failed to check consumption. Norway and Sweden, both of which combine the principle of disinterested management, though not in the same form, with a certain amount of prohibition, show markedly different results. The British licensing system has been at least as successful as any of the others. The most probable conclusion to be drawn from the facts is that the movement in each country has been mainly determined by other forces; the rise of consumption in the United States by the rapid and progressive urbanization of the people and the great increase of wealth; the diminution of consumption in the United Kingdom by a change in the habits of the people due to many causes, to which further reference is made below; while the difference between Norway and Sweden is largely due to differences of national character and habits already noted, though some influence must be attributed to the superior system and greater stringency of control in Norway. But if we go back to earlier periods there is no doubt at all that an incomparably worse state of things existed in the United Kingdom and in Scandinavia when the spirit traffic was under little control or none at all.

Intemperance.—Police statistics are the best evidence we have of the prevalence of drunkenness, which is the most visible and direct result of intemperance. Like other statistics, they must be used with due regard to the circumstances of origin and compilation. They vary according to (1) the laws relating to drunkenness; (2) the administration by police and justices; (3) the method of compiling returns. All these vary in different countries and towns and at different times, so that the statistics must not be used for minute comparisons. But properly handled they are of great value, and the discrepancies are less than might be supposed, because it is found on inquiry that the actual behaviour of the police towards drunken persons does not greatly differ. Neither exceptional zeal nor exceptional laxity lasts very long. The general practice is only to interfere with those persons whose violence causes disturbance or whose helplessness creates obstruction or annoyance. The mode of compiling returns is the most serious cause of error. Many countries have no returns, and in others they are incomplete. Those available, however, throw considerable light on the subject. The following quinquennial table shows the movement in England and Wales since the drunken period 1874–78. The important act of 1872, which increased the number of offences, vitiates comparison with the earliest returns, which are, however, given in the article on DRUNKENNESS.

Drunkenness, England and Wales.

Number of Persons proceeded against per 10,000.

1874–78	81·2	1894–98	60·4
1879–83	69·7	1899–1903	65·5
1884–88	63·6	1904–08	62·4
1889–93	61·4		

There has been a marked improvement since 1874–78, and on the whole a progressive one, though interrupted by a moderate rise in the period of prosperity about 1900. The figures for the most recent years would be considerably lower but for the Licensing Act of 1902, which altered the police procedure and caused a sudden rise, as shown by the following table, for the last 10 years:—

1900	63·4	1905	64·2
1901	64·5	1906	61·3
1902	63·6	1907	60·1
1903	69·0	1908	59·3
1904	67·4	1909	53·2

When allowance is made for the act of 1902 it is seen that the movement of drunkenness corresponds broadly with that of consumption, but the decline of drunkenness is more marked; the level is lower than it used to be whether good or bad times be taken. This plainly shows a large change in the habits of the people, which is further emphasized by the fact that police procedure has become more stringent and the returns more complete. The exceptional figure for 1909 (estimated) is ascribed to the heavy increase of spirit duties in that year. The change has been accompanied by a continuous fall in the number of public-houses in proportion to population. Between 1870 and 1909 the number of "on" licences was reduced from 53·3 to 26·3 per 10,000 of the population; but the correspondence between the two movements is not exact. The number of public-houses has fallen steadily from year to year, whereas drunkenness, like consumption, has fluctuated with the state of trade. The facts, therefore, demonstrate a connexion, but hardly establish one of cause and effect. The principal causes which have brought about the general decline of drunkenness are wider and deeper. The standard of behaviour has gradually changed with education and the provision of alternative recreations in many forms, among which the chief are games, theatres, locomotion, public libraries, institutes, tea shops and eating houses. At the same time great social changes have taken effect and have tended to remove class barriers and foster the aspirations of the working classes, who have more and more adopted the standard of conduct prevalent among the more highly educated sections of society. The old drinking habits of the latter, which were notorious at the end of the 18th century, began to give way to greater sobriety early in the 19th century; and the movement was greatly promoted, as a feature of social life, by the influence of Queen Victoria's reign. Drunkenness went "out of fashion," and the social standard has gradually permeated downwards. All this has no doubt been stimulated by temperance organization and teaching, which has constantly kept the question before the public and exercised an educational influence in spite of ridicule and abuse. The change has been very gradual, but far greater than can be shown in figures. It can be better realized by contrasting the present state of things with that described in the past, as in the evidence given before a select committee of the House of Commons in 1834, when witnesses described the scenes that regularly occurred on Sunday morning in London—the crowd round the public-houses, women with babies to which they gave gin, and people lying dead drunk in the streets. The evidence given at this inquiry and by contemporary writers reveals a condition of things to which modern times afford no parallel; and in particular it disposes of the current belief that female drunkenness is a comparatively new thing and increasing. The practice of frequenting public-houses and drinking to excess in England has been noted for centuries and repeatedly denounced. It was described at a meeting of the Middlesex magistrates in 1830, when the chairman said that of 72 cases of drunkenness brought up at Bow Street on the previous Monday the majority were women "who had been picked up in the streets where they had fallen dead drunk." At the inquiry of 1834 Mr Mark Moore gave the number of customers counted entering 14 public-houses in a week; out of a total of 269,437 there were 108,593 women and 18,391 children. Of late years the proportion of female drunkards to the whole has been perceptibly diminishing. In 1870 the proportion of females to the total number proceeded against for drunkenness was 25·9 per cent.; in 1890 it was 23·4 per cent. The percentage of convictions credited to women in the last few years is: 1905, 20·42; 1906, 20·60; 1907, 20·26; 1908, 20·13; 1909, 19·79.

The foregoing observations on drunkenness apply only to England and Wales. The returns for Scotland and Ireland are less complete, but they show the movement in those parts of the kingdom. In Ireland a diminution has taken place in recent years, but in Scotland an increase.

Number of Charges of Drunkenness.

Year.	Scotland.	Ireland.
1890	36,293	100,202
1900	43,943	97,457
1901	..	88,295
1902	..	91,276
1903	36,930	85,502
1904	41,852	81,775
1905	43,518	79,968
1906	55,408	77,262
1907	58,900	76,860
1908	55,104	..

It is worthy of note that police drunkenness is higher in Wales, Scotland and Ireland than in England. The respective number of proceedings per 10,000 in the year 1907 was: England, 59·8; Wales, 65·2; Scotland, 123·3; Ireland, 175·6. The figures for Wales are strictly comparable, those for Scotland and Ireland less so; but the coincidence is striking. The greater prevalence of spirit drinking as a national habit, particularly in Scotland and Ireland, may account in part for the discrepancy. Other points which distinguish the three countries from England are their Celtic blood and Sunday closing. No connexion can be shown between the number of licensed houses and the prevalence of drunkenness; they are fewer in Scotland than in England and Wales, but more numerous in Ireland, though there has been a diminution there since 1902, which may have something to do with the fall of drunkenness. The same lack of correspondence is shown more fully by the detailed figures for England and Wales published in the official volume of licensing statistics. Taking the county boroughs in groups according to the number of licences in proportion to the population we get the following:—

Licences and Drunkenness, County Boroughs, 1905.

Licences per 10,000	under 20	20 to 30	30 to 40	40 to 50	over 60
Convictions per 10,000	71·05	55·89	62·4	36·6	35·27

The corresponding figures for the counties are as follows:—

Licences and Drunkenness, Counties, 1905.

Licences per 10,000	under 30	30 to 40	40 to 50	over 50
Convictions per 10,000	57·39	36·74	40·0	33·2

If any other year be taken similar discrepancies are shown. In 1909 the six counties with the highest and the six with the lowest number of licences exclusive of county boroughs, gave the following results:—

County.	Licences per 10,000.	Convictions per 10,000.	County.	Licences per 10,000.	Convictions per 10,000.
Huntingdon	91·51	20·60	Middlesex	11·84	33·32
Cambridge	74·04	11·18	Northumberland	19·09	133·12
Oxford	63·68	9·56	Essex	19·13	16·95
Brecon	63·28	54·34	Glamorgan	20·56	75·34
Rutland	61·79	14·14	Lancaster	21·43	38·45
Buckingham	59·72	15·76	Durham	21·67	80·49
Mean	69·00	20·93	Mean	18·95	62·94

It is curious that the mean figures for these two groups at opposite ends of the scale almost exactly reverse the number of licences and convictions; but the individual discrepancies show that other factors really determine the results. The chief of these is unquestionably occupation. All the counties with the highest number of convictions are pre-eminently mining counties. Year after year Northumberland, Durham and Glamorgan occupy the same place at the head of the convictions, and other mining counties are always high up. These areas are not drunken because the public-houses are few, but vice versa; the licences are kept down because of the drunkenness. The influence of occupation and character is further revealed by a broader survey. The following table from the judicial statistics for 1894 brings out these elements very clearly:—

Persons Proceeded Against for Drunkenness per 10,000.

Seaports	126·07
Mining counties	113·67
Metropolis	63·74
Manufacturing towns	47·00
Pleasure towns	28·93
Agricultural counties—	
(1) Home counties	24·50
(2) South-Western	20·94
(3) Eastern	10·99

In other countries the same distribution is observed; drunkenness is most prevalent in seaports and mining districts. It is further fostered by a northerly situation, and these three factors go far to explain the condition of Scotland, as of Northumberland and Durham.

The United States.—The Census Bureau at Washington issues from time to time statistics of cities, which contain a good deal of information concerning drunkenness. The last return, published in 1910, contains details of 158 cities having a population of over 30,000 in the year 1907, to which the statistics relate. It appears from these returns that drunkenness is exceedingly prevalent in American towns. The figures are not comparable with the English ones, because they relate to arrests, which are more numerous than "proceedings" and still more than convictions. The number of women included is very considerable, but the data are too imperfect to permit the calculation of a general percentage. In New York the proportion of women arrested for drunkenness and disorder was 24·3 per cent. of the whole number. The cities are divided into four groups according to population:—(1) over 300,000, (2) 100,000 to 300,000, (3) 50,000 to 100,000, (4) 30,000 to 50,000. The average number of arrests per 10,000 inhabitants in each group and in all cities together is—(1) 191·0, (2) 193·6, (3) 245·8, (4) 244·8; mean of all cities, 205·1. The comparatively small range of difference between the groups is remarkable, and indicates a general prevalence of police drunkenness. The higher figures for groups (3) and (4) are explained by the excessive number of cases in certain manufacturing, mining and Southern coloured towns of small and medium size. These figures are for drunkenness alone, so that they cannot be confused with other offences; but on examining the details of individual cities it becomes clear that the practice varies considerably in making up the returns, and that in some places nearly all the arrests of drunken persons are charged to drunkenness whereas in others a large proportion are returned under the head of disorderly conduct. In considering the relation between drunkenness and the number of licensed houses, therefore, it seems desirable to put both sets of figures, as in the following table. It will be seen that there is no correspondence between the number of licensed houses and the amount of drunkenness alone or of drunkenness and disorderly conduct together, except that the fourth group has the largest number of licences and the most disorder.

Arrests and Licences per 10,000.

Cities.	Arrests, Drunkenness.	Arrests, Disorderly Conduct.	Retail Liquor Dealers.
Group 1 Over 300,000	191·0	108·8	30·3
Group 2 100,000 to 300,000	193·6	112·8	27·7
Group 3 50,000 to 100,000	245·8	78·7	28·4
Group 4 30,000 to 50,000	244·8	121·4	31·5
Mean	205·1	106·8	29·6

There are large discrepancies between different cities, but not greater than among British towns. The following table gives the figures corresponding to the above for each of the great cities included in group 1, with the exception of San Francisco, the population of which could not be estimated:—

Arrests and Licences per 10,000.

Cities.	Arrests, Drunkenness.	Arrests, Disorderly Conduct.	Retail Liquor Dealers.
New York	105·9	120·2	25·5
Chicago	169·1	5·3	34·2
Philadelphia	287·5	81·0	13·1
St Louis	106·3	173·7	33·5
Boston	614·9	16·9	13·5
Baltimore	75·1	302·5	41·3
Pittsburg	331·4	236·9	15·3
Cleveland	355·2	34·9	40·4
Buffalo	318·9	153·3	38·4
Detroit	87·2	82·5	46·9
Cincinnati	82·4	66·4	44·8
Milwaukee	100·5	53·1	70·4
New Orleans	239·5	220·7	50·0
Washington	130·6	338·4	16·6

To a certain extent the same inverse relation appears here as in England; the places with the smallest proportion of licences—namely, Philadelphia, Boston, Pittsburg and Washington—are conspicuous for drunkenness and disorder, while those with the largest proportion of licences—namely, Detroit, Cincinnati, Milwaukee and New Orleans—are distinguished by the lowest amount, with the exception of New Orleans, which is a special case by reason of the large coloured and Creole population. The exceptional position of Boston is obviously due to exceptional police activity and that of Chicago to the opposite. At Boston and Cleveland, it will be noticed, the police prefer the charge of drunkenness; at Baltimore the opposite. The position of Washington is explained by the very large coloured population and the strength of the police force, which is greater in the capital than elsewhere and very strict in regard to order in the streets. Philadelphia, Pittsburg and Cleveland are great manufacturing centres with a large population of foreign workmen; the vast influx of European immigrants, consisting of men disposed to drink by age, occupation, race and habits, and receiving higher wages than they have been used to, must always be borne in mind with regard to drunkenness in the United States. It is interesting to note the condition of those cities in which there is no licensed trade. There are none such in the first two groups, but 14 in the third and fourth groups. The following are the figures:—

Arrests for Drunkenness and Disorder per 10,000.

Group 3		Group 4	
Cambridge (Mass.)	218·5	Topeka (Kansas)	227·1
Kansas City (Kansas)	178·0	Malden (Mass.)	100·8
Somerville (Mass.)	130·5	Chelsea (Mass.)	336·0
Charleston (S. Carolina)	342·7	Salem (Mass.)	329·0
Portland (Maine)	605	Newton (Mass.)	168·1
Brockton (Mass.)	240·9	Wichita (Kansas)	392·7
		Fitchburg (Mass.)	161·5
		Everett (Mass.)	99·6

The majority are prohibition cities in Massachusetts, the only state in which this measure was applied to any place of considerable size in 1907. In all of them the drunkenness is below the mean for the group and considerably below that of similar and neighbouring towns. For instance, Brockton is a boot-manufacturing town, comparable with Lynn in the same state; the respective figures are 240·9 and 561·1. The evidence here, so far as it goes, is in favour of local prohibition. On the other hand there are a number of licensed cities with lower figures, and two of those on the list—Chelsea and Salem—are very high up. State prohibition does not make such a good showing. Portland is one of the most drunken places in America—a fact confirmed by many observers—and Wichita in Kansas is above the mean. Kansas City is better. This place is peculiarly situated, being continuous with Kansas City in Missouri; the boundary between the two states passes through the town. Consequently the inhabitants have only to go into the Missouri half to obtain drink. Cambridge is very similarly situated in relation to Boston. Charleston, which is above the mean for the group, was under the state dispensary system. In sum, these police figures furnish some argument for prohibition and some against; but they clearly demonstrate the limits of compulsion. Altogether the statistical evidence from the United States, whether of consumption, expenditure or drunkenness, offers no inducement to the United Kingdom to adopt any of the American methods of control in place of its own system.

Norway and Sweden.—Police statistics for some of the principal towns in Norway and Sweden, which are the seats of the company system or disinterested management applied to spirit bars, are frequently quoted and we will therefore give them here. When all allowances have been made they show that drunkenness is very prevalent in these seaport towns, and that it fluctuates as in England but exhibits no general tendency to improvement.

Convictions per 1000 *in Gothenburg.*

1865	46	1886	31
1866	30	1887	32
1867	29	1888	31
1868	26	1889	34
1869	28	1890	40
1870	26	1891	44
1871	28	1892	42
1872	28	1893	38
1873	32	1894	34
1874	38	1895	31
1875	42	1896	35
1876	39	1897	44
1877	40	1898	54
1878	32	1899	54
1879	31	1900	51
1880	31	1901	42
1881	32	1902	45
1882	29	1903	47
1883	30	1904	45
1884	29	1905	52
1885	29		

The principal feature of this table is the much higher level in the second 20 years than in the first, though the police procedure has been the same. Several times in recent years the figure has exceeded that of 1865, which was practically the year before the company system was introduced, as it did not begin operations until October. Once more the influence of trade oscillations is well marked, particularly in the prosperous period of 1897–1900. To convert convictions into arrests for comparison with the following tables about 3 per 1000 should be added; this difference is very evenly maintained in Gothenburg.

Arrests per 1000 *in Bergen.*

1877	26	1892	12
1878	21	1893	14
1879	19	1894	16
1880	21	1895	22
1881	17	1896	29
1882	13	1897	27
1883	18	1898	27
1884	15	1899	26
1885	17	1900	31
1886	14	1901	29
1887	13	1902	27
1888	14	1903	24
1889	14	1904	20
1890	21	1905	23
1891	19		

Arrests per 1000 *in Christiania.*

1890	70	1898	94
1891	77	1899	101
1892	74	1900	90
1893	80	1901	75
1894	75	1902	59
1895	77	1903	58
1896	105	1904	52
1897	111	1905	43

Use and Abuse of Alcohol.

The evils caused by the abuse of alcoholic liquors have always been recognized by mankind; they are too obvious to be ignored. Intoxication produces imbecility, bestiality, violence and crime; continued excess produces incapacity, poverty, misery, disease, delirium, insanity and death. But all these effects are produced by other causes and it is very difficult to estimate the precise share of this particular agent. In modern times scientific investigation has attempted to do this and to give precision to the conclusions drawn from ordinary observation. We will briefly summarize some of the results.

Crime.—Drink is associated with crimes against the person, but not with crimes against property, which form in England nine-tenths of the whole (Judicial Statistics, 1901). Dr W. C. Sullivan, medical officer in the prison service, calculates that "alcoholic intoxication is answerable for about 60 per cent. of indictable crimes of violence and for a rather higher proportion of minor offences of the same class"; and further that "it is probably the cause of nearly half the crimes of lust," but it "makes no appreciable contribution to crimes of acquisitiveness." He gives the following table:—

Annual Average per 100,000—1891–1900.

Areas.	Drunkenness.	Homicides and Assaults.	Attempted Suicide.
Agricultural	226·3	116·33	3·46
Mining	1091·2	237·34	2·43
Manufacturing	479·8	265·73	6·42
Seaports	990·6	409·73	10·56

This does not show a regular connexion. The mining areas, which have the most drunkenness, are only second in violence and lowest of all in suicide. Dr Sullivan explains this discrepancy by the theory that chronic alcoholism is less prevalent among miners, and that this form is chiefly responsible for the crimes in question. It is impossible, however, to establish any constant relation between drink and violent crime; the two do not vary together. It was pointed out in the Judicial Statistics for 1901 that whereas in the drunken year 1899 consumption of drink was 8 per cent. higher and the police records of prosecutions for drunkenness 15 per cent. higher than in the previous quinquennial period, crimes of violence were 1·62 per cent. lower. These statistics apply only to England. When other countries are taken it becomes still clearer that other factors are more important. Mr W. D. Morrison gives the following table of homicides in proportion to population in different countries (*Crime and its Causes*):—

Persons Tried for Homicide per 100,000.

Italy	15·40	France	2·73
Spain	11·91	Scotland	2·11
Austria	4·01	Germany	1·61
Ireland	3·35	England	1·60
Belgium	3·02	Holland	1·10

Except that England, Scotland and Ireland are in the order of relative drunkenness, the table shows no correspondence between drink and homicide. National character and climate are evidently more important determining factors. Some calculations of the proportion of crime associated with drink have been made in different countries. In Germany 36·5 per cent. of the prisoners in one gaol were found to be drunkards (Baer); assaults, 51·3 per cent.; resistance to the police, 70·1 per cent.; offences against morality, 66 per cent. (Aschaffenburg). In Italy 50, 60, and 75 per cent. of crimes against the person have been attributed to drink. In Switzerland 40 per cent. of male criminals in 1892 were found to have been under the influence of drink when their offences were committed. In Denmark 43 per cent. of the men convicted in 1903 were drunkards. These estimates, some of which are official, suffice to confirm the connexion between drink and a great deal of crime, but the basis of investigation is too narrow to permit more than a general conclusion. There is, however, one form of crime for which drink is almost wholly responsible, and this furnishes the blackest of all indictments against it. The intensity of suffering and injury inflicted on children by the atrocious cruelty and neglect of drunken parents cannot be overstated. The Society for the Prevention of Cruelty to Children finds that 90 per cent. of the cases which come under its notice are due to drink.

Poverty.—Much poverty is undoubtedly caused by drink, but it is even less possible to establish any constant connexion between the two than in the case of crime. Pauperism and drink stand to a great extent in inverse relation; in good times the first diminishes and the second increases, in bad times the reverse takes place. For instance, pauperism in England, which has had a general tendency to fall for many years, rose rapidly in the period of low consumption after 1860, fell still more rapidly in the great drinking years 1870–77, and rose again when they gave place to depression. With falling consumption after 1891 (see the table above) it rose till 1894, when the opposite movement began; and during the steady fall of drink since 1900 pauperism has been rising again. The only exception to this regular inverse movement is the very depressed period 1884–1888, when pauperism was stationary. The conclusion to be drawn is that while drink is a chief cause of poverty in many cases and the sole cause in some, it is swamped in the aggregate by the larger influence of work and wages. Mr Charles Booth's statistical investigation in East London resulted in the following estimates of the percentage of poverty caused by drink: "great poverty" (the two lowest classes)—drink, 9 per cent., drunken or thriftless wife, 5 per cent.; "poverty" (the two next classes) the figures were—drink, 7 per cent., drunken or thriftless wife, 6 per cent. These results can hardly be said to confirm the opinion that drink is the chief cause of poverty; they rather agree with the conclusions drawn from the movement of pauperism. Mr Rowntree's investigation of poverty in York did not enable him to make any numerical estimate; drink was not among the chief causes of "primary" poverty (the lowest class), but he thought it the "predominant factor" in producing "secondary" poverty. Alderman McDougall's inquiry in Manchester (1883) resulted in the following proportions of drink-pauperism:—Male drunkenness, 24·32 per cent.; female, 4·40 per cent.; widows and children of drunkards, 21·84 per cent. An inquiry conducted in 1894–95 by the Massachusetts Bureau of Statistics of Labour found that 39·44 per cent. of paupers attributed their position to their own intemperance and about 5 per cent. to that of their parents. All these inquiries are on a very small basis, and the last is particularly deceptive. Drink is commonly confessed by criminals and paupers, as a venial offence to serve as a plausible excuse for a condition really due to dislike of work. When poverty is examined by local distribution it is found to have very little connexion with drink. In 1901 the average proportion of pauperism to population in England was 5·3 per cent. The exceptionally drunken districts of Northumberland and Durham were all below it, the sober eastern counties all above it (Blue-book on Public Health and Social Conditions, Col. 4671).

Insanity.—Dr Robert Jones finds that 16 per cent. of all the persons (7182 out of 43,694) admitted into the London asylums during the twelve years 1893–1905 "were definitely ascertained to owe their insanity to drink or intemperance." The proportion in Claybury Asylum during the same period was 17 per cent., being 22 per cent. of the men and 12 per cent. of the women. Dr R. H. Crowley says:—"One may safely assert that from 20 to 25 per cent. of all cases of insanity under the poor law are directly due to intemperance." Dr T. B. Hyslop says:—"With regard to insanity there is some difference in experience as to the relative frequency of alcohol in its causation. This difference ranges from between 10 and 30 per cent. . . . My own experience leads me to believe that alcohol is either a direct or an indirect factor in the causation of at least 50 per cent. of the cases of insanity." Dr T. S. Clouston estimates that alcoholic excess is the cause of about 20 per cent. of all the insanity in Great Britain and Ireland. These are the opinions of experienced medical men in charge of the insane. On the other hand, those in charge of inebriates are inclined to attribute inebriety to a great extent to mental deficiency of some kind. Dr Branthwaite, government inspector under the Inebriates Acts, observes in his Report for 1908, published in 1910, "There is no doubt whatever in detaining and treating persons sent to us under the Inebriates Acts that we are dealing to a large extent with a class known as 'feeble-minded.' . . . It would be difficult to find many more than about a third of all persons under detention capable of passing muster as of average mental capacity." In support of this statement he gives the following classification of 3032 cases:—

Classification.	Number.	Percentage.
(1) Insane; persons since admission certified and sent to asylums	63	14·51
(2) Very defective; persons more or less congenitally imbecile, degenerate, or epileptic	377	
(3) Defective; eccentric, silly, dull, senile, or subject to periodical paroxysms of ungovernable temper	1487	49·04
(4) Of average mental capacity, on admission or after six months' detention	1105	36·45

Insanity is therefore a cause as well as a consequence of excessive drinking, and the estimates given about it must be qualified accordingly. The following are given for foreign countries. In Italy a report from 26 asylums returned 18·6 per cent. as directly or indirectly (by heredity) due to alcoholism. Professor Seppili reports from the Brescia asylum the following: 1894–98, 15·7 per cent.; 1899–1903, 19·8 per cent.; 1904–08, 27·6 per cent. Experts in such statistics will recognize at once in this enormous rise a change in the method of classification. In Switzerland, of the admissions in 1900–04, 21·1 per cent. among males and 4·37 per cent. among females were alcoholics. In Denmark, of the admissions in 1899–1903, 21·37 per cent. were alcoholics. In Austria, of the admissions in 1903, 14·0 per cent. were alcoholics. In France the proportion of all persons in asylums in 1907 with an alcoholic history was 12·5 per cent.

Mortality.—The influence of drink on mortality is an unascertainable quantity, because it may be associated with other causes to an extent which varies in an infinite series of gradations. All attempts to estimate it are more or less plausible guesses. We have, however, some positive data. The Registrar-General's Returns contain the heading "alcoholism, delirium tremens," as a cause of death. The following are the rates per million recorded in quinquennial periods from 1870 to 1905: 37·6, 42·4, 48·2, 56·0, 67·8, 85·8, 78·2. This is unsatisfactory for two reasons: the first is, that alcoholism does not nearly cover all the mortality directly caused by drink; and the second is that, being a very vague term, its use in certifying the cause of death depends largely on the views of the practitioner and current opinion in the medical profession. The attention paid to the subject has led to a growing recognition of alcoholism, which, indeed, does not appear at all in the older text-books. This accounts for the steady increase of deaths ascribed to it, which is otherwise inexplicable, being quite at variance with the consumption of drink during the same period. The Seventy-first Annual Report of the Registrar-General states that the mortality from alcoholism in the years 1900 and 1901 was materially increased by the transference of deaths that had been originally certified as from neuritis. It is now usual to classify alcoholism and cirrhosis of the liver together, since the latter is most frequently caused by intemperance. The following are the crude death-rates for twenty years:—

Death-Rates to a Million Living—England and Wales.

	Alcoholism.			Cirrhosis.		
Year.	Male.	Female.	Persons.	Male.	Female.	Persons.
1889	72	39	55	140	103	121
1890	94	50	70	144	105	124
1891	94	49	71	148	104	125
1892	86	49	67	142	104	122
1893	93	55	73	139	103	120
1894	76	47	61	136	96	115
1895	84	51	67	133	104	118
1896	91	52	71	140	106	122
1897	97	58	77	151	115	133
1898	98	59	78	152	112	132
1899	113	69	90	167	119	142
1900	132	95	113	162	127	144
1901	113	80	96	151	115	132
1902	105	65	84	144	104	123
1903	91	62	76	136	100	117
1904	85	55	70	135	101	117
1905	79	52	65	131	104	117
1906	80	53	66	127	98	112
1907	79	48	63	123	101	112
1908	65	45	55	120	88	104

These figures dispose of the current belief in an enormous increase of female intemperance based on the progressive rise of the death-rates. Discussing this question some years ago the present writer pointed out the defects of the statistics and said that the returns of the next few years might upset the whole argument. They have done so.

The statistics of alcoholism and cirrhosis, however, are very far from covering all the mortality due to drink. Dr Newsholme calculates by inference from the returns of Denmark and Switzerland that the deaths directly attributed to alcohol in England and Wales should be some six times higher than they appear in the returns, and that they would then amount to 5 per cent. of the total deaths of adults instead of about 0·8 per cent. He adds: "This percentage probably greatly understates the real facts." It may be so, but the calculation is based on too many assumptions to be accepted with confidence. In addition to the direct mortality there is an unknown score against alcohol in predisposing to other diseases and in accelerating death. Consumption is one of the diseases thought to be particularly associated with alcohol, but there are several others. The following table shows the comparative mortality of males aged 25 to 65 from certain classes of disease in different groups of occupations. They include those with the highest and those with the lowest mortality. The heading "diseases of the circulatory system" includes heart disease and aneurism; diseases of respiratory system include bronchitis, pneumonia and pleurisy, but not phthisis, which is separately given; diseases of urinary system include Bright's disease. The table is compiled from the supplement to the Sixty-fifth Annual Report of the Registrar-General, published 1908. No other country has similar statistics. There are some partial ones for Switzerland, which attribute 2·47 per cent. of the deaths of males over 20 years directly or indirectly to alcohol, and for Denmark, where the corresponding figure is 42 per cent.

The association of a high degree of alcoholic mortality with weakness of all the organs is clearly shown by the figures for unoccupied males, general labourers, dockers, costermongers, innkeepers and inn-servants. Potters and file-makers, with a comparatively low degree of alcoholic mortality, alone show a similar condition, *Comparative Mortality—England and Wales.*

	All Causes.	Alcoholism.	Diseases of Liver.	Phthisis.	Diseases of Nervous System.	Diseases of Circulatory System.	Diseases of Respiratory System.	Diseases of Urinary System.
All males	1,000	16	27	186	105	144	174	52
Occupied and retired males	1,004	16	27	187	103	146	177	52
Unoccupied males	2,884	42	68	583	879	294	310	112
Clergy	524	2	14	55	64	88	53	38
Agriculturists	602	7	13	85	62	96	86	29
Railway engine-drivers	610	4	18	65	74	107	84	36
Civil Service	723	5	40	129	80	102	78	51
Navvies, &c.	740	6	9	95	63	113	154	29
Shopkeepers	872	19	34	161	96	124	139	51
Coal-miners	885	5	17	89	87	134	196	35
Building trades	934	14	21	190	94	134	163	54
Metals	1,027	11	23	189	109	151	213	56
Textiles	1,055	10	21	190	123	165	193	61
Dockers	1,481	50	22	308	112	198	365	64
Potters	1,493	8	21	285	131	219	473	53
Seamen	1,646	26	34	262	170	238	220	83
File-makers	1,700	14	15	387	225	198	325	160
Innkeepers	1,781	111	201	271	188	207	252	127
Inn-servants	1,883	131	49	543	146	211	224	100
Costermongers	2,007	59	40	554	167	276	392	86
General labourers	2,235	40	37	491	233	324	444	96

and it is no doubt due to the inhalation or absorption of irritating or poisonous particles through the nature of their occupation. The clergy, who have the lowest alcoholic mortality, show a remarkably low level of organic disease of all kinds; railway engine-drivers, who come next, suffer more from circulatory and respiratory diseases, navvies and coal-miners still more, while civil servants are more susceptible to phthisis. Agriculturists, though with a higher alcoholic mortality, nearly equal the clergy in general healthiness, which must be attributed to the open-air life. The low alcoholic level of coal-miners and navvies is striking, because both are hard-drinking classes; their position can only be explained by the fact that they drink beer, and it goes far to prove the innocuousness of beer when combined with hard work. The enormous and absurdly disproportionate mortality from diseases of the liver among innkeepers, and in a lesser degree among unoccupied males, is obviously due to a preference for stating that cause on certificates in place of alcoholism. The condition of unoccupied males revealed by this table is worth a volume of sermons. The mortality among them between the ages of 25 and 65 is higher than that of any other class of the community. It is also worth noting that poverty is good for health. The clergy are the poorest of the educated and professional classes; and agricultural labourers, who are the poorest of the manual working classes, are nearly as healthy all round except that they are somewhat more liable to phthisis; their comparative mortality figure from all causes is only 621.

Longevity.—A great deal of statistical information with regard to the comparative longevity or expectation of life at different ages among abstainers and non-abstainers has been collected by life-insurance companies and friendly societies. The following table is given in the syllabus of temperance teaching in elementary schools issued in 1909:—

Expectancy of Life.

Age.	General Expectancy of Total Male Population (Registrar-General).	General Expectancy based on Experience of Insurance Offices.	Odd-fellows.	Rechabites (abstainers).	United Kingdom Temperance Institution (abstainers).
20	41·0	43·2	41·4	48·8	46·9
25	37·0	39·1	37·6	44·3	43·0
30	33·1	35·1	34·0	39·7	38·8
35	29·2	31·2	30·3	35·1	34·6
40	25·6	27·4	26·8	30·6	30·3
45	22·2	23·7	23·3	26·1	26·1
50	18·9	20·1	19·9	21·8	22·0
55	15·8	16·7	16·6	17·7	18·1
60	12·9	13·6	13·6	13·8	14·6

Similar statistics have been prepared showing the relative mortality experience among insured persons. Mr R. M. Moore gives the following proportional figures at different ages for all the societies embraced in the Institute of Actuaries tables, as compared with the abstaining section of the United Kingdom Temperance and Provident Institution, which is taken as 100:—

Mortality Experience of Non-Abstainers to Abstainers as 100.

Age.	Mortality Experience.	Age.	Mortality Experience.
15–19	67	55–59	144
20–24	21	60–64	132
25–29	172	65–69	120
30–34	194	70–74	116
35–39	190	75–79	91
40–44	181	80–84	107
45–49	179	85–89	107
50–54	165	90–94	127

The United Kingdom Temperance Institution has a general as well as an abstaining section. The experience of the twenty-two years 1884–1905 gives the following result: percentage of actual to expected deaths—general section, 79·53; temperance section, 54·25. Other offices having abstaining sections show similar results, thus:—

	General.	Temperance.
Sceptre Life Association (25 years)	79·67	53·05
Scottish Temperance Life Assurance Co. (25 years)	64	46

Pathology.—Dr Sims Woodhead thus summarizes the results of experimental investigation into the direct action of alcohol upon living cells and tissues.

Alcohol plays a prominent part in bringing about degeneration of nerves, muscles and epithelial cells; it determines the accumulation of waste products in the tissues by paralysing the tissue cells, interfering with oxidation, with secretion and with excretion; it induces the proliferation of the lower forms of tissue, often at the expense of the more highly developed tissues, which in its presence undergo marked degenerative changes; it interferes directly with the production of immunity against specific infective diseases, and reasoning from analogy it may be assumed that it plays an equally important part in impairing the resistance of tissue to the advance of the active agents in the production of disease that may have already obtained a foothold in the body.

With regard to this aspect of the subject it must be remembered that laboratory experiments by which alcohol is placed in direct contact with cells and tissues are an entirely different thing from the dietetic use of beverages containing dilute alcohol with other things. It would be interesting to know how the tissues would behave when similarly treated with common salt, lemon juice, vinegar, theine, caffeine or other substances in general dietetic use, or with ordinary tonics such as quinine, quassia and dilute acids.

Inebriety.—Much study has been devoted to inebriety as a diseased condition. It generally results from long-continued and excessive indulgence in alcohol and is characterized by dipsomania or a craving for alcohol, which is chronic or periodical and which the subject cannot resist. It is accompanied by organic changes in the nervous system, which probably begin in the stomach, but end in disintegration of the brain cells with the development of alcoholic insanity. The only chance of cure lies in complete abstinence from liquors with, at first, suitable medical treatment. The recognition of this fact has led to the establishment of special institutions for this purpose, both of a voluntary and a compulsory character. An account of the laws relating to the subject is given under the heading of Inebriety. In accordance with the law three classes of institutions have been established in the United Kingdom:—(1) Certified inebriate reformatories, to which patients are committed by the courts for various periods of detention. They are 11 in number, and during 1908—the last year reported—the committals to them numbered 262 (218 women and 44 men). The total number committed since their establishment in 1897 is 3002 (2548 women and 484 men); the highest number in any one year was 493 (428 women and 65 men) in 1907. (2) State Inebriate Reformatories, more of a penal character, for persons committed but too refractory for the previous class. There are two, one for women and one for men; the average number under detention in 1908 was 74 women and 42 men; the admissions were 27 women and 10 men. (3) Licensed retreats, for voluntary patients. In 1908 they numbered 20, and had under treatment 493 patients (288 women and 205 men). In all about 800 habitual inebriates are thus treated. The results cannot be stated with any precision, but they are certainly disappointing. The Inebriates After-Cure Association gives the following analysis of 407 cases discharged from reformatories and looked after in the years 1903–8:—Satisfactory result, 82 (50 women, 32 men); unsatisfactory, 114 (78 women, 36 men); not known, 221 (162 women, 49 men). One explanation of the failure of treatment and the frequency of relapses which has been revealed by longer and closer study of the problem is that many inebriates are really mental defectives, as already noted in connexion with insanity. Such cases constantly reappear in the police courts after discharge.

Heredity.—It has long been generally assumed that the children of alcoholics suffer in body and mind for the sins of their parents, that they are weak, diseased and defective; and it is very often assumed that they inherit an alcoholic craving. The latter assumption is not admitted by scientific students of the question, but the former has been generally held, though without any proof. It has been made the subject of a statistical investigation (1910) in the Eugenics laboratory of London University by Miss E. M. Elderton and Professor Karl Pearson. The object was to "measure the effect of alcoholism in the parents on the health, physique and intelligence of their offspring," whether by toxic or environmental influence, but not by the transmission of original defective characters, which is omitted from the inquiry. The material used is a report by the Edinburgh Charity Organization Society on the children in one of the Edinburgh schools and one by Miss Mary Dendy on those in the special schools of Manchester. The number of children is not stated, but so far as can be gathered from the tables the Edinburgh inquiry covered about 1000 and the Manchester inquiry about 2000. The ages were from 5 to 14 (Edinburgh report), and both sexes are included in approximately equal numbers. The general conclusion reached is that "no *marked* relation has been found between the intelligence, physique or disease of the offspring and parental alcoholism in any of the categories investigated." The principal particular conclusions reached are as follows:—Higher death-rate in alcoholic than in sober families, more marked in the case of mother than of father, but alcoholic parents more fertile, and therefore nett family about equal; height and weight of alcoholic children slightly greater, but when corrected for age slightly less; general health of alcoholic children slightly better, markedly so in regard to tuberculosis and epilepsy; parental alcoholism not the source of mental defect in children; no perceptible relation between parental alcoholism and filial intelligence.

These conclusions, which run counter to current opinions, have been much criticized, and it is true that the scope of the inquiry is inadequate to establish them as general propositions. Moreover, the chronological relation of parental intemperance to the birth of the children is not stated. But so far as it goes the investigation is sound and it is the first attempt to treat the subject in a scientific way. Nor is there anything in the conclusions to surprise careful and unbiassed observers. The existence of a broad relation between superior vigour and an inclination for alcoholic drinks was pointed out years ago by the writer; drinking peoples are noticeably more energetic and progressive than non-drinking ones. It is the universal experience of shipmasters that British seamen, whose intemperance causes trouble and therefore induces a preference for more sober foreigners, exhibit an energy and endurance in emergency of which the latter are incapable. Similar testimony has repeatedly been borne by engineers and contractors engaged in large works in the south of Europe. And that acute observer, Miss Loane, has related a particular and striking case in regard to offspring from her own experience, which is curiously in keeping with the conclusions of the Eugenics laboratory. The question, however, needs much more elucidation.

The whole subject has, in truth, got somewhat out of perspective. The tendency of the statistical and experimental investigations, summarized above into the relations of alcohol with crime, mortality, disease, &c., has been to obliterate the distinction between the use and abuse of alcohol, between moderate and excessive drinking, and to bring into relief all the evils associated with excess, while ignoring the other side of the question. It is legitimate and desirable to emphasize the evils, but not by the one-sided and fallacious handling of facts. Alcoholic excess produces the evils alleged, though not to the extent alleged, but there is no evidence to show that its moderate use produces any of them. Yet they are all put down to "alcohol," and the inference is freely drawn that its abolition would practically put an end to crime, vice, poverty and disease without any counterbalancing loss whatever. The facts do not warrant that inference, nor has mankind at large ever accepted it. Both the statistical and experimental evidence is full of fallacies, and especially the latter. The pathological investigations on the action of alcohol referred to above elucidate the organic changes which the tissues undergo in the chronic inebriate who is saturated with spirit, but to draw the inference that alcoholic liquors taken in moderation and consumed in the body have any such action is wholly fallacious. In point of fact we know that they have not. But there is more than that. These experiments only take cognizance of alcohol; they ignore the other substances actually consumed along with it. Some of these, and notably sugar, are recognized foods; the balance of opinion on the vexed question whether alcohol itself is a food—which really depends on what is meant by a food—is now on the side of alcohol. But in addition to the principal constituents, easily separable by analysis, are many other substances of which science takes no cognizance at all; they are not identified. They may be in minute quantities yet extremely powerful, as are many other vegetable extractives. We know that they exist by their taste and their effect; they make the difference between port and sherry, between claret and Burgundy, between one vintage and another, between brandy and whisky, differences unknown to chemistry—which only recognizes alcohol, and knows very little about that—but vastly important to the human organism. Another group of experiments are equally fallacious in a different way. The effect of alcohol in mental operations is tested by the comparative speed and ease with which work is done after a dose and without it. The effect has been found to be diminished speed and ease; but these experimenters do not apply the same test to a good meal or a sound sleep or hard exercise. The writer finds in concentrated mental work that the immediate effect of even a small dose of alcohol is to impair efficiency, but the other three do so in a much higher degree. The inference is not that these are injurious, but that the proper time for each is not just before work; after work he finds them all, alcohol included, beneficial. The mortality statistics are treated in a similar one-sided way. They clearly show the injury done by the abuse of alcohol, but what of its moderate use? Agricultural labourers are the most typical moderate drinking class, and they are one of the healthiest in spite of exposure, bad housing and poverty. If all the unhealthiness of those who drink hard is referred to their drink, then the healthiness of those who drink moderately should be referred to it too.

The absolute condemnation of alcoholic drinks has never been endorsed by public opinion or by the medical profession, because it is contradicted by their general experience. That many persons are better without any alcohol, and that many more would be better if they took less than they do is undeniable; but it is equally undeniable that many derive benefit from a moderate amount of it. Sir James Paget, than whom no man was more completely master of his appetites or better qualified to judge, drank port wine himself because he found that it did him good. He represents the attitude of the medical profession as a whole and of temperate men in general. Attempts to support the case for abolishing the use of alcoholic liquors by denying them any value and by attributing to them effects which spring from many other causes, do not carry conviction or advance the cause of temperance. A much stronger argument lies in the difficulty of drawing a definite line between use and abuse; they tend to merge into one another, and it may be urged that the evils of the latter are sufficiently great to justify the abandonment of the former. But the use of most things is open to the same objection, and mankind at large has never consented to forego the gratification of a natural appetite because it is liable to abuse. Nor is there any sign of an intention to make an exception in favour of alcohol. On the other hand, moderation is attainable by every sane individual. It is in fact observed by the great majority and to an increasing extent. There *is* a line between use and abuse, and every one really knows where it is in his own case. If he cannot draw it let him abstain, as Dr Johnson did for that reason. But society can do much to assist the individual by inculcating moderation, setting a standard, promoting its maintenance by helpful environment, discouraging excess and diminishing temptation. All the evidence points to those means as the effective agents in securing the improvement which has taken place in Great Britain.

This article should be read in conjunction with that on LIQUOR LAWS, and it will therefore be in place here to give some additional information regarding the latter. The policy of prohibition has recently gained ground in several countries. In 1910 nine American states had adopted it—namely: Maine, Kansas, N. Dakota, Georgia, Oklahoma, Alabama, Mississippi, N. Carolina and Tennessee; and it was estimated that nearly half the population of the United States were living under state or local prohibition. In Canada the province of Prince Edward Island has adopted complete prohibition. In 1908 Iceland by a popular vote resolved to prohibit the manufacture, importation and sale of intoxicating liquor. In Norway nearly half the towns have adopted prohibition under the law of 1906. In Belgium and Switzerland the manufacture, importation and sale of absinthe was forbidden in 1908. In New Zealand the principle of prohibition has gained ground, and in 1910 was in force over one-seventh of the colony.

AUTHORITIES.—Licensing Statistics Home Office (annual); Statistical Tables of Alcoholic Beverages, Board of Trade, 1905; Report of Inspector under Inebriates Acts (annual); Judicial Statistics (annual); Registrar-General's Annual Report; Statistics of Cities, United States Census Bureau; *Alliance Year Book*; Church of England Temperance Society Annual Report; *American Prohibition Year Book*; *Brewers' Almanack*; *New Encyclopaedia of Social Reform*; "The Drink Problem" (*New Library of Medicine*); Eugenics Laboratory Memoirs; Morrison, *Crime and its Causes*; Pratt, *Licensing and Temperance in Sweden, Norway and Denmark*; Rowntree and Sherwell, *The Temperance Problem and Social Reform*; A. Shadwell, *Drink, Temperance and Legislation.*

(A. Sl.)

TEMPEST, MARIE (1866–), the stage name of the English actress, *née* Marie Susan Etherington, who in 1898 married Cosmo Gordon-Lennox ("Cosmo Stuart"), a grandson of the 5th duke of Richmond, and himself an actor and playwright. She had a charming soprano voice and was educated for the operatic and concert stage, but at first appeared in light comic opera, in which she became very popular. Abandoning music, however, for the comedy stage, she made an even greater success as an actress, notably in *Becky Sharp* (1901); and under her own management in later years she produced a succession of modern comedies, in which her capacity for rivalling in London the triumphs of Réjane in Paris was conspicuously displayed.

TEMPIO PAUSANIA, a town of Sardinia, in the province of Sassari, from which town it is 52 m. E.N.E. by road. It is also reached by rail by a branch line (25 m.) N.W. from the main line from Terranova to Cagliari, leaving the latter at Monti, 14 m. S.W. of Terranova. Pop. (1901) 6511 (town), 14,573 (commune). It lies in a mountainous district 1856 ft. above sea-level, to the N.N.W. of the Monte Limbara. It is the chief town of the Gallura, and has been an episcopal see since the 19th century (with Ampurias). The cathedral is a modern building. The district is agricultural and pastoral. The costumes are picturesque, especially those of the women. For the name Pausania see TERRANOVA PAUSANIA.

TEMPLARS. The Knights Templars, or Poor Knights of Christ and of the Temple of Solomon (*pauperes commilitones Christi templique Salomonici*), formed one of the three great military orders, founded in the 12th century. Unlike the Hospitallers and the Teutonic Knights it was a military order from its very origin. Its founders were a Burgundian knight named Hugues de Payns [1] (Hugo de Paganis) and Godeffroi de St Omer, a knight from northern France, who in 1119 undertook the pious task of protecting the pilgrims who, after the first crusade, flocked to Jerusalem and the other sacred spots in the Holy Land. They were quickly joined by six other knights and soon afterwards organized themselves as a religious community, taking an oath to the patriarch of Jerusalem to guard the public roads, to forsake worldly chivalry, "of which human favour and not Jesus Christ was the cause," and, living in chastity, obedience and poverty, according to the rule of St Benedict, "to fight with a pure mind for the supreme and true King."

To this nascent order of warrior monks Baldwin I., king of Jerusalem, handed over a part of his royal palace lying next to the former mosque of al-Aksa, the so-called "Temple of Solomon," whence they took their name. They had at first no distinctive habit, wearing any old clothes that might be given to them. Nor was their community exclusive. Their primitive rule seems to have enjoined them especially to seek out excommunicated knights, and to admit them, after absolution by the bishop, to their order, and they thus served a useful purpose in at once disciplining and converting the unruly rabble of "rogues and impious men, robbers and committers of sacrilege, murderers, perjurers and adulterers"[2] who streamed to the Holy Land in hope of plunder and salvation. It was this rule which led later to the most important privilege of the order, the immunity from sentences of excommunication pronounced by bishops and parish priests.[3]

This practice, as Prutz points out, might have brought them at once under the suspicion of the Church, and it soon became expedient to obtain the highest sanction for the new order and its rules. In the autumn of 1127 accordingly Hugues de Payns, with certain companions, appeared in Europe, where he was fortunate enough to secure the enthusiastic support of the all-powerful abbot of Clairvaux. Grateful pilgrims had already begun to enrich the order; the *De laude novae militae*, a glowing panegyric of this new and holy conception of knighthood, addressed by Bernard to Hugues de Payns by name, insured the success of his mission. In 1128 the council of Troyes discussed and sanctioned the rule of the order which, if not drawn up by Bernard, was undoubtedly largely inspired by him.[4]

Rule of the Temple.—No MS. of the original French Rule of the Temple (*Règle du Temple*) exists. Of the three extant MSS. representing later recensions, one is preserved at the Accademia dei Lincei at Rome (Cod. 44, A 14), one at the Bibliothèque Nationale (*fonds français* 1977), the third in the departmental archives at Dijon (H. 111). The last of these, probably intended for the use of the master of a subordinate house, is much abbreviated; it dates, however, from the early part of the 13th century, whereas the others are of the end of the century at earliest. In essentials these copies preserve the matter and spirit of the primitive Rule, and they prove that to the end the order was, in principle at least, submitted to the same strict discipline as at the beginning.[5]

The *Règle du Temple* in its final form as we now possess it contains the rules for the constitution and administration of the order; the duties and privileges of the various classes of its personnel; the monastic rules, regulations as to costume and as to religious services; rules for the holding of chapters, and a summary of offences and their punishment; the procedure at the election of a grand master and at receptions into the order; a definition of the relations of the order to the pope, and to other religious orders. It must be borne in mind, however, that the organization of the order as described below was only gradually developed, not having been fixed at Troyes. At first the master of the Temple at Jerusalem was only one among many; the seneschal and marshal appear not to have existed; and it was not till the bull *Omne datum optimum* of Pope Alexander III. (1163), the great charter of the order, that its organization was definitively centralized.

Constitution.—As finally constituted, the order consisted of (1) knights (*fratres milites*), (2) chaplains (*fratres capellani*), (3) serjeants or esquires (*fratres servientes armigeri*), (4) menials and craftsmen (*fratres servientes famuli* and *officii*). All were bound by the rules of the order and enjoyed its privileges. Women were not admitted to the order.[6]

1. At the head of the order was the master of the Temple at Jerusalem (in Cyprus after the fall of the Latin Kingdom), known as the grand master. His authority was very great—except in certain reserved cases his word was law—but he was not absolute. Thus in matters of special importance—alienation of the estates of the order, attack on a fortress, declaration of war, conclusion of an armistice, reception of a new brother—he had to consult the chapter, and was bound by the vote of the majority; nor could he modify or abrogate a decree of the council of the order without their consent. He had to obtain the consent of the chapter also to the nomination of the grand commanders of the provinces of the order; the lesser offices were absolutely in his gift. He was elected by a complicated process, a chapter summoned *ad hoc* electing a "commander of the election" and one other brother who, after vigil and prayer, co-opted two more, these four choosing another two, and so on till the number of the twelve apostles had been reached. A chaplain, representing Jesus Christ, was then added to complete the electoral college (see Curzon, *Règle du Temple*, p. xxxv).[7]

The grand master was allowed four horses for his ordinary use. His household consisted of a *frater capellanus*, a cleric, a *frater serviens* with two horses, a Saracen secretary (*écrivain sarrazinois*)

[1] A fief in Champagne, near Troyes.

[2] Bernard of Clairvaux, *De laude novae militae*, cap. v. (in Migne, *Patrol. lat.* 182, p. 928).

[3] Prutz, *Templerherrenorden*, p. 12. The Latin copy of the Rule (Bibliothèque Nationale) reads "*Milites non excommunicatos*" for "*chevaliers escomenies*"; which means, according to Prutz, that when the Latin version was made the original significance of the rule had been forgotten. M. de Curzon (*Règle du Temple*, p. iv.), on the other hand, assumes that the Latin text represents the original rules drawn up in 1128 and that the French version is a corrupt copy. That Prutz is right would seem to be shown not only by the reasonableness of the rule in itself (why should the Templars be instructed to look out for gatherings of *non*-excommunicated knights?) but by the language of cap. v. of the *De laude novae militae*, in which Bernard extols the knights for turning the enemies of Christ into his soldiers (*ut quos diu pertulit oppugnatores magis jam propugnatores habere incipiat; faciatque de hoste militem*).

[4] Bernard was not present at the council. But the "humble escrivain" of the Règle du Temple, Johan Michiel, writes "*par le comandement dou concile et dou venerable pere Bernart abbés de Clerevaus.*" Compare the rule also with the chapter (iii.) of the *De laude: De militibus Christi.*

[5] Of a secret Rule, in spite of the most diligent research, no trace has ever been found. It is now generally held that none ever existed. The legend of its existence, so fatal to the order, is probably traceable to the fact that the complete Rule was jealously guarded by the chief office-bearers of the order, only excerpts being given to the heads of the lesser houses (*e.g.* the Dijon MS.) and known generally to the knights.

[6] Rule 70. *Perillouse chose est compaignie de feme, que le deable ancien par compaignie de feme a degeté pluisors dou droit sentier de paradis.* It is interesting to compare this with the more wholesome view of the best of the contemporary chivalrous poets, *e.g.* Walther von der Vogelweide or Wolfram von Eschenbach (*Parzival*), who hold up true love as the highest earthly incentive to noble deeds.

[7] The bull *Omne datum optimum* (1163) decreed that the master must be a knight of the order who had taken the vows, and vested the election exclusively in the knights.

as interpreter, a *turcople, i.e.* a soldier belonging to the light-horse attached to the order, a farrier and a cook, two footmen (*garçons à pied*) to look after his special Turcoman horse, only used in war time. He was further attended by two knights of the order of high rank. The ensigns of his presence on campaign were the large round tent and the *gonfanon baucent*, the black and white pennant, charged with the red cross of the order.

2. The second officer of the Temple was the *seneschal.* He had a right to attend all chapters, even the most secret. His equipage, tent, banner and seal were the same as the master's. Attached to his person were two squires, a knight companion, a *frater serviens*, a secretary in deacon's orders to say the hours, a *turcople*, a Saracen secretary and two foot servants.

3. Third in order was the *marshal*, who was supreme military authority, and had under his charge the horses and arms. In the absence of master and seneschal he acted as *locum tenens.* His equipage and *suite* were much the same as those of master and seneschal.

The provincial marshals were absolute in their provinces, but subordinate to the marshal of the order.

The commander of the land and realm of Jerusalem was grand treasurer of the order, administered its estates in the province of Jerusalem, and was responsible for the lodging of the brethren. He also had charge of the fleet, the commander of the port of Acre being his subordinate. His equipage and suite were much the same as those of seneschal and marshal.

The commander of the city of Jerusalem was the hospitaller of the order. He was charged with the defence of pilgrims visiting the Holy Land, and with the duty of supplying them with food and horses. Ten knights were specially attached to him for this purpose, and to act as guard to the relics of the True Cross. Subordinate to him was a second commander for the city itself.

The commanders of Tripoli and Antioch enjoyed all the rights of the grand master within their provinces, except when he was present. They too had the round tent and the *gonfanon.*

Besides these, the rule mentions the commanders of France, England, Poitou, Portugal, Apulia and Hungary, whose rights and privileges are analogous to those of the commanders above mentioned.[1]

Lastly, of the great officers of the order must be mentioned the *drapier*, who was charged with the supervision of the clothing of the brethren. He was closely associated with the commander of the kingdom of Jerusalem, his equipage was that of the commanders, but his suite included a number of tailors.

Below the great dignitaries there were in the provinces *commanders of houses*, under the provincial commanders, and the *commanders of the knights*, who acted as lieutenants of the marshals.

Turning to the general body of the order: the knights (*milites*) were entitled to three horses and a squire, or by special favour to four horses and two squires. They had two tents.

Of the serjeants (*servientes*) five occupied an exceptional position: the deputy-marshals (*souz-mareschau*), who looked after the arms and armour, the *gonfanonier*, who was responsible for the discipline and catering of the squires, the *kitchener* (*cuisinier*) and the *farrier.* These had two horses, a squire and a tent. All the others, even if commanders of houses, had but one horse. At the head of all the serjeants in time of war was the *turcoplier*, the chief of the *turcoples.* He had four horses in his equipage and certain special prerogatives; in battle he took his orders only from the master or seneschal.

Of peculiar importance were the *chaplains* (*fratres capellani*). These did not originally form part of the order, which was served by priests from outside. The bull *Omne datum optimum* of 1163 imposed on clerics attaching themselves to the order an oath of life-long obedience to the grand master; by the middle of the 13th century the chaplains took the same oath as the other brothers and were distinguished from them only by their orders and the privileges these implied (*e.g.* they were spared the more humiliating punishments, shaved the face, and had a separate cup to drink out of). The order thus had its own clergy, exempt from the jurisdiction of diocesan bishops and parish priests, owing obedience to the grand master and the pope alone. By the rules, no Templar was allowed to confess to any save a priest attached to the order, if one were available, and such priest was formally declared to have received from the pope more power to absolve than an archbishop.[2]

It remains to be said that the brethren were admitted either for life or for a term of years. Married men were also received, but on condition of bequeathing one half of their property to the order (rule 69).

The chapters of the order were either secret, composed of such brothers as the master might esteem "wise and profitable for giving advice," or general assemblies of the order, at the discretion of the master, who was to listen to the counsel given and do what seemed best to him (rule 36).

Habit of the Order.—The characteristic habit of the order was the white mantle, symbolic of purity, with the red cross, the ensign of the champions of the Church, first granted by Pope Eugenius III. (1145–53). Only the unmarried knights bound by life-long vows, however, were privileged to wear the white mantle, which was also given to chaplains in episcopal orders. The rest wore a black or brown mantle, the red cross being common to all. The chaplains were distinguished by wearing the mantle closed.

Conduct and Discipline.—The brethren were to attend daily services; but the soldier outwearied with his nightly duties might on certain conditions absent himself from matins with the master's consent. Two regular meals were allowed for each day; but to these might be added, at the master's discretion, a light collation towards sunset. Meat might be eaten thrice a week; and on other days there was to be a choice of vegetable fare so as to suit the tenderest stomach. Brethren were to eat by couples, each keeping an eye on his fellow to see that he did not practise an undue austerity. Wine was served at every meal, and at those times silence was strictly enjoined that the words of Holy Writ might be heard with the closest attention.[3] Special care was to be taken of aged and ailing members. Every brother owed the most absolute obedience to the master of the order, and was to go wherever his superior bade him without delay, "as if commanded by God." All undue display in arms or harness was forbidden. Parti-coloured garments were forbidden. All garments were to be made of wool; but from Easter to All Souls a linen shirt might be substituted for one of wool. The hair was to be worn short, and a rough beard became one of the distinguishing marks of the order. Hunting and hawking were unlawful; and the very allusion to the follies or secular achievements of earlier life was forbidden. A lion, however, being the type of the evil one, was legitimate prey. Strict watch was kept on the incomings and outgoings of every brother, except when he went out by night to visit the Sepulchre of our Lord. No letter, even from the nearest relative, might be opened except in the master's presence; nor was any member to feel annoyance if he saw his relative's gift transferred at the master's bidding to some other brother. The brethren were to sleep in separate beds in shirts and breeches, with a light always burning in the dormitory. Those who lacked a mattress might place a piece of carpet on the floor; but all luxury was discouraged.

A term of probation was assigned to each candidate before admission; and a special clause discouraged the reception of boys before they were of an age to bear arms.[4] Lastly, the brethren of the Temple were exhorted to shun the kiss of every woman, whether maid or widow, mother, aunt or sister.

For grievous offences, such as desertion to the Saracens, heresy, losing the gonfalon, murdering a Christian, or failing to account for all the property of the order in his possession, a Templar might be expelled (*perdre la maison*); for minor offences, such as disobedience, lowering the banner in battle, or killing a slave or a horse, he suffered a temporary degradation (*perdre son abit*). No member of another religious order was received by the Templars, and no Templar could leave the order without permission of the master, and then only on condition of joining a stricter monastic community. By mutual agreement the Templars and Hospitallers, despite their long and deadly feud, were bound not to receive ejected members of the rival order; and the Templar cut off in battle and defeat from all hope of rejoining his own ranks might rally to the cross of St John.

History.—Long before St Bernard's death (1153) the new order was established in almost every kingdom of Latin Christendom. Henry I. granted them lands in Normandy. They seemed to have been settled in Castile by 1129, in Rochelle by 1131, in Languedoc by 1136, at Rome by 1138, in Brittany by 1141, and in Germany at perhaps a still earlier date. Alphonso I. of Aragon and Navarre, if we may trust the Spanish historians, bequeathed them the third of his kingdom (Mariana, x. c. 9). Raymond Berengar IV., count of Barcelona, and Alphonso's successor in Aragon, whose father had been admitted to the order, granted them the strong castle of Monzon (1143), and established a new chivalry in imitation of theirs. Louis VII. in the latter years of his reign gave them a piece of marsh land outside Paris, which in later times became known as the Temple, and was the headquarters

Spread of the order.

[1] The titles varied. The provincial commander is "Master" or "Grand Prior" or "Grand Preceptor" under him are "priors" over large estates, and under them "preceptors" of houses. Preceptors took their name from the mandate of the master issued to them: "*Praecipimus tibi.*"

[2] Rule 269 . . . *Car il en ont greignor povir de l'apostoile* (*i.e.* the pope) *d'eaus assoudre que un arcevesque* (Curzon, p. 165).

[3] The Bible was read in a French translation. A MS. of a Templar Bible, exhibiting curious touches of the critical spirit, is now in the Bibliothèque Nationale in Paris. See Prutz, *Templerherrenorden*, p. 116.

[4] This rule was not observed later on, postulants being admitted without any period of noviciate, and among the Templars arrested in 1307 were many young boys.

of the order in Europe.[1] Stephen of England granted them the manors of Cressing and Witham in Essex, and his wife Matilda that of Cowley, near Oxford. Eugenius III., Louis VII., and 130 brethren were present at the Paris chapter (1147) when Bernard de Balliol granted the order 15 librates of land near Hitchin; and the list of English benefactors under Stephen and Henry II. includes the noble names of Ferrers, Harcourt, Hastings, Lacy, Clare, Vere and Mowbray. Spiritual privileges were granted to them by the popes as lavishly as temporal possessions by the princes and people. Pope Adrian IV. allowed them to have their own churches; Eugenius III. added to these the right to have churchyards; and churches and churchyards, as in the case of the order generally, were exempted from the operation of ordinary excommunications and interdicts. Thus a person dying excommunicated, refused burial elsewhere, sometimes—like Geoffrey de Mandeville[2]—found a resting-place in the consecrated ground of the Templars. Eugenius III. also granted the Templars the right to have interdicted churches opened twice a year for the purpose of making their collections. They were, moreover, as defenders of the Church, exempted from the payment of tithes. Finally, they were exempted from the action even of general censures and decrees of the popes, unless mentioned in them by name. Very soon the order refused to submit in any way to the ordinary jurisdiction of the diocesan bishops and formed in effect a separate ecclesiastical organization under the pope as supreme bishop. The result was that, scarce twenty-five years after its foundation, the order was at open feud with bishops and parish priests, and the popes found it necessary to issue decree after decree to protect it from violence and spoliation. The complaints of the secular clergy, on the other hand, came to a head in 1179 at the Lateran Council, when even Pope Alexander III. had to consent to a series of decrees directed against the abuse of its privileges by the order (Prutz, p. 41).

So long, however, as the attention of the papacy and of Christendom was fixed on the problem of recovering and safeguarding the Holy Land, the position of the Templars was unassailable, and all efforts to curb the growth of their power vain. The order as such had no European policy;[3] the whole of its vast organization was maintained for the purpose of feeding the holy war against the infidels with recruits and with money; and its ultimate fate depended on its success or failure in the East. (W. A. P.)

After the council of Troyes Hugues de Payns came to England and induced a number of knights to follow him to the Holy Land. Among these was Fulk, count of Anjou, who would thus seem to have been a Templar before assuming the crown of Jerusalem in 1131. Hugues de Payns died about the year 1136 and was succeeded by Robert de Craon, who is said to have been Anselm's nephew. Everard de Barris, the third master, was conspicuous in the second crusade. In the disastrous march from Laodicea to Attalia his troops alone kept up even the show of discipline; and their success prompted Louis VII. to regulate his whole army after the model of the Templar knights. In the French king's distress for money the Templars lent him large sums, ranging from 2000 silver marks to 30,000 solidi. When Conrad III. of Germany reached Jerusalem he was entertained at their palace (Easter 1148); and in the summer of the same year they took part in the unsuccessful siege of Damascus. The failure of this expedition was ascribed by a contemporary writer to their treachery—a charge to which Conrad would not assent. This is the first note of the accusations which from this time were of constant recurrence.[4]

Early grand masters.

Henceforward for 140 years the history of the Templars is the history of the CRUSADES (*q.v.*). In 1149 the Templars were appointed to guard the fortress of Gaza, the last Christian stronghold on the way towards Egypt. Four years later the new master, Bernard de Tremelai, and forty of his followers, bursting into Ascalon, were surrounded by the Saracens and cut off to a single man. William of Tyre has preserved the scandal of the day when he hints that they met a merited fate in their eagerness to possess themselves of the city treasure. Next year the rumour went abroad that they had sold a noble half-converted Egyptian prince, who had fallen into their hands, to chains and certain death for 60,000 aurei. In 1166 Amalric, the Latin king of Jerusalem, hanged twelve Templars on a charge of betraying a fortress beyond the Jordan to an amir of Nūr al-Dīn of Damascus. The military power of Nūr al-Dīn (1145–73) was a standing menace to the Christian settlements in the East. Edessa had fallen to the prowess of his father (1144–45); Damascus was conquered by the son (1153), who four years earlier had carried his depredations almost to the walls of Antioch, and in 1157 laid siege to the Christian town of Paneas near the sources of the Jordan. In the disastrous fight that followed for the safety of the fortress of the Hospitallers, Bertrand de Blanquefort, the master of the Templars, and Odo de St Amand, one of his successors, were taken prisoners. Bertrand was released later when Manuel was preparing to march against Nūr al-Dīn. The Templars do not seem to have opposed Amalric's early expeditions against Egypt. It was Geoffrey Fulcher, the Templar correspondent of Louis VII., who brought back (1167) to Jerusalem the glowing accounts of the splendour of the caliph's court at Cairo with which Gibbon has enlivened his great work. Nor was the order less active at the northern limits of the Latin kingdom. Two English Templars, Gilbert de Lacy and Robert Mansel, "qui Galensibus praeerat," starting from Antioch, surprised Nūr al-Dīn in the neighbourhood of Tripoli and put him barefooted to flight. But jealousy or honour led the Templars to oppose Amalric's Egyptian expedition of 1168; and the wisdom of their advice became apparent when the renewed discord on the Nile led to the conquest of Egypt by Asad al-Dīn Shīrkūh, and thus indirectly to the accession of Saladin, in 1169. In 1170 they beat Saladin back from their frontier fortress of Gaza; and seven years later they shared in Baldwin IV.'s great victory at Ascalon.

Relations with Nūr al-Dīn.

Relations with Saladin.

Meanwhile Saladin had possessed himself of Emesa and Damascus (1174–75), and, as he was already lord of Egypt, his power hemmed in the Latin kingdom on every side. In July 1173 Amalric was succeeded by his son Baldwin IV., a boy of twelve. Raymond III., count of Tripoli, a man suspected of being in league with the Saracens, was appointed regent, although in 1176 the masters of the Templars and the Hospitallers united in offering this office to the newly arrived Philip of Flanders. The construction of the Templar fortress at Jacob's ford on the upper Jordan led to a fresh Saracen invasion and the disastrous battle of Paneas (1179), from which the young king and the Holy Cross escaped with difficulty, while Odo de St Amand, the grand master, was carried away captive and never returned.

During Odo's mastership the Old Man of the Mountains sent to Amalric offering to accept the Christian faith if released from the tribute he had paid to the Templars since (according to the

[1] In August 1279, Philip IV. ceded to the Templars within the precincts of the Temple at Paris (*vicus Templi*), *i.e.* the whole fortified quarter on the right bank of the Seine, the right to exercise higher and lower justice (*alta et bassa justicia*), to retain all property usually escheated to the crown, and to guard their fortress "night and day" by means of their own *servientes* without interference. The king undertook, for himself and his successors, not to endeavour to levy any *taille* or other tax nor to exact any of the customary feudal services within the Temple. Text in Prutz, *Templerherrenorden*, p. 298.

[2] Illo autem, in discrimine mortis, ultimum trahente spiritum, quidam supervenere Templarii qui religionis sacre habitum cruce rubea signatum ei imposuerunt (*Mon. Ang.*, iv. 142). There must be a slight error here on the part of the chronicler; for Geoffrey died in 1144 and the red cross was not granted to the Templars until the following year. This does not, however, affect the main fact that Geoffrey, though excommunicated, was buried in consecrated ground at the New Temple in London. This was in 1163, twenty-two years before the consecration of the Temple Church now standing. See Round, *Geoffrey de Mandeville*, p. 224.

[3] Finke, p. 42. Individual Templars, of course, acted from time to time as diplomats or as royal advisers; but they in no sense represented the order.

[4] *Hist. Pontific.*, ap. Pertz, xx. 535–536.

reckoning of M. Defrémery) somewhere about 1149. The Templars murdered the envoys on their return (*c.* 1172). Amalric demanded that the offenders should be given up to justice. Odo refused to yield the chief culprit, though he was well known, and invoked the protection of the pope. Amalric had to vindicate his right by force of arms at Sidon, and died while preparing to take stronger measures. The connexion between the Templars and the Old Man was still vital eighty years later when the two grand masters rebuked the insolence of the Assassin envoys in the presence of Louis IX. Odo de St Amand was succeeded by Arnold de Torroge, who died at Verona on his way to implore European succour for the Holy Land. The power of Saladin was now (1184) increasing daily; Baldwin IV. was a leper, and his realm was a prey to rival factions. There were two claimants for the guardianship of the state—Raymond III. of Tripoli and Guy de Lusignan, who in 1180 had married Sibylla, sister of the young king. Baldwin inclined to the former, against the patriarch and Arnold de Torroge.

There is something Homeric in the story of the fall of the Latin kingdom as related by the historians of the next century.

Fall of Latin kingdom.

A French knight, Gerard de Riderfort or Bideford, coming to the East in quest of fortune, attached himself to the service of Raymond of Tripoli, looking for the hand of some wealthy widow in reward. But on his claiming the hand of the lady of Botron he was met with a refusal. Angered at this, Gerard enrolled himself among the Templars, biding his time for revenge, and was elected grand master on the death of Arnold. Baldwin IV. died (1185), leaving the throne to his young nephew Baldwin V., the son of Sibylla, under the guardianship of Raymond, whose office was not of long duration, as the little king died in September 1186. This was Gerard's opportunity. The Templars carried the body of their dead sovereign to Jerusalem for burial; and then, unknown to the barons of the realm, Gerard and the patriarch crowned Sibylla and her husband Guy. The coronation of Guy was the triumph of Raynald of Châtillon, once prince of Antioch, and Saladin's deadliest foe. It was at the same time the overthrow of Raymond's ambition; and both Latin and Arabic writers are agreed that the Christian count and the Mahommedan sultan now entered into an alliance. To break this friendship and so save the kingdom, the two grand masters were sent north to make terms with Raymond. But the rash valour of the Templars provoked a hopeless contest with 7000 Saracens. The grand master of the Hospitallers was slain; but Gerard made his escape with three knights to Nazareth (1st May 1187). In this emergency Raymond became reconciled with Guy; and Gerard placed the Temple treasures of Henry II. at his king's disposal. Once more it was the Templars' rashness that led to the disastrous battle of Hittin (4th July). Gerard and the king fell into the hands of Saladin, but were released about a year later; Raymond of Tripoli made his escape through treachery or fortune; and 230 Templars fell in or after the battle, for the fight was scarcely over before Saladin ordered all the Templars and Hospitallers to be murdered in cold blood. One after another the Christian fortresses of Palestine fell into the hands of Saladin. Jerusalem

Fall of Jerusalem.

surrendered on 2nd-3rd October 1187, and the treasures of the Temple coffers were used to purchase the redemption of the poorer Christians, part of whom the Templar warriors guarded on their sad march from the Holy City to Tripoli. Part of their wealth was expended by Conrad of Montferrat in the defence of Tyre; but, when this prince refused to admit Guy to his city, both the Templars and the Hospitallers from the neighbouring parts flocked to the banner

Siege of Acre.

of their released king and accompanied him to the siege of Acre (22nd August 1189). In his company they bore their part in the two years' siege and the terrible famine of 1190–91; and their grand master died in the great battle of 4th October 1189, refusing to survive the slaughter of his brethren.

On the fall of Acre Philip Augustus established himself in the palace of the Templars, who are, however, stated to have sympathized with Richard. This king sold them the island of Cyprus for 100,000 besants; but, unable to pay the purchase money, they transferred the debt and the principality to Guy of Lusignan. The English king consulted them before deciding on any great military movement; and in June 1192 they advocated the bold plan of an advance on Egypt rather than on Jerusalem. In the disputes for the Latin kingdom of the East the Templars seem to have supported Guy, and, like Richard, were credited with having had a hand in the murder of Conrad of Montferrat (April 1192). It was in the disguise of a Templar and in a Templar galley that Richard left the Holy Land. When Acre was recovered, the Templars, like the Hospitallers, received their own quarters in the town, which from this time became the centre of the order. On the death of Henry of Champagne (1197) they vetoed the election of Raoul de Tabarie; after the death of his successor Amalric they refused to renew the truce with Saladin's brother, Saif al-Dīn, and led an expedition against the Saracens before the arrival of the new king, John de Brienne, at whose coronation in

John de Brienne.

1210 William de Chartres, the grand master, was present. Seven years later, with the aid of Walter de Avennis and of the Teutonic Knights, they commenced the building of their fortress of Castle Pilgrim, near Acre, on a rocky promontory washed by the Mediterranean on every side except the east. This wonderful structure, whose ruins are still to be seen, was fortified with a strong wall, founded on the substructure of a yet more extensive one running from sea to sea, and was flanked by lofty towers of huge squared stones. Within was a spring of pure water, besides fishponds, salt-mines, woods, pastures, orchards, and all things fitted to furnish an abode in which the Templars might await the day of their restoration to Jerusalem.

It was from this castle that in May 1218 the fifth crusade started for the expedition against Egypt. The Templars were the heroes of the siege of Damietta, at which William

Fifth crusade.

de Chartres was slain. "First to attack and last to retreat," they saved the Christian army from annihilation on 29th August 1219; and when the city surrendered (5th November) the only one of its twenty-eight towers that had begun to give way had been shaken by their engines. On the other hand, it was largely owing to their objections that John de Brienne refused the sultan's offer to restore Jerusalem and Palestine.

From the very first the Templars seem to have been opposed to Frederick II., and when he landed at Acre (7th September 1228) they refused to march under the banners of an excommunicated man, and would only accompany his host from Acre to Joppa in a separate body. They were accused of notifying Frederick's intended pilgrimage to the Jordan to the sultan, and they were certainly opposed to Frederick's ten years' peace with Al-Kāmil, the sultan of Egypt, and refused to be present at his coronation in Jerusalem. Frederick was not slow to avenge himself: he left Jerusalem abruptly, publicly insulted the grand master, demanded the surrender of their fortresses, and even laid siege to Castle Pilgrim. He left Acre on the 3rd of May 1229, and on landing in Apulia gave orders to seize the estates of the order and chase all its members from the land.

Long before the expiration of Frederick's peace Europe was preparing for a fresh crusade against the now divided realm of the Ayyubids. Theobald of Navarre and his crusaders

Seventh crusade.

reached Palestine about August 1239. The Templars shared in the great defeat near Jaffa, an engagement which their temerity had done much to provoke (13th November 1239). If the king ever accepted the overtures of Ṣāliḥ of Damascus, he was supporting the policy of Hermann of Perigord, the grand master, who towards the summer of 1244 wrote a triumphant letter to England, telling how he had engaged this sultan and Nāsir of Kerak to make an alliance against the sultan of Egypt and restore the whole of Palestine from the Jordan to the sea. Theobald, however, before leaving the Holy Land (27th September 1240), signed a ten years' truce with Ṣāliḥ of Egypt. The Hospitallers seem to have been won over to his view, and when Richard of Cornwall arrived (11th October) he had to decide between the two rival orders and their opposing policies. After some hesitation he concluded a treaty with the sultan of Egypt, much to the annoyance of the Templars, who openly mocked his efforts. On his departure the three orders came to open discord: the Templars laid siege to the Hospitallers in Acre and drove out the Teutonic Knights "in contumeliam imperatoris." They were successful on all sides. The negotiations with Damascus and Kerak were reopened, and in 1244 Hermann of Perigord wrote to the princes of Europe that after a "silence of fifty-six years the divine mysteries would once more be celebrated in the Holy City."

Kharizmian invasion.

It was in this moment of danger that the sultan of Babylon called in the barbarous Kharizmians, whom the Mongol invasions had driven from their native lands. These savages, entering from the north, flowed like a tide past the newly built and impregnable Templar fortress of Safed, swept down on Jerusalem, and annihilated the Christian army near Gaza on St Luke's day (18th October) 1244. From this blow the Latin kingdom of the East never recovered; 600 knights took part in the battle; the whole force of the Templars, 300 in number, was present, but only 18 survived, and of 200 Hospitallers only 16. The masters of both orders were slain or taken prisoners. Despite the admirable valour of the Templars, their policy had proved the ruin of the land. Jerusalem was lost to Christendom for ever; and, though the Kharizmians melted away in the course of the next three years, they left the country so weak that all the acquisitions of Theobald and Richard fell an easy prey to the sultan of Babylon.

Louis IX.'s crusade.

Recognizing the fact that the true way to Jerusalem lay through Egypt, Louis IX. led his host to the banks of the Nile, being accompanied by the Templars. Their master, William de Sonnac, attempted in vain to restrain the rash advance of the count of Artois at the battle of Mansura (8th February 1250), which only three Templars survived. St Louis, when captured a few weeks later, owed his speedy release to the generosity with which the order advanced his ransom-money. Shortly after his departure from Acre (April 1254) they consented to an eleven years' truce with the sultans of Egypt and Damascus.

Successes of Bibars.

A new enemy was now threatening Mahommedan and Christian alike. For a time the Mongol advance may have been welcomed by the Christian cities, as one after another the Mahommedan principalities of the north fell before the new invaders. But this new danger stimulated the energies of Egypt, which under the Mameluke Bibars encroached year after year on the scanty remains of the Latin kingdom. The great Frankish lords, fearing that all was lost, made haste to sell their lands to the Templars and Hospitallers before quitting Palestine for ever. In 1260 the former purchased Sidon and Beaufort; next year the Hospitallers purchased Arsuf. In 1267, by a skilful adaptation of the banners of both orders, Bibars nearly surprised Antioch. The Templar fortress of Safed surrendered with its garrison of 600 knights, all of whom preferred death to apostasy (June 1266). Beaufort fell in 1268, Antioch six weeks later; and, though the two orders still made occasional brilliant dashes from their Acre stronghold, such as that to Ascalon in 1264 and that with Prince Edward of England to destroy Ḳāḳūn in 1271, they became so enfeebled as to welcome the treaty which secured them the plain of Acre and a free road to Nazareth as the result of the English crusade of 1272.

But, though weak against external foes, the Templars were strong enough for internal warfare. In 1277 they espoused the quarrel of the bishop of Tripoli, formerly a member of the order, against his nephew Bohemond, prince of Antioch and Tripoli, and began a war which lasted three years. In 1276 their conduct drove Hugh III., king of Cyprus and Jerusalem, from Acre to Tyre. In the ensuing year, when Mary of Antioch had sold her claim to the crown to Charles of Anjou, they welcomed this prince's lieutenant to Acre and succeeded for the moment in forcing the knights of that city to do homage to the new king. Thirteen years later (26th April 1290) Tripoli fell, and next year Acre, after a siege of six weeks, at the close of which (16th May) William de Beaujeu, the grand master, was slain. The few surviving Templars elected a new master, and, forcing their way to the seashore, sailed for Cyprus, which now became the headquarters of the order. A futile attempt against Alexandria in 1300 and an unsuccessful effort to form a new settlement at Tortosa about the same time (1300–2) are the closing acts of their long career in the western parts of Asia.

Abandonment of Palestine.

Power and influence of the order.

For more than a hundred years the Templars had been one of the wealthiest and most influential factors in European politics. If we confine our attention to the East, we realize but a small part of their enormous power. Two Templars were appointed guardians of the disputed castles on the betrothal of Prince Henry of England and the French princess in 1161. Other Templars were almoners of Henry III. of England and of Philip IV. of France. One grand master was godfather to a daughter of Louis IX.; another, despite the prohibition of the order, is said to have been godfather to a child of Philip IV. They were summoned to the great councils of the Church, such as the Lateran of 1215 and the Lyons council of 1274. Frederick II.'s persecution of their order was one of the main causes of his excommunication in 1239; and his last will enjoined the restoration of their estates. Their property was scattered over every country of Christendom, from Denmark to Spain, from Ireland to Cyprus. Before the middle of the 13th century Matthew Paris reckons their manors at 9000, Alberic of Trois-Fontaines at 7050, whereas the rival order of St John had barely half the latter number. Some fifty years earlier their income from Armenia alone was 20,000 besants. Both in Paris and in London their houses were used as strongholds for the royal treasure. In the Temple in London Hubert de Burgh and the Poitevin favourites of Henry III. stored their wealth; and the same building was used as a bank into which the debtors of the foreign usurers paid their dues. From the English Templars Henry III. borrowed the purchase money of Oléron in 1235; from the French Templars Philip IV. exacted the dowry of his daughter Isabella on her marriage with Edward II. To Louis IX. they lent a great part of his ransom, and to Edward I. of England no less than 25,000 *livres Tournois*, of which they remitted four-fifths. Jacques de Molay, the last grand master, came to France in 1306 with 150,000 gold florins and ten horse-loads of silver.[1] In the Spanish peninsula they occupied a peculiar position, and more than one king of Aragon is said to have been brought up under their discipline.[2]

[1] The wealth of the Templars was due not so much to their territorial possessions as to the fact that they were the great international financiers and bankers of the age. The Paris Temple was the centre of the world's money market. In it popes and kings deposited their revenues, and these vast sums were not hoarded but issued as loans on adequate security. Above all, it was the Templars who made the exchange of money with the East possible. It is easy, indeed, to see how they were the ideal bankers of the age; their strongholds were scattered from Armenia to Ireland, their military power and strict discipline ensured the safe transmission of treasure, while their reputation as monks guaranteed their integrity. Thus they became the predecessors, and later the rivals, of the great Italian banking companies. See L. Delisle, "Mémoire sur les opérations financières des Templiers" in *Mémoires de l'Institut national de France*, t. xxxii. To take interest (usury) was of course unlawful. The method of circumventing this seems to have been that the mortgages paid to the mortgagors a *nominal* rent which was used towards the reduction of the debt. The difference between this and the *real* rent represented the interest. See *Ancient Charters*, Pt. i. (Pipe Roll Soc., London, 1888), edited by J. H. Round, p. 94 note. A document throwing a vivid light on the banking methods of the Templars and Hospitallers is a charter of Margaret, queen of the English, A.D. 1186, from the abbey of Fontevrault, printed in *Calendar of Documents, France* (London, 1899), vol. i., ed. J. H. Round, No. 1084. (W. A. P.)

[2] The Templars in Aragon and the other kingdoms of the Spanish peninsula were far more subordinate to the crown than elsewhere. None but natives were admitted to their ranks, and there were very few exchanges of knights with foreign commanderies. They were

Such were the power and wealth of the Templars at the time when Philip IV. of France accused them of heresy and worse offences, had them arrested (13th October 1307), and forced them to confess by tortures of the most excruciating kinds. Five years later (26th May 1312) the order was suppressed by decree of the council of Vienne and its goods transferred to the hospital of St John. (T. A. A.)

Suppression of the order.

Never had the order of the Temple been to all appearance more powerful than immediately before its ruin. Sovereign power, in the sense of that of the Teutonic Knights in Prussia or the Knights of St John in Rhodes and later in Malta, it had never possessed; but its privileges and immunities constituted it a church within the church and—in France at least—a state within the state. Philip IV., indeed, in pursuance of his policy of centralizing power in the crown, had from 1287 onwards made tentative efforts to curtail the power and wealth of the order; in 1287 he commanded the sequestration of all its property acquired since the confirmation of its privileges by Louis IX. in 1258; in 1289 the ordinance of Ferrières in Gâtinais was directed against its illegal acquisitions and its interference with the jurisdiction of the king and his vassals; in 1290 the parlement decided that the privileges of the order could only be enjoyed by those who actually wore its habit. Soon, however, the king's necessities forced him to change his policy. In January 1293 the privileges of the order in and about Paris were confirmed and extended, and in 1297 Philip borrowed 5200 *livres tournoises* from the Paris Temple. Then came the great quarrel with Pope Boniface VIII., and on the 10th of August 1303 the king signed with Hugues de Peraud, the general visitor of the French Templars, a formal treaty of alliance against the pope. On the 6th of February 1304 Boniface's successor, Benedict XI., once more confirmed all the Templars' privileges; while Philip, for his part, appointed Hugues de Peraud receiver of the royal revenues and, under pressure of the disastrous campaign in Flanders, in June granted a charter exempting the order from all hindrances to the acquisition of property. Two years later the king took refuge in the Temple from the violence of the Paris mob,[1] and so late as the spring of 1307 was present at the reception of a new Templar.[2]

Yet for some two years past the king had been plotting a treacherous attack on the order. His motives are clear: he had used every expedient to raise money, had robbed and expelled the Jews and the Lombard bankers, had debased the coinage; the suppression of the Templars would at once rescue him from their unwelcome tutelage and replenish his coffers. He cherished also another ambition. The question of an amalgamation of the great military orders had often been mooted; the project had been approved by successive popes in the interests of the Holy Land; it had been formally proposed at the Lyons council of 1274, only to be rejected by the opposition of the Templars and Hospitallers themselves. To Philip this scheme commended itself as an opportunity for bringing the orders under the control of the French crown; there was to be but one order, that of the "Knights of Jerusalem," of which the grand master was always to be a prince of the royal house of France.[3] Clearly, it only needed an excuse and a favourable opportunity to make him attack the Templars; and, once having attacked them, nothing short of their entire destruction would have been consistent with his safety. The excuse was found in the denunciation of the order for heresy and unspeakable immoralities by a venal informer; the opportunity was the election of a pope, Clement V., wholly devoted to the interests of the king of France.

Accusations.

For perhaps half a century there had been strange stories circulating as to the secret rites practised by the order at its midnight meetings, stories which probably had their origin in the extreme precautions taken by the Templars, originally perhaps for military reasons, to secure the secrecy of their proceedings, which excited popular curiosity and suspicion. Among the Templars alone of the religious orders the ceremonies of reception were conducted in strict privacy; chapters were held at daybreak with closely guarded doors, and no one participating was allowed to reveal what had passed, even to a fellow-member of the order, under pain of expulsion. It was inevitable that, considering the temper of the age, all this should lead to stories of rites too repulsive to bear the light. It was said that on his initiation each member had to disavow his belief in Christ, to spit upon the crucifix, to submit to indecent ceremonies. When the mass was celebrated the consecrating words *Hoc est corpus* were omitted; on Good Friday the holy cross was trampled under foot; and the Christian duty of almsgiving had ceased to be observed. Even the vaunted chastity of the order towards women had, it was said, been turned into the formal obligation to commit more horrible offences. These evil practices were part of the secret statute law of an order which in its nightly assemblies worshipped an idol named Baphomet[4] or the devil in the shape of a black cat. Devils, too, appeared in the form of beautiful women (*succubi*), with whom the brothers had carnal intercourse. In England the very children at their play bade one another beware of a Templar's kisses. Stranger stories yet were rife in England and gravely reported before bishops and priests—of children slain by their fathers because they chanced to witness the nightly orgies of the society; of one prior's being spirited away at every meeting of the general chapter; of the great preceptor's declaring that a single hair of a Saracen's beard was worth more than the whole body of a Christian man. In France they were said to roast their illegitimate children and smear their idols with the burning fat.

Denunciation of the order.

In the spring of 1304 or 1305 a certain Esquiu de Floyran of Beziers pretended to betray the "secret of the Templars" (*factum Templariorum*) to James II. of Aragon. The pious king, who had every reason to think well of the order, did not affect to be convinced; but the prospect of spoils was alluring, and he seems to have promised the informer a share of the booty if he could make good his charges.[5] Esquiu now turned to Philip of France, with more immediate success. For the purpose of collecting additional evidence the king caused twelve spies to find admission to the order, and in the meantime sought to win over the pope to his views. Bertrand de Got, archbishop of Bordeaux, who on the 5th of June 1305 became pope as Clement V., owed the tiara to the diplomacy of Philip's agents, perhaps to their gold; but though a weak man, and moreover a martyr to ill health, he was not so immediately accommodating as the king might have wished,

bound to respond to demands of the grand master for consignments of men and money, but their main duty was to assist the king in his wars against the Moors at home (*ad Sarracenorum Yspanie ofensionem*), a duty they fulfilled with conspicuous success and courage to the last. See Finke i. 3, *Papsttum und Untergang des Templerordens* (p. 27), "*Die Sonderstellung der aragonesischen* (*und spanischen*) *Templer*." See also Prutz, *Templerherrenorden*, p. 61 seq. In Portugal the Templars were practically feudatories of the crown, the master taking an oath of fealty to the king and his heir (*ib*. p. 59). (W. A. P.)

[1] For details see Lavocat, p. 120. [2] Finke i. 119.

[3] He himself was to be its first head, with the title of "King of Jerusalem." See the letter (No. 75) from Leget F. to Bernart F. in Finke ii. 114.

[4] Two of the Templars examined at Carcassonne spoke of an idol named Baphomet or a piece of wood on which was represented a figure of Baphomet. A Templar at Florence called the idol Mahomet or Magomet. Baphomet was a common mediæval corruption of Mahomet (Maphomet, Mahom, &c.), who was regarded, not as a false prophet only, but as a demon, a false god to whom human sacrifices were offered. Hence any unholy or fantastic rites came to be called *baffumerie*, *mahomerie*, *mômerie*, *i.e.* "mummery." Hammer-Purgstall's derivation from Βαφὴ Μητοῦς, *i.e.* the baptism of Metis (the supreme wisdom), has no trustworthy evidence to support it. See Loiseleur, *Doctrine secrète*, p. 97 seq.

[5] Finke ii. 83, No. 57, publishes a letter of Esquiu to the king, dated 21st January 1308, claiming his reward. Esquiu is the Squin de Florian of Villani; the other informer mentioned by him, Noffo Dei (Deghi) of Florence, had, however, nothing to do with the matter; he was in financial relations with the Temple at Paris, and was hanged for swindling. Nor was Esquiu's motive to save himself from execution, but purely mercenary. The existence of an informer, doubted by Lea (*Inquisition* iii. 255) and others, is now proved.

expressing his disbelief in the charges against the order, and, though promising an inquiry, doing his best to procrastinate. Philip determined to force his hand. All France was at this time under the jurisdiction of the Inquisition, and the Inquisition could act without consulting the pope. The grand inquisitor of France, William of Paris, was Philip's confessor and creature. The way was thus open for the king to carry out his plan by a perfectly legal method. His informers denounced the Templars to the Inquisition, and the grand inquisitor—as was the customary procedure in the case of persons accused of heresy—demanded their arrest by the civil power. On the 14th of September 1307, accordingly, Philip issued writs to his *baillis* and seneschals throughout the kingdom, directing them to make preparations to arrest the members of the order on the following 13th of October.

The Templars had for some time past been aware of the charges against them. On the 6th of June 1306 Pope Clement had summoned Jacques de Molay, the grand master, from Cyprus to France, in order to consult him on the projected crusade. He had obeyed the call, and, in an interview with the pope, had taken the opportunity to demand a full inquiry. They had, however, taken no measures to defend themselves; the sudden action of the king took them wholly by surprise; and on the night of Friday, the 13th of October 1307, their arrest was effected without difficulty, Jacques de Molay himself with sixty of his brethren being seized in Paris. Next day they were haled before the university of Paris, to hear the recital of their crimes; on Sunday the populace was collected in the royal gardens, where preachers inveighed against the iniquities of the order.

Arrest of the Templars.

The Templars were caught in toils from which there was no escape. To force them to confess, they were first tortured by the royal officials, before being handed over to the inquisitors to be, if need were, tortured again. In Paris alone thirty-six died under the process.[1] The result was, at the outset, all that the king could desire. Of 138 Templars examined in Paris between the 19th of October and the 24th of November, some of them old men who had been in the order the greater part of their lives, 123 confessed to spitting on (or "near") the crucifix at their reception. Many of the prisoners, on the other hand, confessed to all the charges, however grotesque. But the most damning confession was that of the grand master himself, publicly made with tears and protestations of contrition and embodied in a letter (October 25) sent to all the Templars in France. He had been guilty, he said, of denying Christ and spitting on the cross; the grosser charges he indignantly repudiated.[2]

To the pope, meanwhile, the proceedings in France were to the highest degree unwelcome. He had, indeed, become convinced, if not of the general guilt of the order, at least of the guilt of some of its members. But the affair was one which he desired to reserve for his own judgment; Philip's action he interpreted, rightly, as an encroachment of the civil power on the privileges and property of the Church, and his fears were increased when the French king, without consulting him, sent letters to King James of Aragon, Edward II. of England, the German king Albert and other princes, calling upon them to imitate his example. On the 27th of October Clement issued letters suspending the powers of the Inquisition in France. What followed is not clear, for the documentary evidence for these months is very defective. On the 17th of November James of Aragon wrote to Philip, in answer to his letter and the report of the proceedings in Paris forwarded to him,[3] expressing his surprise at the charges against the Templars, who had done himself and his forefathers great service against the infidel, but promising to proceed against them since required to do so 'by the Church."[4] In Portugal no action was taken at all. Edward II. of England replied that he must first receive information as to the charges from his officials in Agen (whence the charges had originated), and on the 5th of December he wrote to the kings of Aragon, Castile, Portugal and Sicily begging them not to believe the evil reports against the order (Prutz, p. 159). But meanwhile, on the 22nd of November, Pope Clement had issued a bull calling on all kings and princes to arrest the Templars everywhere, his motive probably being (according to Finke) to forestall the probable action of the secular powers and keep the affair in his own hands. All scruples and hesitations now vanished. In England the Templars were arrested on the 10th of January 1308, in Sicily on the 24th of the same month, in Cyprus on the 27th of May; in Aragon and Castile the process was less easy, for the knights, forewarned, had put their fortresses into a state of defence, notably their strong castle of Monzon, which was only taken after a long siege on the 17th of May, while the last of the Templars' strongholds, Castellat, did not fall until the 2nd of November.[5]

Meanwhile, on the 26th of May, Philip had made his solemn entry into Poitiers, where the pope and cardinals had already assembled for the purpose of conferring with the king on the matter. The debates that followed were protracted and stormy; but Philip was in a positon to back his argument for the suppression of the order by pressing other and more dangerous claims: the canonization of Celestine V., the condemnation of Boniface VIII. for heresy, the absolution of Guillaume de Nogaret, the executer of the outrage at Anagni, the summoning of a general council, the settlement of the papacy at Avignon. At last, on the 27th of June, an arrangement was come to. The king agreed to hand over to the papal commissioners the property[6] and persons of the Templars; Clement, for his part, withdrew the sentence of suspension against the grand inquisitor of France (July 5) and ordered an inquisition into the charges against individual Templars by the diocesan bishops with assessors nominated by himself. The examination of the grand master, of the grand visitor of France, and of the grand preceptors of Cyprus, Normandy and Aquitaine he reserved to himself. Inquisition was to be made into the conduct of the order in each country by special papal commissions; and the fate of the order as a whole was to be decided by a general council.[7]

These decisions were at once acted on. At Poitiers Clement had already heard the confessions of seventy-two Templars, carefully selected from the royal prisons (June 29 to July 1).[8] The grand master and the three preceptors were re-examined at Chinon, and renewed their old confessions (20th August). Lastly, the bull *Regnans in Coelo* summoned a great council at Vienne for the 1st of October 1311, when the question of the guilt of the order might be considered. Meanwhile the pope and cardinals had elaborated the organization of the new inquisition. In this the actual inquisitors, though admitted, played a quite subordinate part: the commissions centred round the diocesan bishops, who had as assessors prelates, abbots, priors and canonists. These commissions were twofold, usually—though erroneously—distinguished as papal and episcopal (both were in fact papal); the first were charged with the inquisition into the accusations against the order itself and the grand preceptors of the various countries, the second with

[1] Michelet, *Procès*, i. 36.

[2] Jacques de Molay's confession was partly due to fear of torture, partly to secure the withdrawal of a specific charge of unnatural crime brought against him by the Templar Guillaume de Giac (Gmelin ii., *Tab.* i. No. 12). But he continued to demand access to the pope, declaring that he could satisfactorily explain the practices of the order.

[3] Text in Finke ii. The writer, Romeus de Brugaria, of the university of Paris, boldly declares that the proceedings were taken *domini papae assensu precedente.*

[4] Text in Finke ii. 55.

[5] Finke i. 302 ff. Some of the Spanish Templars turned Mahommedan and joined the king of Granada in an invasion of Aragon (Finke ii. 188, No. 105).

[6] This was to be devoted to the cause of the Holy Land. In fact its administration fell into the hands of Philip's confidants and the greater part remained in his possession (Finke i. 227).

[7] For a detailed account of the negotiations see Finke i. 200 ff. He holds that Clement, though now convinced of the Templars' guilt, was anxious to treat them leniently and, if possible, to save the order (p. 215).

[8] See Gmelin ii., *Tab.* vii. and viii.

that into the accusations against individual Templars. The papal commission in Paris began its sessions on the 9th of August 1309; on the 12th, citations were issued to those Templars who "of their own free will" were prepared to come and defend the order. There was much confusion and delay, however, and the actual public trial did not begin till the 11th of April 1310.[1] Many Templars, trusting in the assurance implied in their citation, had volunteered to defend the order and withdrew their previous confessions. They were soon undeceived; the commission, presided over by the *garde des sceaux* of the king, the archbishop of Narbonne, was packed with creatures of the crown. The evidence given in Paris for or against the order was, it was soon found, used against the individual Templars on their return to the provinces; the retractation of a confession, under the rules set up for the diocesan inquisition, was punished with death by fire. On Tuesday the 12th of May, fifty-four Templars who had retracted their confessions before the commission were burnt in Paris by order of the archbishop of Sens;[2] a few days later four were burnt at Senlis, and towards the end of May nine more, by order of the archbishop of Reims. Forty-six Templars now withdrew their defence, and the commissioners in Paris decided (30th May) to adjourn till November. The second examination lasted from the 17th of December 1310 to the 16th of May 1311. Meanwhile (*c.* April 1311) Clement and Philip had come to terms. The pope condemned the Templars. The council of Vienne met in October 1311. A discussion arose as to whether the Templars should be heard in their own defence. Clement, it is said, broke up the session to avoid compliance; and when seven Templars offered themselves as deputies for the defence he had them cast into prison. Towards the beginning of March Philip came to Vienne, and he was seated at the pope's right hand when that pontiff delivered his sermon against the Templars (3rd April 1312), whose order had just been abolished, not at the general council, but in private consistory (22nd March). On 2nd May 1312 he published the bull *Ad Providam*, transferring the goods of the society, except for the kingdoms of Castile, Aragon, Portugal and Majorca, to the Knights of St John. The order was never formally pronounced guilty of the crimes laid to its charge; its abolition was distinctly, in the terms of Clement's bull *Considerantes Dudum*, "non per modum definitivae sententiae, cum eam super hoc secundum inquisitiones et processus super his habitos non possemus ferre de jure sed per viam provisionis et ordinationis apostolicae" (6th May 1312).

The trial.

The final act of the stupendous tragedy came early in 1314. Jacques de Molay, the grand master, had not hitherto risen to the height of his great position; the fear of torture alone had been enough to make him confess, and this confession had been used to extract avowals from his brethren, subject as they were to unspeakable sufferings and accustomed to yield to the military chief. Humiliation on humiliation had been heaped on the wretched man, public recantations, reiterated confessions. Before the papal commission he had flamed into anger, protested, equivocated—only in the end to repeat his confession once more. The same had happened before the commission of cardinals at Chinon; the audience with the pope, which he demanded, he had never obtained. On the 6th of May 1312 Pope Clement issued his final decision as to the fate of the Templars in general; that of the five great offices of the order he reserved in his own hand. With this a silence falls over the history of the Templars;[3] the fate of the order had been decided, that of the individuals still under trial was of little interest to contemporary chroniclers. Then the veil is suddenly lifted. Jacques de Molay has found his wonted courage at last, and with him Gaufrid de Charney, the preceptor of Normandy; on the 14th of March 1314 they were brought out on to a scaffold erected in front of Notre Dame, there in the presence of the papal legates and of the people to repeat their confessions and to receive their sentence of perpetual imprisonment. Instead, they seized the opportunity to withdraw their confessions and to protest to the assembled thousands the innocence of the order. King Philip the Fair did not wait to consult the Church as to what he should do; he had them burnt "in the little island" of the Seine "between the Augustinians and the royal garden"; with them perished Guy (the Guido Delphini of the trials), the youthful son of the dauphin of Auvergne. After the deaths of the pope and king, which followed shortly, the people remembered that the grand master had summoned them with his dying breath before the judgment seat of God; but the sole recorded contemporary protest is that of the Augustinians against the trespass committed by the royal officers on their land!

On the question of the guilt or innocence of the Templars in respect of the specific charges on which the order was condemned opinion has long been divided. Their innocence was maintained by the greatest of all their contemporaries, Dante,[4] and among others by the historian Villani and by the sainted Antoninus, archbishop of Padua. In more recent times a certain heat was introduced into the discussion of the question owing to its having been for centuries brought into the arena of party controversy, between Protestants and Catholics, Gallicans and Ultramontanes, Freemasons and the Church. Thus in 1654 Pierre Du Puy, librarian of the Bibliothèque Royale, published his work on the Templars to confute those who sought to establish their innocence in order to discredit a king of France. On the other hand, Nicolas Gurtler published his *Historia Templariorum* (Amsterdam, 1691, 2nd ed. 1703) to show, as a good Protestant, that the Templars had the usual vices of Roman Catholics, while, according to Loiseleur, the later editors of Du Puy (especially of the 1751 edition,[5] ostensibly printed at Brussels) were Freemasons who, under false names, garbled the old material and inserted new in the interests of the supposed origin of their own order in that of the Templars.[6] Several Roman Catholic champions of the order now entered the field, *e.g.* the Benedictine historian of Languedoc, Dom Dominique Joseph Vaissète, and notably the Premonstratensian canon R. P. M. Jeune, prior of Etival, who in 1789 published at Paris his *Histoire critique et apologétique de l'ordre des chevaliers . . . dits Templiers*, a valuable work directed specifically against Gurtler and Du Puy. In the 19th century a fresh impetus was given to the discussion by the publication in 1813 of Raynouard's brilliant defence of the

[1] This was, of course, only one of some twenty-five separate commissions in different countries. It was, however, the most important and is the best known.

[2] Philippe de Marigny, brother of Enguerrand de Marigny, the king's minister, had been appointed archbishop of Sens at Philip IV.'s instance in April, and was naturally full of zeal for the royal cause. The condemned Templars appealed to the papal commission, which was sympathetic, but replied that it had no authority to interfere with the archbishop's ordinary jurisdiction. (Raynouard, p. 92.)

[3] Finke devotes an interesting chapter to tracing what became of the property of the order and of the individual Templars. The property was nominally handed over to the Hospitallers, but most of it actually remained in the hands of the sovereigns or their followers (Philip, *e.g.*, claimed a vast sum for the expenses incurred in suppressing the order and torturing its members). In the Spanish peninsula the Temple castles and estates were in some cases handed over to other military orders; in Portugal to the new order of Christ, 1319; in Castile to those of Ucles and Calatrava; in Aragon one frontier castle with its domain, Montasia, was given to the knights of Calatrava; the rest—so far as they had not been annexed by the king and the *ricos hombres*—to the Hospitallers. As to the Templars: they were granted in most cases generous pensions; some continued to live in groups, though without organization, on their old property; others joined various orders; many married, on the plea that the suppression of the order had released them from their vows; while others, again, took service with the Moors in Africa. (Finke, i. cap. x.)

[4] Veggio il nuovo, Pilato si crudele,
Che ciò nol sazia, ma, senza decreto,
Porta nel tempio le cupide vele.—(*Purg.* xx. 92.)

[5] *Histoire de l'ordre militaire des templiers, &c.* The titles of the various editions differ.

[6] There is, of course, no foundation whatever for this claim. It is examined and refuted, *inter alios*, by Wilcke, iii. 383 seq. A delightfully absurd attempt to assert the continuity of the modern Order of Knights Templars, which still has a considerable organization in the United States, with the suppressed order, is made by Jeremy L. Cross in *The Templars' Chart* (New York, 1845); he actually gives a complete list of grand masters from Hugues de Payns to Sir Sidney Smith (1838), and asserts that "the Encampment of Baldwin which was established at Bristol by the Templars who returned with Richard I. from Palestine, still continues to hold its regular meetings, and is believed to have preserved the ancient costume and ceremonies of the order."

order.[1] The challenge was taken up, among others, by the famous orientalist Friedrich von Hammer-Purgstall, who in 1818 published his *Mysterium Baphometis revelatum*,[2] an attempt to prove that the Templars followed the doctrines and rites of the Gnostic Ophites, the argument being fortified with reproductions of obscene representations of supposed Gnostic ceremonies and of mystic symbols said to have been found in the Templars' buildings. Wilcke, while rejecting Hammer's main conclusions as unproved, argued in favour of the existence of a secret doctrine based, not on Gnosticism, but on the unitarianism of Islam, of which Baphomet (Mahomet) was the symbol.[3] On the other hand, Wilhelm Havemann (*Geschichte des Ausganges des Tempelherrenordens*, Stuttgart and Tübingen, 1846) decided in favour of the innocence of the order. This view was also taken by a succession of German scholars, in England by C. G. Addison, and in France by a whole series of conspicuous writers: *e.g.* Mignet, Guizot, Renan, Lavocat. Others, like Boutaric,[4] while rejecting the charge of heresy, accepted the evidence for the *spuitio* and the indecent kisses, explaining the former as a formula of forgotten meaning and the latter as a sign of *fraternité!* Michelet, who in his history of France had expressed himself favourably to the order, announced his conversion to the opposite opinion in the prefaces to his edition of the *Procès*. This view was reinforced by the work in which Loiseleur endeavoured to prove that the order had secretly rejected Christianity in favour of an heretical religion based on Gnostic dualism as taught by the Cathari;[5] it was crowned with the high authority of Ranke in the great *Weltgeschichte* (8 Theil, 1887, p. 621 ff.); it has been adopted in the later *Weltgeschichte* of Weber (8 Theil, 1887, p. 521 ff.). The greatest impulse to this view was, however, given by the brilliant contributions of Hans Prutz. The first of these, the *Geheimlehre*, in the main an expansion of Loiseleur's argument, at once raised up a host of critics; and, as a result of five years' study of the archives at Rome and elsewhere, Konrad Schottmüller published in 1887 his *Untergang des Templerordens*, in which he claimed to have crushed Prutz's conclusions under the weight of a mass of new evidence. The work was, however, uncritical and full of conspicuous errors, and Prutz had little difficulty in turning many of its author's arguments against himself. This was done in the *Entwicklung und Untergang des Tempelherrenordens* (1888), in which, however, Prutz modifies his earlier views so far as to withdraw his contention that the Templars had a "formally developed secret doctrine," while maintaining that the custom of denying Christ and spitting on the cross was often, and in some provinces universally, practised at the reception of the brethren, "as a coarse test of obedience, of which the original sense had partly been forgotten, partly heretically interpreted under the influence of later heresies."[6] This view was maintained by Mr T. A. Archer in the 9th ed. of the *Encyclopaedia Britannica*. It was criticized and rejected by Döllinger in the last of his university lectures (19th Nov. 1889), and by Karl Wenck in several articles in the *Göttinger Gelehrte Anzeigen;* and it was further attacked by J. Gmelin (*Schuld oder Unschuld*, 2 Bd. 1893), whose work, in spite of its somewhat ponderous polemic, is valuable as a mine of learning and by reason of the sources (notably the tables of the evidence taken at the trials) which it publishes. H. C. Lea, in his *History of the Inquisition* (1888, vol. iii.), had already come independently to the conclusion that the Templars were innocent. Lastly appeared the fascinatingly interesting and closely reasoned book of Professor H. Finke (1907) which, based partly on a mass of new material drawn from the Aragonese archives, had for its object to supplement the work of Gmelin and to establish the innocence of the order on an incontrovertible basis.

[1] F. J. M. Raynouard, *Monuments historiques, relatifs à la condamnation des chevaliers du Temple*, &c. (Paris, 1813).

[2] In vol. vi. of *Fundgruben des Orients* (Vienna, 1818). In reply to his critics Hammer published in 1855 his "Die Schuld der Templer" (*K. Akad. zu Wien Denkschrift.*, vi.), in which he reproduced drawings of two remarkable caskets, sculptured with Gnostic pictures, from the former collection of the duc de Blacas, said to have been found on the sites of Temples. To the present writer the evidence that any of these objects had been connected with the Templars seemed singularly unconvincing even before he had seen the trenchant criticisms of Wilcke (ii. 290, ed. 1862, Beilage 22) and Loiseleur (*Doctrine secrète*, 4me partie, p. 97 seq.). If such objects existed, why were none brought up as evidence against the Templars at their trial?

[3] Wilhelm Ferdinand Wilcke, *Geschichte des Tempelherrenordens* (3 vols. Leipzig, 1826 ff., 2nd ed., enlarged and revised 1860).

[4] Edgard Boutaric, *La France sous Philippe le Bel* (Paris, 1861), pp. 140 seq.

[5] J. Loiseleur, *La Doctrine secrète des Templiers* (Orleans, 1872).

[6] Prutz points out, with much truth, that the failure of the Crusades had weakened men's absolute belief in Christianity, at least as represented by the medieval Church (*Kulturgeschichte der Kreuzzüge*, p. 268 ff.). Walther von der Vogelweide had merely accused the archangels of neglecting their duty (Pfeiffer's ed. 1880, p. 288); a Templar minstrel complained that God Himself had fallen asleep! (Prutz, *Tempelherrenorden*, 126.)

In the opinion of the present writer, the defenders of the order have proved their case. Even the late Mr Archer, who took the contrary view, was inclined to restrict it to the Templars in France. "The opinion that the monstrous charges brought against the Templars were false," he wrote (*Ency. Brit.*, 9th ed. xiii. 164), "and that the confessions were only extracted by torture is supported by the general results of the investigation (in almost every country outside France), as we have them collected in Raynouard, Labbe, and Du Puy. In Castile, where the king flung them into prison, they were acquitted at the council at Salamanca. In Aragon, where they held out for a time in their fortresses against the royal power, the council of Tarragona proclaimed in their favour (4th November 1312). In Portugal the commissioners reported that there were no grounds for accusation. At Mainz the council pronounced the order blameless. At Treves, at Messina, and at Bologna, in Romagna and in Cyprus, they were either acquitted or no evidence was forthcoming against them. At the council of Ravenna the question as to whether torture should be used was answered in the negative except by two Dominicans; all the Templars were absolved—even those who had confessed through fear of torture being pronounced innocent (18th June 1310). Six Templars were examined at Florence, and their evidence is for its length the most remarkable of all that is still extant. Roughly speaking, they confess with the most elaborate detail to every charge,—even the most loathsome; and the perusal of their evidence induces a constant suspicion that their answers were practically dictated to them in the process of the examination or invented by the witnesses themselves.[7] In England, where perhaps torture was not used, out of eighty Templars examined only four confessed to the charge of denying Christ, and of these four two were apostate knights. But some English Templars would only guarantee the purity of their own country. That in England as elsewhere the charges were held to be not absolutely proved seems evident from the form of confession to be used before absolution, in which the Templars acknowledge themselves to be defamed in the matter of certain articles that they cannot purge themselves. In England nearly all the worst evidence comes at second or third hand or through the depositions of Franciscans and Dominicans," *i.e.* the rivals and enemies of the order. But what is the nature of the evidence "too strong to be explained away" on which Mr Archer bases his opinion that certain of the charges were proved "at least in France"? The modern practice of the English courts tends to discount altogether the value as evidence of confessions, even freely made. What is the value of these confessions of the Templars which lie before us in the Tables published by Gmelin? The procedure of the Inquisition left no alternative to those accused on "vehement suspicion" of heresy, but confession or death under lingering torture; to withdraw a confession meant instant death by fire. The Templars, for the most part simple and illiterate men, were suddenly arrested, cast separately into dark dungeons, loaded with chains, starved, terrorized, and tortured. They were told the charges to which their leaders had confessed, or were said to have confessed: to repeat the monotonous formula admitting the *spuitio super crucem* and the like was to obtain their freedom at the cost of a comparatively mild penance. The wonder is not that so many confessed, but that so many persisted in their denial. The evidence, in short, is, from the modern point of view, wholly worthless, as even some contemporaries suspected it to be.

A word must be added as to the significance of the work of the Templars and of the manner of their fall in the history of the world. Two great things the order had done for European civilization: in the East and in Spain it had successfully checked the advance of Islam; it had deepened and given a religious sanction to the idea of the chivalrous man, the *homo legalis*, and so opened up, to a class of people who for centuries to come were to exercise enormous influence, spheres of activity the beneficent effects of which are still recognizable in the world.[8] On the other hand, the destruction of the Templars had three consequences fateful for Christian civilization: (1) It facilitated the conquests of the Turks by preventing the Templars from playing in Cyprus the part which the Knights of St John played in Malta.[9] (2) It partly set a precedent for, partly confirmed, the cruel criminal procedure of France, which lasted to the Revolution. (3) It set the seal of the highest authority on the

[7] See the evidence in full, ap. Loiseleur, pp. 172–212.

[8] G. Schnürer, quoted in Finke, i. 1.

[9] In his essay on the Templars (*The Spanish Story of the Armada and other Essays*, 1892) Froude says that the order lacked "the only support that never fails—some legitimate place among the useful agencies of the time." Was there no use for them against the advancing tide of Turkish conquest in the East? Or in Spain against the Moorish powers? If not, why did the Hospitallers survive? Froude's contribution is but a popular lecture, however, and, for all its beauty of style, characteristically careless (*e.g.* such mistakes as Hugh *von* Peyraud, Esquin *von* Florian).

popular belief in witchcraft and personal intercourse with the devil, sanctioned the expedient of wringing confessions of such intercourse from the accused by unspeakable tortures, and so made possible the hideous witch-persecutions which darkened the later middle ages and, even in Protestant countries, long survived the Reformation. "If I were to name a day in the whole history of the world," said Döllinger at the conclusion of his last public lecture, "which appears to me in the truest sense as a *dies nefastus*, I should be able to name no other than the 13th of October 1307."[1]

AUTHORITIES.—A great mass of original sources has now been published. Those given by Du Puy, though often valuable, were selected and edited with a purpose, as Jeune pointed out. A new departure was made with the publication of Michelet's *Procès des Templiers* (t. i. 1851, t. ii. 1861), an edition of the original minutes of the trial preserved at the Bibliothèque Nationale (it is specially interesting as the earliest complete and detailed record of a criminal trial in existence). This is elaborately analysed and the results tabulated in vol. ii. of Gmelin. Of documents published in other works the most important collections are those in Schottmüller (mainly from the Vatican Archives) and Finke (Aragonese Archives). The Rule of the Temple has been several times published; the most accessible edition, giving the various Rules with critical commentary, is that of H. de Curzon, *La Règle du Temple* (Paris, 1886); see also Maillard de Chambure, *Règle et statuts secrets des Templiers, préc. de l'hist. de cette ordre* (Dijon—Paris, 1840).

A comprehensive bibliography of works is given by Ulysse Chevalier in his *Répertoire des sources hist. Topo-biblio-graphie*, s.v. "Templiers." Of the works not fully indicated in the text must be mentioned M. Lavocat, *Procès des frères et de l'ordre du Temple* (Paris, 1888); G. Schnürer, *Die ursprüngliche Templerregel* (1903); H. Finke, *Papsttum und Untergang des Templerordens* (Münster,-i.-W., 1907); C. G. Addison, *The Knights Templars* (London, 3rd ed. 1854), which contains a valuable account of the suppression of the order in England. For the order and its suppression in Ireland see Herbert Wood, "The Templars in Ireland," in *Proceedings of the Royal Irish Academy*, vol. xxvi. Section c. p. 327 (Dublin, 1906–1907). (W. A. P.)

TEMPLE, FREDERICK (1821–1902), English divine, archbishop of Canterbury, was born in Santa Maura, one of the Ionian Islands, being the son of Major Octavius Temple, who was subsequently appointed lieutenant-governor of Sierra Leone. On his retirement he settled in Devonshire as a small landowner, and contemplated a farming life for his son Frederick, giving him a practical training to that end. But the boy was sent to Blundell's School, Tiverton, and soon exhibited abilities which marked him out for a different career. He retained through life a warm affection for the school, where he did well both in the classes and the games, and was famous as a walker. His father's means were narrow, and the boy knew that he must win his own way in life. He took the first important step in that way by winning a scholarship at Balliol College, Oxford, before he was quite seventeen years old. The "Tractarian Movement" had set in five years earlier, but the memorable tract, No. 90, had not yet been written, and Temple entered a university which was vibrating with intellectual and religious excitement. After much discussion and reflection he drew closer to the camp of "the Oxford Liberal Movement." In 1842 he took a "double-first" and was elected fellow of Balliol, and lecturer in mathematics and logic. Four years later he took orders, and with the aim of helping forward the education of the very poor, he accepted the headship of Kneller Hall, a college which the government formed for the training of masters of workhouse and penal schools. But the experiment was not altogether successful, and Temple himself advised its abandonment in 1855. He then accepted a school-inspectorship, which he held until he went to Rugby in 1858. In the meantime he had attracted the admiration of the prince consort, and in 1856 he was appointed chaplain-in-ordinary to the queen. In 1857 he was select preacher at his university.

At Rugby Dr Arnold had died in 1842 and had been succeeded by Dr Tait, who again was followed by Dr Goulburn. Upon the resignation of the latter the trustees appointed Temple, who in that year (1858) had taken the degrees of B.D. and D.D. His life at Rugby was marked by great energy and bold initiative. Whilst making the school a strong one on the classical side, he instituted scholarships in natural science, built a laboratory, and gave importance to that side of the school work. He had the courage also to reform the games, in spite of all the traditions of the playing fields. His own tremendous powers of work and his rugged manner somewhat alarmed his boys at first, but his popularity was soon undisputed, and he brought up the school to a very high level. His school sermons were deeply impressive: they rooted religion in the loyalties of the heart and the conscience, and taught that faith might dwell secure amid all the bewilderments of the intellect, if only the life remained rooted in pure affections and a loyalty to the sense of duty. It was two years after he had taken up his work at Rugby that the volume entitled *Essays and Reviews* gave rise to an extraordinary storm. The first essay in the book, "The Education of the World," was by Dr Temple. It was declared in a prefatory note to the volume that the authors were responsible only for their respective articles, but some of these were deemed so destructive that many people banned the whole book, and a noisy demand, led by Samuel Wilberforce, then bishop of Oxford, called on the headmaster of Rugby to dissociate himself from his comrades. Temple's essay had treated of the intellectual and spiritual growth of the race, and had pointed out the contributions made respectively by the Hebrews, the Egyptians, the Greeks, the Romans, and others. It was generally declared by the critics of the volume to be in itself harmless, but was blamed as being found in bad company. Temple refused, so long as the storm lasted, to comply with the request that he would repudiate his associates, and it was only at a much later date (1870) that he saw fit quietly to withdraw his essay. In the meantime, however, he printed a volume of his Rugby sermons, to show definitely what his own religious positions were.

In politics Temple was a follower of Mr Gladstone, and he approved of the disestablishment of the Irish Church. He also wrote and spoke in favour of Mr Forster's Education Act, and was an active member of the Endowed Schools Commission. In 1869 Mr Gladstone offered him the deanery of Durham, but this he declined on the ground of his strong interest in Rugby. When later in the same year, however, Henry Phillpotts, bishop of Exeter, died, the prime minister turned again to Temple, and he accepted the bishopric of that city so dear to him from boyhood, and left Rugby for a home amongst his own people. The appointment, however, raised a fresh storm.

G. A. Denison, archdeacon of Taunton, Lord Shaftesbury, and others formed a strong committee of protest, whilst Pusey declared that "the choice was the most frightful enormity ever perpetrated by a prime minister." At the confirmation of his election counsel was instructed to object to it, and in the voting the chapter was divided. But Gladstone stood firm, and Temple was duly consecrated on the 21st of December 1869. There were at first murmurings among his clergy against what they deemed his harsh control, but his real kindness soon made itself felt, and, during the sixteen years of his tenure of the see, his sound and vigorous rule dissipated the prejudices against him, so that when, on the death of Dr John Jackson in 1885, he was translated to London, the appointment gave general satisfaction. In 1884 he was Bampton Lecturer, taking for his subject "The Relations between Religion and Science." In 1885 he was elected honorary fellow of Exeter College, Oxford.

Dr Temple's tenancy of the bishopric of London was marked, if possible, by more strenuous labours than ever. His normal working day at this time was one of fourteen or fifteen hours, and he refused to spare himself one hour of toil, though under the strain blindness was rapidly coming on. He was still felt by many of his clergy and by candidates for ordination to be a rather terrifying person, and to enforce almost impossible standards of diligence, accuracy and preaching efficiency, but his manifest devotion to his work and his zeal for the good of the people rooted him deeply in the general confidence. In London he was not less conspicuous as a temperance worker than he had been in Exeter, and the artisan classes instinctively

[1] Döllinger, *Akademische Vorträge* (Munich, 1891), ix. "*Der Untergang des Templerordens.*"

recognized him as their friend. When, in view of his growing blindness, he offered to resign the bishopric, he was induced to reconsider his proposal, and on the sudden death of Archbishop Benson in 1896, though now seventy-six years of age, he accepted the see of Canterbury.

As archbishop he presided in 1897 over the decennial Lambeth Conference. In the same year Dr Temple and his brother archbishop issued an able reply to an encyclical of the pope which denied the validity of Anglican orders. In 1900 the archbishops again acted together, when an appeal was addressed to them by the united episcopate, to decide the vexed questions of the use of incense in divine service and of the reservation of the elements. After full hearing of arguments they gave their decision against both the practices in question. During his archbishopric Dr Temple was deeply distressed by the divisions which were weakening the Anglican Church, and many of his most memorable sermons were calls for unity. His first charge as primate on "Disputes in the Church" was felt to be a most powerful plea for a more catholic and a more charitable temper, and again and again during the closing years of his life he came back to this same theme. He was zealous also in the cause of foreign missions, and in a sermon preached at the opening of the new century he urged that a supreme obligation rested upon Britain at this epoch in the world's history to seek to evangelize all nations. In 1900 he presided over the World Temperance Congress in London, and on one occasion preached in the interests of women's education. In 1902 he discharged the important duties of his office at the coronation of King Edward VII., but the strain at his advanced age told upon his health. During a speech which he delivered in the House of Lords on the 2nd of December 1902 on the Education Bill of that year, he was seized with sudden illness, and, though he revived sufficiently to finish his speech, he never fully recovered, and died on the 23rd of December 1902. He was interred in Canterbury cathedral four days later. His second son, William Temple (b. 1881), who had a distinguished career at Oxford, was in 1910 appointed headmaster of Repton.

See Archdeacon E. G. Sandford, *Frederick Temple: an Appreciation* (1907), with biographical introduction by William Temple; *Memoirs of Archbishop Temple*, by "Seven Friends," ed. E. G. Sandford (1906).

TEMPLE, SIR RICHARD, Bart. (1826–1902), English administrator, a descendant in the female line of the Temples of Stowe, was born on the 8th of March 1826, and after being educated at Rugby and Haileybury, joined the Bengal Civil Service. His industry and ready pen soon obtained appreciation, and after acting as private secretary for some years to John Lawrence in the Punjab, and gaining useful financial experience under James Wilson, he was appointed Resident at Haidarabad. In 1867 he was made K.C.S.I. In 1868 he became a member of the supreme government, first as foreign secretary and then as finance minister; and he did admirable work during the famine of 1874, in the course of which he was made lieutenant-governor of Bengal. His services were recognized by the bestowal of a baronetcy in 1876. In 1877 he was made governor of Bombay, and his activity during the Afghan War of 1878–80 was untiring. In 1880 he left India to enter on a political career in England, but it was not till 1885 that he was returned as a conservative for the Evesham division of Worcestershire. Meanwhile he produced several books on Indian subjects. In parliament he was assiduous in his attendance, and he spoke on Indian subjects with admitted authority; but he was not otherwise a parliamentary success, and to the public he was best known by the caricatures in *Punch*, which exaggerated his physical peculiarities and made him look like a lean and hungry tiger. In 1885 he became vice-chairman of the London School Board, and as chairman of its finance committee he did useful and congenial work. In 1892 he changed his constituency for the Kingston division, but in 1895 he retired from parliament, being in 1896 made a Privy Councillor. He had kept a careful journal of his parliamentary experiences, intended for posthumous publication; and he himself published a short volume of reminiscences. He died at Hampstead on the 15th of March 1902. He was twice married, and left a daughter and three sons, all of the latter distinguishing themselves in the public service.

TEMPLE, RICHARD GRENVILLE-TEMPLE, 1st Earl (1711–1779), English statesman, eldest son of Richard Grenville (d. 1727) of Wootton, Buckinghamshire, was born on the 26th of September 1711. His mother was Hester (*c.* 1690–1752), daughter, and ultimately heiress, of Sir Richard Temple, Bart. (1634–1697), of Stowe, Buckinghamshire,[1] and sister of Richard Temple, Viscount Cobham, whose title she inherited under a special remainder in 1749; in the same year, her husband having been long dead, she was created Countess Temple. Her son, Richard Grenville, was educated at Eton, and in 1734 was returned to parliament as member for the borough of Buckingham. In 1752, on the death of his mother, he inherited her titles together with the rich estates of Stowe and Wootton; and he then took the name of Temple in addition to his own surname of Grenville. The turning point in his political fortunes was the marriage of his sister Hester in 1754 to William Pitt, afterwards earl of Chatham. Although Lord Temple was a man of little ability and indifferent character, Pitt persistently linked his own career with that of his brother-in-law. In November 1756 Temple became first lord of the admiralty in the ministry of Devonshire and Pitt. He was intensely disliked by George II., who dismissed both him and Pitt from office in April 1757. But when the memorable coalition cabinet of Newcastle and Pitt was formed in June of the same year, Temple received the office of privy seal. He alone in the cabinet supported Pitt's proposal to declare war with Spain in 1761, and they resigned together on the 5th of October. From this time Temple became one of the most violent and factious of politicians, and it is difficult to account for the influence, wholly evil, which he exerted over his illustrious brother-in-law. He himself is said to have avowed that "he loved faction, and had a great deal of money to spare." He was at variance with his younger brother, George Grenville, when the latter became first lord of the treasury in April 1763, and he had no place in that ministry; but the brothers were reconciled before 1765, when Temple, who probably aimed at forming a ministry mainly confined to his own family connexions, refused to join the government, and persuaded Pitt to refuse likewise. A few weeks later the king offered the most liberal terms to induce Pitt to form or join an administration; and "a ministry directed by that great statesman," says Lecky, "would have been beyond all comparison the most advantageous to the country; it had no serious difficulty to encounter, and Pitt himself was now ready to undertake the task, but the evil genius of Lord Temple again prevailed. Without his co-operation Pitt could not, or would not proceed, and Temple absolutely refused to take office even in the foremost place." Pitt's continued refusal to join the first Rockingham administration was no doubt partly due to the same disastrous influence, though before the close of 1765 the old friendship between the brothers-in-law was dissolving; and when at last in July 1766 Pitt consented to form a government, Temple refused to join; being bitterly offended because, although offered the head of the treasury, he was not to be allowed an equal share with Pitt in nominating to other offices. Temple forthwith began to inspire the most virulent libels against Pitt; and in conjunction with his brother George he concentrated the whole Grenville connexion in hostility to the government. After George Grenville's death in 1770 Lord Temple retired almost completely from public life. He died on the 12th of September 1779.

[1] The Temple family belonged originally to Leicestershire, where, at Temple Hall, the elder line had resided since the 14th century. Peter Temple (1600–1663), the regicide, was a member of this elder line; a younger branch had settled in Oxfordshire and passed thence to Buckinghamshire, where John Temple purchased Stowe in 1589. This John was brother of Anthony, who was great-grandfather of Sir William Temple, the famous statesman. John Temple's son Thomas, who was created a baronet in 1611, was the great-grandfather of Earl Temple.

Lord Temple was entirely without statesmanship; he possessed an insatiable appetite for intrigue, and is said to have been the author of several anonymous libels, and the inspirer of many more. Macaulay's well-known comparison of him with a mole working below "in some foul, crooked labyrinth whenever a heap of dirt was flung up," which perpetuates the spleen of Horace Walpole, perhaps exceeds the justice of the case; but there can be no question that Temple's character as a public man was rated very low by his contemporaries. In private life he used his great wealth with generosity to his relations, friends and dependents. Pitt was under pecuniary obligation to him. He paid the costs incurred by Wilkes in litigation, and he provided the agitator with the freehold qualification which enabled him to stand for Middlesex in the famous election of 1768.

In addition to the estates he inherited, Temple gained a considerable fortune by his marriage in 1737 with Anne, daughter and co-heiress of Thomas Chambers of Hanworth, Middlesex; a volume of poems by her was printed at the Strawberry Hill press in 1764. The only issue of the marriage being a daughter who died in infancy, Temple was succeeded in the earldom by his nephew George (1753–1813), second son of George Grenville the prime minister, who then assumed in addition to the name of Grenville not only the name of Temple, but also that of Nugent, his wife being daughter and co-heiress of Robert, Viscount Clare, afterwards Earl Nugent. The 2nd Earl Temple was lord-lieutenant of Ireland in 1782–3; in 1784 was created marquess of Buckingham; and was again lord-lieutenant of Ireland in 1787–9.

His son and successor, Richard Temple-Nugent-Brydges-Chandos-Grenville (1776–1839), was created duke of Buckingham and Chandos in 1822, his wife being only daughter of the 3rd duke of Chandos; he was in the same patent created Earl Temple of Stowe, with special remainder as regards this title, in virtue of which, on the death without male issue in 1889 of the 3rd duke of Buckingham and Chandos and the consequent extinction of the original earldom of Temple, the title of Earl Temple of Stowe devolved upon William Stephen Gore-Langton (1847–1902), whose mother was granddaughter of the 1st duke of Buckingham, grantee of this earldom. In 1902 Algernon William Stephen Temple-Gore-Langton (b. 1871) became 5th Earl Temple.

See *The Grenville Papers* (London, 1852), a considerable portion of which consists of Earl Temple's correspondence; Horace Walpole, *Memoirs of the Reign of George II.*, 3 vols. (London, 1847); *Memoirs of the Reign of George III.*, 4 vols. (London, 1845 and 1894); Earl Waldegrave, *Memoirs 1754–8* (London, 1821); Sir N. W. Wraxall, *Historical Memoirs*, edited by H. B. Wheatley, 5 vols. (London, 1884); *Correspondence of Chatham*, edited by W. S. Taylor and J. H. Pringle, 4 vols. (London, 1838–40); W. E. H. Lecky, *History of England in the Eighteenth Century*, vols. ii. and iii. (7 vols., London, 1892). (R. J. M.)

TEMPLE, SIR WILLIAM, Bart. (1628–1699), English statesman, diplomatist, and author, was born in London, and came of an old English family, but of the younger branch of it, which had for some time been settled in Ireland. He was the eldest son of Sir John Temple (1600–1677), Irish master of the rolls, whose father was Sir William Temple (1555–1627), provost of Trinity College, Dublin. His mother was Mary Hammond. Temple received a liberal education, calculated to produce that moderation of judgment for which he was afterwards remarkable. He was first a pupil of his uncle Dr Henry Hammond, the divine, after which he went to the grammar-school at Bishop Stortford, and then to the Puritan college of Emmanuel at Cambridge, where he came under the influence of Cudworth. At the commencement of the civil troubles his father embraced the popular cause and was deprived of his office. Coming to England, he sat in the Long Parliament as member for Chichester, and was one of the recalcitrant members turned out by Colonel Pride. Before this event happened his son had left Cambridge, without taking a degree, and in 1647 started to travel abroad. In the Isle of Wight, while on his way to France, he fell in with Dorothy Osborne, and won her affections. Her father, Sir Peter Osborne, was governor of Guernsey and a Royalist. Her family were opposed to the match, and threw difficulties in the way, which hindered its consummation for seven years. During this period Temple travelled in France, Spain, Holland, and other countries, gaining knowledge of the world and keeping up a constant correspondence with his betrothed. At length, apparently in 1654, the difficulties were surmounted and the marriage took place. In 1655 Temple and his wife went to Ireland. The next five years were spent in the house of Sir John Temple, who had made his peace with Cromwell, and had resumed his official position. His son took no part in politics, but lived the life of a student and a country gentleman.

The accession of Charles II. rescued Temple, like many others, from obscurity. In 1660 he sat in the convention parliament at Dublin as member for Carlow, and he represented the same county along with his father in the regular parliament that followed. After a short visit to England in 1661, as commissioner from the Irish parliament, he finally removed thither in 1663. There he attached himself to Arlington, secretary of state, and two years later received his first employment abroad. It was in March 1665 that the disastrous war with the United Netherlands began. Charles II. was anxious to obtain allies, especially as Louis XIV. was taking up a hostile attitude. At this juncture Christoph Bernhard van Galen, bishop of Münster, sent an envoy to England, offering to attack the Dutch if the English government would supply the means. Temple was sent over to negotiate a treaty, and in this business gave evidence not only of the diplomatic skill but of the peculiar candour and frankness for which he was afterwards so distinguished. He was successful in making the treaty, but it was rendered ineffectual by the declaration of war by France, the threats of Louis, and the double-dealing of the prelate, who, after receiving a great part of the subsidy, made a separate peace with the Netherlands. As a reward for his services Temple was created a baronet, and in October 1665 became the English representative at the viceregal court at Brussels. While the war continued, Temple's duties consisted chiefly in cultivating good relations with Spain, which was a neutral in the quarrel between England and the Dutch, but was threatened by the claims of Louis XIV. on the Spanish Netherlands. Louis's designs became apparent in the spring of 1667, when he marched an army into Flanders. This event was one of those which led to the peace of Breda, and to the subsequent negotiations, which are Temple's chief title to fame. The French conquests were made at the expense of Spain, but were almost equally dangerous to the United Netherlands, whose independence would have been forfeited had Louis succeeded in annexing Flanders. While the French were taking town after town, Temple made a journey into Holland and visited De Witt. The friendship established and the community of views discovered during this interview facilitated the subsequent negotiations. Temple had for some time pressed on his government the necessity of stopping the French advance, and had pointed out the way to do so, but it was not till December 1667 that he received instructions to act as he had suggested. He at once set out for The Hague, and in January 1668 a treaty was made between England and the United Netherlands, which, being joined shortly afterwards by Sweden, became known as the Triple Alliance. It was a defensive treaty, made against the encroachments of France. Whether we regard the skill and celerity with which the negotiations were conducted or the results of the treaty, the transaction reflects great credit on Temple. The French king was checked in mid-career, and, without a blow being struck, was obliged to surrender almost all his conquests. Pepys records public opinion on the treaty by saying that it was "the only good public thing that hath been done since the king came into England."

Unfortunately the policy thus indicated was but short-lived. In taking up a hostile attitude towards France Charles's object had apparently been only to raise his price. Louis took the hint, increased his offers, and two years later the secret treaty of Dover reversed the policy of the Triple Alliance. Meanwhile Temple had developed the good understanding with the Dutch by contracting a commercial treaty with them (February 1668), and had acted as English plenipotentiary at Aix-la-Chapelle, where peace between France and Spain was made in May 1668. Shortly afterwards he was appointed ambassador at The Hague. Here he lived for two years on good terms both with De Witt and with the young prince of Orange, afterwards William III. The treaty of Dover led to Temple's recall; but the plot was not yet ripe, and Temple nominally held his post for another year. He perceived, however, that his day was over and retired to his house at Sheen. In June 1671 he received his formal dismissal. The war with the Netherlands broke out next year, and was almost as discreditable to England as that of 1665. Want of success and the growing strength of the opposition in parliament forced Charles to make peace, and Temple was brought out of his retirement to carry through the change of front. After a negotiation of three days, carried on through the medium of the Spanish ambassador, the treaty of Westminster was made (February 1674). As a recognition of his services Temple was now offered the embassy to Spain. This he declined, as well as the offer of a far more important post, that of secretary of state, but accepted instead a renewal of his embassy to The Hague, whither he went in July 1674. In the March following he was nominated ambassador to the congress at Nijmwegen; but, owing to the tortuousness of Charles's dealings, it was not till July 1676 that he entered that town. The negotiations dragged on for two years longer, for Charles was still receiving money from France, and English mediation was no more than a ruse. In the summer of 1677 Temple was summoned to England and received a second offer of the secretaryship of state, which he again declined. In the autumn of the same year he had the satisfaction of removing the last difficulties which hindered the marriage of William and Mary, an event which seemed to complete the work of 1668 and 1674. Louis still remaining obstinate in his demands, Temple was commissioned in July 1678 to make an alliance with the states, with the object of compelling France to come to terms. This treaty was instrumental in bringing about the general pacification which was concluded in January 1679.

This was Temple's last appearance in the field of diplomacy; but his public life was not yet over. A third offer of the secretaryship was made to him; but, unwilling as ever to mix himself up with faction and intrigue, he again declined. He did not, however, withdraw from politics; on the contrary, he was for a short time more prominent than ever. The state was passing through a grave crisis. Political passion was embittered by religious fanaticism. Parliament was agitated by the popish plot, and was pressing on the Exclusion Bill. The root of all the mischief lay in the irresponsibility of the cabinet to parliament and its complete subservience to the crown. To remedy this, Temple brought forward his plan for a reform of the privy council. This body was to consist of thirty members, half of whom were to be the chief officers of the crown, the other half being persons of importance, lords and commoners, chosen without reference to party. Special care was taken to select men of wealth, which Temple considered as the chief source of political influence. By the advice of this council the king promised to act. The parliament, it was supposed, would trust such a body, and would cease to dictate to the crown. The scheme was accepted by the king, but was a failure from the outset. Intended to combine the advantages of a parliament and a council, it created a board which was neither the one nor the other. The conduct of affairs fell at once into the hands of a junta of four, of whom Temple was at first one, and the king violated his promise by dissolving parliament without asking the advice of the council. Temple retired in disgust to his villa at Sheen, and appeared only occasionally at the council, where he soon ceased to exercise any influence. In 1680 he was nominated ambassador to Spain, but stayed in England in order to take his seat in parliament as member for the university of Cambridge. He took no part in the debates on the great question of the day, and acting on the king's advice declined to sit in the parliament of 1681. Early in that year his name was struck off the list of the council, and henceforward he disappeared from public life. He continued to live at Sheen till 1686, when he handed over his estate there to his son, the only survivor of seven children, and retired to Moor Park in Surrey. When William III. came to the throne Temple was pressed to take office, but refused. His son became secretary at war, but committed suicide immediately afterwards. Sir William, though occasionally consulted by the king, took no further part in public affairs, but occupied himself in literature, gardening and other pursuits. It should not be omitted that Swift lived with him as secretary during the last ten years (with one short interval) of his life. Temple died at Moor Park on the 27th of January 1699.

Temple's literary works are mostly political, and are of considerable importance. Among them may be mentioned *An Essay on the Present State and Settlement of Ireland* (1668); *The Empire, Sweden*, &c., a survey of the different Governments of Europe and their relations to England (1671); *Observations upon the United Provinces* (1672); *Essay upon the Original and Nature of Government* (1672); *Essay upon the Advancement of Trade in Ireland* (1673). Some of these were published in the first part of his *Miscellanea* (1679). In the same year apparently his *Poems* were privately printed. In 1683 he began to write his *Memoirs*. The first part, extending from 1665 to 1671, he destroyed unpublished; the second, from 1672 to 1679, was published without his authority in 1691; the third, from 1679 to 1681, was published by Swift in 1709. In 1692 he published the second part of his *Miscellanea*, containing among other subjects the essay *Upon the Ancient and Modern Learning*, which is remarkable only as having given rise to the famous controversy on the "Letters of Phalaris." His *Introduction to the History of England*, a short sketch of English history to 1087, was published in 1695. Several collections of his letters were published by Swift and others after his death.

His fame rests, however, far more on his diplomatic triumphs than on his literary work. His connexion with domestic affairs was slight and unsuccessful. He was debarred both by his virtues and his defects—by his impartiality, his honesty, and his want of ambition—from taking an active part in the disgraceful politics of his time. But in the foreign relations of his country he was intimately concerned for a period of fourteen years, and in all that is praiseworthy in them he had a principal hand. He cannot be called great, but he will be remembered as one of the ablest negotiators that England has produced, and as a public servant who, in an unprincipled age and in circumstances peculiarly open to corruption, preserved a blameless record.

See *Life and Works of Sir William Temple* (2 vols., 1720; 2nd ed., with *Life* by Lady Giffard, 1731); a more complete edition, including the *Letters*, was published in 4 vols. in 1814; Burnet, *History of his own Time*; T. P. Courtenay, *Memoirs of the Life, &c., of Sir William Temple* (2 vols., 1836); Macaulay, *Essay on Sir William Temple*; A. F. Sieveking, *Sir W. Temple and other Carolean Garden Essays*, (1908); and E. S. Lyttel, *Sir William Temple* (Stanhope Prize Essay, Oxford, 1908). (G. W. P.)

TEMPLE, a city of Bell county, Texas, U.S.A., about 35 m. S.S.W. of Waco. Pop. (1890) 4047; (1900) 7065 (1423 being negroes and 360 foreign-born): (1910) 10,993. It is served by the Gulf, Colorado & Santa Fé, and the Missouri, Kansas & Texas railways (the former has repair shops here), and is connected with Belton (pop. in 1910, 4164), the county seat, about 10 m. W., by an electric railway. In the city are a Carnegie library, a King's Daughters' Hospital, the Temple Sanitarium, and a hospital of the Gulf, Colorado & Santa Fé railway. Temple is situated in a rich farming country; cotton is ginned and baled here, and there are various manufactures. The city owns the water supply. Temple was founded in 1881–82 by the Gulf, Colorado & Santa Fé railway, and was chartered as a city in 1884.

TEMPLE, a term derived from the Lat. *templum* (Gr. *τέμενος*), which originally denoted a space marked off by the augurs for the purpose of observing the flight of birds or other ceremonies; later it was applied to the dwelling-place, the *aedes sacrae*, of the gods. In this latter sense it is the equivalent of the native Hebrew expression *bêth 'ĕlōhīm*, literally "a god-house," and of the foreign *hêkal*, palace, temple, a loan-word from Sumerian through the medium of the Babylonian *ê-kallu* (lit. great house). A temple or "god-house," however, represents a comparatively advanced stage in the development of Semitic religion. At first the Semite recognized the abodes of his deities in certain outstanding and impressive natural objects, a spreading tree, a bubbling spring, a conspicuous rock or stone, a lofty mountain peak and the like. Beside these he met and held converse with his gods. The native rock was the first altar.

It was a distinct step in advance when it was recognized that a deity might take up his abode elsewhere than in such natural sanctuaries, as in the *massebah* or stone pillar and the *ashērah* or sacred post of wood, reared not by nature but by the hand of man (cf. Gen. xxviii. 18, 22, the origin of the sacred pillar at Beth-el).

The further advance to a real house or temple may be traced to the influence of at least two factors in the social and religious life of a people. One such factor came into play when men began to represent the deity by means of an image, or even when some object, whether natural, like the black stone of Mecca, or manufactured, like the ark of the Hebrews, came to be regarded as specially sacred from its association with the deity. Such objects or images required a house to shelter and guard them. Another factor is to be found in the advance in material comfort which follows the transition from the nomadic to the agricultural mode of life. Among the settled Semites there arose the feeling that the gods of the community ought also to share in this advance (cf. 2 Sam. vii. 2). Accordingly they were invited to take up their abode in a *bêth 'ĕlōhīm* or temple. The dignity and comfort of the gods advance *pari passu* with those of their worshippers.

It must be kept in mind, however, that the altar remained as before the centre of the sacrificial worship. Around it or before it, under the open sky, the worshippers assembled. To the temple the priests alone, or the head of the sacral community in his priestly capacity, had access. In this respect the worship associated with altar and temple offers a striking contrast to the more spiritual worship of the Jewish synagogue and the Christian Church.

At the date of the Hebrew invasion of Canaan its numerous city-states had reached a fairly high level of civilization. Alongside of the typical Canaanite sanctuary, as known to us from the Old Testament references and from recent excavations, with its altar of earth or stone and its stately massebahs, a temple was probably to be found in all the more important centres. In an early Hebrew document there is a reference to the temple of El-berith at Shechem, which was large enough and strong enough to serve as a place of refuge in time of war (Judges ix. 46 ff.). The Philistines also had their temples in this period: thus we hear of a "house" of Dagon at Gaza (*ib.* xvi. 23 ff.) and also at Ashdod (1 Sam. v. 2), while a temple of Ashtart (Ishtar-Astarte) is mentioned in 1 Sam. xxxi. 10, probably at Ashkelon (Herod. i. 105).

The earliest reference to a temple built by Hebrew hands is to "an house of gods" reared by Micah to shelter an ephod and other sacred images which he had made (Judges xvii. 5). Micah's images were soon transported to Dan, where doubtless another house was built for their protection (xviii. 18, 30 f.). Somewhat later we find the ark of Yahweh installed in "the house of Yahweh" at Shiloh, which house was not a mere tent but a real temple (*hêkāl*, 1 Sam. i. 9, iii. 3) with doors (iii. 15) and doorposts (i. 9), and a hall in which the worshippers partook of the sacrificial meals (i. 18, Greek text; cf. ix. 22 "the guest-chamber," Heb. *lishkāh*). After the destruction of Shiloh at the hands of the Philistines, its priesthood migrated to Nob, where also the incidents recorded in 1 Sam. xxi.—note especially the presence of the shew-bread and the ephod—imply the existence of a temple.

The Temple of Solomon.—The primary source of our information regarding the erection of Solomon's temple is the account contained in 1 Kings vi.–vii., the details of which must have been derived ultimately from the temple archives. On this earlier narrative the chronicler (2 Chron. iii.–iv.) and Josephus (*Antiq.*, VIII. iii. 1 ff.) are alike dependent.

Unfortunately these two chapters of Kings are among the most difficult in the Old Testament, partly by reason of our ignorance of the precise meaning of several of the technical terms employed, partly owing to the unsatisfactory state of the received text, which has been overlaid with later additions and glosses. As regards both text and interpretation, most recent writers have adopted in the main the results of Stade's epoch-making essay in his *Zeitsch. f. d. alttest. Wissenschaft*, iii. (1883), 129–177, reprinted in his *Akademische Reden*, &c., with which is now to be compared Stade and Schwally's critical edition of Kings in Haupt's *Sacred Books of the Old Test.* See also, in addition to the standard commentaries, Burney, *Notes on the Heb. Text of . . . Kings*, Vincent's critical and exegetical study, *Rev. biblique* (Oct. 1907), and the literature cited at the end of this article.

(*a*) *The Site of the Temple.*—On this important point our earliest authority is silent. It is now universally acknowledged, however, that the whole complex of buildings erected by Solomon stood along the crest of the eastern hill, crowned by the temple at the highest point, as Josephus expressly testifies (*Bell. Jud.*; V. v. 1, with which compare the letter of (Pseudo) Aristeas, sect. 84). This at once brings the site of the temple into proximity to the world-famous sacred rock, the *sakhra*, over which now stands the building known as the Mosque of Omar, and, more correctly, as the Dome of the Rock. Here another important consideration comes to our aid. From the recognized persistence of sacred sites in the East through all the changes in the dominant religion, it is well-nigh certain that the sanctity of the *sakhra* rock goes back to the days of David and Solomon, or even, it may be, to prehistoric times. On it, or over it, the angel was believed to have been seen by David, and there David built his altar (2 Sam. xxiv. 18-25; cf. Judges vi. 20 f., 24; xiii. 19 ff.). This is undoubtedly the site assigned to the temple by the oldest extant tradition (see 1 Chron. xxii. 1; cf. 2 Sam. xxiv.). By every token, then, Solomon's altar of burnt-offering, if it was not identical with the *sakhra* (see below), at least stood upon it. Since the altar necessarily stood in front, *i.e.* to the east, of the temple, *the site of the latter was a short distance to the west of, and in line with, the sacred rock* (see JERUSALEM).

The alternative view, associated in recent times with the names of Schick and Conder, which places the most holy place, or innermost shrine of the temple, over the *sakhra*, has now few advocates (*e.g.* Col. Watson in the *Quarterly Statement* of the Palestine Exploration Fund for 1896 and 1910). Apart from difficulties of space towards the east, which this location involves, it cannot be accepted in face of the fact that the *sakhra* still bears the marks of its former use as a rock-altar (see esp. Kittel, *Studien zur hebr. Archäologie*, 12 ff.). Moreover the rock, measuring as it does some 55 ft. by 40, could not have been contained within the "holy of holies," which was less than 30 ft. square (see below).

A third site, still within the present Haram area, but towards its south-west angle, favoured by Fergusson (*The Temples of the Jews*), Robertson Smith (*Ency. Brit.*, 9th ed., art. "Temple") and others is open to even more serious objection, and has no prominent advocate at the present day.

(*b*) *The Temple Building.*—In the fourth year of his reign Solomon "began to build the house of the Lord" with the laying of a massive foundation of "great stones," as required by the rapid fall of the ground to the west of the *sakhra*. Architecturally the temple consisted of three distinct parts: (1) the *naos* or temple proper, (2) a porch or pylon in front of the naos, and (3) a lower and narrower building which surrounded the naos on its other three sides (see fig. 1).

(1) The first of these, "the house of the Lord" in the strict sense, in which alone He was worshipped, was oblong in plan, and was divided into two compartments in the proportion of 2 : 1 by a partition wall. The room next the porch was 40 cubits in length by 20 in breadth, with a height of 30 cubits,[1]

[1] The length of the cubit at this period cannot be determined with absolute certainty. From the fact that Herod's naos was an exact replica of Zerubbabel's as regards inside measurements, coupled with the presumption that Zerubbabel built upon Solomon's foundations, it is permissible to suppose that one and the same standard of length was used throughout. Now the present writer has shown from an inductive study of the height of the courses in the walls of the Haram and of other existing remains of the Herodian period that the cubit used by Herod's builders was exactly 17·6 in. or 447 millimetres (see *Expository Times*, xx. [1908–09] 24 ff.). There is therefore good reason for believing that this was also the cubit of Solomon's temple, notwithstanding the statement of 2 Chron. iii. 3 that the latter was a cubit "after

all *inside* measurements, and is termed in our oldest source the *hêkāl* or palace; later it was known as "the holy place." It was dimly lighted by a row of latticed windows, which must necessarily have been placed in the upper third of the side walls, as will presently be seen. Adjoining the hêkāl on the west lay the *dĕbîr* or sanctuary, later termed "the most holy place" (lit. "holy of holies"). The inside space formed a perfect cube of 20 cubits, say 30 ft., in length, breadth and height (vi. 20), symbolizing the perfection of the Deity, for whose abode this part of the naos was specially designed. The dĕbîr, as has been said, was separated from the hêkāl by a transverse wall, whose existence we are left to infer from the obscure description of the door between the two compartments (vi. 31, see next section).[1]

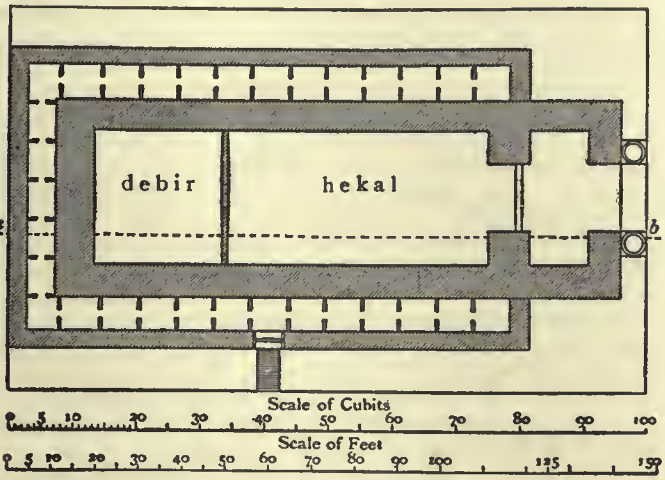


FIG. 1.—Ground Plan of Solomon's Temple.

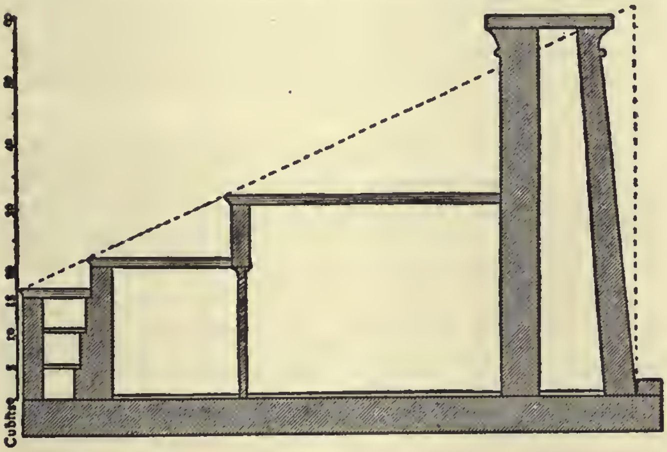


FIG. 2.—Section of Temple along *a–b* of Ground Plan.

(2) In front of the hêkāl and facing eastwards rose the porch, its inside "length" 20 cubits "according to the breadth of the house" (vi. 3), and its inside depth from east to west 10 cubits. The more precise character and elevation of this element will fall to be considered at a later stage.

(3) The third architectural element was a lateral building enclosing the naos on the other three sides, and consisting of three storeys, each 5 cubits in height from floor to ceiling. Each storey contained a number of small storage chambers, probably thirty in all (Ezek. xli. 6). A peculiarity in the architecture of this part of the temple is noteworthy. Instead of the beams forming the floors and ceilings of the several storeys being let into the wall of the hêkāl, three successive rebatements of one cubit each were made in the latter for their support (see fig. 2), consequently the width of the chambers was 5, 6 and 7 cubits in the three storeys respectively (vi. 6). The total height, allowing for floors and roof, of the lateral building cannot have been less than 17 cubits. Entrance to the side-chambers was provided by a single door on the south side (see ground-plan, fig. 1).

So far there is no difficulty as regards the general plan and dimensions of the temple, provided it is kept in mind that the figures given in the text of Kings are all inside measurements. It is otherwise when one endeavours to calculate the area covered by the temple, and to determine the elevation of the several parts and the general architectural style of the whole. As to the area much depends upon the thickness of the walls. Here our only clue is furnished by the figures for the corresponding walls of Ezekiel's temple, but the necessary caution has not hitherto been observed in applying them to the proportions of the actual temple of Solomon. It cannot be too strongly emphasized that in the dimensions of his temple of the future and its courts Ezekiel is dominated by a passion for symmetry and for the number 50 and its multiples,[2] which there is no ground for importing into the dimensions of the older temple. Nevertheless the walls of the naos may be taken at Ezekiel's figure of 6 cubits (xli. 5), with successive rebatements of one cubit (fig. 2) until the thickness is reduced to 3 cubits (4½ ft.) above the side-chambers, as explained above. If one cubit is allowed for the partition wall corresponding to the space in Herod's temple, where a curtain took the place of the wall, we obtain a total of 73 cubits for the length of the naos and of 32 for the outside width, or 107 ft. by 47. If 3 cubits—equal to the thickness of the wall of the naos above the side-chambers—be allowed for the outer wall of the latter, the extreme width of the temple works out at 48 cubits, or 70½ ft. Adopting Ezekiel's thickness of 5 cubits for the front wall of the porch, we reach a total of 96 cubits or 141 ft. for the extreme length from east to west (see the accompanying ground-plan). The proportion of length to breadth is thus 2 : 1, precisely as Ezekiel's temple with its artificial numbers of 100 and 50 respectively. The area of the platform on which Solomon's temple stood probably measured 100 cubits by 60, as in the plan annexed.

As regards the height of the various parts even fewer data are available. Our primary source gives the height of "the house" as 30 cubits (1 Kings vi. 2). By the great majority of previous students this has been understood to mean that a single flat roof, at this height from the floor, covered the three parts—porch, hêkāl and dĕbîr—leaving an empty space of 10 cubits above the last of these. But the Hebrew document, as has been repeatedly pointed out, is concerned only with inside dimensions, and in vi. 2 has probably in view the inside height of the hêkāl, as the largest of the three compartments. On the other hand, a characteristic feature of the contemporary Egyptian temples is the gradual diminution in the height of their component parts from front to back (Maspero, *L'Archéologie égyptienne* (1907), p. 77; Erman, *Handbk. of Egyptn. Religion*, 41; cf. the restoration of a typical temple in Perrot and Chipiez, *Anct. Egypt. Art.* i. 373, and in Erman, *Life in Anct. Egypt*, 280).

In this respect the present writer believes that Solomon's temple followed the Egyptian model, the height decreasing as one proceeded from the porch to the hêkāl, dĕbîr and side-chambers respectively. The porch, for instance, was probably modelled on the pylons which flank the principal entrance to an Egyptian temple, tall and narrow, with a sloping front wall surmounted by a cornice with its characteristic cavetto moulding. The 120 cubits which 2 Chron. iii. 4 gives as the height of the porch, followed by Josephus, *Ant.* XV. xi. 1 and elsewhere, seem to be out of proportion to the probable height of the rest of the building. But this objection does not apply to the 60 cubits given as the extreme height for the second temple in the trustworthy document, Ezra vi. 3.[3] This,

the former measure." For this statement is probably a mere inference from Ezek. xl. 5, where the divine messenger uses a cubit of seven handbreadths or 20½ in., the royal cubit of Egypt. For the smaller measurements the cubit of 17·6 in. may for greater convenience be reckoned at 1½ ft.

[1] If the view presented below as to the height of the various parts of the temple is accepted, this wall becomes a structural necessity, being required to support the back wall of the hêkāl.

[2] This has led Ezekiel certainly to increase the depth of his porch from 10 cubits to 12 (original text of Ezek. xl. 49), and probably to add a cubit to the thickness of the partition wall (xli. 3), in order to bring up the total length of his temple to 100 cubits.

[3] The numbers of this passage have been unnecessarily called in question by recent critics. The figures given are naturally those of the two extremes, which were not to be exceeded, viz. 60 cubits for the extreme height, that of the porch, and the same figure for the extreme width, that of the raised platform.

it may reasonably be inferred, was the height of the porch in the first temple, from which, in that case, the figure was derived. The probable outside measurements for the porch are thus 32 cubits for the breadth across "the house," 15 for the depth including the front wall, and 60 cubits or 88 ft. for the height.

Still following the Egyptian model, the hêkāl will have had its separate roof of massive cedar beams, covered probably by heavy limestone slabs, for which 1½–2 cubits may be allowed, giving a total of 32 cubits (47 ft.), equal to the outside width of this part of the temple. In the same way the roof of the dĕbîr will have been 10 cubits lower, or *circa* 32 ft. in all, that of the lateral building about 4 cubits lower still, say 26 ft. (cf. the section through the temple from W. to E. in fig. 2). While the measurements above given are, as they must necessarily be, in part conjectural, it is claimed for them that they introduce the element of proportion between the parts to an extent not attempted hitherto.

(*c*) *The Interior of the Temple and its Furniture.*—The entrance to the temple was through a wide and lofty opening in the front wall of the porch. Crossing the vestibule one entered the hêkāl by a large folding-door of cypress wood (vi. 34)—probably 10 cubits wide as in Ezekiel's temple—each of its four leaves ornamented with carved figures of cherubim, palms and flowers, all overlaid with gold. The inner walls of the hêkāl and the dĕbîr were lined with boards of cedar from floor to ceiling, while the floor was covered with planks of cypress wood.[1] From the hêkāl a door in the partition wall gave entrance to the dĕbîr. The doorway was not rectangular but apparently pentagonal in form (see the commentaries on vi. 31), the lintel consisting of two blocks of stone meeting at an angle, a feature "introduced to distribute the pressure of the superincumbent wall" (W. R. Smith).[2] The walls of the dĕbîr were overlaid with "pure gold" according to our present text (vi. 20); this enhancement of the dignity of the adytum as the earthly dwelling-place of the heavenly King is not so incredible as the profuse application of gold decoration to other and inferior parts of the house, even, as we have seen, to its floor (on this question see the critical works cited above).

As regards the furniture of the house, it is probable that the original text of 1 Kings introduced only the altar of cedar now found in the corrupt text of vi. 20, and to be identified with the table of shewbread, as the sole furniture of the holy place. The ten golden candlesticks, properly lampstands, of vii. 49 are generally believed to have been introduced at a later date (cf. Jer. lii. 18 f.). In the most holy place stood the palladium of Israel's religion, the sacred ark of Yahweh. On either side of this venerable relic of the past were two cherubim, sculptured from olive wood and overlaid with gold, each 10 cubits high, their outstretched wings reaching right across the dĕbîr, and forming a baldachin over the ark (vi. 23–28).

Although forming no part of the interior furniture of the temple, the remarkable twin pillars which stood on either side of the entrance to the porch may be mentioned here, since they belonged rather to the temple than to its court. These pillars, which in the received text bear the enigmatical names of "Jachin and Boaz,"[3] were hollow columns—the bronze metal being about 3 in. in thickness—over 26 ft. in height and 6 ft. in diameter, surmounted by elaborate capitals about 7½ ft. high. The latter were globular in form, ornamented by a specially cast network of bronze, over which were hung festoon-wise two wreaths of bronze pomegranates, each row containing a hundred pomegranates. As the pillars doubtless stood on plinths, the total height of each will have been at least 35 ft. Such free-standing pillars were a feature of temple architecture in Phoenicia and elsewhere in western Asia, as later reproductions on local coins attest, and would appear to Solomon's Phoenician architects as a natural adjunct of his temple. Jachin and Boaz, therefore, may be regarded as conventional symbols of the Deity for whose worship the temple was designed.[4]

(*d*) *The Temple Court, Altar and other Apparatus of the Cult.*—The temple stood within the western half of "the court of the house of the Lord," also known as "the inner court" to distinguish it from "the other court" round the adjoining palace and from "the great court" which surrounded the whole complex of Solomon's buildings. All three had walls in which three courses of hewn stone alternated with a course of cedar beams (see next section). To the "court of the house" laymen as well as priests had access (Jer. xxxv. 1 ff., xxxvi. 10). Several gates gave entrance to it, but their precise position is uncertain. The principal entrance from "the great court" was doubtless in the east wall. Another was in the south wall and communicated with "the other court" and the royal palace. There were also one or more gates on the north side of the court.

In our present text of 1 Kings vi.–vii., there is no mention of so indispensable a part of the apparatus of the cult as the altar of burnt-offering. This silence has been explained in two ways. The majority of critics believe that the original account did contain a reference to the making of a bronze altar (cf. 2 Chron. iv. 1), but that it was excised by a later editor, who assumed that the bronze altar of the tabernacle accompanied the ark to the new sanctuary. Others, with greater probability, maintain that the silence of our oldest source is due to the fact that Solomon followed the primitive Semitic custom and used the bare *sakhra* rock as his great altar. In this case the altar, which was removed by order of Ahaz to make way for his new altar after a Damascus model (2 Kings xvi. 10–16), must have been introduced by one of Solomon's successors.[5]

In the court, to the south of the line between the altar and the temple, stood one of the most striking of the creations of Solomon's Phoenician artist, Huram-abi of Tyre. This was the "brazen sea," a large circular tank of bronze with the enormous capacity of over 16,000 gallons (1 Kings vii. 23–26), resting on the backs of twelve bronze bulls, which, in groups of three, faced the four cardinal points.

It is doubtful if this strange "sea" served any practical purpose (see 2 Chron. iv. 6). Most recent writers agree in assigning to it a purely symbolical significance, like the twin pillars above described. Babylonian temples are now known to have had a similar apparatus, termed *apsu*, which symbolized either the primeval abyss, personified as the monster Tiamat subdued by Marduk, whose symbol was the bull, or, according to a later theory, the upper or heavenly sea, bounded by the Zodiac with its twelve signs.

Associated with the "brazen sea" were ten lavers of bronze, also the work of Huram-abi (vii. 27–39). Each laver consisted of a circular basin holding over 300 gallons, and borne upon a wheeled carrier or "base."[6] The sides of the carriers were open frames composed of uprights of bronze joined together by transverse bars or rails of the same material, the whole richly ornamented with palm trees, lions, oxen and cherubim in relief. Underneath each stand were four wheels of bronze, while on the top was fitted a ring or cylinder on which the basin rested. According to Kittel, "it is highly improbable that these lavers served any practical purpose. They were rather like the great 'sea,' the embodiment of a religious idea; they were symbols of the rain-giving Deity" (*op. cit.*, p. 242).

The Relation of the Temple to Contemporary Art.—Of the many problems raised by the description of the temple in 1 Kings none is of greater interest than the question of its relation to

[1] The overlaying of the floor with gold (1 Kings vi. 30) is a later interpolation; the same is probably true of the gilding of the sculptures on the walls, which may have been added at a later date (cf. Ezek. xli. 18).

[2] This partition wall, it will be remembered, had to support the back wall of the hêkāl according to the view of the temple architecture advocated above.

[3] The various forms which the latter name assumes, in the Greek text, suggest that Boaz is an intentional disguise of an original Baal, applied of course to Yahweh (Barnes, *Jour. of Theol. Studies*, v. 447 ff.).

[4] Robertson Smith's theory that they were huge cressets in which "the suet of the sacrifices" was burned (*Rel. Sem.*, 2nd ed., 488) has found no support. For recent attempts to explain the symbolism of the pillars in terms of the "early oriental *Weltanschauung*," see A. Jeremias, *Das alte Test.*, &c., 2nd ed., 494; Benzinger, *Heb. Archäol.*, 2nd ed., 323, 331.

[5] For a detailed study of the successive altars that stood upon the *sakhra* and their relation thereto, see Kittel, *Studien zur hebr. Archäologie*, pp. 1–85, with illustrations and diagrams.

[6] This section of Kings is peculiarly difficult, and has been made the subject of a special study by Stade in his *Zeitschrift* (1901), 145 ff. (cf. "Kings" in Haupt's critical edition), and more recently by Kittel, *op. cit.*, pp. 189–242, with illustrations of similar apparatus found in Cyprus and Crete.

contemporary art. Where, it has often been asked, shall we look for the model or prototype of the temple edifice? Whence were derived the *motifs* to be seen in its decoration? What influences can be detected in the elaborate apparatus above described? Now it has for long been recognized that Syria, including Phoenicia and Palestine, was from the earliest times the meeting-place of streams of influence, religious, artistic and other, issuing from the two great fountains of civilization and culture in the ancient world, Egypt and Babylonia. To these must now be added the early civilization of the Aegean as revealed by the excavations in Crete, and the later but highly developed culture of the Hittites. As a result the art of Phoenicia and Syria, originally borrowed from Egypt mainly, had by the 10th century become thoroughly eclectic. Of this syncretism the best illustration is furnished by the masterpieces of contemporary art, for which Solomon was indebted to Phoenician architects and Phoenician artists. Thus the general disposition of the temple with its walled court, porch or vestibule and naos has been shown by modern excavation, and by later representations on coins, to be characteristic of Phoenician and North Syrian temple architecture. Here, however, we have an adaptation of the earlier temple architecture of Egypt. Egyptian influence is most clearly seen in the gradual decrease in the illumination of the several parts. In the temple court, as in its Egyptian counterpart, men worshipped under the bright eastern sky; in the covered porch there was still no door to exclude the light which streamed in through the lofty entrance. But in the holy place only a dim light was admitted through latticed windows high up in the side walls, while the holy of holies, like the Egyptian *cella*, was completely dark.[1]

The sculptured panels of the interior were shown by Robertson Smith (*Ency. Brit.*, 9th ed., art. "Temple") to reveal familiar Phoenician motives, although Babylonia is probably the ultimate home of the cherubim. Excavations at Sinjirli in Northern Syria and at Megiddo have, further, solved the problem of the "three rows of hewn stones and a row of cedar beams" which was the architectural feature of the walls of the various courts (1 Kings vii. 12).[2] The use of wooden beams alternately with courses of stone was a familiar expedient in early times. The practice of building walls with recurring rebatements has also been illustrated by the recent excavations.

While the prototype of the temple itself is to be sought, as has been said, in Egypt, Babylonian influence is clearly traceable in the symbolical "brazen sea," the *apsu* of contemporary Babylonian, and doubtless also Phoenician, temples. The bronze lavers, finally, have been found to be dependent, both in their construction and in the *motifs* and execution of their reliefs, on the art of the Aegean. From Crete and Cyprus they passed through Phoenician intermediaries to Syria and Palestine. The temple of Solomon, in short, is a product of the best Syro-Phoenician art of the period, itself the product of ideas which had their source in other lands.

The Temple of Zerubbabel.—In the year 586 B.C. the temple of Solomon was committed to the flames by order of Nebuchadrezzar (2 Kings xxv. 8; Jer. lii. 12 f.). Seventy years later its successor was finished and dedicated, the foundation having been laid in the second year of Darius Hystaspes (520) during the governorship of Zerubbabel (Hag. ii. 18). There is every reason for assuming that the massive foundation courses of the earlier temple were still *in situ*, and available for the new building.[3] The latter's inferiority, attested by Hag. ii. 3, was rather in respect of its decoration and equipment, as compared with the magnificence of the first temple, than as regards the size of the building. The dimensions given in the royal decree (Ezra vi. 3)—60 cubits for height and the same for breadth—probably refer, as was pointed out in a previous section, to the extremes of height and breadth applicable to the porch and platform respectively. In these and most other respects it may be supposed that Zerubbabel's builders followed the lines of Solomon's temple. It is probable, however, that the walls of the naos, including both the holy and the most holy place, were now raised to a uniform height, the separate back wall of the former having been abolished and the naos covered by a single roof. This seems a legitimate inference from the absence in the second and third temples of a supporting partition wall within the naos. Its place, as separating the two compartments, was taken by a magnificent curtain or "veil," which is mentioned among the spoils carried off by Antiochus Epiphanes (1 Macc. i. 22).[4]

In the matter of the sacred furniture, the holy place contained from the first the table of shewbread, and one golden "candlestick" or lampstand in place of the ten which illuminated the hêkāl in the later days, at least, of the first temple (Jer. lii. 19). The golden altar of incense, which fell a prey with the rest of the furniture to Antiochus (1 Macc. i. xxi. f.) was probably introduced later than the time of Zerubbabel, since a Jewish author, writing in the 3rd century B.C. under the name of Hecataeus of Abdera, mentions only "an altar and a candlestick both of gold," and it is natural to identify the former with the gold-plated table of shewbread.[5] In one important respect the glory of the second house was less than that of the first. The holy of holies was now an empty shrine, for no one had dared to construct a second ark.

The second temple also differed from the first in having two courts, an outer and an inner, as prescribed by Ezekiel for his temple of the future. The outer court formed a square, each side of which was 500 cubits in length, also as prescribed by Ezekiel, with the *sakhra* rock in the centre (see *Exp. Times*, xx. 182). Within the inner court stood the altar and the temple. The former, as described by Hecataeus, was composed of white unhewn stones (cf. Exod. xx. 25), "having each side 20 cubits long, and its height 10 cubits" (Josephus, *Contra Apion.* i. § 198), dimensions which agree with those assigned by the chronicler to the earlier altar of bronze (2 Chron. iv. 1).

In 165 B.C., three years after the spoliation of the temple and the desecration of its altar by Antiochus IV., Judas Maccabaeus rededicated the holy house, made new sacred furniture, and erected a new altar of burnt-offering (1 Macc. iv. 41 ff.). But long before this date the temple had assumed a character which it retained to the end of the Jewish state. It had become a fortress as well as a place of public worship, and existing records tell of the repeated strengthening of its defences. "At the time of Pompey's siege (63 B.C.) it constituted an almost impregnable fastness, strengthened on its weakest or northern side by great towers and a deep ditch (*Ant.*, xiv. 4, § 2). Twenty-six years later the temple was again besieged by Herod, who, attacking like Pompey from the north, had to force three lines of defence—the city wall, and the outer and inner temple," *i.e.* the walls of the outer and inner courts (W. R. Smith).

The Temple of Herod.—In the 18th year of his reign (20–19 B.C.) Herod obtained the reluctant consent of his subjects to his ambitious scheme for rebuilding the temple and for enlarging and beautifying its courts. The former was finished in eighteen months by a thousand priests trained for this special purpose, the courts in eight years, but the complete reconstruction occupied more than eighty years, lasting almost till the final breach with Rome, which culminated in the destruction of the sacred edifice by the soldiers of Titus in A.D. 70.

[1] This feature gives valuable support to the view presented above that Solomon's temple resembled its Egyptian contemporaries in an equally striking characteristic, the decrease in height with the decrease in illumination.

[2] This description possibly applies to all the buildings (note verse 9), including the temple itself, and was so understood by the writer of Ezra vi. 4.

[3] From Hag. i. 8. Driver indeed infers that "there would probably be almost sufficient stonework remaining [for all purposes] from Solomon's temple" (*Cent. Bible in loc.*).

[4] M. Clermont-Ganneau has put forward the interesting conjecture that the veil presented by Antiochus to the temple of Zeus at Olympia (Pausanias, V. xii. 4) was that taken from the temple at Jerusalem (see "*Le Dieu satrape*," &c., in the *Journ. asiatique*, 1878).

[5] The witness of the Pseudo-Hecataeus and of another Jewish Hellenist, the Pseudo-Aristeas, regarding the second temple has recently been examined by G. A. Smith in his volumes on Jerusalem (see esp. index to vol. ii., and cf. Vincent, "Jérusalem d'après la lettre d'Aristée," *Rev. biblique* (1908), 520 ff. (1909), 555 ff.).

(*a*) *The Outer Court, its Gates and Colonnades.*—The outer court of Zerubbabel's temple (500×500 cubits) was doubled in area according to Josephus (*Bell. Jud.* I. xxi. 1). The extension was principally on the south, which involved enormous substructions on both sides of the hill, in order to secure the necessary level surface. There can be little doubt that this part of the present Haram area with its containing walls is essentially the work of Herod. The northern boundary of this great court, termed "the mountain of the house" in the Mishnah, and now generally known as "the court of the Gentiles," remained as before, and is represented by a line of scarped rock immediately to the north of the present inner platform of the Haram. This line of scarp, when prolonged east and west for about 1000 ft. in all, meets the east wall of the Haram a little to the north of

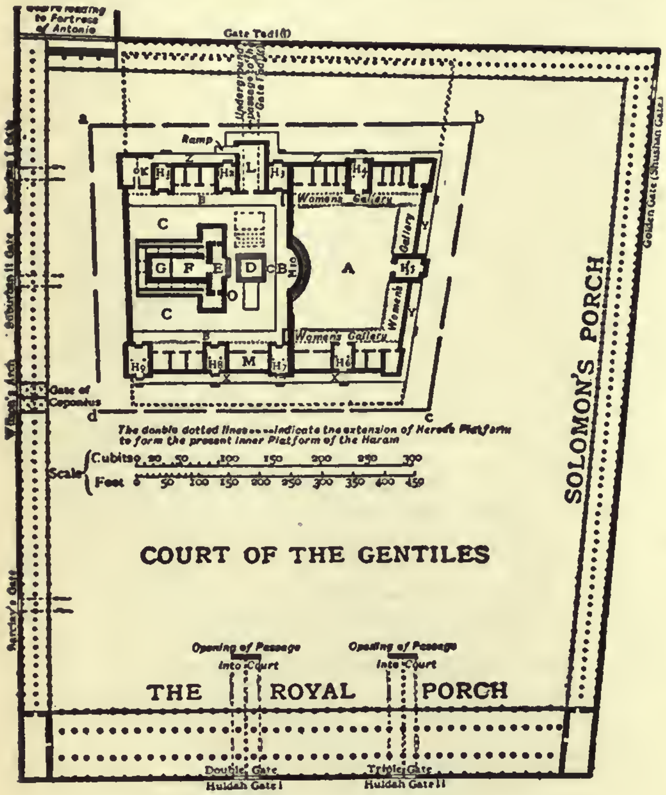


FIG. 3.—Plan of Herod's Temple and Courts.

From the *Dictionary of the Bible* (1909),[1] by kind permission of T. & T. Clark.

the Golden Gate, at a point 390 yds. (800 cubits) from the S.E. angle, and the west wall at the same distance from the S.W. angle.[2]

The principal entrance to the temple enclosure, and the only one on a level with it, was on its western side by a bridge or viaduct which spanned the Tyropoeon at the spot marked by Wilson's arch. It is first mentioned in connexion with the siege of Pompey in 63 B.C., and according to the Mishnah it bore the name of the Gate of Kiponos (probably Coponius, the first procurator of Judea). Of the other three gates which Josephus assigns to this side (*Ant.* XV. xi. 5), the two leading to "the suburb" necessarily lay further north; one is represented by the old entrance now named Warren's gate, the other has not been identified. Josephus' third gate which led to the "other" or lower city was undoubtedly Barclay's gate, and not, as is usually maintained, an entrance from Robinson's arch. In the south wall were two gates—the Huldah or "mole" gates of the Mishnah (*Middoth*, i. 3)—represented by the present "double" and "triple" gates. Like the three last mentioned they had to be placed at the foot of the lofty retaining wall. From either gate a double ramp, which passed under the royal porch, led into the court in the direction shown on the accompanying plan. The Mishnah also names the "Shushan gate" on the east and the "Tadi gate" on the north.

Round the four sides of the great court ran a succession of magnificent porticoes in the style of contemporary Hellenistic architecture (*Ant.* XV. xi. 5). Those on the E., N. and W. sides had each three rows of columns forming a double walk or aisle; the eastern colonnade bore the old name of "Solomon's Porch" (John x. 23; Acts iii. 11). The southern portico was still more imposing and magnificent.

It had three aisles formed by four rows of monolithic marble columns of the Corinthian order,[3] the first row engaged in the south wall of the court. The two side aisles were 30 ft. in width, the central aisle half as wide again (45 ft.); the height of the former may be estimated at *circa* 60 ft., that of the latter at 100 ft. (*Exp. Times*, xx. 68 f.). The roofs were formed of deeply coffered cedar beams, that of the centre aisle being supported on pillars partly engaged in an ornamental stone balustrade. The "royal porch," as it was termed, worthily represents the high-water mark of Herod's architectural achievements in connexion with the reconstruction of the temple.

(*b*) *The Inner Courts and Gates.*—To the outer court Jew and Gentile, under certain conditions, had alike access. The sanctuary proper, from which the Gentile was rigidly excluded, began when one reached the series of walls, courts and buildings which rose on successive terraces in the northern half of the great enclosure. Its limits were distinguished by an artistic stone balustrade, named the *sōrēg*, which bore at intervals notices in the Greek tongue warning all Gentiles against advancing further on pain of death. Beyond the *sōrēg* a narrow stone terrace, approached by flights of steps, was carried round all sides of the sanctuary save the west (see *Bell. Jud.* V. i. 5 [§ 38]), and extended to the foot of the lofty fortified walls of the temple enclosure (see X Y Z on plan, fig. 3).

The walls, over 35 ft. in height (25 cubits), were pierced by nine gateways, marked H1 to H9 on the accompanying plan, of which four were in the north and south walls respectively, and one in the east wall. These nine gates opened into massive two-storeyed towers, each 30 cubits deep (*Bell. Jud.* V. v. 3). Eight were "covered over with gold and silver, as were also the jambs and lintels" (ibid.), while the ninth, the principal entrance to the sanctuary, in the east wall (H5) was composed entirely of Corinthian brass, the gift of a certain Nicanor. Hence it was variously named "the Corinthian gate," "the gate of Nicanor" and "the beautiful gate" (Acts iii. 2, 10).[4]

Entering the sacrosanct area by this gate one found oneself in a colonnaded court, known as the court of the women (A) since women as well as men were admitted to this court, which indeed was the regular place of assembly for public worship. The four corners of the women's court were occupied by large chambers for various ceremonial purposes, while between these and the gate-houses were smaller chambers, one set being known as "the treasury" (Mark xii. 42). The western side was bounded by a high wall, beyond which, on a higher level, lay the inner or priests' court. The entrance to the latter was by an enormous gateway, 50 cubits by 40, through which an uninterrupted view was obtained of the altar and of the temple beyond it. To this "upper gate"

[1] Which see for key to the several parts.

[2] The area of the "court of the Gentiles," including the walls, was thus 800 cubits in length from N. to S., with an average width of *circa* 650 cubits of 17·6 in.—the present south wall measures 922 ft.—*i.e.*, *circa* 520,000 sq. cubits as compared with the former area of 250,000, a remarkable confirmation of Josephus' statement as to the doubling of the temple courts. For the statements and measurements in this and the following sections differing from those of previous writers, reference may be made to the series of preliminary studies entitled "Some Problems of Herod's Temple," by the present writer, which appeared in *The Expository Times*, vol. xx (1908–1909), pp. 24 ff., 66 ff., 181 ff., 270 ff.

[3] One such gigantic monolith was discovered a few years ago in a disused quarry (see *Exp. Times*, xx. 69).

[4] For this triple identification see Schürer's essay, *Zeits. f. neutest. Wiss.* (1906), 51–58; Berto, *Rev. des études juives*, lix. (1910), 30 f.; also *Exp. Times*, xx. 270 f.

(H10) a flight of fifteen semicircular steps led up from the court of the women.

On a level with the entrance and running round three sides of the inner court (so Josephus) was a narrow strip (B), about 18 ft. broad, called the "court of the men of Israel." The rest of the oblong area, however, was reserved for the priests and such of the laity as might require admission for the offering of their sacrifices. As in the lower court, the spaces between the gates were occupied by chambers, as to the purpose of which details are given in the Mishnah.

With regard to the more precise location of these temple courts, the present writer in the series of essays above referred to (see esp. *Exp. Times*, xx. 181 ff.),[1] has endeavoured to prove that the *whole fortress-sanctuary within the great walls stood on what is now the inner platform of the Haram*, the present extended area of which is indicated by the double dotted line on the plan.

According to the Mishnah (*Middoth*, ii. 5, 6) the upper and lower courts together formed a rectangle measuring 322 cubits from west to east by 135 cubits from north to south, the upper court 187 by 135, the lower 135 by 135. But, on the one hand, no account is taken of the gate-towers and priests' chambers which lined the courts, and on the other, the frequent recurrence of the number 11 and its multiples in the details which make up the above totals awakens suspicion as to their accuracy. The measurements of the accompanying plan are based on a critical comparison of the data of the Mishnah and those of Josephus with the relation of the whole to the altar on the *sakhra* (see next section). The total area covered by the sanctuary, including the terrace or *khēl*, is entered as 315 cubits (462 ft.) across the rock from west to east, and 250 cubits (367 ft.) from north to south (for the detailed measurements see *Exp. Times*, xx. 181 ff., 271 ff.). The upper court shows an area of 170 cubits by 160, the lower court has a free space between the colonnades of 135 cubits (the Mishnah figure) by an average width of 110 cubits.

(*c*) *The Altar of Burnt-offering.*—Herod's great altar (D on the plan) was formed of unhewn stones, like that which preceded it. Its size, however, was increased till it formed a square, each side of which measured 32 cubits or 47 ft. at the base, thus occupying almost the whole of the exposed surface of the *sakhra*. The sides of the square decreased upwards by three stages until the altar-hearth was only 24 cubits square. The priests went up by an inclined approach on the south side (cf. Exod. xx. 26). To the north was the place where the sacrificial victims were slaughtered and prepared for the altar (cf. Levit. i. 11). It was provided with rings, pillars, hooks and tables. A laver (O on the plan) for the priests' ablutions stood on the west of the altar ramp.

(*d*) *The Temple Building.*—A few yards to the west of the altar rose the temple itself, a glittering mass of white marble

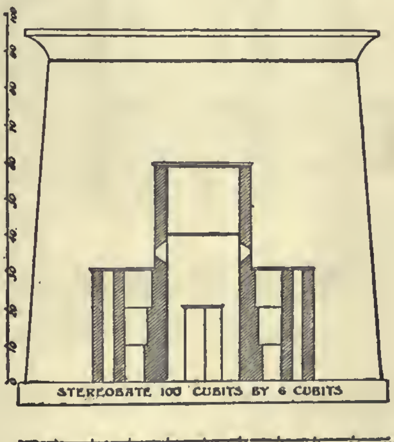


FIG. 4.—Diagrammatic Section of Herod's Temple and Porch.

and gold. Twelve steps, corresponding to the height (12 half-cubits) of the platform, led up to the entrance to the porch. In the disposition of its parts Herod's temple was in all essential respects a replica of its two predecessors. But there were differences in details. Thus the porch was increased in width and height until its front elevation measured, according to our authorities, Josephus and the Mishnah, 100 cubits by 100. This, however, probably includes the platform, as the principles of proportion in relation to the other dimensions suggest 96 cubits by 96 (over 140 ft.) as the actual measurements. In shape the porch may be supposed to have retained its original likeness to an Egyptian pylon, as suggested in the accompanying diagram (fig. 4).

The holy place (F) retained its former area (40×20 cubits), but was raised in height to 40 cubits. A magnificent double curtain, embroidered in colours, screened off the most holy place, which remained a perfect cube of 20 cubits each way. By introducing a passage-way giving access to the side-chambers and requiring an extra outer wall, Herod increased the width of the temple building to at least 60 cubits (70 according to the Mishnah). The problem of the height of the naos remains almost as perplexing as before. Josephus, it is true, agrees with the Mishnah (*Middoth*, iv. 6) in giving it a height of 100 cubits. It may be that Herod, "if he was forbidden to extend the House, would at least make it soar!" (G. A. Smith). But the details given by the Jewish doctors do not inspire confidence, for, as Fergusson long ago perceived, "one storey is merely an ill-understood duplication of the other." A more modest height of 60 cubits (88 ft.), equal to the extreme width, gives at least an element of proportion to the edifice which is altogether wanting in the traditional figures (compare the accompanying cross section, fig. 4).

The open entrance to the porch now measured 40 cubits by 20, equal to the section of the holy place. The "great door of the house," 20 cubits high and 10 wide, was covered with gold; in front was suspended a richly embroidered Babylonian veil, while above the lintel was fixed a huge golden vine.

(*e*) *The Temple Furniture.*—This remained as before. In the holy place in front of the holy of holies, still a dark and empty shrine, stood the altar of incense, against the south wall the seven-branched golden lampstand, and opposite to it the table of shewbread. The two latter, as every one knows, were carried to Rome by Titus, and representations of them may still be seen among the sculptures adorning the arch which bears his name.

When one considers the extraordinary height and strength of the outer walls of the temple area, parts of which excite the wonder of every visitor to the holy city, the wealth of art lavished upon the wide-extended cloisters, the imposing character of the temple façade, and the impression produced by the marble-paved terraces and courts rising in succession, each above and within the other, one is not surprised that the temple of Herod was reckoned among the architectural wonders of the ancient world. There is for once no exaggeration in the words of Josephus when he records that from a distance the whole resembled a snow-covered mountain, and that the light reflected from the gilded porch dazzled the spectator like "the sun's own rays" (*Bell. Jud.* V. v. 6).

LITERATURE.—In addition to the primary sources, the Bible, Josephus, and the Mishnah treatise *Middoth* (ed. Surenhusius with commentaries), the commentaries and notes on Kings by Benzinger, Kittel, Stade, Burney and Skinner, the articles on the temples in the recent Bible Dictionaries and the "Archaeologies" of Benzinger and Nowack, the following should be consulted: De Vogüé, *Le Temple de Jérusalem* (1864); Jas. Fergusson, *The Temples of the Jews* (1878); Perrot et Chipiez, *Le Temple de Jérusalem* (1889); C. Schick, *Die Stiftshütte, der Tempel*, &c. (1896); W. Shaw Caldecott, *Solomon's Temple* (1906), and *The Second Temple*, &c. (1908); R. Kittel, "*Tempel*" and "*Tempelgeräte*" in Herzog-Hauck, *Realencyklopädie*, 3rd ed. (1907), vol. xix.; G. A. Smith, *Jerusalem*, 2 vols. (1908, see index to each vol.); also W. R. Smith's art. "Temple" in *Ency. Brit.*, 9th ed. For Herod's temple more especially see Maimonides' treatise *Beth Ha-bekhîra* (the chosen house), trans. in *Quart. Statement* of Pal. Explor. Fund (1885); and the recent studies by Watson, *ibid.* (1896 and 1910); Waterhouse in Sanday's *Sacred Sites of the Gospels* (1903); A. R. S. Kennedy, "Some Problems of Herod's Temple," *Expository Times*, vol. xx. (1908–1909); G. Dalman, "Der zweite Tempel zu Jerusalem," in the *Palästinajahrbuch* (1909); P. Berto, "Le Temple de Jérusalem," *Rev. des études juives*, lix.–lx. (Jan.–July 1910), and the articles in the *Jewish Encyclopaedia*. For the study of the site the works of the English surveyors (see JERUSALEM), including Sir C. Wilson's large-scale map of the Haram, are indispensable.

(A. R. S. K.)

[1] A summary of the results is given in the article "Temple" in Hastings' *Dict. of the Bible* (1909).

Egyptian Temples.—In the architectural sense the earliest temples in Egypt probably consisted only of a small cella, or sanctuary, with a portico, such as are represented in the models of soul-houses found in 1907 by Flinders Petrie at Rifeh; in front of these various additions were made, so that eventually the temple assumed far greater importance than was at first contemplated. This custom is at variance with that which takes place in the development of other architectural styles, where the older buildings are constantly taken down and rebuilt in accordance with the increased knowledge acquired in construction and design. It follows from this that although the Egyptian temples vary in their dimensions and extent, as a rule they present the same disposition of plan. The principal exceptions to this rule are the sepulchral temples, such as those of Deir el Bahri, and the more ancient example adjoining it, discovered in 1906, in which there are no enclosed halls of columns or sanctuary, and the Mammeisi temples (fig. 5), which in plan resemble the Greek peristylar temples and might have been suggested by them, had not the example at Elephantine (destroyed in 1822) been of much earlier date, having been built by Amenophis III. (1414–1379).

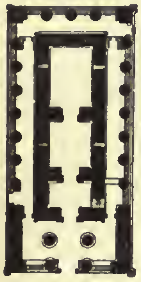


Fig. 5.—Plan of Mammeisi Temple, Philae.

The earliest example of which remains have been found is the temple built by Cephren in front of his pyramid at Memphis, and this consisted only of a sanctuary of small size without any architectural pretensions. The next in date would be the sepulchral temple built by Mentuhotep (2832–2796) adjoining Deir el Bahri at Thebes; then follows the sanctuary of Karnak, built by Senwosri (Usertesen) I. (2758–2714), which formed the nucleus of that immense temple, which covered an area of 400,000 sq. ft. This temple may be taken as an extreme type of the accumulation which is found in nearly all the Egyptian temples, owing to the additions made to the original structure by successive monarchs, instead of rebuilding, as was the general custom in all other styles. To a certain extent the same conservative principle seems to have governed the design of all other temples, and even the temple at Edfû, which was set out on a plan conceived from the first, has the appearance of having been added to at various periods, the fronts of the inner halls showing inside those built in front. It is not only in the plan that the close resemblance of one building to another is shown; the architectural design is repeated in the earliest and latest temples; the raking sides of the pylons and walls with the torus-moulding of the quoins and the cavetto cornice are identical, so that it is only by the inscriptions that one is able to ascribe the buildings to the kings of the 18th or following dynasties and distinguish them from those erected by the Ptolemies, or even under Roman rule. The only differences are those exhibited in the great halls of columns, which, in the earlier temples, were built in between the pylons and side walls, receiving their light through clerestory windows, as at Karnak (fig. 6), the other temples in its vicinity and the Ramesseum; whereas in the later temples

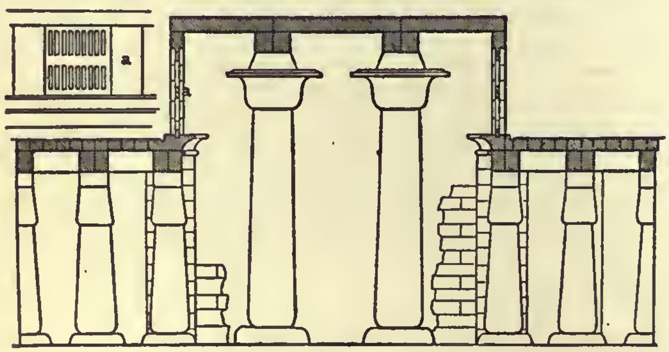


Fig. 6.—Hall of Columns, Karnak.

on one side of the walls a screen was built between the columns, over which the interior was lighted. The second change was that made in the capitals of the columns, which are of wonderful diversity of design, even in the same hall, including every variety of river plant, in addition to the papyrus and lotus flowers; in the later temples also the columns are more slender in their proportions and not set so closely one to the other.

Although generally the temples are built symmetrically on a central axis, with walls at right angles to one another, there are some special exceptions; thus the axial line of the great entrance court of the temple at Luxor is at an angle of about 15° with that of the temple in its rear, and in the island of Philae no two buildings are on the same axis or are parallel to or at right angles to one another, thus conforming to the irregular site on which they were built.

Assyrian.—The temple in Chaldaea or Assyria (known as a *ziggurat*) was of an entirely different class, and took the form of a many-storeyed structure, of which the typical example is the Birs Nimrud. This originally consisted of six storeys, each one set behind the other, so as to admit of a terrace round each, the upper storey being crowned by a shrine.

Access to the several storeys was obtained by flights of steps, either lying parallel with the front or in one continuous flight in centre of same, or again as at Khorsabad by a ramp winding round the tower; the architectural design consisted of sunk panels on the various storeys with battlement parapets, and, like the Birs Nimrud, the several storeys were dedicated to the seven planets, the walls being enriched with the colours sacred to each.

Greek and Roman.—In Greece the earliest example of a temple is that of the Heraeum at Olympia, ascribed by Dr Dörpfeld to the 10th century B.C. The Heraeum (fig. 7) consisted of

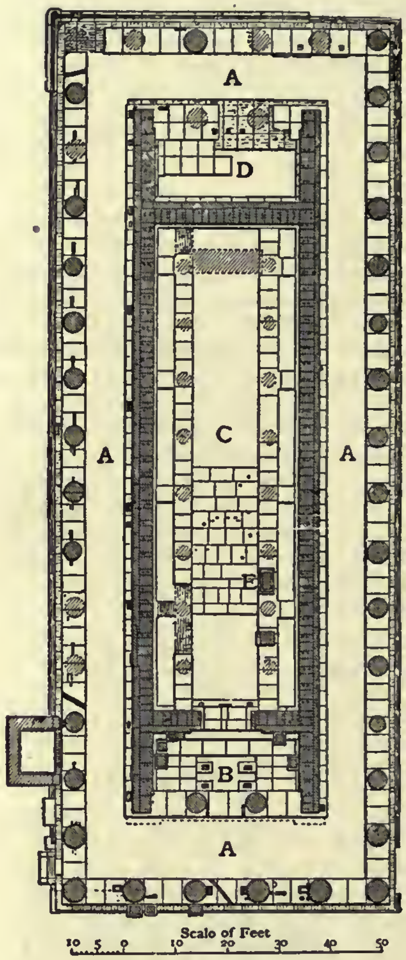


Fig. 7.—The Heraeum.

From Curtius and Adler's *Olympia*, by permission of Behrend & Co.

a central naos or sanctuary with pronaos in front and opisthodomus in the rear, the whole enclosed by a peristyle, thus presenting the characteristics of the fully developed temple of the 5th century. As, however, the description of the several types would be rendered clearer if they were taken from the simplest plan to the more elaborate, adopting to a certain extent the definitions given by Vitruvius, they are as follows:—

Distyle-in-antis, a cella or naos preceded by a portico of two columns placed between the prolongation of the cella wall. Fig. 8. The Temple of Themis Rhamnus.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

Amphidistyle-in-antis, similar to the foregoing but with a second portico in the rear. Fig. 9. The Temple of Diana Propyloea, Eleusis.

Tetrastyle prostyle, with a portico of four columns in front. Fig. 10. The Temple B. Selinus, Sicily.

Tetrastyle amphiprostyle, with an additional portico of four columns in the rear. Fig. 11. The Temple of Nike Apteros, Athens.

Hexastyle peripteral, six columns in front and rear and a peristyle round the cella forming a covered passage round. Fig. 12. The Temple of Theseus, Athens.

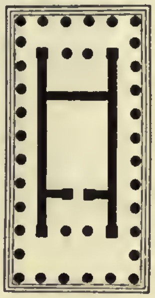


FIG. 12.

Octostyle peripteral, eight columns in front and rear and a peristyle round. FIG. 13. The Parthenon, Athens.

Octostyle dipteral, eight columns in front and rear and a double row in the peristyle. Fig. 14. The Temple of Jupiter Olympius, Athens.

Octostyle pseudo-dipteral, similar to the last, except that the inner row of columns is omitted, thus giving a passage round of twice the ordinary width. Fig. 15. The Temple of Apollo (Smintheus), Troad.

Decastyle dipteral, ten columns in front and rear and a double row in the peristyle. Fig. 16. The Temple of Apollo Didymaeus, at Branchidae, near Miletus.

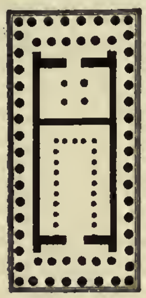


FIG. 13.

To these there are a few exceptions:—

Heptastyle pseudo-peripteral, seven columns in front and rear with walls built in between the outer range of columns, so that they were only semi-detached, as in the temple of Jupiter Olympius at Girgenti.

Enneastyle peripteral, nine columns in front and rear and a peristyle round as in the so-called Basilica at Paestum. Of circular temples there were two varieties:—

Monopteral, a series of columns built in a circle, but without any cella in the centre; and

Peripteral, with a circular cella in the centre. Fig. 17. The Philippeion, Olympia.

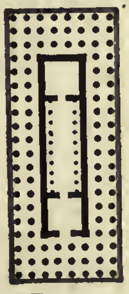


FIG. 14.

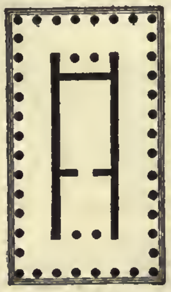


FIG. 15.

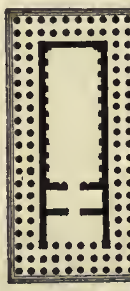


FIG. 16.

The above definitions apply to Greek temples, whether of the Doric, Ionic or Corinthian orders. The Romans in some of their temples adopted the same disposition, but with this important difference, that, instead of the temple resting on a stylobate of three steps, it was raised on a podium with a flight of steps in front. In some of their temples, requiring a larger cella wherein to store their works of art, it occupied in the rear the full width of the portico in front; they retained, however, the semblance of the peristyle, the columns of which became semi-attached to the cella wall. If the portico had four columns, the temple was known as *tetrastyle pseudo-peripteral*, of which the so-called temple of Fortuna Virilis at Rome is an example; and if six columns, *hexastyle pseudo-peripteral*, as in the Maison Carrée at Nîmes.

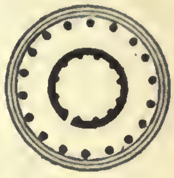


FIG. 17.

In front of the naos or cella of the Greek temple there was always a pronaos, viz. a vestibule with two or more columns *in antis*, and in the rear a similar feature known as the opisthodomus or treasury; in a few cases, as in the Parthenon, this formed a separate chamber, which was entered through a similar vestibule to that in front of the naos; this same vestibule in the absence of the separate chamber was sometimes enclosed with bronze grilles and used as the opisthodomus; the Latin term *posticum* is frequently given to this rear vestibule, for which the Germans and Americans have adopted the term *epinaos* when speaking of Greek temples. In Roman temples the posticum is rarely found; the portico, on the other hand, was increased in importance, being frequently the depth of three bays or columniations. In most of the early Greek temples the cellas were comparatively narrow, owing to the difficulty of roofing them over, as the Greeks do not seem to have been acquainted with the principle of the trussed beam. When therefore more than the usual width was required it became necessary to introduce columns on each side within the cella to carry the ceiling and roof, the earliest example of which existed in the Heraeum at Olympia. There are two other temples in which some of these internal columns still exist, as in the temples at Aegina and Paestum. At Aegina there were five columns on each side, carrying an architrave with five smaller columns superposed; in the temple of Neptune at Paestum there were seven on each side; and in the Parthenon nine columns and a square pier at the end with three columns in the rear, thus constituting an aisle on three sides, round which privileged visitors, like Pausanias, were allowed to pass, there being bronze rails between the columns. In the temple of Zeus at Olympia traces of the barriers have been found, as also of an upper gallery, access to which was given by a wooden staircase. The question of the lighting of these temples has never

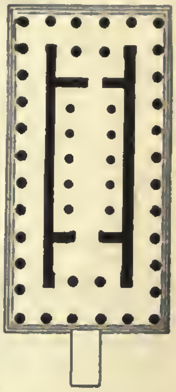


FIG. 18.

FIG. 19.—Temple of Aphaea at Aegina. West Front.

been definitely settled; it is probable that as a rule the only direct light received was that through the open doorway (see HYPAETHROS).

In the earliest temples, those of the Heraeum at Olympia, of Apollo at Thermon, and the archaic temple at Argos, the columns of the peristyle were in wood and carried a wooden architrave; in the Heraeum the wooden columns were replaced by columns in stone when they showed signs of deterioration; the earliest stone columns which were introduced date from the 6th century, and Pausanias in the 2nd century saw one wood column still *in situ* in the opisthodomus. From about the middle of the 7th century the columns were always in stone, and were generally built in several courses with drums or frusta, there being very few instances of monolith columns in Greek temples; the Romans, on the other hand, in their principal columns considered the monolith to be more monumental, and not only employed the finest Greek marbles to that end, but used granite and porphyry.

The favourite type of Greek temple was that known as hexastyle peripteral, of which the temple of Aphaea at Aegina, of the

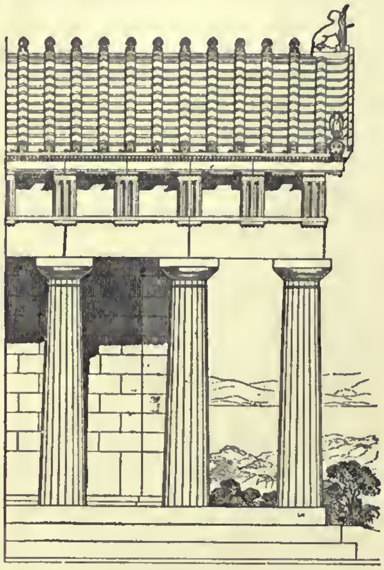


FIG. 20.

Doric order, is one of the best-preserved examples; on account of the width of its naos it was necessary to provide columns inside it to carry the ceiling and the roof, so that it represents the fully developed type of a Greek temple. The plan of the temple is shown in fig. 18; the elevation is given in fig. 19, representing the west front, the columns of which rest on a stylobate of three steps, and carry the entablature and pediment. Fig. 20 shows the three first columns of the flank elevation, the entablature carried by them, and the tiled roof with antefixa and crested ridge.

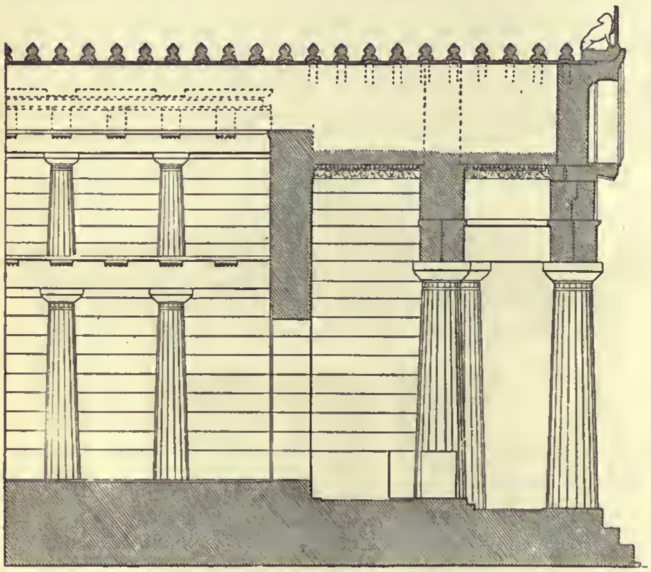


FIG. 21.

Fig. 21 gives the section through the stylobate, peristyle and pronaos, and half of the naos, showing the superposed columns, ceiling and roof, all based on the conjectural restoration by Cockerell. The temple of Aegina is supposed to have been erected about 500 B.C., the magnificent sculpture with which it is enriched being added *c.* 480 B.C. The temple was built of a fine calcareous stone from quarries close by, which was coated over with a thin layer of stucco of lime and marble dust; this enabled the masons to give finer profiles to the mouldings, and afforded a field for colour, of which the restoration is shown in Cockerell's *Temple of Aegina*, from which the illustrations are taken; the cymatium and the tiles covering the roof were in Parian marble.

The Greek Temples were always enclosed in a temenos, in which were other shrines, altars and treasuries; in Athens the temenos was the Acropolis, on which the temples were built; at Delphi it was in a valley on inclined ground; and in Girgenti the temples were raised on the ridge of a hill; in all these cases the Greeks accepted the inequalities of the site, and, adding art to nature,

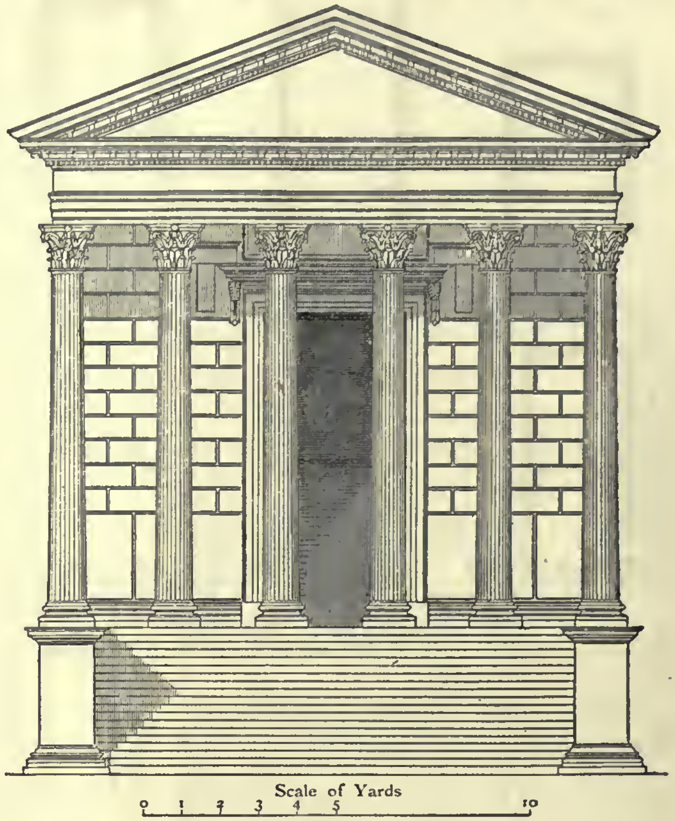


FIG. 22.

united their work with that of the Creator, so that it seemed to form part of the same design. Some of the sites of the temples, such as those at Olympia, Epidaurus and Delos, were practically level, but even in those the temples and other structures were arranged in groups, thus producing a much more picturesque effect than in those of the Romans, which, when enclosed, were always

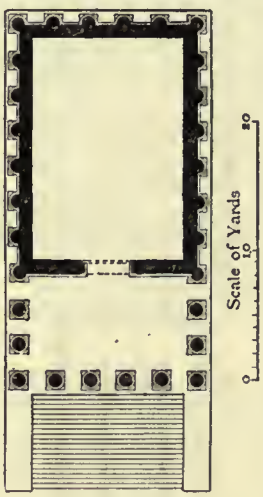


FIG. 23.

planned on axial lines and raised on artificial platforms or terraces, as at Baalbek, Palmyra and Aizani, with peristyles round the raised court. The best-preserved Roman temple is that known as the Maison Carrée at Nîmes in the south of France, a hexastyle pseudo-peripteral temple, of which the elevation is given in fig. 22 and the plan in fig. 23. It was of the Corinthian order, and instead of a stylobate of three steps was raised on a podium 11 ft. high with a flight of steps in front. For further descriptions of both the Greek and Roman temples see ARCHITECTURE.

(R. P. S.)

TEMPLE BAR, an historic site in London, England. In more than one of the main roads converging upon the city of London a bar or chain marked the extra-mural jurisdiction of the Corporation. Temple Bar stood at the junction of the present Strand and Fleet Street, over against the Law Courts. A bar is first mentioned here in 1301, but the name is most familiar in its application to the gateway designed by Sir Christopher Wren, which replaced an older structure on this spot in 1672. This was removed in 1878, and set up in 1888 at the entrance to Theobalds Park near Cheshunt, Hertfordshire. A pedestal surmounted by a dragon or "griffin" marks the old site. When the sovereign is about to enter the city in state, whether by Temple Bar or elsewhere, the Lord Mayor, in accordance with ancient custom, presents the sword of the city to him, and he at once returns it. Formerly the bar or gate was closed against the sovereign until this ceremony was carried out.

TEMRYUK, a seaport of Russia, in northern Caucasia, and in the government of Kuban, on the Sea of Azov, 81 m. W.N.W. of Ekaterinodar. Pop. (1897) 14,476. Here was a Turkish fortress, Abas, till 1774. The place is now a growing seaport for the export of grain, and has many flour-mills.

TENANT (from Lat. *tenere*, to hold), one who holds real property by some form of title from a landlord. For the forms of tenancy, &c., see LANDLORD AND TENANT.

TENANT-RIGHT, in law, a term expressing the right which a tenant has, either by custom or by law, against his landlord for compensation for improvements at the determination of his tenancy. In England it is governed for the most part by the Agricultural Holdings Acts and the Allotments and Small Holdings Acts (see LANDLORD AND TENANT). In Ireland, tenant-right was a custom, prevailing particularly in Ulster, by which the tenant acquired a right not to have his rent raised arbitrarily at the expiration of his term. This resulted in Ulster in considerable fixity of tenure and, in case of a desire on the part of the tenant to sell his farm, made the tenant-right of considerable capital value, amounting often to many years' rent.

TENASSERIM, a division of Lower Burma, bordering on Siam. Area, 36,076 sq. m. Pop. (1901) 1,159,558, including 38,269 Christians, the great majority of whom are Karens. The headquarters of the commissioner are at Moulmein. It is divided into six districts: Toungoo, Salween, Thatôn, Amherst, Tavoy and Mergui. It formed the tract south of Pegu conquered from Burma in 1826, which was for many years known as the Tenasserim province. The southern extremity of the division approaches the insular region of Malaysia, and it is fringed along its entire western coast by a number of islands, forming in the north the Moscos and in the south the Mergui Archipelago. The eastern frontier is formed by a mountain range 5000 ft. high, which acts as a water-parting between the Tenasserim and the Siamese river systems.

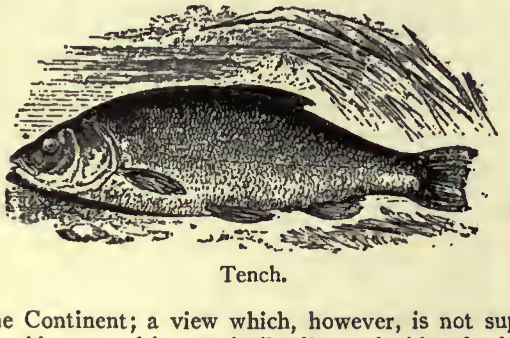
TEN BRINK, BERNHARD EGIDIUS KONRAD (1841–1892), German philologist, of Dutch origin, was born at Amsterdam on the 12th of January 1841, but was sent to school at Düsseldorf, and afterwards studied at Münster, and later under Diez and Delius at Bonn. In 1866 he began to lecture at the Münster Academy on the philology of the English and Romance languages. In 1870 he became professor of modern languages at Marburg, and after the reconstitution of Strassburg University was appointed professor of English there in 1873. In 1874 he began to edit, in conjunction with W. Scherer, E. Martin and E. Schmidt, *Quellen und Forschungen zur Sprache und Kulturgeschichte der germanischen Völker.* He devoted himself for many years to the study of Chaucer. In 1877 he published *Chaucer: Studien zur Geschichte seiner Entwickelung und zur Chronologie seiner Schriften*; in 1884, *Chaucers Sprache und Verskunst.* He also published critical editions of the *Prologue* and the *Compleynte to Pitê.* Ten Brink's work in this direction stimulated a revival of Chaucer study in the United Kingdom as well as in Germany, and to him was indirectly due the foundation of the English Chaucer Society. His *Beowulf-Untersuchungen* (1888) proved a hardly less valuable contribution to the study of Early English literature. His best known work is his *Geschichte der englischen Literatur* (1889–93), (English by H. Kennedy in Bohn's *Standard Library*), which was unfortunately never completed, and broke off just before the Elizabethan period. It was his intense admiration of Shakespeare that first attracted him to the study of English, and five lectures on Shakespeare delivered at Frankfort were published after his death (1893). Ten Brink died at Strassburg on the 29th of January 1892. He was a great teacher as well as an accurate and brilliant writer, and from many countries students flocked to his lecture-room.

TENBURY, a market town in the Bewdley parliamentary division of Worcestershire, England, on the Kidderminster-Wooferton branch of the Great Western railway, 153 m. W.N.W. of London. Pop. (1901) 2080. It is pleasantly situated on the right bank of the Teme, here the boundary with Shropshire. The town has a spa, whose waters are efficacious in rheumatic affections and diseases of the skin. The church of St Mary the Virgin has Norman remains in the tower and chancel. The district produces hops and fruit, and there is trade in cider. The Teme abounds in trout and grayling, and Tenbury is in favour with anglers. At Old Wood, 2 m. S.W. of Tenbury, are St Michael's church and college (1858), founded and partially endowed by the Rev. Sir Frederick Gore Ouseley, in which the ordinary preparatory education of boys is combined with a school for choristers and instruction in ecclesiastical music.

TENBY, a market town, seaside resort, a municipal and contributory parliamentary borough of Pembrokeshire, Wales, finely situated on a long narrow promontory of limestone rock washed on three sides by the sea on the west shore of Carmarthen Bay. Pop. (1901) 4400. Tenby is a station on the Whitland-Pembroke Dock branch of the South Wales system of the Great Western railway. Its chief attractions as a watering-place are its picturesque appearance and surroundings, its extensive antiquarian remains, its mild climate and its two excellent beaches known as the North and South Sands. The ancient town walls survive almost intact on the north and west sides, and retain the fine St George's gateway, locally called the "Five Arches." These walls, which were largely rebuilt by Jasper Tudor, earl of Pembroke, during the Wars of the Roses, were again repaired under Elizabeth during the alarm of the Spanish invasion, as is shown by a contemporary tablet bearing the queen's cipher and the date 1588. The inconsiderable ruins of the castle, presenting a portion of the keep and outer walls, occupy a rocky peninsula to the S.E. of the town known as the Castle Hill, which also contains the Welsh national monument to Albert, prince consort, an immense statue and pedestal of white marble erected in 1865. Upon the Castle Hill is a small museum, containing some antiquities and good collections of the local flora and marine fauna, for which last Tenby has long been celebrated. Opposite the Castle Hill, about 100 yds. distant, but only accessible to foot passengers at low tide, is St Catherine's Rock with a fort constructed in 1865. Facing the Esplanade and South Sands, about $2\frac{1}{2}$ m. from the shore, stretches Caldy Island, 1 m. in length and $\frac{2}{3}$rd m. in breadth, with a population of seventy persons and containing a ruined priory, which was a subsidiary house to St Dogmell's Abbey. To the west, between Caldy Island and Giltar Point on the mainland, lies St Margaret's Rock. The parish church of St Mary, situated at the northern end of Tudor Square, the principal open space in the town, is one of the largest churches in South Wales, and exhibits all varieties of architecture from the 12th to the 16th centuries. Its massive tower, crowned with a spire, is 152 ft. high, and forms a prominent object in all views of the town. The handsome interior is remarkably rich in early tombs and monuments, the most important of them being the elaborate altar-tomb of John and Thomas White (*c.* 1482), members of an opulent family of merchants long seated in Tenby. In the adjoining churchyard are some remains of the Carmelite friary founded by John de Swynemore in 1399. The harbour on the northern beach is protected by an ancient stone pier, and in 1895 an iron pier was erected below the Castle Hill for the convenience of the steamboats which ply between the town and Bristol, Ilfracombe, &c. The trade of Tenby is inconsiderable, but the fisheries, for which the place was noted at an early period and which gave it its Welsh name of Dinbych y Pysgod, are of great value.

The name of Tenby is undoubtedly a corrupted form of Daneby, recalling the Scandinavian origin of the place. The real importance of Tenby dates from the 12th century, when walls, castle and church were erected for the convenience of the Flemish colonists, who were then being planted in Dyfed. On more than one occasion the newly-founded town was captured, sacked and destroyed by marauding bands of Welshmen, notably in 1152; but on each occasion the place was rebuilt and refortified by the earls-palatine of Pembroke, who greatly favoured this important settlement. The first earl of Pembroke to grant a charter of incorporation was William de Valence, 9th earl (*temp.* Henry III.), and these privileges were extended by his successor, Earl Aylmer. Henry IV., by a charter obtained in 1402, vested the government of the town in a mayor and two bailiffs to be elected annually. Elizabeth in 1580 confirmed all previous charters and incorporated the freeholders under the designation of " the mayor, bailiffs and burgesses of the borough of Tenby." During the 15th century and under the Tudors the town grew extremely prosperous, and contained many wealthy mercantile families, of which that of White offers the most striking example. A member of this house, Thomas White, whilst mayor of Tenby, did signal service to the Lancastrian cause in 1471 by harbouring Jasper Tudor, earl of Pembroke, and his nephew Henry Tudor, earl of Richmond (afterwards King Henry VII.), prior to their escape to France. John Leland (*c.* 1540) described Tenby as being " very wealthy by merchandise," and noted its stone pier and well-built walls. The town suffered severely during the Civil Wars, undergoing two sieges, firstly in 1644 when the parliamentarian, Colonel Laugharne, took the place by storm, and secondly in 1648 when it capitulated to Colonel Horton. After the Restoration the importance and wealth of Tenby showed a constant tendency to decline, but towards the close of the 18th century it rose into great popularity as a watering-place, and it has since maintained its reputation as the most picturesque seaside resort of South Wales. Since 1536 Tenby has been a contributory borough to the Pembroke (now Pembroke and Haverfordwest) parliamentary district.

TENCH (*Tinca vulgaris*), a small fish of the Cyprinid family, which is one of the commonest and most widely spread freshwater fishes of Europe. It is generally distributed in all suitable localities throughout England, but is limited to a few lakes and ponds in the south of Scotland and in Ireland. As the tench is of comparatively uncommon occurrence in unenclosed waters, its place among the indigenous fishes of Great Britain has been denied, and it has been supposed to have been introduced



Tench.

from the Continent; a view which, however, is not supported by any evidence, and is practically disposed of by the fact that fossil remains of the fish are found in the Pleistocene deposits of Great Britain. In central Europe it thrives best in enclosed, preserved waters, with a clayey or muddy bottom and with an abundant vegetation; it avoids clear waters with stony ground, and is altogether absent from rapid streams. The tench is distinguished by its very small scales, which are deeply imbedded in a thick skin, whose surface is as slippery as that of an eel. All the fins have a rounded outline; the short dorsal fin is without a spine, but the males possess a very thick and flattened outer ray in the ventral fins. The mouth is rather narrow and provided at each corner with a very small barbel. Tench if kept in suitable waters are extremely prolific, and as they grow within a few years to a weight of 3 or 4 ℔, and are then fit for the table, they may be profitably introduced into ponds which are already stocked with other fishes, such as carp and pike. They live on small animals or soft vegetable substances, which they root up from the bottom. The albino variety especially, which is known as the " golden tench," can be recommended for ornamental waters, as its bright orange colours render it visible for some distance below the surface of the water. This variety, which seems to have been originally bred in Silesia, is not less well-flavoured than the normally coloured tench, and grows to the same size, viz., to 6 and even 8 ℔.

The tench is really an excellent fish for the table, if kept in cool, clear water for a few days, as it is the custom to do in Germany, in order to rid it of the muddy flavour imparted to it by its favourite abode.

TENCIN, CLAUDINE ALEXANDRINE GUÉRIN DE (1681–1749), French courtesan and author, was born at Grenoble. Her father, Antoine Guérin, sieur de Tencin, was president of the parlement of Grenoble. Claudine was brought up at a convent near Grenoble and, at the wish of her parents, took the veil, but broke her vows and succeeded, in 1714, in gaining formal permission from the pope for her secularization. She joined her sister Mme. de Ferriol in Paris, where she soon established a salon, frequented by wits and roués. Among her numerous lovers were the Chevalier Le Camus Destouches, the duc de Richelieu, and according to her biographer many other persons of distinction. The last of her liaisons had a tragic ending. M. de la Fresnaye committed suicide in her house, and Mme. de Tencin spent some time in the Châtelet in consequence, but was soon liberated as the result of a declaration of her innocence by the Grand Conseil. From this time she devoted herself to political intrigue, especially for the preferment of her brother the abbé Tencin, who became archbishop of Embrun and received a cardinal's hat. Eventually she formed a literary salon, which had among its *habitués* Fontenelle, Montesquieu, the abbé de Saint Pierre, Pierre Marivaux, Alexis Piron and others. Hers was the first of the Parisian literary salons to which distinguished foreigners were admitted, and among her English guests were Bolingbroke and Chesterfield. By the good sense with which she conducted what she called her " menagerie," she almost succeeded in effacing the record of her early disgrace. She was a novelist of considerable merit. Her novels have been highly praised for their simplicity and charm, the last qualities the circumstances of the writer's life would lead one to expect in her work. The best of them is *Mémoires du comte de Comminges* (1735), which appeared, as did the other two, under the name of her nephews, MM. d'Argental and Pont de Veyle, the real authorship being carefully concealed. Mme. de Tencin died on the 4th of December 1749.

Her works, with those of Mme. de la Fayette, were edited by Étienne and Jay (Paris, 1825); her novels were reprinted, with introductory matter by Lescure, in 1885; and her correspondence in the *Lettres de Mmes. de Villars, de La Fayette et de Tencin* (Paris, 1805–1832). See P. Masson, *Madame de Tencin* (Paris, 1909).

TENÇIN, PIERRE GUÉRIN DE (1679–1758), French ecclesiastic, archbishop of Embrun and Lyons, and cardinal, was born at Grenoble on the 22nd of August 1679. He owed his quick advance to power to his sister Claudine (see above). He was a strong opponent of the Jansenists, and in 1742 was appointed a minister of state to Louis XV., though he held no portfolio. He died on the 2nd of March 1758.

TENDER. (1) An adjective meaning soft, either physically or figuratively, derived from Fr. *tendre*, Lat. *tener*, soft, allied to *tenuis*, thin, and ultimately to be referred to the root, *tan-*, to stretch out, as in Lat. *tendere*. (2) A legal term meaning an offer for acceptance, particularly an offer in money for the satisfaction of a debt or liability or an offer to pay or deliver according to the terms of a contract; for "legal tender," the currency which can legally be offered and must be accepted in payment, see PAYMENT. The term is also applied specifically to an offer to do a specified piece of work or to supply certain goods for a certain sum or at a certain rate or to purchase goods at a certain rate. Contracts for large or important works or for the supply of large amounts of goods are usually put out to tender in order to secure the lowest price. In this sense the word is from "to tender," to offer, Fr. *tendre*, Lat. *tendere*, to stretch out. (3) A "tender" is also one who "attends" (Lat. *attendere*, to stretch towards, to give heed to), and so is applied particularly to a small vessel which brings supplies, passengers, &c., to a larger vessel, or which is used to take or bring messages from or to her, and similarly to a carriage attached to a locomotive engine on a railway which carries coal or other fuel and water.

TENEBRAE (Lat. for "shadows," "darkness"), the name for an office sung in Roman Catholic churches on the afternoon or evening of Wednesday, Thursday, and Friday of Holy Week. The name is derived, according to Durandus (*Ration.*, lib. vi. cap. 72, n. 2), from the fact that "the church on these days cultivates darkness (*tenebras colit*): firstly because it is in sorrow and grief on account of the Lord's Passion, and because for three days it celebrates his exequies since for three days he was dead; secondly, the office of Tenebrae symbolizes the darkness that fell on the face of the earth while the Sun of justice was hung upon the cross," &c. The falling darkness is symbolized by a peculiar and singularly impressive ceremony (see LIGHTS, CEREMONIAL).

TENEMENT (Med. Lat. *tenementum*, from *tenere*, to hold), in law, a term which, according to Coke, "includes not only all corporate inheritances which are or may be holden, but also all inheritances issuing out of those inheritances, or concerning, or annexed to, or exercisable within the same" (Co. Litt. 20a). In its more general legal sense it is applied to realty, as opposed to personalty. In its popular sense tenement is used as meaning a house or dwelling, and, more particularly in large cities, tenement houses are buildings occupied by several families living independently of one another, but having a common right in the hall, staircases and outhouses. In the heart of great towns the problem of housing is a difficult one, and it is only of recent years that attention has been directed to the unsuitable and insanitary condition of many houses occupied on the tenement system as defined above, but in many cases never built with the conveniences necessary for joint occupation. In most of the large cities in Great Britain and the United States tenement houses are now built on the most modern plans (see HOUSING), and it is to be noted that the municipality of New York has a special Tenement-house Department, under charge of a commissioner, with wide authority to supervise the structure of tenement houses and their occupancy in the interest of health and general welfare.

TENERIFFE [Tenerife], the largest of the Canary Islands; in the Atlantic Ocean, and belonging to Spain. Pop. (1900) 138,008; area, 782 sq. m. Teneriffe lies a little west of the centre of the archipelago, between the islands of Grand Canary and Gomera. It is of irregular shape, 60 m. long, with an extreme breadth of 30 m. A chain of mountains traverses the island in the direction of its greatest length (east to west), and in the middle of the broadest part rises the celebrated peak, locally known as the Pico de Teyde (or Teide), which, with its supports and spurs, occupies nearly two-thirds of the whole island. It has a double top; the highest point, El Piton, is 12,200 ft. above the sea; the other, Chahorra, connected with the first by a short narrow ridge, has a height of 9880 ft. They are both orifices in the same grand dome of trachyte. Neither reaches the line of perpetual snow. There is, however, a natural cavern, 11,050 ft. above the sea, where snow is preserved all the year. Snow remains for about four months on the upper part of the peak.

For more than one-half of its circumference the base of the true peak rises from an elevated but comparatively level tract, called by the Spaniards *El Llano de la Retama* (*retama* being the name of the *Cytisus nubigenus* which abounds there), and by the English the Pumice-Stone Plains. On the south-east, south and south-west there is a high curved ridge overlooking the Pumice-Stone Plains, and presenting a very steep face to the peak. Between the ridge and the sea the slope is more gradual, and there are intervening tablelands. Peaks rise from the ridge, one of which (Guajara) attains the height of 8900 ft. This ridge (the Llano) and the modern volcanic cone resemble in aspect a fortress with circular ramparts and a fosse. The ramparts are about 8 m. in diameter, and tower in some places more than 1500 ft. above the fosse. On the north-west comparatively late eruptions have filled up the fosse. The modern cone is a pile of lava, pumice and ashes, thrown up in an ancient crater which had become greatly enlarged either by a falling in of the upper part of the cone, or by a series of violent explosions. Both El Piton and Chahorra have craters on their summits, from which issue steam and a little sulphurous vapour. The crater on El Piton is partly surrounded by a wall of lava, which has been made white by the action of sulphurous vapours, and every crevice contains small crystals of sulphur. The thermometer rises considerably when thrust into the ground. The crater is about 300 ft. across, with a depth of 70 ft. The crater on Chahorra has a diameter of 4000 ft.; its depth is scarcely 150 ft. The view from the highest point, when no clouds intervene, is very extensive. All the islands of the archipelago are visible, and the horizon is 140 m. distant. Neither the coast of Africa nor the island of Madeira is within the range of vision.

The ascent of the peak is usually made from Orotava, on the northern side of the island. After the cultivated grounds are left, the region of arborescent heaths is crossed. Above this is a belt covered with *codeso* (*Adenocarpus frankenioides*), and this extends to the region of *retama*, the first bushes of which are found at the pass which admits the traveller into the *Llano de la Retama*. The scenery here is in striking contrast with what it has previously been. Instead of a steep and rugged ascent among black basaltic rocks, the traveller enters upon gently sloping ground, covered to a considerable depth with white pumice gravel, amongst which spring bushes of retama. The tender shoots of this shrub serve the wild goats for food, and the flowers yield a rich honey. The entrance to the Llano at a sort of natural gateway (called *Portillo*) between two basaltic hills, is about 7000 ft. above the sea. Between two and three hours are consumed in crossing the Llano to the base of the cone, the lower part of which (*Monton de Trigo*) is ascended to a point 9750 ft. above the sea, called *Estancia de los Ingleses*, where the mules are usually left, and travellers frequently pass the night. Then comes the Malpays, 1000 ft. in altitude, consisting of rough black lava streams broken up into blocks and stones. These cease at the Rambleta, the lip of an older crater over which the lava poured before the sugar-loaf cone of pumice and ashes was thrown up. The pumice is in such quantity that at a distance it has the appearance of snow coating the peak. From twenty to twenty-four hours are consumed in ascending the peak and returning to Orotava.

To the north-west of the grand cone, some thousands of feet below Chahorra, there are many small cones of eruption, showing that the intensity of volcanic action was greatest on this side. Eastward from the ridge bounding the Pumice-Stone Plains extends a chain of mountains to the north-eastern extremity of the island. The highest peaks are Izana (7374 ft.), Perejil (6027), and Cuchillo (5467).

There is no record of eruptions from either crater of the peak. In 1795 a great quantity of lava was poured out from three vents on the eastern side; and in the same year lava streams issued from a crater near Guimar, half-way between Santa Cruz and the peak. In the year 1706 a vent on the north-western side of the peak discharged a copious stream, which flowed down to the sea, and nearly filled up the harbour of Garachico. For three months in 1798 much lava and other volcanic matter were ejected from orifices to the west of Chahorra.

Santa Cruz, the capital of Teneriffe and of the Canaries (pop. 1900, 38,419), and La Laguna (13,074), the former capital, are described in separate articles. A good road connects Santa Cruz and Orotava, a town on the north coast 25 m. W.N.W. It passes through Laguna and Matanza—a place deriving its name from the overthrow of the invading Spaniards by the Guanches in 1494. All travellers speak in terms of warm admiration of the scenery in this part of the island. Date-palms form a striking feature in the landscapes. The town of Orotava (pop. 9192) is 1040 ft. above the sea. The houses are solidly built, but it has a deserted aspect. A stream of water is conducted through every street. The famous dragon-tree, which so many travellers have described, no longer exists. Port Orotava, 3 m. N. of the town, is a clean place, with about 4500 inhabitants. The streets are broad and the houses well built. The roadstead, protected by a fort and some batteries, affords little or no shelter against wind. At Icod de los Vinos, a pretty town of

4000 inhabitants, farther to the west, in a fertile district, is a dragon-tree, the largest now existing in the island. The stem near the ground has a circumference of 38 ft. and its height is upwards of 60 ft. Near the town is an immense cavern, in which many Guanche bones were found. There are several other towns of less importance, principally in the north-west, not far from the coast. The highest inhabited place is Chasna, on a plain more than 4000 ft. above the sea, to the south of the peak. See also CANARY ISLANDS.

TENIERS, the name of a family of Flemish artists who flourished at Antwerp and Brussels during the 17th century.

DAVID TENIERS, the elder (1582–1649), was born at Antwerp. Having received his first training in the painter's art from his brother Juliaen, he studied under Rubens in Antwerp, and subsequently under Elsheimer in Rome; he became a member of the Antwerp gild of painters in 1606. Though his ambition led him at times to try his skill in large religious, historical and mythological compositions, his claim to fame depends chiefly on his landscapes and paintings of peasants carousing, of kermesse scenes and the like, which are marked by a healthy sense of humour, and which are not infrequently confused with the early works of his son David. There is a large painting by the elder Teniers at St Paul's church in Antwerp, representing the "Works of Charity." At the Vienna Gallery are four landscapes painted by Teniers under the influence of Elsheimer, and four small mythological subjects, among them "Vertumnus and Pomona," and "Juno, Jupiter and Io." The National Gallery has a characteristic scene of village life, "Playing at Bowls," a "Conversation" of three men and a woman, and a large "Rocky Landscape." Other examples of his work are to be found at the galleries of St Petersburg, Madrid, Brussels, Munich, Dresden and Berlin ("The Temptation of St Anthony"). Teniers also achieved success as a picture dealer, and is known to have attended the fair of St Germain in Paris in 1635, with a large number of paintings by himself and by his four sons. He died at Antwerp in 1649.

DAVID TENIERS, the younger (1610–1690), the more celebrated son of the last-named, almost ranking in celebrity with Rubens and Van Dyck, was born in Antwerp on the 15th of December 1610. Through his father, he was indirectly influenced by Elsheimer and by Rubens. We can also trace the influence of Adrian Brouwer at the outset of his career. There is no evidence, however, that either Rubens or Brouwer interfered in any way with Teniers's education, and Smith (*Catalogue Raisonné*) may be correct in supposing that the admiration which Brouwer's pictures at one time excited alone suggested to the younger artist his imitation of them. The only trace of personal relations having existed between Teniers and Rubens is the fact that the ward of the latter, Anne Breughel, the daughter of John (Velvet) Breughel, married Teniers in 1637. Admitted as a "master" in the gild of St Luke in 1632, Teniers had even before this made the public acquainted with his works. The Berlin Museum possesses a group of ladies and gentlemen dated 1630. No special signature positively distinguishes these first productions from those of his father, and we do not think it correct to admit with some writers that he first painted religious subjects. Dr Bode, in a remarkable study of Brouwer and his works, expresses the opinion that Teniers's earliest pictures are those found under the signature "Tenier." Tenier is a Flemish version of a thoroughly Walloon name, "Taisnier," which the painter's grandfather, a mercer, brought with him when he came from Ath in 1558; and Dr Bode's supposition is greatly strengthened by the circumstance that not only David the elder but his brother Abraham and his four sons were all inscribed as "Tenier" in the ledgers of the Antwerp gild of St Luke. Some really first-rate works—the "Prodigal Son" and a group of "Topers" in the Munich Gallery, as well as a party of gentlemen and ladies at dinner, termed the "Five Senses," in the Brussels Museum—with the above signature are remarkable instances of the perfection attained by the artist when he may be supposed to have been scarcely twenty. His touch is of the rarest delicacy, his colour at once gay and harmonious. Waagen and Smith agree that the works painted from 1645 to 1650 testify most highly to the master's abilities; there is no doubt that a considerable number of earlier productions would have been sufficient to immortalize his name. He was little over thirty when the Antwerp gild of St George enabled him to paint the marvellous picture which ultimately found its way to the Hermitage Gallery in St Petersburg—the "Meeting of the Civic Guards." Correct to the minutest detail, yet striking in effect, the scene, under the rays of glorious sunshine, displays an astonishing amount of acquired knowledge and natural good taste. This painting leads us to mention another work of the same year (1643), now in the National Gallery, London, "The Village Fête" (or "*La fête aux chaudrons*") (No. 952), an equally beautiful repetition of which, dated 1646, belongs to the duke of Bedford. Truth in physiognomy, distribution of groups, the beautiful effect of light and shade, command our warmest admiration. A work like this, says Waagen, stamps its author as the greatest among painters of his class. Frankness in expression and freedom in attitude guided his preference in the choice of a model, but we may suppose him occasionally to have exaggerated both. He seems anxious to have it known that, far from indulging in the coarse amusements of the boors he is fond of painting, he himself lives in good style, looks like a gentleman, and behaves as such. He never seems tired of showing the turrets of his château of Perck, and in the midst of rustic merry-makings we often see his family and himself received cap in hand by the joyous peasants. We may also observe that he has a certain number of favourite models, the constant recurrence of whom is a special feature of his works. We have even met them in a series of life-size portrait-like figures in the Doria Pamphili Gallery in Rome.[1]

Teniers was chosen by the common council of Antwerp to preside over the gild of painters in 1644. The archduke Leopold William, who had assumed the government of the Spanish Netherlands, being a great lover of art, employed Teniers not only as a painter but as keeper of the collection of pictures he was then forming. With the rank and title of "ayuda de camara," Teniers took up his abode in Brussels shortly after 1647. Immense sums were spent in the acquisition of paintings for the archduke. A number of valuable works of the Italian masters, now in the Vienna Museum, came from Leopold's gallery after having belonged to Charles I. and the duke of Buckingham. De Bie (1661) states that Teniers was some time in London, collecting pictures for the duke of Fuensaldaña, then acting as Leopold's lieutenant in the Netherlands. Paintings in Madrid, Munich, Vienna and Brussels have enabled art critics to form an opinion of what the imperial residence was at the time of Leopold, who is represented as conducted by Teniers and admiring some recent acquisition. No picture in the gallery is omitted, every one being inscribed with a number and the name of its author, so that the *ensemble* of these paintings might serve as an illustrated inventory of the collection.[2] Still more interesting is a canvas, now in the Munich Gallery, where we see Teniers at work in a room of the palace, with an old peasant as a model and several gentlemen looking on. When Leopold returned to Vienna, Teniers's task ceased; in fact, the pictures also travelled to Austria, and a Flemish priest, himself a first-rate flower painter, Van der Baren, became keeper of the archducal gallery. Teniers nevertheless remained in high favour with the new governor-general, Don Juan, a natural son of Philip IV. The prince was his pupil, and de Bie tells us he painted the likeness of the painter's son. Honoured as one of the greatest painters in Europe, Teniers seems to have made himself extremely miserable through his aristocratic

[1] Under the name of Weenix.

[2] It was not until recent years that the MS. inventory of this collection was discovered among the papers of Prince Schwartzenberg in Vienna. It was published in 1883 by Adolf Berger. In 1658 Teniers published 243 etchings after the best Italian works of Leopold William's collection, which, with the portraits of the archduke and Teniers, were brought together as a volume in 1660, under the title *El Teatro de Pinturas*.

leanings. Shortly after the death of his wife in 1656 he married Isabella de Fren, daughter of the secretary of the council of Brabant, and strove his utmost to prove his right to armorial bearings. In a petition to the king he reminded him that the honour of knighthood had been bestowed upon Rubens and Van Dyck. The king at last declared his readiness to grant the request, but on the express condition that Teniers should give up selling his pictures. The condition was not complied with; but it may perhaps account for the master's activity in favour of the foundation in Antwerp of an academy of fine arts to which only painters and sculptors should be admitted, whereas the venerable gild of St Luke made no difference between art and handicraft: carvers, gilders, bookbinders, stood on an even footing with painters and sculptors: the separation was not obtained till 1773. There were great rejoicings in Antwerp when, on the 26th of January 1663, Teniers came from Brussels with the royal charter of the academy, the existence of which was due entirely to his personal initiative.

Teniers died in Brussels on the 25th of April 1690. The date is often wrongly given as 1694 or 1695. A picture in the Munich Gallery (No. 906), dated 1680, represents him as an alchemist, oppressed with a burden of age beyond his years. From this date we hear more of his doings as a picture-dealer than as a painter, which most probably gave birth to the legend of his having given himself out as deceased in order to get higher prices for his works. David, his eldest son, a painter of talent and reputation, died in 1685. One of this third Teniers's pictures—"St Dominic Kneeling before the Blessed Virgin," dated 1666—is still to be found in the church at Perck. As well as his father, he contributed many patterns to the celebrated Brussels tapestry looms.

Smith's *Catalogue Raisonné* gives descriptions of over 900 paintings accepted as original productions of Teniers. Few artists ever worked with greater ease, and some of his smaller pictures—landscapes with figures—have been termed "afternoons," not from their subjects, but from the time spent in producing them. The museums in Madrid, St Petersburg, Vienna, Munich, Dresden, Paris, London and Brussels have more than 200 pictures by Teniers. In the United Kingdom 150 may be found in private hands, and many other examples are to be met with in private collections throughout Europe. Although the spirit of many of these works is as a whole marvellous, their conscientiousness must be regarded as questionable. Especially in the later productions, from 1654 onwards we often detect a lack of earnestness and of the calm and concentrated study of nature which alone prevent expression from degenerating into grimace in situations like those generally depicted by Teniers. His education, and still more his real and assumed position in society, to a great degree account for this. Brouwer knew more of taverns; Ostade was more thoroughly at home in cottages and humble dwellings; Teniers, throughout, triumphs in broad daylight, and, though many of his interiors may be justly termed masterpieces, they seldom equal his open-air scenes, where he has, without constraint, given full play to the bright resources of his luminous palette. In this respect he often suggests comparisons with Watteau. But his subjects taken from the Gospels or sacred legend are absurd. An admirable picture in the Louvre shows "Peter Denying his Master" next to a table where soldiers are smoking and having a game at cards. A similar example is the "Deliverance of St Peter from Prison" of which two versions, curiously altered, are in the Dresden Gallery and the Wallace Collection. He likes going back to subjects illustrated two centuries before by Jerome Bosch—the "Temptation of St Anthony," the "Rich Man in Hell," incantations and witches—for the simple purpose of assembling the most comic apparitions. His villagers drink, play bowls, dance and sing; they seldom quarrel or fight, and, if they do, seem to be shamming. This much may be said of Teniers, that no painter shows a more enviable ability to render a conception to his own and other people's satisfaction. His works have a technical freshness, a straightforwardness in means and intent, which make the study of them most delightful; as Sir Joshua Reynolds says, they are worthy of the closest attention of any painter who desires to excel in the mechanical knowledge of his art.

As an etcher Teniers compares very unfavourably with Ostade, Cornelis, Bega and Dusart. More than 500 plates were made from his pictures; and, if it be true that Louis XIV. judged his "baboons" (*magots*) unworthy of a place in the royal collections, they found admirable engravers in France—Le Bas and his scholars—and passionate admirers. The duke of Bedford's admirable specimen was sold for 18,030 livres (£1860) in 1768. The "Prodigal Son," now in the Louvre, fetched 30,000 livres (£3095) in 1776. Smith's highest estimates have long since been greatly exceeded. The "Archers" in St Petersburg he gives as worth £2000. The Belgian government gave £5000 in 1867 for the "Village Pastoral" of 1652, which is now in the Brussels Museum; and a picture of the "Prodigal Son," scarcely 16 by 28 inches, fetched £5280 in 1876.

Although van Tilborgh, who was a scholar of Teniers in Brussels, followed his style with some success, and later painters often excelled in figure-painting on a small scale, Teniers cannot be said to have formed a school. Properly speaking, he is the last representative of the great Flemish traditions of the 17th century.

See T. Smith, *A Catalogue Raisonné of the Works of the most Eminent Dutch, Flemish and French Painters;* John Vermoelen, *Notice historique sur David Teniers et sa famille;* L. Galesloot, *Quelques renseignements sur la famille de P. P. Rubens et le décès de David Teniers* and *Un procès de David Teniers et la corporation des peintres à Bruxelles;* Alph. Wauters, *Histoire des environs de Bruxelles* and *Les tapisseries bruxelloises;* F. T. Van der Brandern, *Geschiedenis der Antwerpsche Schilderschool;* Max Rooses, *Geschichte der Malerschule Antwerpens;* W. Bode, *Adriaen Brouwer, ein Bild seines Lebens und seines Schaffens.* (H. H.; P. G. K.)

TENISON, THOMAS (1636–1715), English archbishop, was born at Cottenham, Cambridgeshire, on the 29th of September 1636. He was educated at the free school, Norwich, whence he entered Corpus Christi College, Cambridge, as a scholar on Archbishop Parker's foundation. He graduated in 1657, and was chosen fellow in 1659. For a short time he studied medicine, but in 1659 was privately ordained. As vicar of St Andrew-the-Great, Cambridge, he was conspicuous for his devoted attention to the sufferers from the plague. In 1667 he was presented to the living of Holywell-cum-Needingworth, Huntingdonshire, by the earl of Manchester, to whose son he had been tutor, and in 1670 to that of St Peter's Mancroft, Norwich. In 1680 he received the degree of D.D., and was presented by Charles II. to the important cure of St Martin's-in-the-Fields. Tenison, according to Gilbert Burnet, "endowed schools, set up a public library, and kept many curates to assist him in his indefatigable labours." Being a strenuous opponent of the Church of Rome, and "Whitehall lying within that parish, he stood as in the front of the battle all King James's reign." In 1678, in a *Discourse of Idolatry*, he had endeavoured to fasten the practices of heathenish idolatry on the Church of Rome, and in a sermon which he published in 1681 on *Discretion in Giving Alms* was attacked by Andrew Pulton, head of the Jesuits in the Savoy. Tenison's reputation as an enemy of Romanism led the duke of Monmouth to send for him before his execution in 1685, when Bishops Ken and Turner refused to administer the Eucharist; but, although Tenison spoke to him in "a softer and less peremptory manner" than the two bishops, he was, like them, not satisfied with the sufficiency of Monmouth's penitence. Under William III., Tenison was in 1689 named a member of the ecclesiastical commission appointed to prepare matters towards a reconciliation of the Dissenters, the revision of the liturgy being specially entrusted to him. A sermon which he preached on the commission was published the same year. He preached a funeral sermon on Nell Gwyn (d. 1687) in which he represented her as truly penitent—a charitable judgment which did not meet with universal approval. The general liberality of Tenison's religious views commended him to the royal favour, and, after being made bishop of Lincoln in 1691, he was promoted to the primacy in December 1694. He attended Queen Mary during her last illness and preached her funeral sermon in Westminster Abbey. When William in 1695 went to take command of the army in the Netherlands, Tenison was appointed one of the seven lords justices to whom his authority was delegated. Along with Burnet he attended the king on his death-bed. He crowned Queen Anne, but during her reign was not in much favour at court. He was a commissioner for the Union with Scotland in 1706. A strong supporter of the Hanoverian succession, he was one of the three officers of state to whom on the death of Anne was entrusted the duty of appointing a regent till the arrival of George I., whom he crowned on the 31st of October 1714. Tenison died at London on the 14th of December 1715.

Besides the sermons and tracts above mentioned, and various others on the "Popish" controversy, Tenison was the author of *The Creed of Mr Hobbes Examined* (1670) and *Baconia, or Certain*

Genuine Remains of Lord Bacon (1679). He was one of the founders of the Society for the Propagation of the Gospel.

The *Memoirs of the Life and Times of the Most Rev. Father in God, Dr Thomas Tenison, late Archbishop of Canterbury*, appeared without date not long after his death. See also Gilbert Burnet's *History of his own Time* and Macaulay's *History of England.*

TEN KATE, JAN JACOB LODEWIJK (1819–1889), Dutch divine, prose writer and poet, was born at The Hague on the 23rd of December 1819. He started in life as a lawyer's clerk. It was his friend, Dr Heldring, pastor at Hemmen, in Gelderland, who, discovering in Ten Kate the germs of poetical genius, enabled him to study theology at the university of Utrecht (1838–43). Having completed his studies, Ten Kate became pastor at Middelburg, Amsterdam, and other places, meanwhile developing well-nigh ceaseless activity, both in prose and lyric poetry. Among his prose works may be mentioned the travel papers (Rhine, 1861; Italy, 1857–62), *Christelijke Overdenkingen* ("Thoughts of a Christian," 1849–52), and other religious studies. His early poetry was in the main original. The best known of his poems were—*Ahasverus op de Grimsel* ("Ahasuerus on the Grimsel," 1840); *Zangen des Tijds* ("Songs of the Times," 1841); *Legenden en Mengelpoëzie* ("Legends and Detached Poems," 1846); *In den Bloemhof* ("In the Flower Garden," 1851); *De Schepping* ("The Creation," 1866); *De Planeten* ("The Planets," 1869); *De Jaargetijden* ("The Seasons," 1871); *De Psalmen* ("The Psalms," 1874); *De Vrouw in het Nederlandsch Lied* ("Woman in Dutch Song," 1882); *Palmtakken en Dichtbloemen* ("Palm-branches and Flowers of Poesy," 1884). Ten Kate reached the pinnacle of his poetic fame in *The Creation, The Planets*, and *The Seasons.* These poems certainly show a masterly grasp of his mother tongue and a wonderful facility of expression, coupled with graceful vigour and fertile fancy. These qualities he also plentifully displayed in the innumerable translations he made of many of the masterpieces of foreign poetry in nearly every European language. He had not only an extraordinary aptitude for learning alien idioms, but also the gift of translating foreign lyrics into clear, fluent and beautiful Dutch verse. Ten Kate's versatility in this respect has never been equalled; it extended from Tasso and Andersen to Dante, Schiller, Victor Hugo, Milton, Tennyson and Longfellow. Ten Kate died at Amsterdam on the 24th of December 1889.

His complete *Poetic Works* were published after his death in 12 volumes (Leiden, 1891).

TENNANT, CHARLES (1768–1838), Scottish industrial chemist, was born at Ochiltree, Ayrshire, on the 3rd of May 1768. He started in business as a bleacher at Darnley, and in 1798 took out a patent for a bleach liquor formed by passing chlorine into a mixture of lime and water. This product had the advantage, as compared with the Eau de Javelles, then generally used, that a cheaper base, lime, was substituted for potash in its preparation; but when he attempted to protect his rights against infringement his patent was held invalid on the double ground that the specification was incomplete and that the invention had been anticipated at some bleach-works near Nottingham. In 1799 he patented a more convenient material in bleaching powder or "chloride of lime," formed by the action of chlorine on slaked lime, and for its manufacture founded at Glasgow in 1800 the well-known St Rollox chemical works, now merged in the United Alkali Company. He died at Glasgow on the 1st of October 1838.

His grandson the iron-master, Sir Charles Tennant (1823–1906), was M.P. for Glasgow from 1878 to 1880 and for Peebles and Selkirk from 1880 to 1886; he was created a baronet in 1885.

TENNANT, SMITHSON (1761–1815), English chemist, was born at Selby, Yorkshire, on the 30th of November 1761. He began to study medicine at Edinburgh in 1781, but in a few months moved to Cambridge, where he devoted himself to botany and chemistry. He graduated M.D. at Cambridge in 1790, and about the same time purchased an estate near Cheddar, where he carried out agricultural experiments. He was appointed professor of chemistry at Cambridge in 1813, but lived to deliver only one course of lectures, being killed near Boulogne on the 22nd of February 1815 by the fall of a bridge over which he was riding. He was a man of more promise than performance, and his chief achievement was the discovery of the elements iridium and osmium, which he found in the residues from the solution of platinum ores (1804). He also contributed to the proof of the identity of diamond and charcoal.

TENNANT, WILLIAM (1784–1848), Scottish scholar and poet, was born on the 15th of May 1784 at Anstruther Easter, Fifeshire. He was lame from childhood. His father sent him to the university of St Andrews, where he remained for two years, and on his return he became clerk to one of his brothers, a corn factor. In his leisure time he mastered Hebrew as well as German and Italian. His study of Italian verse bore fruit in the mock-heroic poem of *Anster Fair* (1812), which gave an amusing account of the marriage of "Maggie Lauder," the heroine of the popular Scottish ballad. It was written in the *ottava rima* adopted a few years later by "the ingenious brothers Whistlecraft" (John Hookham Frere), and turned to such brilliant account by Byron in *Don Juan.* The poem, unhackneyed in form, full of fantastic classical allusions applied to the simple story, and brimming over with humour, had an immediate success. Tennant's brother, meanwhile, had failed in business, and the poet became in 1812 schoolmaster of the parish of Dunino, near St Andrews. From this he was promoted (1816) to the school of Lasswade, near Edinburgh; from that (1819) to a mastership in Dollar academy; from that (1834), by Lord Jeffrey, to the professorship of oriental languages in St Andrews. *The Thane of Fife* (1822), shows the same humorous imagination as *Anster Fair*, but the subject was more remote from general interest, and the poem fell flat. He also wrote a poem in the Scottish dialect, *Papistry Stormed* (1827); two historical dramas, *Cardinal Beaton* (1823) and *John Baliol* (1825); and a series of Hebrew Dramas (1845), founded on incidents in Bible history. He died at Devon Grove, on the 14th of February 1848.

A Memoir of Tennant by M. F. Connolly was published in 1861.

TENNEMANN, WILHELM GOTTLIEB (1761–1819), German historian of philosophy, was born at Erfurt. Educated at his native town, he became lecturer on the history of philosophy at Jena in 1788. Ten years later he became professor at the same university, where he remained till 1804. His great work is an eleven-volume history of philosophy, which he began at Jena and finished at Marburg, where he was professor of philosophy from 1804 till his death. He was one of the numerous German philosophers who accepted the Kantian theory as a revelation.

In 1812 he published a shorter history of philosophy, which was translated into English in 1852 under the title *Manual of the History of Philosophy.*

TENNENT, SIR JAMES EMERSON, Bart. (1804–1869), English politician and traveller, the third son of William Emerson, a merchant of Belfast, was born there on the 7th of April 1804. He was educated at Trinity College, Dublin, of which he afterwards became LL.D. He took up the cause of Greek independence, and travelled in Greece, publishing a *Picture of Greece* (1826), *Letters from the Aegean* (1829), and a *History of Modern Greece* (1830); and he was called to the English bar at Lincoln's Inn in 1831. In this year he married the daughter and co-heiress (with her cousin, Robert James Tennent, M.P. for Belfast, 1848–52) of William Tennent, a wealthy merchant at Belfast, who died of cholera in 1832, and he adopted by royal licence the name of his wife in addition to his own. He entered parliament in 1832 as member for Belfast. In 1841 he became secretary to the India Board, and in 1845 he was knighted and appointed colonial secretary of Ceylon, where he remained till 1850. The result of his residence there appeared in *Christianity in Ceylon* (1850) and *Ceylon, Physical, Historical and Topographical* (2 vols., 1859). On his return, he became member for Lisburn, and under Lord Derby was secretary to the Poor Law Board in 1852. From 1852 till 1867 he was permanent secretary to the Board of Trade, and on his retirement he received a baronetcy from Lord Palmerston. In his early years his political views had a Radical tinge, and, although he subsequently joined the Tories, his Conservatism was of a mild type. He withdrew from the Whigs along with Lord Stanley and Sir James Graham, and afterwards adhered to Peel. He died in London on the 6th of March 1869. His family consisted of two daughters and a son, Sir William Emerson Tennent, 2nd baronet (1835–1876), who was an official in the Board of Trade, and at whose death the baronetcy became extinct.

Besides the books above mentioned, Emerson Tennent wrote *Belgium in 1840* (1841), and *Wine; its Duties and Taxation* (1855), and was a contributor to magazines and a frequent correspondent of *Notes and Queries*. (H. Ch.)

TENNESSEE, a South Central state of the United States of North America, lying between latitude 35° and latitude 36° 40′ N. and between longitude 81° 37′ and longitude 90° 28′ W. It is bounded on the N. by Kentucky and Virginia along a line which, because of erroneous surveys, varies considerably, east of the Tennessee river, from the intended boundary—the line of latitude 36° 30′ N.—the variations all being measured to the north of that parallel; on the E. by North Carolina along the line of the crest of the culminating ridge of the Unaka Mountains till within 26 m. of the Georgia frontier, where it turns due south, giving to Tennessee a triangular piece of territory which should have belonged to North Carolina; on the S. by Georgia, Alabama and Mississippi along the 35th parallel of N. lat.; on the W. by the Mississippi river which separates it from Arkansas and Missouri. The extreme length of the state from E. to W. is 432 m., and the extreme breadth is 109 m. its area being 42,022 sq. m., of which 335 sq. m. is water surface.

Physical Features.—Tennessee is traversed in the east by the Unaka Ridges of the Older Appalachian Mountains and by the Great Appalachian Valley; in the middle by the Cumberland Plateau, the Highland Rim Plateau, and the Nashville Basin of the Appalachian Plateau; and in the west by the Gulf Coastal Plains and a narrow strip of the Mississippi Flood Plain. From a maximum elevation of 6636 ft. at Mount Guyot on the North Carolina border, in Sevier county, the surface descends to 117 ft. or less on the Mississippi Flood Plain in the S.W. corner of the state. The general slope, however, is west by north. About 1700 sq. m. are at least 2000 ft. above the sea, but 28,200 sq. m. are less than 1000 ft. above the sea, and the mean elevation of the state is approximately 900 ft. The Unaka Mountains, which occupy a belt 8 to 10 m. wide along its E. border, are a series of somewhat irregular ridges developed on complexly folded and faulted crystalline rocks. Sixteen peaks exceed 6000 ft. in height. They are Mount Guyot (6636 ft.), Clingman Dome (6619 ft.), Mount Le Conte (6612 ft.), Mount Curtis (6568 ft.), Mount Safford (6535 ft.), Mount Love (6443 ft.), Mount Henry (6373 ft.), Roan Mountain (6313 ft.), Luftee Knob (6232 ft.), Peck Peak (6232 ft.), Raven Knob (6230 ft.), Mount Collins (6188 ft.), Tricorner Knob (6188 ft.), Thermometer Knob (6157 ft.), Oconee Mountain (6135 ft.), and Master Knob (6013 ft.). That part of the Great Appalachian Valley which traverses Tennessee is commonly known as the Valley of East Tennessee. It consists of parallel ridges and valleys developed by erosion on folded sandstones, shales and limestones, the valley quality predominating because the weak limestones were of great thickness. The valley areas vary in height from 600 ft. in the south-west to 1000 ft. in the north-east. In the north-east the ridges are more numerous and higher than in the south-west, where White Oak Ridge and Taylor's Mountain are among the highest, although Missionary and Chickamauga Ridges are better known, because of their association with battles of the Civil War. Along the north-west border of the valley a steep escarpment, known as the Cumberland Scarp, rises to the Cumberland Plateau. This plateau has a mean elevation of about 2000 ft., is only slightly rolling, and slopes gently toward the north-west. The W. edge of the plateau is much broken by deep indentations of stream valleys, and drops suddenly downward about 1000 ft. to the Highland Rim Plateau, so named from the scarp formed by its western rim about the Nashville and (farther north) Louisville basins. It is generally level except where it is cut by river valleys. The Nashville Basin, with a more rolling surface, lies for the most part 400 to 600 ft. below the Rim; a few hills or ridges, however, rise to the level of the Rim. The Basin is elliptical in form, extending nearly across the state from N.E. to S.W., with an extreme width of about 60 m.; near its centre is the city of Murfreesboro, and Nashville lies in the north-west. Westward from the Lower Tennessee river the surface of the East Gulf Coastal Plain rises rapidly to the summit of a broken cuesta or ridge and then descends gently and terminates abruptly in a bluff overlooking the Mississippi Flood Plain. The E. slope, about one-fourth the length of the W. slope, is steep and rocky, and the W. slope is broken by the valleys of numerous streams. The bluff, 150 to 200 ft. in height, traverses the state in a rather straight course and between it and the meandering Mississippi, except at a few points where the latter touches it, lie low bottom lands varying in width according to the bends of the river and containing numerous swamps and ponds. In the northern portion, principally in Lake county, is Reelfoot Lake, which occupies a depression formed during an earthquake in 1811. It is 18 m. long, has a maximum width of 3 m., and is the only large lake in the state.

The whole of the Appalachian Province of Tennessee and the southern portion of the Cumberland Plateau, the Highland Rim, and the Lowland Basin are drained southward and westward by the Tennessee river and its tributaries. The valley of the Lower Tennessee is drained northward by the same river. The northern portion of the Cumberland Plateau, Highland Rim, and Lowland Basin are drained northward and westward by the Cumberland river and its tributaries. The western slope of the East Gulf Plains is drained directly into the Mississippi by several small streams.

Fauna.—A few black bears inhabit the Unaka Mountain region. Deer are quite numerous in the forests of the east half of the state. The wolf, fox, lynx ("wildcat"), otter, mink and beaver have become rare. Squirrels, rabbits, wood-chucks, skunks, muskrats and opossums are common. Among game-birds there are a few wild turkeys, wild geese and bob-white (locally "partridge"), and greater numbers of grouse and various ducks; among song-birds the robin, bluebird and mocking-bird are common; and there are also woodpeckers, whippoorwills, blackbirds, hawks, owls, crows and buzzards. There are a few speckled trout in the mountain streams, but the commoner fish are bass, perch, catfish, crappies, pike, drum buffalo, carp, suckers and eels. Rattlesnakes and moccasins, or cottonmouths, both venomous, are occasionally seen.

Flora.—Originally the state was well covered with forests, and about one-half of it is still woodland containing a large variety of trees. On the mountains the trees are chiefly pines, firs, spruce and hemlock. In the swamps of the western part of the state, especially on the Mississippi Flood Plain, the cypress is dominant. In the Lowland Basin small groves of what was once an extensive forest of red cedar remain. Poplar and larch are much more abundant in the western than in the eastern half of the state, and pine is much more abundant in the eastern than in the western half. But in most parts of the state there are mixed forests of white oak, red oak, ash, red gum, black gum, maple, hickory, chestnut, sycamore, magnolia, tulip tree, cherry, pecan, walnut, elm, beech, locust and persimmon. Birch, mulberry, linden, willow, bass-wood, dogwood, the sorrel tree, pawpaw and wild plum are common. There are a few varieties of the rare shittimwood tree (*Bumelia lanuginosa*). Among indigenous shrubs and vines are the hazel, blackberry, gooseberry, whortleberry, huckleberry, grape and cranberry. Blue grass is indigenous in the Lowland Basin. Of numerous medicinal herbs ginseng is the most important.

Climate.—Tennessee is noted for its delightful climate. The mean summer temperature ranges according to elevation from 62° F. on the Unaka Mountains to 72° on the Cumberland Plateau, to 75° in the Valley of East Tennessee and on the Highland Rim, to 77° in the Lowland Basin, and to about 78° on the East Gulf Plains. But the mean winter temperature for each of these divisions varies little from 38°, and the mean annual temperature ranges only from 57° in East Tennessee to 58° in Middle Tennessee and to 60° in West Tennessee. The altitude being the same, the mean annual temperature on the south border of the state is about 2° higher than that on the north border. Usually the highest temperatures of the year are in July and the lowest in January. In some regions there is no record of a temperature as high as 100°; in others there is none as low as −10°; and the average absolute range is about 90°. However, during a period of fifty-four years (1854–1908) the records show a range of extremes from −30° at Erasmus, Cumberland county, in February 1899, to 107° at several places in July 1901. Rarely there are killing frosts, especially in the southern and western parts of the state from the third week in April to the middle of October. An average annual precipitation of about 50 in. is quite equally distributed over the state and a little more than one-half of it is well distributed through the spring and summer months. The average annual snowfall is about 8 in., and the snowfalls are usually light and melt within a few days. The average number of clear, fair, or only partly cloudy days during a year in Tennessee is 260. The warm, moisture-bearing winds blow low from the south or south-west with a free sweep across the state in a direction nearly parallel with the trend of the mountains. Above these are upper currents from the north or north-west. The commingling of the two currents gives rise frequently to westerly and occasionally to easterly winds. The average velocity of the winds is comparatively low and violent storms are rare.

Soil.—The Lowland Basin, the less elevated parts of the Valley of East Tennessee, and parts of the outer portion of the Highland Rim have a fertile limestone soil. The deep deposit of silt on the Mississippi Flood Plain is even more fertile. There are narrow strips of rich alluvium along many other rivers. The soils on the mountains, on the ridges of the Valley of East Tennessee, and on the E. slope of the East Gulf Plains vary greatly according to the rocks from which they are derived. In the Cumberland Plateau, in the inner portion of the Highland Rim, and in the W. slope of the East Gulf Plains there is for the most part a light sandy soil, much of it too poor for cultivation.

Agriculture.—The total area of farms in the state in 1900 was 20,342,058 acres, of which about one-half was classed as "improved." The average size was 90·6 acres, and the average number of acres of improved land per farm was 45·6. Of the total farm acreage 68·8 per cent. was held or operated by owners or part owners, 9·4 per cent. by cash tenants, 17·4 per cent. by share tenants, and the remainder under miscellaneous tenure. Some 15·1 per cent. of all the farms were operated by coloured farmers, who in 1899 produced 22·2 per cent. of the agricultural products of the state, not fed to live stock. The total value of farms, including buildings, was $265,150,750 (the value of buildings being 23·8 per cent. of the total); in addition implements and machinery valued at $15,232,670 were employed. The principal products and their values in 1909 were: wheat, 8,320,000 bushels ($9,568,000); Indian corn, 78,650,000 bushels ($55,055,000); oats, 4,000,000 bushels ($2,120,000); cotton, 240,000 bales; tobacco, 53,290,000 lb, ($4,156,620). The average yield per acre in 1909 was, of wheat 10·4 bushels, of Indian corn 22 bushels, of cotton (1908) 218 lb, of tobacco 730 lb. Cotton is not raised to any extent except in the rich alluvial land of the Mississippi Valley. Tennessee ranked fifth among the tobacco-growing states in 1899 and fourth in 1909. Considerable areas in the central part of the state are admirably adapted for grazing and the raising of fine horses and cattle. The value of live stock on farms and ranges on the 1st of January 1910 was as follows: horses, $36,288,000; mules, $35,670,000; milch cows, $8,828,000; other cattle, $7,797,000; swine, $8,216,000.

Mining.—Previous to the close of the Civil War (1865) mining had been carried on upon a comparatively small scale, but immediately thereafter attention was attracted to the extensive and valuable deposits of coal and iron ore, and their development was begun on a large scale. The minerals of most commercial importance are coal, iron ores, copper ores, marble and phosphate rock.

About 5000 sq. m., or almost one-eighth of the area of the state, is underlaid by the coal measures, which occupy a belt in the Cumberland Plateau from 50 to 70 m. wide extending entirely across the easterly part of the state in a north-easterly, south-westerly direction. The coal is of the soft or "bituminous" kind, generally of excellent quality, and much of it suitable for conversion into gas and coke, of which latter 468,092 long tons were produced in 1905. The mining of coal in the state has developed rapidly in connexion with the notable expansion of the iron and steel industries of the South. In 1908 the product was 6,199,171 tons, valued at $7,118,499.

Iron ore is found and has been mined in many places in the state. The deposits of most commercial importance are the limonites and brown hematites found west of the Cumberland Plateau, and the fossiliferous red hematite which crops out along the eastern base of that plateau. In the early history of Tennessee iron of superior quality was produced, in small charcoal furnaces, from the brown hematites of the central part of the state. A little later, considerable quantities of this iron were shipped and marketed at Pittsburg. After the close of the Civil War (1865) the iron resources of the state attracted renewed attention, particularly the brown and red hematites, and large and modern furnaces were erected in the Chattanooga district to reduce these ores. The output of iron ore was 874,542 tons (valued at $1,123,527) in 1902, when Tennessee ranked fifth among the iron ore producing states. Owing to the industrial depression following 1907 the output was only 635,343 tons, valued at $876,007, in 1908.

The only copper mines of industrial importance are the Ducktown mines in the extreme south-eastern corner of the state. Copper has been mined here since 1847, and notwithstanding the difficulties of transportation through a rough mountain region, mines were rapidly developed, and in 1855 over 14,000 tons of ore, worth more than a million dollars, were marketed. These mines were the principal source of the supply of copper for the Confederate States during the Civil War. The opening, in 1869, of a railway passing directly through the mining territory, made it possible to work the mines more profitably, and operations were developed on a large scale. In 1908, 618,806 short tons of ore were mined, producing, from the smelters on the ground, 19,710,103 lb of metallic copper. The ore is a sulphide, and in 1898 an extensive plant was erected to manufacture sulphuric acid as a by-product.

In 1892–1893 large deposits of phosphate rock of high quality were discovered in the central-southern part of the state about 60 m. south-west of Nashville, and the rapid development of quarries was begun. The output increased from 19,188 tons in 1894 to 638,612 tons (valued at $3,047,836) in 1907, when Tennessee ranked second among the states of the Union in the production of phosphate-rock. The introduction of this new supply had a marked effect on the fertilizer business of the country.

Inexhaustible deposits of marble are found in Eastern Tennessee in an area about 100 m. long by 20 m. wide, the centre of which is Knox county, the deposits extending southward into Georgia. These marbles are of a distinctive character, being usually mottled in bright shades of red, pink, chocolate and grey. They are employed principally for interior decoration, and were thus largely used in the capitol at Nashville and in the National Capitol at Washington. Systematic quarrying of these marbles was begun as early as 1838, and the output of the quarries has constantly increased since the Civil War.

In 1908 Tennessee produced 179 ozs. of fine gold and 57,696 ozs. of fine silver, a part of each coming, as a by-product, from the copper refineries. Zinc ore is mined on a small scale in the eastern part of the state, the product in 1908 being 341 short tons of metallic zinc valued at $32,054. Among the other minerals found and mined to a limited extent are lead, manganese, barytes, fluorspar, slate, granite and petroleum. The total value of all minerals was $19,277,031 in 1908.

Manufactures.—To an unusual degree the natural resources of the state supply the raw material for its manufactures. The ownership of industrial establishments is largely in the hands of individuals, firms, and comparatively small corporations, rather than of large combinations, the average capital per establishment in 1905 being about $32,000. The amount of capital invested in manufacturing in 1880 was $20,092,845, and the value of the products was $37,074,886. In 1905 capitalization (under the factory system) had increased to $102,439,481, and value of products to $137,960,476. This rapid industrial growth has been due in no small degree to the great natural resources of the state and its excellent transportation facilities. Judged by the value of products, regardless of cost of materials used, the flour and grist mill industry ranked first in 1905 ($25,350,758). Second in importance was the timber and lumber industry and lumber products ($21,580,120.)

The state has always held an important place in the iron and steel industry. The capital invested in blast furnaces in 1905 was $5,939,783, they employed 1486 persons, and the value of their products was $3,428,049. The foundries and machine shops of the state had a capital of $5,516,453, they gave employment to over 4000 persons, and the value of their products was $6,946,567. These figures are exclusive of the numerous and large railway repair shops, the value of whose products was $5,839,445.

The manufacture of leather is another important industry. Large tanneries were attracted to the state, soon after the Civil War, by the abundance of tan bark in the forests, and the cheapness of labour. In 1905 $4,013,289 was invested in the manufacture of leather, and the products were valued at $3,583,871.

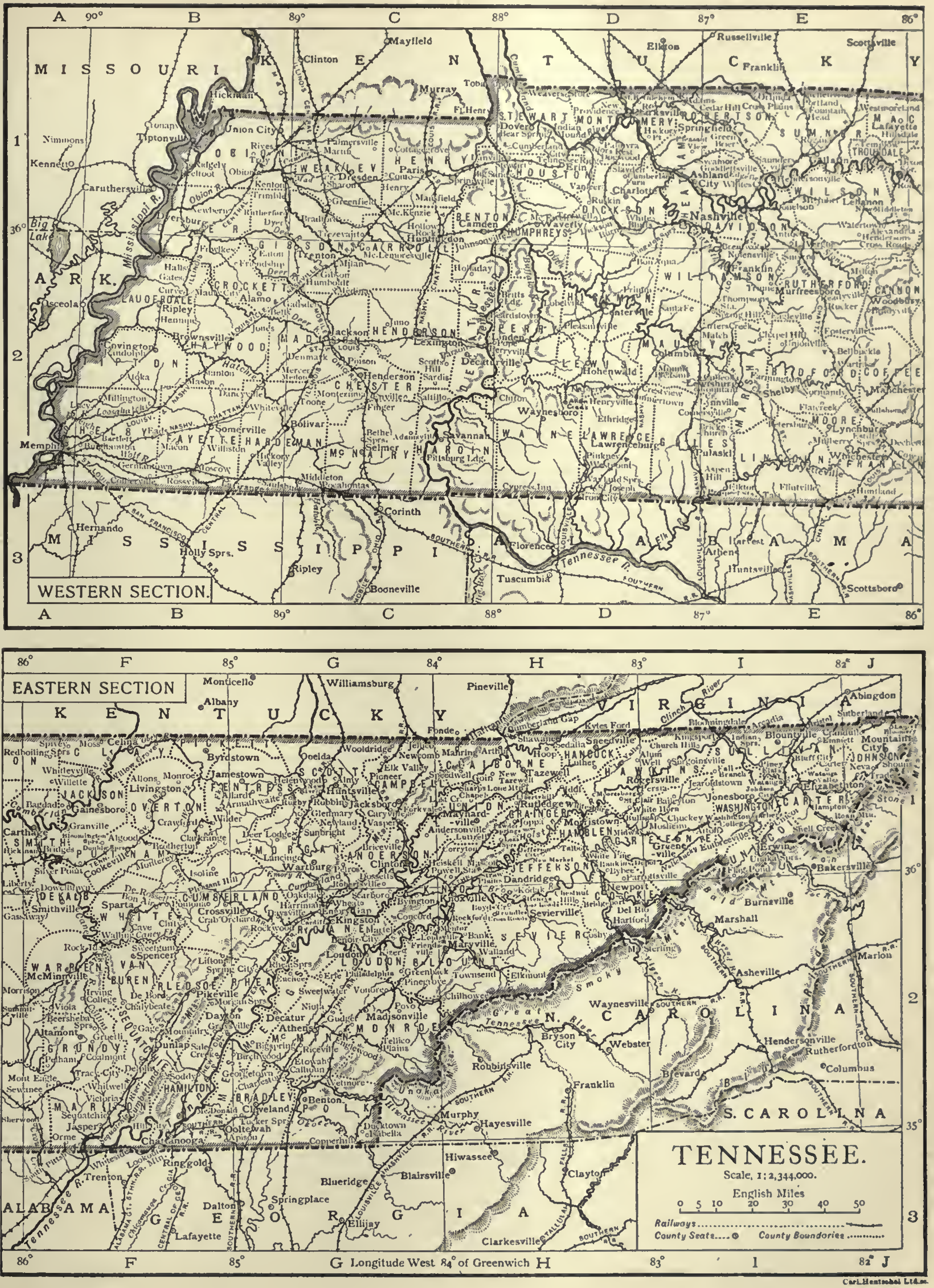
In 1905 the textile industry had an invested capital of $8,583,133, and a product valued at $6,895,203. The manufacture of cotton goods was the chief sub-division of the industry, employing 153,375 spindles, 3008 looms and 1787 knitting machines.

The printing and publishing industry of the state had an invested capital of $4,408,584 and products valued at $5,063,580. The manufacture of malt and distilled liquors employed (1905) a capital of $3,220,899, and the value of the product was $2,400,256. Among the other important manufacturing industries of the state and the value of their products in 1905 are: men's clothing, $2,961,581; patent medicines, $2,680,610; cotton-seed oil and oil cake, $3,743,927; tobacco, $404,241; artificial ice, $727,263; agricultural implements, $768,895; and coke, $809,801.

Transportation.—The railway mileage of Tennessee increased from 1253 m. in 1860 to 3184 in 1900, and 3480 on the 1st of January 1909. The principal railways operating in the state in 1910 were the Louisville & Nashville, the Nashville, Chattanooga & St Louis, the Cincinnati Southern and the Southern. The navigable waterways include the Mississippi river (which forms the western boundary of the state); the Tennessee river, navigable throughout its length, from Knoxville; and the Cumberland river, navigable throughout its length in the state. Chattanooga, Knoxville, Memphis and Nashville are ports of entry.

Population.—The total population in 1880 was 1,542,359; in 1890, 1,767,518; in 1900, 2,020,616; and in 1910, 2,184,789.[1] Of the total population in 1900, 1,522,600 were native whites, 17,746 were foreign-born, 480,243 were negroes, 108 were Indians, 75 were Chinese and 4 were Japanese. Of the inhabitants born in the United States 38,561 were born in Georgia, 36,052 in Kentucky, 28,405 in North Carolina, 27,709 in Alabama, and 25,953 in Virginia. Of the foreign-born 4569 were Germans, 3372 were Irish and 2207 were English. Of the total population 59,032 were of foreign parentage—*i.e.* either one or both parents were foreign-born—and 11,164 were of German, 9268 of Irish and 3532 of English parentage on both the father's and the mother's side. Of the total population of the state in 1906, 697,570 were members of religious denominations. There

[1] The populations in other census years were as follows: (1790), 35,691; (1800), 105,602; (1810), 261,727; (1820), 422,823; (1830), 681,904; (1840), 829,210; (1850), 1,002,717; (1860), 1,109,801; (1870), 1,258,520.



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were 277,170 Baptists, 241,396 Methodists, 79,337 Presbyterians, 56,315 Disciples of Christ, 17,252 Roman Catholics, 7874 Protestant Episcopalians, 3225 Lutherans, 2875 United Brethren and 2426 Congregationalists. From 1890 to 1900 the urban population (*i.e.* the population of places having 4000 inhabitants or more) increased from 219,792 to 285,886, or 30·1 per cent., the semi-urban population (*i.e.* the population of incorporated places, or the approximate equivalent, having less than 4000 inhabitants) increased from 87,351 to 114,837, 10·9 per cent. of the total increase in population; while the rural population (*i.e.* population outside of incorporated places) increased from 1,460,375 to 1,619,893, 63 per cent. of the total. The principal cities of the state, with population for 1910, are Memphis, 131,105; Nashville, 110,364; Chattanooga, 44,604 and Knoxville, 36,346.

Government.—Tennessee has had three constitutions, but the present one, adopted in 1870, is a reproduction of the second (1834) with only a few changes. Amendments may be proposed not oftener than once in six years by a majority of the members elected to each house of the legislature, but before they can be adopted they must be agreed to first by two-thirds of the members elected to each house of the next succeeding legislature, and later by a majority of all the citizens of the state voting for representatives at the next regular election. The legislature may, also, submit to the people the question of calling a convention to amend or revise the constitution, and such a convention must be called whenever, upon the submission of this proposition, a majority of the votes are cast in favour of it. Every attempt to amend or revise the present constitution has, however, been unsuccessful. The right of suffrage is given to every male citizen of the United States who has attained the age of twenty-one years and has been a resident of the state for one year, provided he has paid his poll tax and has not been convicted of bribery, larceny or other infamous crime. The election of the governor, members of the General Assembly and congressmen is held biennially, in even numbered years, on the first Tuesday after the first Monday in November, but the election of judicial and county officers is held on the first Thursday in August.

The governor is the only state executive officer who is elected by the people. He is elected for a term of two years and is not eligible for more than three consecutive terms. He must be at least thirty years of age and have been a citizen of the state for the last seven years before election. Although commander-in-chief of the state forces, he may call the militia into service only when there is a rebellion or an invasion and the General Assembly declares that the public safety requires it. The officers of the penitentiary and of the reformatory for boys are authorized to advise the governor with respect to an application for the pardon of an inmate of their institution, but he is not bound by their advice and there is no real restriction on his power to pardon except that he is not permitted to pardon in cases of impeachment. Among the more important officers appointed by the governor are the superintendent of public instruction, the commissioner of agriculture, statistics and mines, an assayer, state entomologist, and officers of the penitentiary. The governor may veto bills passed by the General Assembly, but to override his veto the vote of only a bare majority of the members elected to each house is required. The governor's salary is $4000 a year. There is no lieutenant-governor; in case of a vacancy in the office of governor the speaker of the Senate becomes acting governor. The secretary of state, the comptroller, and the treasurer are elected by a joint ballot of the Senate and the House of Representatives each for a term of two years; the attorney-general is appointed by the judges of the supreme court for a term of eight years.

Both senators and representatives are elected for a term of two years by counties or by districts having approximately the same population. The number of representatives is limited by the constitution to 99, and the number of senators to one-third the number of representatives. The qualifications prescribed for senators and representatives are that they shall have been citizens of the state for three years and residents of the county or district they are to represent for one year immediately preceding the election, and that senators shall be at least thirty years of age. The legislature meets biennially, in odd numbered years, on the first Monday in January, and the length of the session is limited by a provision that the members shall be paid four dollars a day, besides an allowance for travelling expenses, not to exceed 75 days; whenever the governor calls an extra session they are not paid for more than 20 days. Bills of whatever character may originate in either house, but no bill can become a law until it has passed both houses by a majority of all the members to which the house is entitled under the constitution, and if the governor vetoes a bill it cannot become a law until it has again passed both houses by such a majority. Only the more customary restrictions are placed upon the legislature by the constitution; such, for example, as that it shall pass no laws impairing the obligation of contracts, no *ex post facto* laws, no law authorizing imprisonment for debt, no law restraining the freedom of the press or freedom of speech, and that it shall not lend the credit of the state or make the state "owner in whole or in part of any bank or a stockholder with others in any association, company, corporation or municipality."

The administration of justice is vested in a supreme court, a court of civil appeals, chancery courts, circuit courts, county courts, justice of the peace courts, and, in certain cities and towns, a recorder's court. The supreme court consists of five judges elected by the state at large for a term of eight years, one for each of three grand divisions (eastern, middle and western) and two for the state at large. Each judge must be at least thirty-five years of age and have been a resident of the state for five years before his election. The judges designate one of their number to preside as chief justice. The court has appellate jurisdiction only. For the eastern district it sits at Knoxville; for the middle district at Nashville; and for the western district at Jackson. The concurrence of three judges is necessary to a decision. The court of civil appeals, which in 1907 was substituted for the court of chancery appeals, is also composed of five judges not more than two of whom shall reside in the same grand division. They are elected for a term of eight years, and each of them must be at least thirty years of age and have resided in the state for five years before election. This court has jurisdiction of appeals from equity courts in which the amount in controversy does not exceed $1000, except in cases involving the constitutionality of a Tennessee statute, contested election or state revenue, and ejectment suits; it has jurisdiction also of civil cases tried in the circuit and common law courts in which writs of error or appeals in the nature of writs of error are applied for. It may transfer any case to the supreme court or the supreme court may assume jurisdiction of any of its cases by issuing a writ of *certiorari*, but otherwise its decrees are final. The state is divided into twelve chancery districts in each of which a chancellor is elected for a term of eight years, and at every county-seat in each district a court of chancery is held. The court has exclusive original jurisdiction in equity cases in which the amount in controversy exceeds fifty dollars, concurrent jurisdiction with the county court in such matters as the administration of estates, the appointment and removal of guardians, and concurrent jurisdiction with the circuit courts in proceedings for divorce. The state is also divided into nineteen circuits, in each of which a circuit judge is elected for a term of eight years, and at every county-seat in each circuit a circuit court is held. The original jurisdiction of the circuit courts extends to all cases both civil and criminal not exclusively conferred upon some other court, and they have appellate jurisdiction in all suits and actions begun in the lower courts. In several of the counties the county court is composed of a county judge, elected for a term of eight years, together with the justices of the peace in the county, and in the other counties it consists of the justices of the peace alone. Its judicial business is principally the probate of wills and matters relating to the administration of estates. Each county is divided into civil districts varying in number according to population, and each district elects at least two justices of the peace for a term of six years; each county town or incorporated town also elects one justice of the peace. The jurisdiction of a justice of the peace, usually coextensive with the county, extends to the collection of notes of hand not exceeding $1000; to the settlement of accounts not exceeding $500; to suits for the recovery of property or suits demanding payment for damages, except for libel or slander, not exceeding $500; to equity cases in which the amount in controversy does not exceed $50; and to various other small cases. A recorder has concurrent jurisdiction with a justice of the peace.

Local Government.—The government of each county is vested principally in the county court. This body represents and acts for the county as a corporation; has charge of the erection and repair of county buildings; levies the county taxes, which are limited by law, however, to three mills on the dollar exclusive of those for schools, public highways, interest on the county debt, and other special purposes; divides the county into highway districts, and chooses a highway commissioner for each district for a term of two years; and chooses a superintendent of schools, a surveyor, a public administrator and public guardian, a board for the equalization of taxes, a coroner, a ranger, and a jail physician or health officer each for a term of two years, three commissioners of the poor for a term of three years (one each year), and a keeper and sealer of weights and measures to serve during its pleasure. A county trustee, whose duty it is to collect state and county taxes, and a sheriff are elected by the county for a term of two years; a clerk of the county court and a register are also elected by the county for a term of four years; and the county judge or chairman of the county court, the clerk of the county court, and the county health officer constitute a county board of health. In each civil district of a county which contains the county seat there are two constables, and in other civil districts of the county one constable elected for a term of two years. The general law for the incorporation of cities and towns vests the government of each municipality accepting its provisions principally in a mayor and two aldermen from each ward. All are elected for a term of two years, but one-half of the aldermen retire annually. The mayor and aldermen may appoint such officers as they consider necessary. The mayor may veto any action of the aldermen, and to override his veto a two-thirds majority is required.

Miscellaneous Laws.—For the protection of the property rights of married women the code of Tennessee provides that the wife's real estate shall be exempt from her husband's debts; that the proceeds of her real or personal property shall not be paid to any other person except by her consent certified upon privy examination of her by the court or a commissioner appointed by the court; and that she may mortgage or convey her real estate without the concurrence of her husband provided she be privately examined regarding the matter by a chancellor, circuit judge, or the clerk of the county court. When a husband dies his widow is entitled to a dower in one-third of his real estate, and, if there be not more than two children, to one-third of his personal estate; if there are more than two children her share of the personal estate is the same as that of each child. If a husband die intestate and leave no other heirs the widow is entitled to all his real estate in fee simple. When a wife dies leaving a husband of whom there has been issue born alive, he has by the courtesy a life interest in all her real estate and all her personal estate; if the wife die intestate and leave no other heirs the husband is entitled to all her real estate in fee simple. The causes for divorce are impotency, bigamy, adultery, desertion for two years, conviction of an infamous crime, the attempt of one of the parties to take the life of the other, the husband's cruel and inhuman treatment of his wife, refusal of the wife to remove with her husband into the state without a reasonable cause, pregnancy of the wife at the time of the marriage by another person without the knowledge of the husband, and habitual drunkenness, provided the habit has been contracted subsequent to the marriage. The plaintiff must be a resident of the state for two years before filing a petition for a divorce. If the husband is the plaintiff his interest in his wife's property is not impaired by the dissolution of the marriage, but the defendant wife forfeits all her interest in his property. Either party may marry again, but a defendant who has been found guilty of adultery is not permitted to marry the co-respondent during the life of the plaintiff. A homestead of a head of a family to the value of $1000 is exempt from forced sale except for the collection of taxes, debts contracted for its purchase or in making improvements upon it, or fines for voting out of the election district, for carrying concealed weapons, or for giving away or selling intoxicating liquors on election days. If the owner is married the homestead cannot be sold without the joint consent of husband and wife, and the wife's consent, as in other conveyances by married women, must be certified before the court or a commissioner appointed by the court. The homestead inures for the benefit of the widow and minor children. Ninety per cent. of the salary, wages or income of each person eighteen years of age or over is also exempt from attachment provided such salary, wages or income does not exceed $40 per month, and in any case $36 per month of the salary, wages or income of a person eighteen years of age or over cannot be attached. The employment of children under 14 years of age in any workshop, factory or mine within the state is forbidden by a law of 1901, and the employment of women or of boys under 16 years of age in any manufacturing establishment is limited to 60 hours a week by a law of 1907. Both the sale and the manufacture of intoxicating drinks are prohibited by law.

Charities, &c.—The charitable and penal institutions of the state consist of the Central Hospital for the Insane near Nashville; the Eastern Hospital for the Insane near Knoxville; the Western Hospital for the Insane near Bolivar; the Tennessee School for the blind at Nashville; the Tennessee Deaf and Dumb School at Knoxville; the Confederate Soldiers' Home near Nashville, on the "Hermitage," the estate formerly belonging to Andrew Jackson; and the Penitentiary and the Tennessee Industrial School, both at Nashville; and in 1907 the legislature passed an Act for the establishment in Davidson county of the Tennessee Reformatory for boys. Each hospital for the insane is governed by a board of five trustees appointed by the governor, with the consent of the senate, for a term of six years, and for the immediate supervision of each the trustees appoint a superintendent for a term of eight years. The Schools for the Blind and the Deaf and Dumb are each managed by a board of trustees, vacancies in which are filled by the remaining trustees with the concurrence of the legislature. The Confederate Soldiers' Home is managed by a board of fifteen trustees, of whom six are women, each serving until death or resignation, when his or her successor is appointed by the governor upon the recommendation of the corporation known as the Association of Confederate Soldiers. The Penitentiary is governed by a board of three prison commissioners, a superintendent, a warden, an assistant or deputy warden, a matron, a physician, and a chaplain, all appointed by the governor, the commissioners for a term of four years, the other officers for a term of two years. The prisoners are kept at labour principally in the state coal-mines, in manufacturing coke, on farms, or at contract labour within the prison walls; not more than 199 prisoners are to be leased to any one firm or corporation, or to be employed in any one business within the walls. The income to the state from the prison is greater than the disbursements for its maintenance. By good conduct a convict may shorten his term of service one month the first year, two months the second year, three months each year from the third to the tenth inclusive, and four months each subsequent year. The Industrial School, which is for orphan, helpless, wayward and abandoned children, is governed by a board of directors consisting of the governor, comptroller, secretary of state, and treasurer as *ex officio* members, and seven other members, a portion retiring every two years, and their successors being appointed by the remaining directors with the concurrence of the senate. The act for establishing the Tennessee Reformatory for Boys provides that the institution shall be governed by a board of trustees consisting of the governor and five other members, one retiring each year; that boys under eighteen years of age who are convicted of a penitentiary offence shall be sent to it; that the trustees may transfer incorrigible boys to the penitentiary, put others out in the service of citizens on probation, or recommend them to the governor for pardon. A general control of all public charities and correctional institutions is exercised by an unsalaried Board of State Charities consisting of the governor and six members appointed by him for a term of three years, two retiring every two years. The principal duties of this board are to examine the condition and the management of such institutions and report to the governor; and county and city authorities must submit to it for criticism all plans for new jails, public infirmaries, and hospitals.

Education.—For the administration of the common school system each county having five or more civil districts is divided into five school districts, and in counties having five or less than five civil districts each civil district constitutes a school district. Each school district elects one member of the county board of education, and in counties having less than five school districts one or more members of the county board, the number of which is always five, besides the county superintendent who is *ex officio* its secretary, are elected by the county at large, and to this county board of education together with district advisory boards is entrusted the management and control of the common schools. By the general education law enacted in 1909, 25 per cent. of the gross state revenue is paid into the general education fund, 61 per cent. of this fund is apportioned among the several counties according to their school population, and 10 per cent. of it constitutes a special fund to be apportioned among eligible counties in proportion to their school population but in inverse ratio to their taxable property; to have the use of any portion of this special fund a county must levy for the maintenance of common schools a tax not less than forty cents on each $100 of taxable property, a tax of $2 on each taxable poll, and such privilege taxes as the state permits it to levy for school purposes. Each county court may provide for one or more county high schools to be maintained in part by additional county taxes and miscellaneous funds, and 8 per cent. of the state school fund is set apart for the encouragement of counties in this matter. In 1908 there was a county high school in each of 23 counties, and in 1910 in each of 50 counties. The high schools are largely under the control of the state board of education, consisting of the governor (president), state superintendent of public instruction (secretary and treasurer), and six other members appointed by the governor. When the general education law was enacted in 1909 Tennessee had no state normal schools, but by the law 13 per cent. of the state educational fund is set apart for the establishment and maintenance of schools solely for the education and professional training of teachers for the elementary schools; one for white teachers in each of three grand divisions of the state, and one agricultural and industrial normal school for the industrial education of negroes and for preparing negro teachers for the common schools, and the management of these schools is vested in the state board of education. At the head of the state educational system is the University of Tennessee, which embraces a college of liberal arts, a graduate department, a college of engineering, a college of agriculture, a school of pharmacy, an industrial department, and a law department at Knoxville, and medical and dental departments at Nashville. The institution is governed by a board of trustees consisting of the governor, the state superintendent of public instruction, the commissioner of agriculture, the president of the university and twelve other members; two from the city of Knoxville and one from each congressional district, two elected each year. Seven per cent. of the general school fund is set apart for its maintenance; it was founded in 1794. For the higher education of teachers Tennessee has the Peabody College for Teachers, at Nashville, founded (1875) and maintained chiefly with proceeds from the George Peabody Fund for the improvement of education in the South. Other institutions of higher learning, not under the control of the state, are: the University of Nashville (non-sect., 1785); Washington and Tusculum College (non-sect., 1794), at Greenville; Maryville College (Presbyterian, 1819), at Maryville; Cumberland University (Presbyterian, 1842), at Lebanon; Burritt College (non-sect., 1848), at Spencer;

Hiwassee College (non-sect., 1849), at Sweetwater; Bethel College (Presbyterian 1850), at McKenzie; Carson and Newman College (Baptist, 1851), at Jefferson City; Walden University (Methodist, 1866), at Nashville; Fisk University (Congregational, 1866), at Nashville; University of Chattanooga (Methodist, 1867), at Chattanooga; University of the South (Protestant Episcopal, 1868), at Sewanee; King College (Presbyterian, 1869), at Bristol; Christian Brothers College (Roman Catholic, 1871), at Memphis; Knoxville College (United Presbyterian, 1875), at Knoxville; Milligan College (Christian, 1882), at Milligan; South-western Presbyterian College (1885), at Clarkville; and Lincoln Memorial University (non-sect., 1895), at Cumberland Gap.

Finance.—The state revenue is derived from a general property tax, a poll tax, an income tax, a tax on transfers of realty, an *ad valorem* tax on the average capital invested by merchants in their business, a privilege tax on merchants and many other occupations and businesses; a tax on litigation, levied on the unsuccessful party, a collateral inheritance tax, and fines and forfeitures. State, county and municipal taxes are assessed by a county assessor, who is elected for a term of four years, and one or more deputies whom the assessor is authorized to appoint. The law requires that all property shall be assessed at its full cash value, but personal property to the value of $1000 is exempt from taxation. Real estate is assessed biennially; personal property, privileges and polls annually. Assessments are examined and revised both by a county board of equalization and a state board of equalization. The county board consists of five members elected annually by the county court; justices of the peace are ineligible to election on this board, as are also all persons who have served on it within five years. The state board consists of the secretary of state, treasurer and comptroller. The clerk of the county court collects all taxes of persons, companies or corporations subject to a privilege tax; the county trustee the taxes of other persons. Three revenue commissioners, one of whom is an expert accountant, are elected biennially by each county court to examine the books and reports of the collectors, and three state revenue agents are appointed biennially by the comptroller to examine the records of all officials charged with the collection or disbursement of state or county revenue. The state revenue for the two years ending the 19th of December 1906 amounted to $3,804,740, and the cost of conducting the state government for these two years was $3,568,977. The bonded debt of the state grew from $16,643,666 on the 1st of October 1859 to $37,080,666 on the 1st of October 1869, but by the 19th of December 1906 it had been reduced to $14,236,766.

History.—The present site of Memphis may be the point where the Spanish explorer, Hernando de Soto, reached the Mississippi river, but this cannot be determined with certainty. Father Marquette in his voyage down the Mississippi camped upon the western border, and La Salle built Fort Prud'homme upon the Chickasaw Bluffs, probably on the site of Memphis, in 1682, but it was abandoned, then rebuilt, and again abandoned. The territory was included in the English grant to Sir Walter Raleigh in 1584 and in the later Stuart grants, including that of Carolina, in 1663. No permanent settlement, however, was made until 1769, though wandering explorers and fur traders visited the eastern portion much earlier. A party of Virginians led by Dr Thomas Walker (1715–1794), in 1750 reached and named the Cumberland river and mountains in honour of the royal duke. In 1756 or 1757, Fort Loudon, named in honour of John Campbell, earl of Loudon, was built on the Little Tennessee river, about 30 m. N. of the present site of Knoxville, as an outpost against the French, who were now active in the whole Mississippi Valley, and was garrisoned by royal troops. The fort was captured, however, by the Cherokee Indians in 1760, and both the garrison and the neighbouring settlers were massacred.

Eastern Tennessee was recognized as a common hunting ground by the Cherokees, Creeks, Miamis and other Indian tribes, and the Iroquois of New York also claimed a considerable portion by right of conquest. In 1768 the Iroquois ceded whatever claim they had to the English, and in 1769 several cabins were built along the Watauga and Holston rivers upon what was thought to be Virginian soil. A settlement near the present Rogersville was made in 1771 and in the next year another sprang up on the Nollichucky. After the failure of the Regulator insurrection in North Carolina in 1771, hundreds of the Regulators made their way into the wilderness. When the settlements were found to be within the limits of North Carolina, that colony made no effort to assert jurisdiction or to protect the settlers from Indian depredations. Therefore in 1772 the residents of the first two settlements met in general convention to establish a form of government since known as the Watauga Association. A general committee of thirteen was elected to exercise legislative powers. This committee elected from its members a committee of five in whom executive and judicial powers were lodged. The smaller committee elected a chairman, who was also chairman of the committee of thirteen. A sheriff, an attorney and a clerk were elected, and regulations for recording deeds and wills were made. Courts were held, but any conflict of jurisdiction with Virginia or North Carolina was avoided. In 1775 the settlement on the Nollichucky was forced to join the association, and in the same year the land was bought from the Indians in the hope of averting war. With the approach of the War of Independence, the dream of becoming a separate colony with a royal governor was abandoned, and on petition of the inhabitants the territory was annexed to North Carolina in 1776 as the Washington District, which in 1777 became Washington county, with the Mississippi river as the western boundary. The population increased rapidly and soon several new counties were created.

During the War of Independence the hardy mountaineers under John Sevier and Evan Shelby did valiant service against both the royal troops and the Loyalists in South Carolina, chiefly as partisan rangers under Charles McDowell (1743–1815). Major Patrick Ferguson with several hundred Loyalists and a small body of regulars, made a demonstration against the western settlements, but at King's Mountain in South Carolina he was completely defeated by the Americans, among whom Colonel Sevier and the troops led by him were conspicuous (see KING'S MOUNTAIN).

After the War of Independence the legislature of North Carolina in 1784 offered to cede her western territory to the general government, provided the cession should be accepted within two years. The Watauga settlers, indignant at this transfer without their consent, and fearing to be left without any form of government whatever, called a convention which met at Jonesborough on the 23rd of August 1784, and by which delegates to another convention to form a new state were appointed. Meanwhile North Carolina repealed the act of cession and created the western counties into a new judicial district. A second convention, in November, broke up in confusion without accomplishing anything; but a third adopted a constitution, which was submitted to the people, and ordered the election of a legislature. This body met early in 1785, elected Sevier governor of the new state of Franklin (at first Frankland), filled a number of offices, and passed several other acts looking to separate existence. Four new counties were created, and taxes were levied.[1] Later in the year another convention, to which the proposed constitution had been referred, adopted instead the constitution of North Carolina with a few trifling changes, and William Cocke was chosen to present to Congress a memorial requesting recognition as a state. Congress, however, ignored the request, and the diplomacy of the North Carolina authorities caused a reaction. For a time two sets of officials claimed recognition, but when the North Carolina legislature a second time passed an act of oblivion and remitted the taxes unpaid since 1784, the tide was turned. No successor to Sevier was elected, and he was arrested on a charge of treason, but was allowed to escape, and soon afterwards was again appointed brigadier-general of militia.

Meanwhile, settlers had pushed on further into the wilderness. On the 17th of March 1775 Colonel Richard Henderson and his associates extinguished the Indian title to an immense tract of land in the valleys of the Cumberland, the Kentucky and the Ohio rivers (see KENTUCKY). In 1778, James Robertson (1742–1814), a native of Virginia, who had been prominent in the Watauga settlement, set out with a small party to prepare the way for permanent occupation. He arrived at French

[1] On account of the scarcity of a circulating medium more than twenty articles were valued and declared legal tender. Among them were fox skins, 1s. 6d.; beaver skins, 6s.; bacon, 6d. the pound; rye whisky, 2s. 6d. the gallon.

Lick (so called from a French trading post established there) early in 1779, and in the same year a number of settlers from Virginia and South Carolina arrived. Another party led by John Donelson arrived in 1780, and after the close of the War of Independence, the immigrants came in a steady stream. A form of government similar to the Watauga Association was devised, and block-houses were built for defence against the Indians. Robertson was sent as a delegate to the North Carolina legislature in 1783 and through his instrumentality the settlements became Davidson county. Nashville, which had been founded as Nashborough in 1780, became the county seat. Finally, in 1843, it became the state capital. Robertson, the dominant figure in the early years, struggled to counteract the efforts of Spanish intriguers among the Indians, and when diplomacy failed led the settlers against the Indian towns.

On the 25th of February 1790 North Carolina again ceded the territory to the general government, stipulating that all the general provisions of the Ordinance of 1787 should apply except that forbidding slavery. Congress accepted the cession and, on the 26th of May 1790, passed an act for the government of the "Territory south of the River Ohio." William Blount was appointed the first governor, and in 1792 Knoxville became the seat of government. The chief events of Blount's administration were the contests with the Indians, the purchase of their lands, and the struggle against Spanish influence. A census ordered by the Territorial legislature in 1795 showed more than 60,000 free inhabitants (the number prescribed before the Territory could become a state), and accordingly a convention to draft a state constitution met in Knoxville on the 11th of January 1796. The instrument, which closely followed the constitution of North Carolina, was proclaimed without submission to popular vote. John Sevier was elected governor, and William Blount and William Cocke United States senators. In spite of the opposition of the Federalist party, whose leaders foresaw that Tennessee would be Republican, it was admitted to the Union as the sixteenth state on the 1st of June 1796.

With the rapid increase of population, the dread of Indian and Spaniard declined. Churches and schools were built, and soon many of the comforts and some of the luxuries of life made their appearance. The public school system was inaugurated in 1830, but not until 1845 was the principle of taxation for support fully recognized. As in all new states, the question of a circulating medium was acute during the first half of the 19th century, and state banks were organized, which suspended specie payments in times of financial stringency. The Bank of Tennessee, organized in 1838, had behind it the credit of the state, and it was hoped that money for education and for internal improvements might be secured from its profits. The management became a question of party politics, and during the Civil War its funds were used to advance the Confederate cause. The development of the western section along the Mississippi was rapid after the beginning of the century. Memphis, founded in 1819, was thought as late as 1832 to be in Mississippi, and not until 1837 was the southern boundary, which according to the North Carolina cession was 35°, finally established.[1] In common with other river towns, the disorderly element in Memphis was large, and the gamblers, robbers and horse thieves were only suppressed by local vigilance committees. The peculiar topographical conditions made the three sections of the state almost separate commonwealths, and demand for better means of communication was insistent.

The policy of state aid to internal improvements found advocates very early in spite of the Republican affiliations of the state, but a definite programme was not laid out until 1829, when commissioners for internal improvements were appointed and an expenditure of $150,000 was authorized. In 1835 the state agreed to subscribe one-third to the capital stock of companies organized to lay out turnpikes, railways, &c., and four years later the proportion became one-half. Though these agreements were soon repealed, the general policy was continued, and in 1861 more than $17,000,000 of the state debt was due to these subscriptions, from which there was little return.

Though President Andrew Jackson was for many years practically a dictator in Tennessee politics, his arbitrary methods and his intolerance of any sort of independence on the part of his followers led to a revolt in 1836, when the electoral vote of the state was given to Hugh Lawson White, then United States senator from Tennessee, who had been one of Jackson's most devoted adherents. White's followers called themselves Anti-Van Buren Democrats, but the proscription which they suffered drove most of them into the Whig party, which carried the state in presidential elections until 1856, when the vote was cast for James Buchanan, the Democratic candidate. The Whig party was so strong that James K. Polk (Democrat), a resident of the state, lost its electoral vote in 1844. With the disintegration of the Whig party, the state again became nominally Democratic, though Union sentiment was strong, particularly in East Tennessee. There were few large plantations and fewer slaves in that mountainous region, while the middle and western sections were more in harmony with the sentiment in Mississippi and Alabama. In 1850 representatives of nine Southern states met in a convention at Nashville (*q.v.*) to consider the questions at issue between the North and the South. The vote of the state was given for Bell and Everett in 1860, and the people as a whole were opposed to secession.

The proposition to call a convention to vote on the question of secession was voted down on the 9th of February 1861, but after President Lincoln's call for troops the legislature submitted the question of secession directly to the people, and meanwhile, on the 7th of May 1861, entered into a "Military League" with the Confederacy. An overwhelming vote was cast on the 8th of June in favour of secession, and on the 24th Governor I. G. Harris (1818–1897) issued a proclamation declaring Tennessee out of the Union. Andrew Johnson, then a United States senator from Tennessee, refused to resign his seat, and was supported by a large element in East Tennessee. A Union convention, including representatives from all the eastern and a few of the middle counties, met on the 17th of June 1861 and petitioned Congress to be admitted as a separate state. The request was ignored, but the section was strongly Unionist in sentiment during the war, and has since been strongly Republican.

The state was, next to Virginia, the chief battleground during the Civil War, and one historian has counted 454 battles and skirmishes which took place within its borders. In February 1862, General U.S. Grant and Commodore A. H. Foote captured Fort Henry on the Tennessee river, and Fort Donelson on the Cumberland. The Confederate line of defence was broken and General D. C. Buell occupied Nashville. Grant next ascended the Tennessee river to Pittsburg Landing with the intention of capturing the Memphis & Charleston railway, and on the 6th–7th of April defeated the Confederates in the battle of Shiloh. The capture of Island No. 10 in the Mississippi on the 7th of April opened the river as far south as Memphis, which was captured in June. On the 31st of December and the 2nd of January General William S. Rosecrans (Federal) fought with General Braxton Bragg (Confederate) the bloody but indecisive battle of Stone River (Murfreesboro). In June 1863 Rosecrans forced Bragg to evacuate Chattanooga. Bragg, however, turned upon his pursuer, and on the 19th and 20th of September one of the bloodiest battles of the war was fought at Chickamauga. General Grant now assumed command, and on the 24th and 25th of November defeated Bragg at Chattanooga, thus opening the way into East Tennessee. There General A. E. Burnside at first met with success, but was shut up in Knoxville by General James Longstreet, who was not able, however, to capture the city, and on the approach of General W. T. Sherman retired into Virginia. Almost the whole state was now held by Federal troops, and no considerable military movement occurred until after the fall of Atlanta in September 1864. Then General J. B. Hood moved into Tennessee, expecting Sherman

[1] For account of the settlement of the dispute over the northern boundary, see KENTUCKY.

to follow him. Sherman, however, sent reinforcements to Thomas and continued his march to the sea. Hood fought with General John M. Schofield at Franklin, and on the 15th–16th of December was utterly defeated by Thomas at Nashville, the Federals thus securing virtually undisputed control of the state.[1]

After the occupation of the state by the Federal armies in 1862 Andrew Johnson was appointed military governor by the president (confirmed March 3, 1862), and held the office until inaugurated vice-president on the 4th of March 1865. Republican electors attempted to cast the vote of the state in 1864, but were not recognized by Congress. Tennessee was the first of the Confederate states to be readmitted to the Union (July 24, 1866), after ratifying the Constitution of the United States with amendments, declaring the ordinance of secession void, voting to abolish slavery, and declaring the war debt void. The state escaped "carpet bag" government, but the native whites in control under the leadership of William G. Brownlow (1805–1877) confined the franchise to those who had always been uncompromisingly Union in sentiment and conferred suffrage upon the negroes (February 25, 1867). The Ku Klux Klan, originating in 1865 as a youthful prank at Pulaski, Tennessee, spread over the state and the entire South, and in 1869 nine counties in the middle and western sections were placed under martial law. At the elections in 1869 the Republican party split into two factions. The conservative candidate was elected by the aid of the Democrats, who also secured a majority of the legislature, which has never been lost since that time. The constitution was revised in 1870. For a considerable time after the war the state seemed to make little material progress, but since 1880 it has made rapid strides. The principal occurrences have been the final compounding of the old state debt at fifty cents on the dollar in 1882, the rapid growth of cities, and the increased importance of mining and manufacturing.

Governors of Tennessee

State of Franklin.	
John Sevier	1785–1788
Territory South of the Ohio	
William Blount	1790–1796
State of Tennessee.[2]	
John Sevier, Democratic-Republican	1796–1801
Archibald Roane, „ „	1801–1803
John Sevier, „ „	1803–1809
Willie Blount, „ „	1809–1815
Joseph M'Minn, „ „	1815–1821
William Carroll, „ „	1821–1827
Sam Houston,[3] „ „	1827–1829
William Hall (acting)	1829
William Carroll, Democrat	1829–1835
Newton Cannon, Anti-Jackson Democrat	1835–1839
James K. Polk, Democrat	1839–1841
James C. Jones, Whig	1841–1845
Aaron V. Brown, Democrat	1845–1847
Neil S. Brown, Whig	1847–1849
William Trousdale, Democrat	1849–1851
William B. Campbell, Whig	1851–1853
Andrew Johnson, Democrat	1853–1857
Isham G. Harris,[4] „	1857–1862
Andrew Johnson, Military	1862–1865
Interregnum,[5] 4th March–5th April 1865.	
William G. Brownlow, Republican	1865–1869
De Witt C. Senter, Conservative Republican	1869–1871
John C. Brown, Democrat	1871–1875
James D. Porter, „	1875–1879
Albert S. Marks, „	1879–1881
Alvin Hawkins, Republican	1881–1883
William B. Bate, Democrat	1883–1887
Robert L. Taylor, „	1887–1891
John P. Buchanan, „	1891–1893
Peter Turney, „	1893–1897
Robert L. Taylor, „	1897–1899
Benton McMillin, „	1899–1903
James B. Frazier,[6] „	1903–1905
John I. Cox, „	1905–1907
Malcolm R. Patterson, „	1907–1911
B. W. Hooper, Republican	1911–

[1] The state furnished 115,000 soldiers to the Confederate and 31,000 to the Union Army.

[2] The Constitutions of 1796, 1834 and 1870 all provided that the governor shall not serve more than six years in succession.

[3] Resigned.

[4] Forced to leave capital by invasion of Federal troops.

[5] Andrew Johnson, the governor, was inaugurated as Vice-President, March 4, 1865, thereby vacating the office.

[6] Resigned to enter the U.S. Senate.

Bibliography.—For a general physical description of the state see the *Reports of the Tennessee Geological Survey* (Nashville, 1840) and E. C. Hewett, *Geography of Tennessee* (no place, 1878). On administration see L. S. Merriam, *Higher Education in Tennessee*, in Circulars of Information of the United States Bureau of Education, No. 5 (Washington, 1893), and J. W. Caldwell, *Studies in the Constitutional History of Tennessee* (Cincinnati, 1895; new ed., 1907).

There is no satisfactory complete history of the state. The best is James Phelan's *History of Tennessee* (Boston, 1888). For the early period see John Haywood, *Civil and Political History* (Knoxville, 1823, reprinted Nashville, 1891); J. G. M. Ramsey, *Annals* (Charleston, 1853); A. W. Putnam, *History of Middle Tennessee, or Life and Times of General James Robertson* (Nashville, 1859); Theodore Roosevelt, *Winning of the West* (New York, 1889–1896); John Carr, *Early Times in Middle Tennessee* (Nashville, 1857). For the more recent period see O. P. Temple, *East Tennessee and the Civil War* (Cincinnati. 1899); James W. Fertig, *Secession and Reconstruction of Tennessee* (Chicago, 1898); and the *Report of Joint-Committee on Reconstruction* (U.S. Pub. Docs., Wash., 1866).

TENNESSEE RIVER, the largest tributary of the Ohio river, U.S.A. It is formed by the confluence of the Holston and the French Broad rivers 4·5 m. above Knoxville, Tennessee, flows S.S.W. to Chattanooga, there turns W. through the Cumberland Plateau and into the N.E. corner of Alabama, continues W. across the northern part of Alabama, turns N. on the boundary between Alabama and Mississippi, and continuing N. across Tennessee and Kentucky unites with the Ohio at Paducah. Its principal tributaries rise in the Appalachian Mountains: the Holston and the Clinch on the mountain slopes that flank the Appalachian Valley in western Virginia; and the French Broad, the Little Tennessee, and the Hiwassee in the mountains of western North Carolina. The Tennessee itself is 652 m. long, and with the Holston and the North Fork of the Holston forms a channel about 900 m. long. Its drainage basin covers about 44,000 sq. m., and its low water discharge at Paducah is 10,000 cu. ft. per second. Its average fall is 0·79 ft. per mile: 0·956 ft. from Knoxville to Chattanooga; 1·19 ft. from Chattanooga to Florence, Alabama; and 0·39 ft. from Florence to its mouth. The banks are everywhere easily accessible except at Knoxville and Chattanooga, where, for short distances, high elevations rise precipitously from the water; and as the banks are mostly of clay or rock the channel is permanent and the river is unusually free from silt.

The Tennessee is navigable by steamboats throughout its entire course of 652 m. for several months of the year; its tributaries have a nearly equal navigable mileage, and the main river and its tributaries together have a navigable mileage for rafts and flat-boats of 2400 m. At low water there are three obstructions to steamboat navigation in the main stream: the Colbert and Bee Tree shoals, just below Florence; the Muscle shoals just above Florence; and Hales Bar, 33 m. below Chattanooga. The state of Alabama, aided by the Federal government, constructed a lock canal, affording a depth of 5 ft., around the Muscle shoals in 1831–1836, but because of the obstructions above and below the canal was little used and was soon abandoned. The Federal government, beginning in 1868, completed the reconstruction of the Muscle Shoals Canal in two divisions (one 3·5 m. long with two locks, the other 14·5 m. long with nine locks, and both providing a depth of 5 ft.) in 1890, began in 1893 the construction of a canal, about 8 m. long and with one lock, around Colbert and Bee Tree shoals, and in 1904 authorized the construction with private capital of a lock and dam at Hales Bar to provide a channel 6 ft. deep at low water between it and Chattanooga, the water power to be used by the persons furnishing the capital. In 1905 a committee of the United States Senate recommended that future improvements of the river be made with a view of obtaining ultimately a channel having a minimum depth of 12 ft. at low water; and in 1907 Congress adopted a project for deepening to 5 ft. at low water the channel (145 m. long) between Hales Bar and the Muscle Shoals Canal. In 1908 the commerce carried on the Tennessee between

Chattanooga and Paducah amounted to 755,010 tons, valued at $18,752,180; it consisted chiefly of general merchandise, farm products, forest products and iron ore in the upper section, of general merchandise, cotton, timber products and grain in the middle section, and of general merchandise, farm products and timber products in the lower section.

During the Civil War Fort Henry was erected by the Confederates on the Tennessee river, in Tennessee just below the Kentucky state line, and on the 6th of February 1862 was captured by Com. A. H. Foote; Fort Donelson on the Cumberland, several miles east, was captured on the 16th by General U. S. Grant, and the two rivers were thus opened for the advance of the Federals far into Confederate territory.

TENNIEL, SIR JOHN (1820–), English humorous and satirical artist—specially identified with *Punch*—was born in London in 1820. He educated himself for his career, and although he became a probationer, and then a student, of the Royal Academy, he soon left the schools, where at that time there was little teaching. In 1836 he sent his first picture to the exhibition of the Society of British Artists, and in 1845 contributed a 16-ft. cartoon, "An Allegory of Justice," to the competition, held in that year, of designs for the mural decoration of the new Palace of Westminster. For this he received a £200 premium and a commission to paint a fresco in the Upper Waiting Hall (or "Hall of Poets") in the House of Lords. In spite of his tendency towards "high art," he was already known and appreciated as a humorist, and his early companionship with Charles Keene fostered and developed his talent for scholarly caricature. At Christmas time 1850 he was invited by Mark Lemon to fill the position of joint cartoonist (with John Leech) on *Punch*, from which Richard Doyle, offended by the attitude adopted by the paper towards the Papal see at the time of the so-called "aggression," had suddenly resigned. On the strength of his remarkable illustrations to Aesop's Fables, in which artistic power, humour of observation, and knowledge of animal life were equally apparent, Tenniel was selected, on Douglas Jerrold's initiative, to fill the breach, and he contributed his first drawing in the initial letter appearing on p. 224, vol. xix. His first "cartoon" was "Lord Jack the Giant Killer": it showed Lord John Russell, whose letter on the "aggression" had recently been published, valiantly assailing with the sword of truth and liberty Cardinal Wiseman armed with a crozier. In 1852 we find Tenniel's first superb lion, and his first obituary cartoon. Gradually he took over altogether the weekly drawing of the political "big cut," which John Leech was happy to resign into his hands in order to restrict himself to his pictures of life and character. Leech's work consisted for the most part of farce; Tenniel's was high comedy, and not infrequently tragedy; and the freedom of the humorist heightened the severer beauties of the satirist. When Leech died his friend continued his work alone, and except in 1864, 1868, and 1875–6–7–8, during short spells of illness or holiday, he did not miss a single week. About 2300 cartoons, innumerable minor drawings, double-page cartoons for *Punch's Almanac* and other special numbers, and 250 designs for *Punch's Pocket-books*, comprise the sum of Sir John Tenniel's work for the periodical in the service of which he spent the greater portion of his life. When Tenniel retired from the service of *Punch* in January 1901 he received the honour of a farewell banquet (12th June), at which Mr A. J. Balfour, then leader of the House of Commons, presided, and was supported by distinguished representatives of all that was best in English life. On that occasion Mr Balfour's description of Tenniel as "a great artist and a great gentleman" was applauded by the press of the whole country.

The main quality of Sir John Tenniel's work is accuracy of drawing, precision of touch, grace and dignity of conception, and—so far as such things can be compatible—geniality of satire. Tenniel raised the political cartoon into a classic composition, from which a sense of nobility is rarely absent. The beauty and statuesqueness of his ideal figures recall the influence, perhaps, of Cornelius and Overbeck—that German manner which was characteristic of many of our finer draughtsmen upon wood at the middle of the 19th century. But Tenniel's work is always original, unforced and fresh; and it never suggests, what is the fact, that the artist's work is drawn exclusively from memory, and never from the model. It may be mentioned that Tenniel's wonderful observation has been conducted, and his knowledge accumulated, literally through a single eye, the other having been lost during a fencing bout in his youth. It was in recognition not only of his ability as an artist in black and white, but of his service in infusing good humour and good taste into one phase of political life, that a knighthood was conferred upon him on Mr Gladstone's recommendation in 1893. Without pronounced political opinions of his own, Sir John Tenniel adopted in his work those of his paper, of which the Whig proclivities were to some degree softened by his pencil. The political history not of England only, but to some extent of the world, of half a century appears in Sir John Tenniel's weekly cartoons, which are dignified by a number of types invented by the artist, the classic beauty of which may be looked for in vain in kindred work by any previous cartoonist. (Take, for example, Sir John's famous picture of "Dropping the Pilot," which appeared in *Punch* on 20th March 1890, xcviii. 150–51.) Public exhibitions of Sir John Tenniel's work were held in 1895 and in 1900. Sir John Tenniel is also the author of one of the mosaics, "Leonardo da Vinci," in the South Court in the Victoria and Albert Museum; while his highly stippled water-colour drawings appeared from time to time in the exhibitions of the Royal Institute of Painters in Water Colours, of which society he was elected a member in 1874. As an illustrator on the wood-block he stands very high; his "Lalla Rookh" is perhaps the finest of all his work in point of conception, refinement, power and technical excellence.

WORKS ILLUSTRATED.—(1) *Juvenile Verse and Picture Book*, (1846); (2) *Undine* (1846); (3) *Aesop's Fables*, 100 drawings (1848); (4) Blair's *Grave* (1858); (5) Shirley Brooks's *The Gordian Knot* (1860), and (6) *The Silver Cord* (1861); (7) Moore's *Lalla Rookh*, 69 drawings (1861); (8) Lewis Carroll's *Alice's Adventures in Wonderland* (1866); (9) *The Mirage of Life*, 1867; (10) Carroll's *Through the Looking-Glass* (1870); and the following in collaboration: (11) Pollok's *Course of Time* (1857); (12) *Poets of the Nineteenth Century* (1857); (13) Poe's Works (1857); (14) *Home Affections* (1858); (15) Cholmondeley Pennell's *Puck on Pegasus* (1863); (16) *The Arabian Nights* (1863); (17) *English Sacred Poetry* (1864); (18) *Legends and Lyrics* (1865); (19) Tupper's *Proverbial Philosophy*; (20) Barry Cornwall's *Poems*, and other books. He also contributed to *Once a Week*, the Art Union publications, &c.

TENNIS (sometimes called royal tennis, and, in America, court tennis), one of the oldest of ball-games, and one of the most difficult to learn. It is now played in a walled and roofed court, 110 ft. by 38 ft. 8 in., the floor, however, measuring but 96 ft. by 31 ft. 8 in., the difference being the width of a roofed corridor, the "penthouse," which runs along the two end walls and one of the side walls. Across the middle of the court a net is stretched, and the first object of the game is to strike the ball over this with a bat or racquet. The net is 5 ft. high at the ends, 3 ft. 6 in. at the middle, and divides the floor into two equal parts, the "service" side and the "hazard" side. The floor and walls are made of cement and should be smooth but not polished.

The court is lighted from the roof and sides. The height of the court to the tie-beam is 30 ft., the height of the play-line, above which the ball must not go, 18 ft. at the sides and 23 ft. at the ends. The roof of the penthouse, which is made of wood, slopes downwards towards the court, the lower edge being 7 ft. 1½ in. from the floor, the upper 10 ft. 7 in., the width 7 ft. The illustrations show that each of the walls has its own peculiarities. The "dedans" is an opening in the end wall on the service side, under the penthouse, where provision is made for spectators, who are protected by a net. It is 21 ft. 8 in. in width; the upper edge is 6 ft. 10 in. from the floor, the lower edge 3 ft. 3 in. The opening of the dedans is 4 ft. 6 in. from the main wall, 5 ft. 6 in. from the other side wall. Looking from the dedans (*i.e.* from the service side), the right-hand or main wall has one peculiarity, the "tambour," a sloping buttress to form which the wall is built inward, reducing the breadth of that part of the court to 30 ft. 2 in. In the right-hand corner of the hazard side end wall (as viewed from the dedans) is the "grille," an opening lined with wood, 3 ft. 1 in. square; and on this wall is painted a continuation of the "pass-line." The left-hand wall, along which runs the pent-house, is not continuous, being broken by a long opening between the floor and the penthouse similar to the dedans, and at the same height from the ground. The low walls under this opening and the dedans are called the "batteries." There is no wall in front of the "marker's box," through which the court is entered on either side of the net-post. This long opening in the left-hand wall is divided into "galleries" and "doors," the latter situated where the entrances to the court used to be in early times. The measurements in order from the dedans are as follows, the numbers of the galleries being counted from the net: Service side—last gallery, 9 ft. 6 in.; second gallery, 9 ft. 6 in.; door, 3 ft. 6 in.; first gallery, 5 ft. 8 in.; marker's box or line-opening, 7 ft. 10 in.; hazard side—first gallery, 5 ft. 8 in.; door, 3 ft. 6 in.; second gallery, 9 ft. 6 in.;

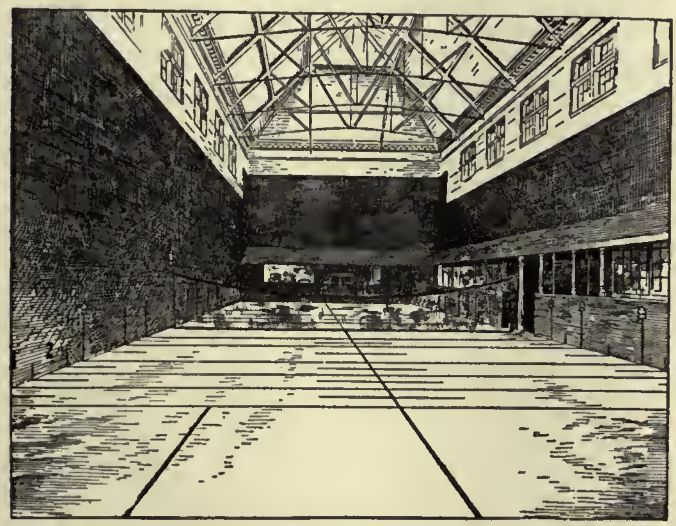
last gallery (also called "winning" gallery), 9 ft. 6 in. The last galleries are 15 ft. 11 in. each from their respective end walls. The galleries are marked by "posts" which also serve to support the penthouse. The galleries, dedans and grille are known as the "openings"; three of these—the grille, dedans and winning gallery—are "winning-in openings"; for if a ball in play is struck into one of these, the striker scores a point. In the earlier French courts were other "winning openings," *l'ais* (the board), an upright board 9 ft. by 1 ft. in the left-hand corner of the dedans-wall, *le petit trou* or *le trou*, a hole 16 in. square at the bottom of the other side of that wall, and *la lune*, a round opening high up by the play-line, one at each end of the court. In the illustrations are shown certain lines painted on the floor, which are also continued perpendicularly on the walls. On the hazard side is the "half-court line," the "pass-line" and the "service-line." The first is only required when one player gives the other the odds of "half the court" (*vide infra*, "Scoring and Handicapping"). The pass-line is drawn 7 ft. 8 in. from the main wall; the service-line 21 ft. 1 in. from the grille-wall. The rectangle contained by the pass and service lines forms the "service-court." The other lines, both on the hazard side and service side, mark the "chases," which will be explained below. The cost of a tennis-court is about £2000.

The Implements.—The balls, for which there are no regulation dimensions, weigh $2\frac{1}{2}$ oz. and are $2\frac{1}{4}$ in. in diameter. They are made of strips of cloth, no twine being used except to keep the outside layer in place, and are covered with white Melton cloth. The American balls, made of layers of cotton and cloth alternately, are somewhat lighter and slower than the English. A set of balls consists of six or seven dozen; the same set should not be used twice in a day. The racquet is usually about 27 in. long and weighs about 16 oz. The head is about 9 in. long and 6 in. broad, but there are no restrictions as to size or weight. The head is somewhat pear-shaped; but its centre line does not correspond with the centre-line of the handle, as it is curved upwards to facilitate the stroke when the ball is taken close to the floor. The earliest racquets were strung diagonally, *i.e.* in diamonds; later the present vertical-horizontal stringing was adopted, then followed knotting at the points of intersection; but now the knotting has disappeared. The name *racquet* (or racket) appears in French as *racquette* and in Italian as *racchetta.* It is variously derived from Latin *reticulata* (netted), Dutch *racken* (to stretch), later Latin *racha* (palm of the hand or wrist), or the Arabian *ráhat* (palm of the hand): in favour of the two last derivations is the fact that tennis is a development of a game originally played with the hand, protected by a leather glove, and later on strings were stretched violin-fashion across the palm, to give more power to the stroke. Then followed a wooden bat (*battoir*), and then a short-handled racquet, either strung or covered with parchment, and finally the modern implement.

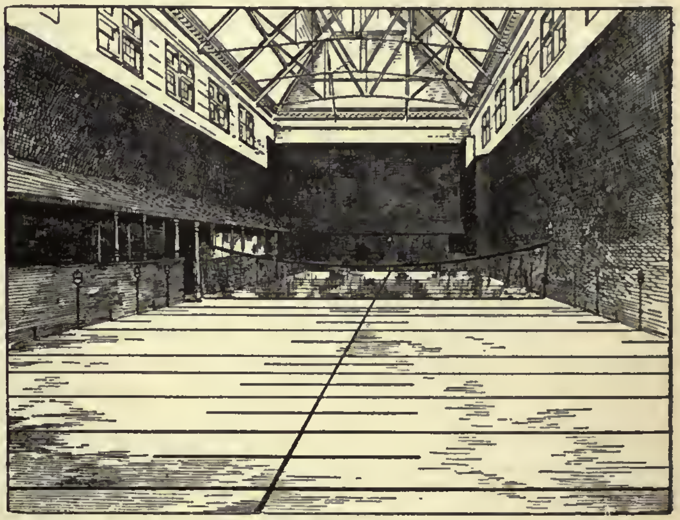
Technical Terms.—Some of these have already been explained, but the following may be added. "Bisque": the privilege, given as a form of odds, of scoring a stroke during any part of the game, except after the delivery of "service" or after a "fault." "Boast": to hit the ball on to the side wall first. "Cut": to strike the ball with the head of the racquet held at an angle to the ball's course instead of meeting it with the full face, thus causing backward rotation of the ball (similar to the "screw" in billiards), which alters its natural rebound from the wall. "Twist": analogous to "cut," but the strings are drawn across the ball at the moment of impact, so as to make it rotate sideways. A ball so struck with a fore-hand stroke twists inwards towards the other player off the floor, and away from him if it is allowed to strike the end wall; the reverse being the effect of twist from a back-hand stroke. "Rest": a series of strokes between the two players. "Service": the first stroke of a "rest." The server may serve from any part of the court on the service side. The ball must strike the roof of the side penthouse, and fall within the service-court. "Fault": a ball so served that it either does not touch the side penthouse, or falls outside the service-court. "Pass": a service in which the ball drops beyond the pass-line; the service in this case does not count, but a "pass" does not annul a previous fault, as was once the case. "Force": to strike the ball hard; a hard-hit stroke. "Volley": to strike a ball in its flight (*à la volée*) before it has touched the floor. "Half-volley": to strike a ball immediately after it touches, and before it rises from, the floor. "Nick": the angle where the floor and walls meet. "Marker": the attendant who marks and calls the chases and other points scored in the game.

Scoring and Handicapping.—A match consists of three or five "sets"; a "set" of eleven games. The winner of six games wins the set. If a player wins six games consecutively he wins a "love set," even though his opponent may have won several games. The loser of a love set, by an old custom, gives the marker a shilling. Should the score be called "Five games all," the players may arrange to play a "vantage game," the set in that case not being won till one or other has won two games in succession. A game consists ordinarily of four winning strokes, called by the marker as "Fifteen," "Thirty," "Forty," "Game"; if the score is "forty-all," the marker calls "Deuce," and two strokes have to be won in succession by one of the players. When one has won a stroke his score is called "Vantage"; if he wins the next, he wins the game; if he loses it, the score reverts to deuce. The score of the player who won the last stroke or made the last chase is called first. In handicapping the usual odds are (1) bisques, which may also be given in addition to other odds, or to balance odds received; (2) half-fifteen, or one point to be taken at the beginning of the second and every alternate game; (3) fifteen, or one point in every game; (4) half-thirty, or one point in every odd game and two points in every even game; (5) thirty, or two points in every game; (6) half-forty, or two points in every odd game and three in every even game; (7) forty, or three points in every game. Other handicaps are:—"Round services," the giver of odds having to serve so that the ball hits both the side and end penthouse; "half the court," the giver of the odds confining his strokes, except service, to one side of the court as divided by the half-court line, a stroke played into the other half counting to his adversary; "touch no walls," the giver of odds confining his play except service to the floor; "bar the openings," the giver of odds losing a point if his ball goes into a gallery or into the dedans or grille; "bar winning openings," which are closed to the giver of odds, who loses a point if the ball enters them; "side walls," the giver of odds losing a point if he plays the ball on to any side wall, the end penthouses being open to him, and the dedans and grille. In these "cramped" odds the rules do not apply if the ball goes out of limits after the second bound.

The Game and Hints on Play.—The players decide who shall serve by spinning a racquet on its head. One spins and the other calls "rough" or "smooth," the "rough" side of the head of the racquet showing the knots of some of the lower



From the Hazard Side.



From the Service Side.

Tennis-court at Crabbett Park, Sussex, belonging to the Hon. Neville Lytton.

strings. The winner takes the service side, service being an advantage. He serves from any part of the court, and in any way he thinks best, and the ball must go over the net, strike the side penthouse, and fall into the service-court (see "Fault" and "Pass"). His opponent ("striker-out") tries to return the ball over the net before it has touched the ground a second time; he may volley or half-volley it. For a stroke to be "good" it must be made before the second bound of the ball, and the ball must go over the net (even if it touches it), and must not strike the wall above the play-line, nor touch the roof or rafters. The first point to be attained is to be sure of getting the ball over the net, the next to do so in such a way as to defeat the opposing player's attempt to make a "good" stroke in return.

It often happens that a player, either intentionally or from inability, does not take or touch a ball returned to him over the net. In this event, chiefly on the service side, a "chase" (in Italian *caccia*, in French *chasse*) is made, the goodness or the badness of which depends upon the spot on the floor which the ball touches next after its first bound. The nearer this spot is to the end wall the better the chase. The chase lines are numbered, being one yard apart, the shorter lines representing the half-distance. The chases are noted and called by the marker. Thus if a ball fell on the line marked 4, he would call "chase four"; if between 4 and 3, he would call "Better than four" if it fell nearer to 4 than the short line, and "Worse than three" if it fell on the short line or between the short line and 3; for if the ball fall on a line the striker is credited with the better stroke. Strokes into the galleries and doors, with the exception of the winning gallery (last gallery, hazard side) count as chases. The making, or, in technical language, the "laying down" of a chase does not immediately affect the score: it has to be won first, *i.e.* the other player tries to make a better chase; if he fails, the original maker wins. For this purpose after two chases have been laid down (or one, if either player's score is at 40) the players change sides, *e.g.* if X has been serving and Y has laid down two chases, Y becomes the server and tries to defend them, X to win them by making the ball fall nearer to the back wall after its first bound than Y did. Either player wins the chase if he "finds" (*i.e.* hits the ball into) one of the winning openings, or if his opponent fails to make a good return. The winner of the chase scores a point. The chases are played off in the order in which they are made. Should X in trying to win a chase make the same chase as Y originally laid down, the chase is off and neither side scores. In France the chase is played again. The "rest" goes on till one of the players fails to make a good return, or deliberately leaves the ball alone in order that his opponent may lay down a chase (a procedure to be followed at the discretion of a player in whose judgment the chase will be a bad one), or lose a chase already laid down and in the course of being played off. Either player can score, there being no "hand-in" or "hand-out" as at racquets. A point is scored by that player whose opponent fails to make a good return stroke in a rest, or who strikes the ball into a winning opening, or wins a chase, or to whom two faults are served in succession. A player loses a stroke who strikes the ball twice, or allows it to touch himself or his clothes.

"He who would excel as a tennis-player must learn to serve," is the *dictum* of an amateur champion, but the necessary variations, the difference between the "railroad" and the "giraffe," &c., can only be explained by an experienced player and in the court. Variety is all-important, as is the knowledge of what sort of service is most valuable in defending a particular chase. All service should be heavily "cut." For the winning of hazard-side chases, indeed for all purposes, the "nick" service is useful, the endeavour being to make the service drop at the nick of the grille-wall and the floor. In attempting this service it should be remembered that it is better for the ball to hit the floor first than the wall, as this allows the cut to act. It is wise to cultivate one sort of service to perfection, if possible, with a reserve of others to suit the occasion. Again, the tennis "stroke," differing essentially as it does from the racquet stroke, can only be learnt in the court from a good teacher; but it is an axiom that tennis is not a game in which hard hitting necessarily tells, though force may be usefully employed in trying to "find" the winning openings. This, however, is an important point of etiquette—it is not "correct" to force for the dedans when the striker is close to the net, unless the force is "boasted" or there is no danger of hitting his opponent. In some clubs such a stroke is forbidden by a by-law. Some modern players play a faster and harder game than their predecessors, who considered strokes "on the floor," *i.e.* carefully judged chases, to be the true feature of the game; but in any case the beginner should remember that it is better to save his breath and to trust to winning an easy chase by-and-by than to run after a hard-hit stroke, which if left alone would leave "chase the door" or "second gallery" to be played for afterwards. Similarly in defending a chase, he should remember during the rest what that chase is, and not endeavour to return a stroke which would have lost it. Chases act as breathing-spaces, especially to the player who can trust to his skill "on the floor," and these, together with good service, form the reason why men can play tennis, and play it well, at a time of life when cricket, racquets and other active games have to be abandoned.

History.—Tennis may well be called a royal game, having been popular with various kings of England and France, though it is fanciful to connect it with Homer's Nausicaa, princess of Phaeacia (*Odyss.* vi. 115), who is represented by him as throwing, and not as hitting the ball to her maids of honour. In the ball-games of the Greeks and Romans we may see the rudiments of the French *jeu de paume*, which is undoubtedly the ancestor of modern tennis in a direct line. The origin of the name is quite obscure. Some give a numerical derivation from the fact that *la longue paume* was played by ten players, five on each side; others regard it as a corruption of *tamis* (sieve), for in a form of *la paume* the server bounced the ball on a sieve and then struck it: there is no possible reason for connecting "tennis" with the term Tenois, or Senois; most probable is the derivation from *Tenez!* (Take it! Play!), especially when we remember the large number of French terms that adhere to the game, *e.g.*, *grille*, *tambour* (drum, from the sound on the board that formed the face of that buttress) and *dedans*. Further, a poem dealing with the game, written in Latin elegiacs by R. Frissart, makes the striker cry "*Excipe!*" (Take it!) after each stroke: this seems to correspond with the custom which enjoins the racquet-marker to call "Play" whenever a legitimate stroke has been made. In the "Alexiad" of Anna Comnena (about A.D. 1120) is a reference to a game played on horseback in which a staff, curved at the end and strung with strings of plaited gut, was used. This game was played in a court called "a court for goff (*sic*)" (according to the *Lexicon of Alexandrine Greek*), and some similar game, corrupted through *tchangan* into *chicane*, was played in France. In A.D. 1300 the game was also known as *La boude*. Throughout the century indeed it was played in France and by the highest in the land: thus Louis X. died from a chill contracted after playing; Charles V. was devoted to the game, though he vainly tried to stop it as a pastime for the lower classes; Charles VI. watched the game from the room where he was confined during his attack of insanity, and Du Guesclin amused himself with it during the siege of Dinan. In England the game, or some form of it, was known, Chaucer possibly alluding to it in the words "But canstow playen racket to and fro"; and hand-ball, which may have been either tennis or cricket, was proscribed with other games by Edward III. in 1365. In France the game was prohibited to priests in A.D. 1245, and also in 1485, 1512 and 1673. In 1427 we hear of a woman named Margot, who was a skilful player, both her forehanded and backhanded strokes being commended; hence we may infer that the racquet had now been introduced. Tennis was at this time frequently played in some crude form in the moats of castles, where Charles VIII. used to watch the game. Henri II. is described as the best

Tennis Racquet.

player in France, and worthy of the silver ball given to the finest players. Later, Henri IV. and Louis XIV. (who kept a regular staff to look after his court) were patrons and players of tennis; indeed, in Henri IV.'s reign so popular was the sport that it was said that there were "more tennis-players in Paris than drunkards in England"; in the 16th century Paris alone could boast of 250 courts, yet it is stated that in 1879 there were only six courts in the whole of France. The word "tennis"—the game having hitherto been described as *luens pilae*—is first found in Gower's "Balade unto the worthy and noble kynge Henry the fourth" (1400), but Shakespeare's allusion to tennis as known to Henry V. must not be omitted. In reply to messengers from the dauphin, who had sent him a present of tennis-balls by their hands, Henry says:—

> "When we have match'd our rackets to these balls.
> We will, in France, by God's grace, play a set
> Shall strike his father's crown into the hazard.
> Tell him he hath made a match with such a wrangler
> That all the courts of France will be disturb'd
> With chases."
>
> —(*Henry V.*, Act i., sc. 2.)

Even if it be an anachronism that the poet should put these technical terms into the king's mouth, yet the fact is established that the terms were familiar in Elizabeth's time. Henry VII. indeed both played the game and revoked the edicts that forbade it; there was a court at Windsor Castle in his time, an open court with four bare walls, no penthouse, &c., being visible, and connected with the palace by a covered way. This court still existed in 1607. It was in that reign, possibly in that court, that the king of Castile played a match with the marquis of Dorset, the king, who used a racquet, conceding "fifteen" to the marquis, who played with his hand. The king won the set. Henry VIII. probably built the court at Hampton Court Palace. In 1615 there were further courts in London of various sizes, and a picture of James II. as a boy represents him standing in a tennis-court holding a short-handled racquet, strung diagonally. Pepys frequently alludes to tennis at a time when there were two courts at Oxford and five at Cambridge. Though the game flourished in the 19th century, it lost some of its popularity, mainly through the demolition of courts as building operations increased; moreover, courts complete in every detail alone were built, the play being consequently confined to the members of the clubs that could afford the expense. The last of the old courts to disappear stood in Windmill Street, at the top of the Haymarket, London. King Edward VII., when prince of Wales, frequently played tennis at "Prince's" Court.

The evolution of the court as now built is not easily traced, but courts undoubtedly existed side by side which differed from each other both in detail and in dimensions. It is generally assumed that such details as the penthouse, grille, galleries, &c., were deliberately planned to elaborate the game, but it is not unreasonable to suggest that the game, played , as it must often have been, in extemporized courts, took some of its modifications from them: it is at least significant that in an old illustration of *la paume* a miniature penthouse appears (from which the ball is rolling), apparently a shelter for a bell. The net does not appear till the 17th century, a rope, fringed or tasselled, being stretched across the court: further, the racquet was not in universal use in 1527, since Erasmus in his *Colloquies* says, "*Reticulum* (net, or racquet) *piscatoribus relinquamus: elegantius est palma uti*." An Italian, Antonio Scanio de Salo, is the first bibliographer of tennis. In his *Trattato della Palla* (treatise on the Ball) he mentions a large court for the game as played with a racquet, and a small court for the hand-game. The large court was 121 ft. long; it was entered by two doors, one between the first and second galleries on either side of the net; there were four galleries on each side; the dedans extended across the whole width of the court: the tambour was there and two grilles. He also mentioned chases, but these were decided by the place where the ball finally stopped, the spot being marked by a small movable standard. In another kind of court he says that there was no tambour, but two grilles. The penthouse was sometimes confined to two walls, sometimes to one, the end wall service side. In the hand-court one side was open all its length, with the exception of the battery and some pillars that perhaps gave variety to the stroke. The Latin poem to which allusion has been made shows the similarity of the 17th-century game to the modern: the racquet is spun; the marker (*signator*) is there to mark the chases (*metae*) with the movable standard; there is the grille (*fenestra*); the scoring by "15, 30, 40, game"; the volley (*volatu ludere*); the nick (*pedi ludere*, French *au pied*); the appeal to the spectators; the board (tatella, French *l'ais*); deuce and vantage, and the penthouse. In the 15th and 16th centuries tennis-balls were so largely imported from France that the Ironmongers' Company, who were the English manufactures, twice petitioned—the last time in 1591—for "protection" in the matter of balls. The term "bisk" (*bisque*, originally *bisquaye*) does not appear in English tennis till 1697 (Shadwell's *True Widow*), nor is the winning gallery mentioned before 1767. In the 17th century tennis became a spectacle in France, and the professional player came into existence, the most famous of that time being Le Pape, Clergé and Servo, and about the same time was formed the gild of *Paulmiers-racquetiers* (manufacturers of tennis material) with its arms, "Sable, a tennis-racquet proper; in a cross four tennis-balls of the same." De Garsault, writing in 1797, says, "*La Paume* is the only game that can take rank in the list of Arts and Crafts," and his book, *L'art du Paumier-Racquetier*, was adopted by the *Académie Royale*. In France very large sums of money were wagered on the game, especially at the end of the 16th century, the stakes being deposited under the cord or net, while in England, about 1750, there was so much betting and swindling, especially by professional players, that the game as played in the public courts fell into disrepute. In the middle of the 19th century, tennis-courts were rare indeed in England, the best known being those of the Marylebone Cricket Club (built in 1838), of the Messrs Prince in Hans Place, S.W., besides one at Brighton, one at Hampton Court, two at Cambridge, and one at Oxford; but the game progressed so fast that in 1910 there were between thirty and forty courts in England, one each in Ireland and Scotland, five in America, six in France, one in Melbourne (Australia) and one in Tasmania. The game has disappeared in Italy, Germany, Austria and Spain, though in Spain it was popular in the days of Philip III. (1578–1621) who was himself fond of playing.

The great French players mentioned above were followed by others—Cabasse (who invented the "boasted force" known as the *coup de Cabasse*), Barcellon, Farolais and Barnéon, and in the 18th century the Charniers, Bergeron and Masson, the last-named a really great player who could give fifteen to any of his contemporaries. One of his feats was to stand in a barrel before receiving the service, spring out of it and into it before and after each stroke. Other good players of later date were C. A. Delahaye, and greatest of all, J. E. Barre, who in 1855 re-opened the Versailles court, famous for the meeting of the *Tiers État* on the 20th of June 1789, which body there assembled and took the celebrated "Oath of the tennis-court." Masson is supposed to have visited England in 1792 and to have played against Messrs Hawkins and Price, and a professional called Pillet (or Pilet); but of Barre's visit there can be no doubt, as he played on the new court of the Marylebone Club in 1839, meeting "Peter" Tompkins, the English champion, and beating him so severely that when they met again next year Tompkins received the odds of thirty and a bisque. As an instance of the meagre interest taken in tennis at the time, Julian Marshall in his *Annals of Tennis* states that in *Bell's Life*, the leading sporting paper, Barre is reported as playing Cox and Tompkins "giving 7½ for a bisque," the tennis term "half fifteen" being arithmetically rendered. C. G. Taylor, the great cricketer, was one of the best amateurs, about this time. Barre eventually resigned the championship in favour of George Lambert, who was beaten in 1885 by T. Pettitt, of Boston U.S.A. Athletic Association, an Englishman by birth, who learnt all his tennis in America. Charles Saunders beat Lambert in 1886, thereby becoming champion of England. Pettitt and Saunders met for the championship of the world at Dublin, Pettitt winning by seven sets to five. The match took place in May 1890, and during the autumn, Pettitt declining to defend the title, Saunders assumed it, but five years later he was challenged by Peter Latham and beaten, Latham thus becoming the champion of the world both at racquets and tennis. An American, George Standing, challenged him in 1897 for the racquets championship, but was beaten, and next year Pettitt challenged Latham at tennis. In 1904 C. Fairs ("Punch") challenged Latham for the championship, but was beaten; but in 1908 Latham resigned his title, and Fairs then issued a challenge to any other player in the world to contest his right to the position of champion. The challenge was taken up in 1910 by G. F. Covey, the match for the championship, played at Brighton in the summer of 1910, being won by Fairs after a close contest, in which the younger player secured six sets to his opponent's seven, and fifty-three games to fifty-nine won by the champion. Among amateurs a formal championship was not established till 1889, the recognized champion being the winner of the gold prize annually given by the Marylebone Cricket Club to its members, the competition not being made "open" till 1896. For fifteen years, from 1867 to 1881, J. M. Heathcote held the title, among those whom he defeated during that period being such fine tennis-players as Julian Marshall, G. B. Crawley, the Hon. C. G. Lyttelton (afterwards Lord Cobham), R. D. Walker, C. E. Boyle, and the Hon. Alfred Lyttelton. In 1882 A. Lyttelton defeated Heathcote, only to be beaten next year by him, and to beat him in turn in 1884 and 1885; but in 1886 Heathcote (then fifty-three years of age) was again champion. From 1887 to 1895 inclusive the Hon. A. Lyttelton was champion, defeating during that time (besides Heathcote) A. J. Webbe, Sir Edward Grey and H. E. Crawley. Grey's perseverance—he won the silver prize on six occasions—was rewarded with the gold prize in 1896, but he was dispossessed in 1897 by E. H. Miles, who won for the next ten years, with the exception of 1900 when he was beaten by J. B. Gribble. On six occasions during this series Sir Edward Grey was second to the winner.

In 1889 the amateur championship, open to all amateurs, was instituted at Queen's Club, West Kensington. The following list shows the winners:—

1889. Sir E. Grey.	1900. E. H. Miles.
1890. E. B. Curtis.	1901. E. H. Miles.
1891. Sir E. Grey.	1902. E. H. Miles.
1892. H. E. Crawley.	1903. E. H. Miles.
1893. H. E. Crawley.	1904. V. Pennell.
1894. H. E. Crawley.	1905. E. H. Miles.
1895. Sir E. Grey.	1906. E. H. Miles.
1896. Sir E. Grey.	1907. Jay Gould.
1897. J. B. Gribble.	1908. Jay Gould.
1898. Sir E. Grey.	1909. E. H. Miles.
1899. E. H. Miles.	1910. E. H. Miles.

It may be mentioned that Heathcote and Lyttelton, who monopolized the Marylebone Club's gold prize for twenty-nine years, were strict adherents to the old-fashioned classical game, the winning and defending of chases and the clever placing of the ball being the leading feature of their game. A different and less attractive style of play, consisting of harder hitting, asserted itself in Miles's first success, which was followed by many others; but Jay Gould, an American amateur, who beat Miles for the championship in 1907 and again in 1908, owed his success to the perfection of his style in the older and more scientific tennis. He did not defend his title in 1909, when Miles again became amateur champion in his absence, a title which Miles again retained in 1910.

The universities of Oxford and Cambridge have played two matches, two-handed and four-handed, ever since 1859, with the exception of 1864 when neither match was played. The games are played at the court of the Marylebone Club.

Tennis in America.—Few tennis-courts existed in America before 1880, about which time the buildings of the Boston Athletic Association and the New York Racquet and Tennis Club were built. There are now also courts at Chicago, Tuxedo, Lakewood and several other places, but the game is naturally played by comparatively few persons. Tom Pettitt, mentioned above as for several years champion of the world, was for many years in charge of the Boston courts. Other first-class men are Alfred Tompkins of New York, Boakes of Chicago, and Forester. Richard Sears first won the American championship in 1892, and it has been won since by F. Warren, B. S. de Garmendia, L. M. Stockton (four times), Eustace Miles (champion of Great Britain), Joshua Crane, and Jay Gould (amateur champion 1907 and 1908). The older courts at Boston and New York are rather low and small, but the newer ones are perfect.

See J. M. Heathcote, *Tennis, Lawn Tennis, Rackets, Fives*, in "The Badminton Library," new and revised edition (London, 1903); *Racquets, Tennis and Squash*, by Eustace Miles (London, 1902).

TENNYSON, ALFRED TENNYSON, 1st Baron (1809–1892), English poet, was born at Somersby, Lincolnshire, on the 6th of August 1809. He was the fourth of the twelve children of the Rev. George Clayton Tennyson (1778–1831) and his wife Elizabeth Fytche (1781–1865). The Tennysons were an old Lincolnshire family settled at Bayon's Manor. The poet's grandfather, George Tennyson, M.P., had disinherited the poet's father, who was settled hard by in the rectory of Somersby, in favour of the younger son, Charles Tennyson D'Eyncourt. The rich pastoral scenery of this part of Lincolnshire influenced the imagination of the boy, and is plainly reflected in all his early poetry, although it has now been stated with authority that the localities of his subject-poems, which had been ingeniously identified with real brooks and granges, were wholly imaginary. At a very early age he began to write in prose and verse. At Christmas 1815 he was sent to the grammar school at Louth, his mother having kept up a connexion with this typical Lincolnshire borough, of which her father, the Rev. Stephen Fytche, had been vicar. Tennyson was at this school for five years, and then returned to Somersby to be trained by his father. In the rectory the boys had the run of an excellent library, and here the young poet based his wide knowledge of the English classics. The news of Byron's death (19th April 1824) made a deep impression on him: it was a day, he said, "when the whole world seemed to be darkened for me"; he went out into the woods and carved "Byron is dead" upon a rock. Tennyson was already writing copiously—"an epic of 6000 lines" at twelve, a drama in blank verse at fourteen, and so on: these exercises have, very properly, not been printed, but the poet said of them at the close of his life, "It seems to me, I wrote them all in perfect metre." The family was in the habit of spending the summer holidays at the coast of the county, commonly at Mablethorpe, and here Tennyson gained his impressions of the vastness of the sea. FitzGerald very justly attributed the landscape character of Tennyson's genius to the impress left on his imagination by "old Lincolnshire, where there were not only such good seas, but also such fine hill and dale among the wolds."

In 1827 Frederick Tennyson (1807–1898), the eldest surviving brother, uniting with his younger brothers Charles and Alfred, published at Louth an anonymous collection of *Poems by Two Brothers*. The "two" were Charles and Alfred (whose contributions predominated), and who shared the surprising profits, £20. On the 20th February 1828 Charles and Alfred matriculated at Trinity College, Cambridge, where Frederick was already a student. The poet subsequently told Mr Edmund Gosse that his father would not let him leave Somersby till, on successive days, he had recited from memory the whole of the odes of Horace. The brothers took rooms at 12 Rose Crescent, and afterwards moved into Trumpington Street (now 157 Corpus Buildings). They were shy, and made at first few friends; but they gradually gathered selected associates around them, and Alfred grew to be looked up to in Cambridge "as to a great poet and an elder brother" by a group which included Richard Chenevix Trench, Monckton Milnes (Lord Houghton), James Spedding, W. H. Thompson, Edward FitzGerald, W. H. Brookfield, and, above all, A. H. Hallam (1811–1833). Charles Tennyson (1808–1879) afterwards took the additional name of Turner. He published four volumes of sonnets which have been highly praised. In June 1829 Alfred Tennyson won the Chancellor's prize medal for his poem called "Timbuctoo." With great imperfections, this study in Miltonic blank verse displays the genius of a poet, in spite of a curious obscurity both of thought and style. Here are already both richness and power, although their expression is not yet clarified by taste. But by this time Tennyson was writing lyrics of still higher promise, and, as Arthur Hallam early perceived, with an extraordinary earnestness in the worship of beauty. The results of this enthusiasm and this labour of the artist appeared in the volume of *Poems, chiefly Lyrical*, published in 1830. This book would have been astonishing as the production of a youth of twenty-one, even if, since the death of Byron six years before, there had not been a singular dearth of good poetry in England. Here at least, in the slender volume of 1830, was a new writer revealed, and in "Mariana," "The Poet," "Love and Death," and "Oriana," a singer of wonderful though still unchastened melody. Through these, and through less perfect examples, was exhibited an amazing magnificence of fancy, at present insufficiently under control, and a voluptuous pomp of imagery, tending to an over-sweetness. The veteran S. T. Coleridge, praising the genius in the book, blamed the metrical imperfection of it. For this criticism he has himself constantly been reproved, and Tennyson (whose impatience of anything like censure was phenomenal) continued to resent it to the end of his life. Yet Coleridge was perfectly just in his remark; and the metrical anarchy of the "Madelines" and "Adelines" of the 1830 volume showed that Tennyson, with all his delicacy of modulation, had not yet mastered the arts of verse.

In the summer of 1830 Tennyson and Hallam volunteered in the army of the Spanish insurgent Torrijos, and marched about a little in the Pyrenees, without meeting with an enemy. He came back to find his father ailing, and in February 1831 he left Cambridge for Somersby, where a few days later Dr George Tennyson died. The new incumbent was willing that the Tennysons should continue to live in the rectory, which they did not leave until six years later. Arthur Hallam was now betrothed to Emily Tennyson (afterwards Mrs Jesse, 1811–1889), and stayed frequently at Somersby. This was a very happy time, and one of great physical development on Alfred's part. He took his share in all kinds of athletic exercises, and it was now that Brookfield said, "It is not fair that you should be Hercules as well as Apollo." This high physical zest in life seems to have declined after 1831, when his eyes began to trouble him, and he became liable to depression. The poetical work of these three years, mainly spent at Somersby, was given to the world in the volume of *Poems* which (dated 1833) appeared at the end of 1832. This was certainly one of the most astonishing revelations of finished genius ever produced by a young man of less than four-and-twenty. Here were to be read "The Lady of Shalott," "The Dream of Fair Women," "Oenone," "The Lotos-Eaters," "The Palace of Art," and "The Miller's Daughter," with a score of other lyrics, delicious and divine. The advance in craftsmanship and command over the *matériel* of verse shown since the volume of 1830 is absolutely astounding. If Tennyson had died of the savage article which presently appeared in the *Quarterly Review*, literature would have sustained terrible losses, but his name would have lived for ever among those of the great English poets. Indeed, it may be doubted whether, in several directions, he ever surpassed the glorious things to be found in this most exquisite and most precious book. It was well that its publication was completed before the blow fell upon Tennyson which took for a while all the light out of him. In August 1833 Arthur Hallam started with his father, the great historian, for Tirol. They went no farther than Vienna, where Mr Hallam, returning to the hotel on the 15th of September 1833, found his son lying dead on a sofa: a blood-vessel had broken in his brain. His body was brought back to England, and buried at Clevedon on the 3rd of January 1834. These events affected Tennyson extremely. He grew less than ever willing to come forward and face the world; his health became "variable and his spirits indifferent." The earliest effect of Hallam's death upon his friend's art was the composition, in the summer of 1834, of *The Two Voices;* and to the same period belong the beginnings of the *Idylls of the King* and of *In Memoriam*, over both of which he meditated long. In 1835 he visited the Lakes, and saw much of Hartley Coleridge, but would not "obtrude on the great man at Rydal," although "Wordsworth was hospitably disposed." Careless alike of fame and of influence, Tennyson spent these years mainly at Somersby, in a uniform devotion of his whole soul to the art of poetry. In 1837, to their great distress, the Tennysons were turned out of the Lincolnshire rectory where they had lived so long. They moved to High Beech, in Epping Forest, which was their home until 1840. The poet was already engaged, or "quasi-betrothed," to Emily Sellwood, but ten years more had to pass before they could afford to marry. At Torquay, in 1838, he wrote *Audley Court* on one of his rare excursions, for he had no money for touring, nor did he wish for change: he wrote at this time, "I require quiet, and myself to myself, more than any man when I write." In 1840 the Tennysons moved to Tunbridge Wells, and a year later to Boxley, near Maidstone, to be close to Edmund Lushington, who had now married Cecilia Tennyson. Alfred was from this time more and more frequently a visitor in London.

In 1842 the two-volume edition of his *Poems* broke the ten years' silence which he had enforced himself to keep. Here, with many pieces already known to all lovers of modern verse, were found rich and copious additions to his work. These he had originally intended to publish alone, and an earlier privately printed *Morte d'Arthur, Dora, and other Idylls*, of 1842, is the despair of book-collectors. Most of those studies of home-life in England, which formed so highly popular a section of Tennyson's work—such as "The Gardener's Daughter," "Walking to the Mail," and "The Lord of Burleigh"—were now first issued, and, in what we have grown to consider a much higher order, "Locksley Hall," "Ulysses," and "Sir Galahad." To the older and more luxurious lyrics, as reprinted in 1842, Tennyson did not spare the curbing and pruning hand, and in some cases went too far in restraining the wanton spirit of beauty in its youthful impulse. It is from 1842 that the universal fame of Tennyson must be dated; from the time of the publication of the two volumes he ceased to be a curiosity, or the darling of an advanced clique, and took his place as the leading poet of his age in England. Among the friends whom he now made, or for the first time cultivated, were Carlyle, Rogers, Dickens, and Elizabeth Barrett. Material difficulties now, however, for the first time intruded on his path. He became the victim of a certain "earnest-frothy" speculator, who induced him to sell his little Lincolnshire estate at Grasby, and to invest the proceeds, with all his other money, and part of that of his brothers and sisters, in a "Patent Decorative Carving Company": in a few months the whole scheme collapsed, and Tennyson was left penniless. He was attacked by so overwhelming a hypochondria that his life was despaired of, and he was placed for some time under the charge of a hydropathic physician at Cheltenham, where absolute rest and isolation gradually brought him round to health again. The state of utter indigence to which Tennyson was reduced greatly exercised his friends, and in September 1845, at the suggestion of Henry Hallam, Sir Robert Peel was induced to bestow on the poet a pension of £200 a year. Never was public money expended in a more patriotic fashion. Tennyson's health slowly became restored, and in 1846 he was hard at work on *The Princess;* in the autumn of this year he took a tour in Switzerland, and saw great mountains and such "stateliest bits of landskip" for the first time. In 1847 nervous prostration again obliged him to undergo treatment at Prestbury: "They tell me not to read, not to think; but they might as well tell me not to live." Dr Gully's water-cure was tried, with success. *The Princess* was now published, in a form afterwards considerably modified and added to. Carlyle and FitzGerald "gave up all hopes of him after *The Princess*," or pretended that they did. It was true that the bent of his genius was slightly altered, in a direction which seemed less purely and austerely that of the highest art; but his concessions to public taste vastly added to the width of the circle he now addressed. The home of the Tennysons was now at Cheltenham: on his occasional visits to London he was in the habit of seeing Thackeray, Coventry Patmore, Browning and Macready, as well as older friends, but he avoided "society." In 1848, while making a tour in Cornwall, Tennyson met Robert Stephen Hawker of Morwenstow, with whom he seems—but the evidence is uncertain—to have talked about King Arthur, and to have resumed his intention of writing an epic on that theme. In his absent-minded way Tennyson was very apt to mislay objects; in earlier life he had lost the MS. of *Poems, chiefly Lyrical*, and had been obliged to restore the whole from scraps and memory. Now a worse thing befell him, for in February 1850, having collected into one "long ledger-like book" all the elegies on Arthur Hallam which he had been composing at intervals since 1833, he left this only MS. in the cupboard of some lodgings in Mornington Place, Hampstead Road. By extraordinary good chance it had been overlooked by the landlady, and Coventry Patmore was able to recover it. In this way *In Memoriam* was dragged back from the very verge of destruction, and could be published, in its original anonymous form, in May 1850. The public was at first greatly mystified by the nature and object of this poem, which was not merely a chronicle of Tennyson's emotions under bereavement, nor even a statement of his philosophical and religious beliefs, but, as he long afterwards explained, a sort of *Divina Commedia*, ending with happiness in the marriage of his youngest sister, Cecilia Lushington. In fact, the great blemishes of *In Memoriam*, its redundancy and the dislocation of its parts, were largely due to the desultory manner of its composition. The poet wrote the sections as they occurred to him, and did not think of weaving them together into a single poem until it was too late to give them real coherency. The metre, which by a curious naïveté Tennyson long believed that he had invented, served by its happy peculiarity to bind the sections together, and even to give an illusion of connected movement to the thought.

The sale of Tennyson's poems now made it safe for him to settle, and on the 13th of June 1850 he was married at Shiplake to Emily Sarah Sellwood (1813–1896). Of this union no more need be said than was recorded long afterwards by the poet himself, "The peace of God came into my life before the altar when I wedded her." Every species of good fortune was now to descend on the path of the man who had struggled against ill luck so long. Wordsworth died, and on the 19th of November 1850 Queen Victoria appointed Tennyson poet laureate. The salary connected with the post was very small, but it had a secondary value in greatly stimulating the sale of his books, which was his main source of income. The young couple took a house at Warninglid, in Sussex, which did not suit them, and then one in Montpelier Row, Twickenham, which did better. In April 1851 their first child was born dead. At this time Tennyson was brooding much upon the ancient world, and reading little but Milton, Homer and Virgil. This condition was elegantly defined by Carlyle as "sitting on a dungheap among innumerable dead dogs." In the summer of 1851 was made the tour in Italy, of which *The Daisy* is the immortal record. Of 1852 the principal events were the birth of his eldest son Hallam, the second Lord Tennyson, in August, and in November the publication of the *Ode on the Death of the Duke of Wellington*. In the winter of 1853 Tennyson entered into possession of a little house and farm called Farringford, near Freshwater, in the Isle of Wight, which he leased at first, and afterwards bought: this beautiful place, ringed round with ilexes and cedars, entered into his life and coloured it with its delicate enchantment. In 1854 he published *The Charge of the Light Brigade*, and was busy composing *Maud* and its accompanying lyrics; and this volume was published in July 1855, just after he was made D.C.L. at Oxford: he was received on this occasion, which may be considered his first public appearance, with a "tremendous ovation." The reception of *Maud* from the critics, however, was the worst trial to his equanimity which Tennyson had ever had to endure, nor had the future anything like it in store for him. He had risen in *Maud* far above his ordinary serenity of style, to ecstasies of passion and audacities of expression which were scarcely intelligible to his readers, and certainly not welcome. It is odd that this irregular poem, with its copious and varied music, its splendid sweep of emotion, its unfailing richness of texture—this poem in which Tennyson rises to heights of human sympathy and intuition which he reached nowhere else, should have been received with bitter hostility, have been styled "the dead level of prose run mad," and have been reproved more absurdly still for its "rampant and rabid bloodthirstiness of soul." There came a reaction of taste and sense, but the delicate spirit of Tennyson had been wounded. For some years the world heard nothing from him; he was at Farringford, busying himself with the Arthurian traditions. He had now become an object of boundless personal curiosity, being already difficult to find, and the centre of amusing legends. It was in 1857 that Bayard Taylor saw him, and carried away the impression of a man "tall and broad-shouldered as a son of Anak, with hair, beard and eyes of southern darkness." This period of somewhat mysterious withdrawal from the world embraced a tour in Wales in 1857, a visit to Norway in 1858, and a journey through Portugal in 1859. In 1857 two Arthurian poems had been tentatively and privately printed, as *Enid and Nimue, or the True and the False*, to see how the idyllic form would be liked by the inner circle of Tennyson's friends. In the summer of 1859 the first series of *Idylls of the King* was at length given to the world, and achieved a popular success far beyond anything experienced before by any English poets, save perhaps Byron and Scott. Within a month of publication, 10,000 copies had been sold. The idyls were four in number, "Enid," "Vivien" (no longer called "Nimue"), "Elaine" and "Guinevere." These were fragments of the epic of the fall of King Arthur and the Table Round which Tennyson was so long preparing, and which he can hardly be said to have ever completed, although nearly thirty years later he closed it. The public and the critics alike were entranced with the "sweetness" and the "purity" of the treatment. A few, like Ruskin, were doubtful about "that increased quietness of style"; one or two already suspected that the "sweetness" was obtained at some sacrifice of force, and that the "purity" involved a concession to Victorian conventionality. It was not perceived at the time that the four idyls were parts of a great historical or mystical poem, and they were welcomed as four polished studies of typical women: it must be confessed that in this light their even perfection of workmanship appeared to greater advantage than it eventually did in the general texture of the so-called "epic." In 1859 "Boadicea" was written, and "Riflemen, Form!" published in *The Times*. Urged by the duke of Argyll, Tennyson now turned his attention to the theme of the Holy Grail, though he progressed with it but fitfully and slowly. In 1861 he travelled in Auvergne and the Pyrenees, with Clough, who was to die a few months later; to this year belong "Helen's Tower" and the "Dedication" of the *Idylls* to the prince consort, "These to his Memory." The latter led to Tennyson's presentation in April 1862 to the queen, who "stood pale and statue-like before him, in a kind of stately innocence," which greatly moved his admiring homage. From this time forth the poet enjoyed the constant favour of the sovereign, though he could never be moulded into a conventional courtier. He now put the Arthurian legends aside for a time, and devoted himself to the composition, in 1862, of "Enoch Arden," which, however, did not appear until 1864, and then in a volume which also contained "Sea Dreams," "Aylmer's Field" and, above all, "The Northern Farmer," the first and finest of Tennyson's remarkable studies in dialect. In April of this year Garibaldi visited Farringford; in February 1865 Tennyson's mother died at Hampstead in her eighty-fifth year; in the ensuing summer he travelled in Germany. The time slipped by with incidents but few and slight, Tennyson's popularity in Great Britain growing all the time to an extent unparalleled in the whole annals of English poetry. This universality of fame led to considerable practical discomfort; he was besieged by sightseers, and his nervous trepidation led him perhaps to exaggerate the intensity of the infliction. In 1867 he determined to make for himself a haven of refuge against the invading Philistine, and bought some land on Blackdown, above Haslemere, then a secluded corner of England; here Mr (afterwards Sir) James Knowles began to build him a house, ultimately named Aldworth. This is the time of two of his rare, privately printed pamphlets, *The Window; or, the Loves of the Wrens* (1867), and *The Victim* (1868). The noble poem *Lucretius*, one of the greatest of Tennyson's versified monographs, appeared in May 1868, and in this year *The Holy Grail* was at last finished; it was published in 1869, together with three other idyls belonging to the Arthurian epic, and various miscellaneous lyrics, besides *Lucretius*. The reception of this volume was cordial, but not so universally respectful as that which Tennyson had grown to expect from his adoring public. The fact was that the heightened reputation of Browning, and still more the sudden vogue of Swinburne, Morris and Rossetti (1866–1870), considerably disturbed the minds of Tennyson's most ardent readers, and exposed himself to a severer criticism than he had lately been accustomed to endure. He went on quite calmly, however, sure of his mission and of his music. His next volume (1872), *Gareth and Lynette* and *The Last Tournament*, continued, and, as he then supposed, concluded *The Idylls of the King*, to the great satisfaction of the poet, who had found much difficulty in rounding off the last sections of the poem. Nor, as he was to find, was the poem yet completed, but for the time being he dismissed it from his mind. In 1873 he was offered a baronetcy by Gladstone, and again by Disraeli in 1874; in each case the honour was gracefully declined. Believing that his work with the romantic Arthurian epics was concluded, Tennyson now turned his attention to a department of poetry which had long attracted him, but which he had never seriously attempted—the drama. He put before him a scheme, which he cannot be said to have carried far, that of illustrating "the making of England" by a series of great historical tragedies. His *Queen Mary*, the first of these chronicle-plays was published in 1875, and played by Sir Henry Irving at the Lyceum in 1876. Although it was full of admirably dramatic writing, it was not theatrically well composed, and it failed on the stage. Extremely pertinacious in this respect, the poet went on attempting to storm the theatre, with assault upon assault, all practically failures until the seventh and last, which was unfortunately posthumous. To have really succeeded on the stage would have given Tennyson more gratification than anything else, but he was not permitted to live long enough to see this blossom also added to the heavy garland of his glory. Meanwhile *Harold*, a tragedy of doom, was published in 1876; but, though perhaps the finest of its author's dramas, it has never been acted. During these years Tennyson's thoughts were largely occupied with the building of Aldworth. His few lyrics were spirited ballads of adventure, inspired by an exalted patriotism—"The Revenge" (1878), "The Defence of Lucknow" (1879)—but he reprinted and finally published his old suppressed poem, *The Lover's Tale*, and a little play of his, *The Falcon*, versified out of Boccaccio, was produced by the Kendals at their theatre in the last days of 1879. Tennyson had reached the limits of the threescore years and ten, and it was tacitly taken for granted that he would now retire into dignified repose. In point of fact, he now started on a new lease of poetical activity. In 1880 he published the earliest of six important collections of lyrics, this being entitled *Ballads and other Poems*, and containing the sombre and magnificent "Rizpah." In 1881 *The Cup* and in 1882 *The Promise of May*, two little plays, were produced without substantial success in London theatres: the second of these is perhaps the least successful of all the poet's longer writings, but its failure annoyed him unreasonably. This determination to be a working playwright, pushed on in the face of critical hostility and popular indifference, is a very curious trait in the character of Tennyson. In September 1883 Tennyson and Gladstone set out on a voyage round the north of Scotland, to Orkney, and across the ocean to Norway and Denmark. At Copenhagen they were entertained by the king and queen, and after much fêting, returned to Gravesend: this adventure served to cheer the poet, who had been in low spirits since the death of his favourite brother Charles, and who now entered upon a phase of admirable vigour. During the voyage Gladstone had determined to offer Tennyson a peerage. After some demur, the poet consented to accept it, but added, "For my own part, I shall regret my simple name all my life." On the 11th of March 1884 he took his seat in the House of Lords as Baron Tennyson of Aldworth and Farringford. He voted twice, but never spoke in the House. In the autumn of this year his tragedy of *Becket* was published, but the poet at last despaired of the stage, and disclaimed any hope of "meeting the exigencies of our modern theatre." Curiously enough, after his death *Becket* was the one of all his plays which enjoyed a great success on the boards. In 1885 was published another interesting miscellany, *Tiresias and other Poems*, with a posthumous dedication to Edward FitzGerald. In this volume, it should be noted, *The Idylls of the King* was completed at last by the publication of "Balin and Balan"; it contained also the superb address "To Virgil." In April 1886 Tennyson suffered the loss of his second son, Lionel, who died in the Red Sea on his return from India. The untiring old poet was steadily writing on, and by 1886 he had another collection of lyrics ready, *Locksley Hall Sixty Years After*, &c.; his eyes troubled him, but his memory and his intellectual curiosity were as vivid as ever. Late in 1888 he had a dangerous attack of rheumatic gout, from which it seemed in December that he could scarcely hope to rally, but his magnificent constitution pulled him through. He was past eighty when he published the collection of new verses entitled *Demeter and other Poems* (1889), which appeared almost simultaneously with the death of Browning, an event which left Tennyson a solitary figure indeed in poetic literature. In 1891 it was observed that he had wonderfully recovered the high spirits of youth, and even a remarkable portion of physical strength. His latest drama, *The Foresters*, now received his attention, and in March 1892 it was produced at New York, with Miss Ada Rehan as Maid Marian. During this year Tennyson was steadily engaged on poetical composition, finishing "Akbar's Dream," "Kapiolani" and other contents of the posthumous volume called *The Death of Oenone*, 1892. In the summer he took a voyage to the Channel Islands and Devonshire; and even this was not his latest excursion from home, for in July 1892 he went up for a visit to London. Soon after entering his eighty-fourth year, however, symptoms of weakness set in, and early in September his condition began to give alarm. He retained his intellectual lucidity and an absolute command of his faculties to the last, reading Shakespeare with obvious appreciation until within a few hours of his death. With the splendour of the full moon falling upon him, his hand clasping his Shakespeare, and looking, as we are told, almost unearthly in the majestic beauty of his old age, Tennyson passed away at Aldworth on the night of the 6th of October 1892. *Cymbeline*, the play he had been reading on the last afternoon, was laid in his coffin, and on the 12th he was publicly buried with great solemnity in Westminster Abbey. Lady Tennyson survived until August 1896.

The physical appearance of Tennyson was very remarkable. Of his figure at the age of thirty-three Carlyle has left a superb portrait: "One of the finest-looking men in the world. A great shock of rough, dusky, dark hair; bright, laughing, hazel eyes; massive aquiline face, most massive yet most delicate; of sallow brown complexion, almost Indian-looking, clothes cynically loose, free-and-easy, smokes infinite tobacco. His voice is musical, metallic, fit for loud laughter and piercing wail, and all that may lie between; speech and speculation free and plenteous; I do not meet in these late decades such company over a pipe." He was unusually tall, and possessed in advanced years a strange and rather terrifying air of sombre majesty. But he was, in fact, of a great simplicity in temperament, affectionate, shy, still exquisitely sensitive in extreme old age to the influences of beauty, melancholy and sweetness. Although exceedingly near-sighted, Tennyson was a very close observer of nature, and at the age of eighty his dark and glowing eyes, which were still strong, continued to permit him to enjoy the delicate features of country life around him, both at Aldworth and in the Isle of Wight. His *Life*, written with admirable piety and taste by his son, Hallam, second Lord Tennyson, was published in two volumes in 1897.

At the time of his death, and for some time after it, the enthusiastic recognition of the genius of Tennyson was too extravagant to be permanent. A reaction against this extravagance was perhaps inevitable, and criticism has of late been little occupied with the poet. The reason of this is easy to find. For an unusually long period this particular poetry had occupied public and professional opinion, and all the commonplace things about it had been said and re-said to satiety. It lacks for the moment the interest of freshness; it is like a wonderful picture seen so constantly that it fails any longer to concentrate attention. No living poet has ever held England—no poet but Victor Hugo has probably ever held any country—quite so long under his unbroken sway as Tennyson did. As he recedes from us, however, we begin to see that he has a much closer relation to the great Georgian writers than we used to be willing to admit. The distance between the generation of Wordsworth and Coleridge and that of Byron and Shelley is not less—it is even probably greater—than that which divides Keats from Tennyson, and he is more the last of that great school than the first of any new one. The qualities in which he seems to surpass his immediate predecessors are exactly those which should be the gift of one who sums up the labours of a mighty line of artists. He is remarkable among them for the breadth, the richness, the substantial accomplishment of his touch; he has something of all these his elders, and goes farther along the road of technical perfection than any of them. We still look to the earlier masters for supreme excellence in particular directions: to Wordsworth for sublime philosophy, to Coleridge for ethereal magic, to Byron for passion, to Shelley for lyric intensity, to Keats for richness. Tennyson does not excel each of these in his own special field, but he is often nearer to the particular man in his particular mastery than any one else can be said to be, and he has in addition his own field of supremacy. What this is cannot easily be defined; it consists, perhaps, in the beauty of the atmosphere which Tennyson contrives to cast around his work, moulding it in the blue mystery of twilight, in the opaline haze of sunset: this atmosphere, suffused over his poetry with inestimable skill and with a tact very rarely at fault, produces an almost unfailing illusion or mirage of loveliness, so that, even where (as must sometimes be the case with every poet) the thought and the imagery have little value in themselves, the fictive aura of beauty broods over the otherwise undistinguished verse. Hence, among all the English poets, it is Tennyson who presents the least percentage of entirely unattractive poetry. In his luminous subtlety and his broad undulating sweetness, his relationship with Virgil has long been manifest; he was himself aware of it. But he was also conscious that his exquisite devotion to mere lucidity and beauty might be a snare to him, and a happy instinct was always driving him to a study of mankind as well as of inanimate nature. Few English writers have known so adroitly as Tennyson how to bend the study of Shakespeare to the enrichment of their personal style. It should be added that he was a very deep and original student of literature of every description, and that the comparatively few specimens which have been preserved of his conversation contain some of the finest fragments of modern appreciation of the great poets which we possess. This is worthy of consideration in any attempt made to sketch the mind of a man who was above all other masters of recent literature an artist, and who must be studied in the vast and orbic fullness of his accomplishment in order to be appreciated at all. (E. G.)

Alfred, Lord Tennyson: a Memoir (1897), by Hallam, second Baron Tennyson, is the authoritative source for the poet's biography. Mr R. H. Shepherd in his *Tennysoniana* (1866), supplied a list of criticisms on his work, and a bibliography issued separately in 1896. Among the numerous books on the subject of his life and writings may be mentioned: *A Commentary on Tennyson's In Memoriam* (1901), by Prof. A. C. Bradley; Canon Rawnsley's *Memories of the Tennysons* (1900); *Alfred Tennyson* (1901), by Mr Andrew Lang; an essay on "The Mission of Tennyson" in Mr W. S. Lilly's *Studies in Religion and Literature* (1904); and *The Life of Lord Tennyson* (1904), by Mr A. C. Benson, who gives a more critical estimate of the poet than was possible in the Memoir by his son.

TENOR (through Fr. and It. from Lat. *tenor*, holding on, course, sense of a law, tone), a general course or direction, the drift or general meaning of a statement or discourse, hence, in law, the true purport and effect of a deed or instrument. The most general use of the word is, in music, for the highest kind of the natural adult male voice. This use descends from the Medieval Latin *tenor*, which was applied first to the chief melody, the *cantus firmus*, and then to the male voice to which the singing of this was assigned.

TENREC (*Centetes ecaudatus*), one of the largest representatives of the mammalian order Insectivora, the length being from 12 in. to 16 in.; called also the tailless ground-hog of Madagascar, to which island it is restricted. The coat consists chiefly of bristles and hairs, with an admixture of flexible spines, which in the young form longitudinal lines down the back; but in the adult they are limited to the back of the neck. The general hue is brown tinged with yellow. From twelve to sixteen young are produced at a birth, and twenty-one have been recorded. In habits the tenrec is fossorial and nocturnal; its home is in the brush in the mountain regions, and in the cool season, from May or June till December, it hibernates in deep burrows. The long flexible snout is used to root up worms and grubs, and ground-insects form part of its nourishment. These animals are very fat when hibernation begins, and are then much valued for food by the natives (see also INSECTIVORA).

TENT. A tent is a portable habitation or place of shelter, consisting in its simplest form of a covering of some textile substance stretched over a framework of cords and poles, or of wooden rods, and fastened tightly to the ground by pegs. Throughout the greater part of the interior of Asia the pastoral tribes have of necessity ever been dwellers in tents—the scantiness of water, the consequent frequent failure of herbage, and the violent extremes of seasons compelling a wandering life. Tents have also been used in all ages by armies in campaign. In ancient Assyrian sculptures discovered by Layard at Nineveh the forms of tent and tent-furnishings are similar to those which still prevail in the East, and it appears that then as now it was a custom to pitch tents within the walls of a city. The ordinary family tent of the Arab nomads of modern times is a comparatively spacious ridged structure, averaging from 20 to 25 ft. in length, but sometimes reaching as much as 40 ft. Its covering consists of a thick felt of black goat hair (cp. Cant. i. 5—"black as the tents of Kedar"), or sometimes of alternate stripes of black and white disposed horizontally. The ridge or roof is supported by nine poles disposed in sets of three, the central set being loftier than those at each end, whereby a slope outward is formed which helps to carry off rain. The average height inside at the centre is 7 ft. and at the sides 5 ft., and the cloths at the side are so attached that they can easily be removed, the sheltered end being always kept open. Internally the tent is separated by a partition into two sections, that reserved for the women containing the cooking utensils and food. The *jourt* or tent of the Kirghiz of Central Asia is a very capacious and substantial structure, consisting of a wooden frame for sides, radiating ribs for roof, and a wooden door. The sides are made up of sections of laths, which expand and contract in lozenges, on the principle of lazy tongs, and to their upper extremities ribs are lashed at regular intervals. Over this framework a heavy covering of felt is thrown, which is either weighted down with stones or, when necessary, stitched together.

In Western countries tents are used chiefly in military encampments, by travellers and explorers, and for temporary ceremonial occasions and public gatherings. The material of which they are composed is commonly a light linen canvas or navy duck; but for tents of small size stout cotton canvas is employed, being light, strong, elastic, and sufficiently waterproof. These tents vary in size from a low-pitched covering, under which a couple of men can with difficulty creep, up to spacious marquees, in which horticultural and agricultural shows are held, and which can accommodate thousands of persons.

The marquee is distinguished from the tent by being a ridged structure, devoted to show and social uses; but the humblest tent made—the *tente d'abri* or shelter tent of the French army—is also ridged in form. The *tente d'abri* affords sleeping accommodation for six men, and consists of a rope stretched over three low poles and fixed into the ground. Four separate squares of canvas buttoned together are thrown over the rope and pegged to the ground on each side so as to form a low ridge. Two other squares are used for covering the ends, being thrown over the slanting rope ends by which the poles are pegged to the ground. Each of the six men using the tent carries one of the squares of canvas besides his quota of the poles, rope and pegs. In the British service *tentes d'abri* are often improvised by fastening together blankets or waterproof sheets over a stick. The gipsies and travelling tinkers of England have an equally unpretentious tent, which consists of a framework, of hazel rods bent so as to form a series of low ridges, the ends being stuck into the ground, and over this frame blankets or other coverings are thrown and pegged down. The simplest, but at the same time the least convenient, of ordinary tents is the conical, consisting of a central pole with ropes and canvas radiating from it in an unbroken slope to the ground. The common army bell tent is of this type, but the conical roof terminates at about 1 ft. 9 in. from the ground, and from it there hangs vertically a curtain which is loosely pegged to the ground or looped up to allow of the free circulation of air when the tent is unoccupied or the weather is favourable. This form, however, covers much ground in proportion to the accommodation it affords, as the space round the circumference is of little value. A tent, therefore, which has sides or a fall is a much more convenient structure. The counterpart of the conical is the pyramidal tent, the four equal sides sloping to the ground; and this form with a fall or sides makes the square tent, which is both convenient in shape and firm in structure. Small tents are also made, modified from the Arab form, with a central pole and two lower lateral poles. In the umbrella tent the roof is supported by a set of ribs which radiate from the pole, precisely as the ribs of an umbrella spread out from the stick.

The tents and marquees in use in the British army are the following: The bell tents (single or double thickness) 16 ft. in circumference, accommodating in active service 3 officers, 7 sergeants or 15 men each; the Indian general service tents, of various sizes, square with pyramidal roofs, the Indian "E.P." and "Staff-sergeants'" tents, which are much roomier than the tents used in India on active service, "hospital marquees" and "operating tents."

In former wars, when small professional armies were employed and it was customary to pay extraordinary attention to the soldier's comforts, the train of an army included a full tent equipment, which helped to diminish the already small degree of mobility of which it was capable. Under the Revolution and Napoleon, and generally in the 19th century, the system of housing armies in the field under canvas was practically abolished (except as regards more or less rough *tentes d'abri*) and replaced by that of billets and bivouacs. The strain entailed upon the transport by complete tentage may be judged from the fact that a single battalion on the minimum scale would require four waggons, each with one ton load of poles and canvas, that is, the regimental transport would be doubled.

A tent equipment (of the *tente d'abri* type) was introduced into the German army about 1888, and the troops of Austria and Switzerland also possess tents. In the Russian army cavalry and engineer troops are excepted from the otherwise universal issue of canvas shelter.

TENTERDEN, CHARLES ABBOTT, 1st Baron (1762–1832), lord chief justice of England, was born at Canterbury on the 7th of October 1762, his father having been a hairdresser and wigmaker of the town. He was educated at Canterbury King's School and Corpus Christi College, Oxford, of which he afterwards became fellow and tutor. On the advice of Mr Justice Buller (1746–1800), to whose son he had been tutor, he determined on the legal profession, and entered at the Middle Temple in 1787. For several years he practised as a special pleader under the bar, and was finally called at the Inner Temple in 1796. He joined the Oxford circuit and soon made rapid headway. In 1801 he was appointed recorder of Oxford. In 1802 appeared his *Law relative to Merchant Ships and Seamen*, a concise and excellent treatise, which has maintained its position as an authoritative work. Its publication brought to him so much commercial and other work that in 1808 he was in a position to refuse a seat on the bench; this, however, he accepted in 1816, being made a judge of the court of common pleas. On the resignation of Lord Ellenborough in 1818 he was promoted to the chief justiceship of the king's bench. In his capacity as chief justice he presided over several important state trials, notably that of Arthur Thistlewood and the Cato Street conspirators (1820). He was raised to the peerage in 1827 as Baron Tenterden of Hendon. Never a great lawyer and with no pretence to eloquence, Tenterden made his way by sound common sense and steady hard work. He was an uncompromising Tory, and had no sympathy with the reform of the criminal law carried out by Romilly; while he strongly opposed the Catholic Relief Bill and the Reform Bill. He died on the 4th of November 1832, and was buried, by his own desire, in the Foundling Hospital, London, of which he was a governor.

Tenterden was succeeded in his title by his son, John Henry Abbott (1796–1870), then by his grandson, Charles Stuart Aubrey Abbott (1834–1882), permanent under-secretary for foreign affairs, who was made a K.C.B. in 1878. In 1882 the latter's son, Charles Stuart Henry Abbott (b. 1865) became the 4th Baron.

TENTERDEN, a market town and municipal borough in the Ashford parliamentary division of Kent, England, 62 m. S.E. by E. of London by the South-Eastern and Chatham railway. Pop. (1901) 3243. It lies on an elevation above the Newnill Channel, a tributary of the Rother, whose flat valley, called the Rother Levels, was an estuary within historic times; and even as late as the 18th century the sea was within 2 m. of Tenterden, which is a member of the affiliated Cinque Port of Rye. The church of St Mildred is Early English and later, and its tall, massive Perpendicular tower is well known for the legend connecting it with Goodwin Sands. The story is that the Abbot of St Augustine, Canterbury, diverted the funds by which the sea-wall protecting Earl Godwin's island was kept up, for the purpose of building Tenterden steeple, the consequence being that in 1099 an inundation took place and "Tenterden steeple was the cause of the Goodwin Sands." Attached to the church is a penitentiary used in the reign of Queen Mary for the confinement of persons awaiting trial on a charge of heresy. The church of High Halden, in the neighbourhood, is remarkable for its octagonal wooden tower constructed of huge timbers, with a belfry of wooden tiles (shingles), of the time of Henry VI. Tenterden has a considerable trade in agricultural produce and stock. It is governed by a mayor, four aldermen and twelve councillors. Area, 8946 acres.

Tenterden (*Tenterdenne*, *Tentyrden*) figures frequently in contemporary records from 1300 onwards. In 1449 Henry VI. incorporated it by the name of a "Bailiff and Commonalty," and united it to Rye. In return for these and other privileges it was to contribute towards the services due from the latter as one of the Cinque Ports. The troubles of 1449 apparently hindered the issue of the charter, since in 1463 Edward IV. brought it into operation. In 1600 it was incorporated under the title of the "Mayor, Jurats and Commons" of the town and hundred of Tenterden, in the county of Kent, the members of the corporation ranking henceforward as barons of the Cinque Ports. A weekly corn market on Friday and a yearly fair on the first Monday in May were granted, both of which are held at the present day. In 1790 a contemporary writer mentions the market as being little frequented, whilst the fair was large and resorted to by all the neighbourhood. This charter was exemplified by that of the year 1700. The size and importance of Tenterden can be estimated from a receipt of 1635 for £90 ship-money, as compared with £70 contributed by Faversham, and £60 by Hythe. Under Edward III. several refugee Flemings settled in the town and established the woollen manufacture. An old waste book, still preserved, contains entries of amounts of cloth sent from Tenterden to London. By 1835 this trade had completely died out, and Tenterden was suffering from the depression of agricultural interests.

TENURE (Fr. *tenure*, from Lat. *tenere*, to hold), in law, the holding or possession of land. The holding of land in England was originally either *allodial* or *feudal*. Allodial land was land held not of a superior lord, but of the king and people. Such ownership was absolute. It possibly took its origin from the view that the land was the possession of the clan; that the chief was the leader but not the owner, and was no doubt strengthened by the temporary and partial occupation by the Romans. Their withdrawal, followed by the Saxon invasion, tended, without doubt, to re-establish the principle of common village ownership which formed the basis of both Celtic and German tenure. In the later Saxon period, however, private ownership became gradually more extended. Then the feudal idea began to make progress in England, much as it did about the same time on the continent of Europe, and it received a great impetus from the Norman conquest. When English law began to settle down into a system, the principle of feudalism was taken as the basis, and it gradually became the undisputed maxim of English law that the sovereign was the supreme lord of all the land and that every one held under him as tenant, that there was no such thing as an absolute private right of property in land, but that the state alone as personified by the sovereign was vested with that right, and conceded to the individual possessor only a strictly defined subordinate right, subject to conditions from time to time enacted by the community (see also FEUDALISM). Feudal tenure was divided into free and non-free. Free tenures were frankalmoign, knight service, serjeanty and free socage. These tenures are dealt with under their separate headings. Base or non-free tenure was tenure in villenage (*q.v.*) and copyhold (*q.v.*), and see also MANOR.

TEPIC, a territory of Mexico facing on the Pacific Ocean and bounded N., E. and S. by Sinaloa, Durango and Jalisco. Area 11,275 sq. m. Pop. (1900) 150,098. The active volcano of Ceboruco rises in the western part of the territory. The slopes and valleys are densely wooded, the lower regions being very fertile and adapted to tropical agriculture. The rainfall is abundant, and the climate hot, damp and malarial. The Rio Grande de Lerma, or Santiago, is the principal river, whose sources are to be found on the high plateau in the state of Mexico. The next largest river is the Mezquital, which has its sources in the state of Durango, not far from the city of that name. The products of the territorial coast lands are sugar, cotton, tobacco, maize, palm oil, coffee, fine woods and medicinal plants. Mining attracts much attention in the sierras, and its mineral deposits are rich. There are cotton and cigarette factories at the town of Tepic, besides sugar works and distilleries on the plantations. The capital of the territory is Tepic (pop. 1900, 15,488), attractively situated on a small plateau 2950 ft. above sea level, 26 m. E. by S. of its port, San Blas, with which it is connected by rail.

The territory of Tepic was detached from the State of Jalisco in 1889 on account of the belligerent attitude of its population, chiefly composed of Indians. A territorial form of government places it more directly under the control of the national executive.

TEPIDARIUM, the term given to the warm (*tepidus*) bathroom of the Roman baths. There is an interesting example at Pompeii; this was covered with a semicircular barrel vault, decorated with reliefs in stucco, and round the room a series of square recesses or niches divided from one another by Telamones. The tepidarium in the Roman thermae was the great central hall round which all the other halls were grouped, and which gave the key to the plans of the thermae: it was probably the hall where the bathers first assembled prior to taking the cold bath or passing through the various hot baths, and was decorated with the richest marbles and mosaics: it received its light through clerestory windows, on the sides, the front and the rear, and would seem to have been the hall in which the finest treasures of art were placed; thus in the thermae of Caracalla, the Farnese Hercules, and the Toro Farnese, the two gladiators, the sarcophagi of green basalt now in the Vatican, and numerous other treasures, were found during the excavations by Paul III. in 1546, and transported to the Vatican and the museum at Naples.

TEPLITZ (Czech, *Teplice*), or TEPLITZ-SCHÖNAU, as it is officially called since the incorporation of the village of Schönau in 1895, a town of Bohemia, Austria, 80 m. N.N.W. of Prague by rail. Pop. (1900) 24,420. It is picturesquely situated in the plain of the Biela, which separates the Erzgebirge from the Bohemian Mittelgebirge, and is a favourite watering-place, containing a large *Kurhaus* and numerous handsome bath-houses. The environs are laid out in pretty and shady gardens and promenades, the finest being in the park which surrounds the château of Prince Clary-Aldringen, built in 1751. The other chief buildings are the Roman Catholic Schlosskirche, built in 1568 and altered to its present form in 1790, the Protestant church, the Jewish synagogue with a conspicuous dome, and the theatre. In the garden of the château are two ancient towers, probably the remains of the Benedictine convent, but ascribed by local tradition to the knight Kolostuj, the legendary discoverer of the springs. The saline-alkaline springs of Teplitz, ten to twelve in number, ranging in temperature from 90° to 117° Fahr., are classed among what are called "indifferent" waters. Used almost exclusively for bathing, they are prescribed for gout, rheumatism, and some scrofulous affections, and their reputed efficacy in alleviating the effects of gun-shot wounds had gained for Teplitz the sobriquet of "the warriors' bath." Military baths are maintained in the town by the governments of Austria, Prussia and Saxony, and there are also bath-houses for the poor. Teplitz is much visited for the after-cure, after Carlsbad and similar spas. The number of patients is about 6000 and the passing visitors about 25,000. The presence of a bed of lignite in the neighbourhood has encouraged the industrial development of Teplitz, which carries on manufactures of machinery and metal goods, cotton and woollen goods, chemicals, hardware, sugar, dyeing and calico-printing.

The thermal springs are fabled to have been discovered as early as 762, but the first authentic mention of the baths occurs in the 16th century. The town is mentioned in the 12th century, when Judith, queen of Ladislaus I. of Bohemia, founded here a convent for Benedictine nuns, which was destroyed in the Hussite wars. In the 17th century Teplitz belonged to the Kinskys, and after Kinsky's murder (25th February 1634) the lordship was granted by Ferdinand II. to Johann Count Aldringen. His sister Anna, who inherited it, married Freiherr Hieronymus von Clary, who assumed the additional name and arms of Aldringen. The family, which was raised to the rank of count in 1666 and of prince of the Empire in 1767, still retains the property. Teplitz figures in the history of Wallenstein, and is also interesting as the spot where the monarchs of Austria, Russia and Prussia first signed the triple alliance against Napoleon in 1813. It is a curious fact that on the day of the earthquake at Lisbon (1st November 1775) the main spring at Teplitz ceased to flow for some minutes.

TERAMO, an episcopal see of the Abruzzi, Italy, the capital of the province of Teramo, 16 m. by rail W.S.W. of Giulianova, a junction on the Ancona-Brindisi railway. Pop. (1901) 10,508 (town); 24,091 (commune). The town stands on the left bank of the Tordino, where it is joined by the Vezzola, at an altitude of 876 ft. above sea-level. The picturesque valley of the Tordino is here dominated by the peaks of the Gran Sasso d'Italia. The town is traversed by one straight wide street with large houses, but for the most part it consists of narrow lanes. The cathedral has a Romanesque Gothic portal of 1332 by a Roman marble worker named Deodatus, and the interior is decorated in the Baroque style, but still retains the pointed vaulting of 1154, introduced into Italy by French Benedictines; it contains a splendid silver antependium by the 15th-century goldsmith Nicolo di Guardiagrele (1433–48). The tower is fine. The church of S. Antonio is also in the Romanesque Gothic style. Under the church of S. Anna dei Pompetti remains of Roman houses and of the original cathedral have been discovered (F. Savini in *Notizie degli scavi*, 1898, 137). In the Communal Gallery is an altarpiece from the cathedral by the Venetian Jacobello del Fiore (1400–1439). The antiquities include remains of a gateway, a theatre and baths, as well as numerous inscriptions. There are manufactures of wool and silk, and of straw hats and pottery.

The ancient Interamna Praetuttiorum (so called to distinguish it from Interamna Lirenas and Interamna Nahars) was the chief town of the tribe of the Praetuttii. Its pre-Roman necropolis was discovered in 1905 (F. Savini in *Notizie degli scavi*, 1905, 267). Of its municipal constitution little is known, indeed in an inscription of the end of the Republic it is spoken of both as a *colonia* and a *municipium*. It was situated on a branch of the Via Caecilia (*q.v.*). Remains of an amphitheatre still exist. In the valley of the Vomano near Montorio was a Roman village, probably dependent on Interamna, with a temple of Hercules (*Corp. inscr. Lat.*, ix. p. 484).

See V. Bindi, *Monumenti degli Abruzzi* (Naples, 1889), 1 sqq.

TERAPHIM (A.V. sometimes transcribes, *e.g.* Judges xvii. 5; xviii. 14 seq.; Hosea iii. 4; sometimes translates "image," 1 Sam. xix. 13; "idols," Zech. x. 2; "idolatry," 1 Sam. xv. 23: R.V. renders consistently "teraphim"), a Hebrew word, found only in the plural, of uncertain etymology. The name appears to be applied to some form of idol (cf. Gen. xxxi. 19 and 30), but details as to its precise configuration, &c., are lacking. From 1 Sam. xix. 13, 16 it would seem that in the early monarchical period a regular place in every household was still reserved for the teraphim; while in the 8th century Hosea (iii. 4) speaks of "ephod and teraphim" as essential elements in the national worship. Later the teraphim with other adjuncts of heathenish worship were banned by the prophets. The meaning of the Elohistic story in Gen. xxxv. 2–4 clearly is that the employment of teraphim and of other heathen practices of Aramean paganism was given up by Israel in order that they might serve Jehovah alone at Bethel. In Judges and Hosea the teraphim are closely associated with the ephod; both are mentioned in connexion with divination (cf. 2 Kings xxiii. 24; Ezek. xxi. 21 [26]; Zech. x. 2). Whether the teraphim were "consulted" by lot or not is uncertain. In view of Ezek. xxi. 21 and Hosea iii. 4 it is difficult to suppose that the teraphim were purely household idols. The Rabbinical conjectures on the subject can be found in Buxtorf, *Lex. Talm.* (ed. Fischer), 1315 seq. One of the most curious is that the teraphim consisted of a mummified human head (see also EPHOD). (W. R. S.; G. H. Bo.)

TERBIUM [symbol Tb, atomic weight 159·2 (O=16)], a metallic chemical element belonging to the rare earth group; it was originally called erbia by its discoverer Mosander (see RARE EARTH). Pure terbium compounds were obtained by G. Urbain (*Compt. rend.*, 1904 seq.) by fractional crystallization of the nickel double nitrates, the ethyl sulphates, and the bismuth double nitrates of the terbium earths. Terbium appears to be trivalent. The oxide is a black or brown powder according as it is prepared from the exalate or sulphate, and when pure it is non-fluorescent, but mixed with gadolinia or alumina it possesses this property. It yields colourless salts; the crystallized sulphate has the formula $Tb_2(SO_4)_3 \cdot 8H_2O$.

TER BORCH (or TERBURG), **GERARD** (1617–1681), Dutch subject painter, was born in 1617 at Zwolle, in the province of Overyssel, Holland. He received an excellent education from his father, also an artist, and developed his talent very early. The inscription on a study of a head proves that Ter Borch was at Amsterdam in 1632, where he studied possibly under C. Duyster or P. Codde. Duyster's influence can be traced in a picture bearing the date 1638, in the Ionides Bequest (Victoria and Albert Museum). In 1634 he studied under Pieter Molyn in Haarlem. A record of this Haarlem period is the "Consultation" (1635) at the Berlin Gallery. In 1635 he was in London, and subsequently he travelled in Germany, France, Spain and Italy. It is certain that he was in Rome in 1641, when he painted the small portraits on copper of "Jan Six" and "A Young Lady" (Six Collection, Amsterdam). In 1648 he was at Münster during the meeting of the congress which ratified the treaty of peace between the Spaniards and the Dutch, and executed his celebrated little picture, painted upon copper, of the assembled plenipotentiaries—a work which, along with the "Guitar Lesson" and a portrait of a "Man Standing," now represents the master in the national collection in London. The picture was bought by the marquess of Hertford at the Demidoff sale for £7280, and presented to the National Gallery by Sir Richard Wallace, at the suggestion of his secretary, Sir John Murray Scott. At this time Ter Borch was invited to visit Madrid, where he received employment and the honour of knighthood from Philip IV., but, in consequence of an intrigue, it is said, he was obliged to return to Holland. He seems to have resided for a time in Haarlem; but he finally settled in Deventer, where he became a member of the town council, as which he appears in the portrait now in the gallery of the Hague. He died at Deventer in 1681.

Ter Borch is excellent as a portrait painter, but still greater as a painter of *genre* subjects. He depicts with admirable truth the life of the wealthy and cultured classes of his time, and his work is free from any touch of the grossness which finds so large a place in Dutch art. His figures are well drawn and expressive in attitude; his colouring is clear and rich, but his best skill lies in his unequalled rendering of texture in draperies, which is seen to advantage in such pictures as the "Letter" in the Dutch royal collection, and in the "Paternal Advice" (known as the "Satin Gown")—engraved by Wille—which exists in various repetitions at Berlin and Amsterdam, and in the Bridgewater Gallery. Ter Borch's works are comparatively rare; only about eighty have been catalogued. Six of these are at the Hermitage, six at the Berlin Museum, five at the Louvre; four at the Dresden Museum, and two at the Wallace Collection.

See *Gerard Terburg (Ter Borch) et sa famille*, by Emile Michel (Paris, 1887); *Der künstlerische Entwickelungsgang des G. Ter Borch*, by Dr W. Bode; *Maîtres d'autrefois*, by E. Fromentin (4th ed., Paris, 1882).

TERCEIRA, an island in the Atlantic Ocean, belonging to Portugal, and forming part of the Azores archipelago. Pop. (1900) 48,770; area, 224 sq. m. Terceira, *i.e.* "the third," was so called as being the third island of the archipelago to be discovered by the Portuguese. From its central position it was long the seat of administration, but its capital, Angra (*q.v.*) or Angra do Heroismo (pop. 10,788), has lost much of its commercial importance. The other chief towns are Ribeirinha (3090), and Praia da Victoria (3236). Unlike the neighbouring islands, Terceira exhibits few extensive traces of volcanic action; and the summits of its mountains are generally level. It abounds in grain and cattle; but the wines are inferior, and fruits are raised merely for internal consumption. (See also AZORES.)

TEREBINTH, botanical name *Pistacia Terebinthus*, a member of the natural order Anacardiaceae, usually a small tree common in the south of Europe and the whole Mediterranean area. It has a purplish grey bark and compound leaves with two to four pairs, and an odd terminal one, of smooth dark green oval blunt leaflets, which when young are thin, translucent and strongly tinged with reddish purple. The very small numerous unisexual flowers are borne on panicles which spring from just above the scars of last year's leaves. The fruit is a small roundish bright red drupe with a scanty pulp. The plant has been long known in English gardens. A liquid oleo-resinous exudation, known as Chian, Scio or Cyprus turpentine, is obtained by cutting the stem. The Chian turpentine of commerce is obtained exclusively from the island of Scio; the produce is very small, a large tree yielding only 10 or 11 ounces in one year. An allied species, *P. Lentiscus*, is the mastich tree.

TEREDO, a genus of Lamellibranchiate *Mollusca*, of the order Eulamellibranchia, sub-order Adesmacea, family Teredinidae. The animals included in this genus are commonly known as "ship-worms," and are notorious for the destruction which they cause in ships' timbers, the woodwork of harbours, and piles or other wood immersed for a long period in the sea. They inhabit long cylindrical holes, which they excavate in the wood, and usually occur in great numbers, crowded together so that often only a very thin film remains between the adjacent burrows. Each burrow is lined with a layer of calcareous substance secreted by the mollusc; this lining is not usually complete, but stops short a little distance from the inner end of the burrow, where the boring process continues to take place. In some burrows, however, the lining is complete, either because the animal has reached its full size or because some cause prevents it continuing its tunnel; in such cases the calcareous tube has a hemispherical termination. The burrows are usually driven in the direction of the grain of the wood, but not invariably so. When a knot or nail or the tube of a neighbour is reached, the course of the burrow is altered so as to bend round the obstruction. One burrow is never found to break into another.

The adult *Teredo*, when removed from its burrow and calcareous tube, is from a few inches to 3 ft. in length, according to the species to which it belongs, and is cylindrical and worm-like in appearance. The anterior end, which lies at the bottom of the burrow, is somewhat enlarged and bears a pair of shells or valves, which are not connected by the usual ligament, but are widely separated dorsally. The valves are triangular in shape and very concave on the side which is in contact with the animal. In front their edges are widely separated, and the mantle tube, which is elsewhere closed, has here a slight median aperture, through which the short sucker-like foot can be protruded. The next portion of the body behind the shell-bearing part is naked, except for the shelly lining of the burrow, which is secreted by this part. Anteriorly this portion contains part of the body proper; posteriorly it forms a tube divided internally by a horizontal partition into two chambers and representing the two tubular outgrowths of the mantle called siphons, here united together. In the lower chamber are the elongated gill plates, which have the typical lamellibranchiate structure. In the upper chamber anteriorly is the rectum. A thick muscular ring terminates this region of the body, and bears two calcareous plates shaped like spades or battledores. The expanded parts of these plates are free and project backwards; the handle is fixed in a deep socket or pit lined by epidermis. These calcareous plates are called pallets (Fr. *palmules*). Behind the pallets the tubular body bifurcates, forming two siphons similar to those of other Lamellibranchs; the siphons can be contracted or expanded within wide limits of length. The principal organs of the body—stomach, heart, generative organs and nephridia—are situated in the anterior part of the body, forming a visceral mass, which extends some distance behind the valves. The heart is above the intestine and not perforated by it. There are two adductor muscles of which the anterior is rudimentary and situated just above the mouth, while the posterior is large and passes between the middle parts of the shell-valves. The visceral mass extends some distance behind the posterior adductor, and behind the rectum, and the visceral ganglia, which in most Lamellibranchs are attached to the ventral surface of the posterior adductor, are in this case at the end of the visceral mass and at the anterior end of the gills. Besides the visceral ganglia a cerebral and a pedal pair are present. The stomach is provided with a large crystalline style. The function of the pallets is to form an operculum to the calcareous tube when the siphons are withdrawn into it. In some species the external or narrower end of the calcareous tube is provided with transverse laminae projecting into the lumen; and in some the external aperture is divided by a horizontal partition into two, one for each siphon.

The *Teredo* is dioecious, and the males are only in the proportion of 1 : 500 of he females. As in the case of the oyster, the ova are retained in the branchial chamber during the early stages of their development The segmentation of the ovum is unequal, and leads to the formation of a gastrula by epibole. By the growth of a preoral lobe provided with a ring of cilia, and by the formation of a mouth and an anus, the trochosphere stage is reached. A pair of thin shells then appear on the sides of the larva, connected by a hinge on the dorsal median line, and the foot grows out between mouth and anus. By the time the larvae "swarm," or leave the branchial cavity of the parent to live for a time as free-swimming pelagic larvae, the valves of the shell have grown so large as to cover the whole of the body when the velum is retracted; the foot is also long, cylindrical and flexible, and can be protruded far beyond the shell. The valves of the shell at this stage are hemispherical in shape, so that the whole larva when its organs are retracted is contained in a globular case.

Concerning the later changes of the larva and the method by which it bores into wood little or nothing is known from direct observation. Much has been written about the boring of this and other marine animals, but even yet the matter cannot be said to be satisfactorily elucidated. Osler, in a paper in *Phil. Trans.*, 1826, argued that the *Teredo* bores by means of its shells, fixing itself by the surface of the foot, which it uses as a sucker, and then rasping the wood with the rough front edges of the shell-valves. This view was founded on the similarity of the arrangement of the shells and muscles in *Teredo* to those occurring in *Pholas*, in which the method of boring described was actually observed. W. Thompson, in a paper in the *Edinb. New Phil. Journ.*, 1835, supported the view that the excavation is due to the action of a solvent secreted from the surface of the animal. Albany Hancock, again (*Ann. and Mag. Nat. Hist.*, vol. xv.), thinks that the excavating power of *Teredo* is due to silicious particles imbedded in the anterior portion of the integument, in front of the valves. But the actual existence of either silicious particles or acid secretion has been denied by others. Jeffreys believes that the foot is the organ by which the animal burrows. In the larger number of Lamellibranchs the foot is doubtless a burrowing organ, and it is difficult to see how the limpet hollows out the rock to which it is attached if not by means of the surface of its foot. At the same time it is difficult to explain how the soft muscular foot can penetrate into hard wood. The process is of course slow, and Jeffreys supposes that particles are detached one by one from the moistened surface to which the foot is applied. In any case the valves are covered by an epidermis, which could scarcely be there if they were used in burrowing.

Teredo grows and burrows at an extremely rapid rate: spawning takes place in the spring and summer, and before the end of the year the animals are adult and their burrows of large size. Quatrefages relates that at Guipuzcoa (N. Spain) a ferry-boat was sunk accidentally in the spring, and was raised four months afterwards, when its timbers were already rendered useless by *T. pedicellata*. How long the animals live is not accurately known, but Quatrefages found that they nearly all perished in the winter. This cannot be generally the case, as the size of the tubes varies so greatly. In Holland their greatest ravages are made in July and August. Iron ships have nothing to fear from their attacks, and the copper sheathing now almost universally used protects wooden hulls. A great deal of loss is, however, caused by *Teredo* in harbour works and shipping stages, and the embankments in Holland are continually injured by it. The most efficient protection is afforded by large-headed nails driven in in close proximity. Soaking wood in creosote is not a certain safeguard; Jeffreys found at Christiania in 1863 that a large number of harbour piles previously soaked in creosote had been completely destroyed by *T. navalis*. Coal tar and the silicate of lime used for coating stonework have been suggested as protective coverings, but they do not seem to have been adequately tested.

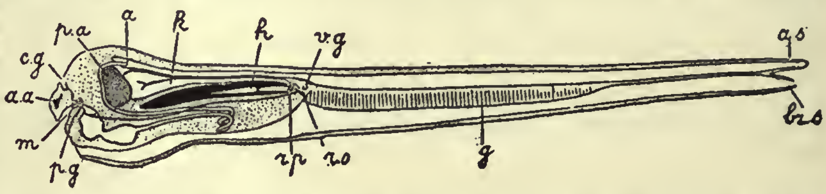


FIG. 1.—Sagittal median section of *Teredo*. *a.*, anus; *a.a.*, anterior adductor muscle; *a.s.*, anal siphon; *br.s.*, branchial siphon; *c.g.*, cerebral ganglion; *g.*, gill; *h.*, heart; *m.*, mouth; *p.a.*, posterior adductor; *p.g.*, pedal ganglion; *r.o.*, renal opening; *r.p.*, reno-pericardial orifice; *v.g.*, visceral ganglion. (Partly after Grobben and Beuck, from Lankester's *Treatise on Zoology*.)

Species of *Teredo* occur in all seas. The animal was known to the ancients and is mentioned by Theophrastus, Pliny and Ovid. In 1715 it is mentioned by Valisnieri, in 1720 by Deslandes. In 1733 great attention was drawn to it on account of the discovery that the wooden dikes of Holland were being rapidly destroyed by ship-worms, and that the country was in danger of inundation. Three treatises were published concerning the animal, by P. Massuet, J. Rousset and Godfrey Sellius. The work of the last-named, which was the best, described the anatomy of the creature and showed that its affinities were with bivalve molluscs. The truth of Sellius's view was not grasped by Linnaeus, who placed *Teredo* together with *Serpula* in the genus *Dentalium*; but its proper position was re-established by Cuvier and Lamarck. Adanson, unaware of the work of Sellius, in 1757 believed himself to be the first to discover the molluscan affinities of *Teredo*. It will not be necessary to give here a definition of the genus taken from any systematist; it will be sufficient to point out that the long cylindrical body with its two small anterior polygonal valves, the absence of a ligament and accessory valves, the muscular ring into which are inserted the calcareous pallets, and the continuous calcareous tube lining the hole bored by the animal are the diagnostic features.

Jeffreys, in his *British Conchology*, gives the following species as British: *Teredo norvegica*, Spengler; *T. navalis*, Linn.; *T. pedicellata*, Quatrefages; *T. megotara*, Hanley. *T. norvegica* occurs chiefly on the west coast of Great Britain. It was taken by Thompson at Portpatrick in Wigtownshire, and occurred in Jeffreys's time in abundance at Milford Haven. This species has been described by Gmelin and a number of British authors as *T. navalis*, Linn. It is distinguished by having the base of the pallets simple, not forked, and the tube semi-concamerated at its narrower posterior end. The length does not usually exceed a foot. It is the *T. navium* of Sellius. *T. navalis* has been identified from the figures of Sellius, to which Linnaeus referred; Sellius called it *T. marina*. It occurs on all the western and southern coasts of Europe, from Christiania to the Black Sea, and is the species which causes so much damage to the Dutch embankments. The pallets of this species are small and forked, and the stalk is cylindrical. The tube is simple and not chambered at its narrow end. *T. pedicellata* was originally discovered by Quatrefages in the Bay of Los Pasages on the north coast of Spain; it has also been found in the Channel Islands, at Toulon, in Provence and in Algeria. In *T. megotara* the tube is simple and the pallets like those of *T. norvegica;* it occurs at Shetland and Wick, and also on the western shore of the Atlantic, where its range extends from Massachusetts to South Carolina. *T. malleolus*, Turton, and *T. bipinnata*, Turton, belong to the West Indies, but are often drifted in floating timber to the coasts of Europe. Other occasional visitants to the British shores are *T. excavata, bipartita, spatha, fusticulus, cucullata*, and *fimbriata*. These were described by Gwyn Jeffreys in *Ann. and Mag. Nat. Hist.*, 1860. *T. fimbriata* is stated to be a native of Vancouver's Island. A kind of ship-worm, the *Nausitora dunlopei* of Perceval Wright, has been discovered in India, 70 m. from the sea, in a stream of perfectly fresh water, namely, the river Kumar, one of the branches of the Ganges. *T. corniformis*, Lam., is found burrowing in the husks of coco-nuts and other woody fruits floating in the tropical seas; its tubes are extremely crooked and contorted for want of space. Fossil wood and palm-fruits of Sheppey and Brabant are pierced in the same way.

Twenty-four fossil species have been recognized in the Lias and succeeding beds of Europe and the United States. The sub-genus *Teredina*, Lam., is a fossil of the Eocene of Great Britain and France.

Literature.—See, besides the works already mentioned, Godfrey Sellius, *Historia naturalis teredinis seu xylophagi marini* (1733); Adanson, *Histoire naturelle du Sénégal* (Paris, 1757); Quatrefages, *Annales des Sci. Nat.* (1848–50); Forbes and Hanley, *Brit. Mollusca* (1853); B. Hatschek, *Entwicklung v. Teredo: Arbeiten aus dem Zool. Inst. Wien* (1880); Deshayes, *Mollusques d'Algérie;* Sir E. Home, "Anatomy of *Teredo*," in *Phil. Trans.*, vol. xcvi.; Frey and Leuckart, *Beiträge zur Kenntniss wirbelloser Thiere* (1847); Woodward, *Manual of Mollusca* (London, 1851); Sigerfoos, "Note on the Organization of the Larva and the Post-larval Development of Shipworms," Johns Hopkins Univ. Circul., xv. 1896; Keer, *Bijdräge tot de kennis van den Paalworm* (Leiden, 1903).

(J. T. C.)

TEREK, a river of Russian Caucasia. It rises in the Caucasus, on the slopes of Mount Kasbek, in several head-streams, and flows north as far as Vladikavkaz, just above which it emerges from the mountains. Then it flows N.W. and N. as far as approximately 43° 45′ N., whereupon it swings round to the E. and pursues that direction as far as 46° 30′ E. Finally, after a comparatively short run towards the N.N.E., it branches out into a large delta on the west side of the Caspian Sea. This river, the ancient *Alutas*, is at first an impetuous mountain torrent, as are also all its chief tributaries—the Zunzha on the right, and the Ardon, Urukh, Cherek, Urvan, Chegem, Baksan and Malka on the left. All these streams, except the first-named, rise at altitudes of 8000 to 9000 ft. between Mount Kasbek and Mount Elbruz. In its lower course the Terek becomes very sinuous and sluggish, and frequently overflows its banks with disastrous results. Opposite its mouth it forms large sand-banks in the Caspian, and is nowhere navigable. Its length is 300 m., and the area of its drainage basin extends to 22,800 sq. m.

TEREK, a province of Russian Caucasia, situated N. of the Caucasus chain. It is bounded by the government of Stavropol on the N., by the Caspian Sea and Daghestan on the E., by Tiflis and Kutais on the S., and by the Black Sea district and the province of Kuban on the W., and has an area of 23,531 sq. m. From Mount Elbruz to Kasbek the southern boundary coincides with the main range of the Caucasus, and thus includes some of its highest peaks; further east it follows a sinuous line so as to enclose the secondary chains and their ramifications. Nearly one-third of the area is occupied by hilly tracts, the remainder being undulating and flat land belonging to the depression of the Terek; one-half of this last, on the left bank of the river, is occupied by sandy deserts, salt clay steppes, and arid stretches unsuited for cultivation. The Caucasus Mountains are described under that heading. Tertiary formations, overlain by Quaternary deposits, cover a wide area in the prairies and steppes. Mineral springs occur near Pyatigorsk.

The climate is continental. The mean annual temperatures are 49·6° Fahr. at Pyatigorsk (1680 ft. above the sea; January 39°, July 70°) and 47·7° at Vladikavkaz (2345 ft.; January 23°, July 69°), but frosts a few degrees below zero are not uncommon. The mountain slopes receive an abundance of rain (37 in.), but the steppes suffer much from drought (rainfall between 10 and 20 in.). Nearly the whole of the government belongs to the drainage area of the river Terek, but the north-west corner is drained by the upper tributaries of the Kuma. In the lower part of its course the Terek flows at a higher level than that of the neighbouring plains, and is kept in its bed by embankments. Nevertheless inundations are frequent and cause great destruction.

The estimated population in 1906 was 1,044,800. The province is divided into seven districts, the chief towns of which are Vladikavkaz, Groznyi, Kizlyar, Nalchik, Pyatigorsk, Sunzhinsk and Khasavyurt, the last two being nomad centres of administration. Agriculture has developed greatly on the prairies, the area under crops being 9 per cent. of the total. Rye, wheat, oats, barley and potatoes are the principal crops. The vine is very extensively cultivated, especially in the districts of Kizlyar and Pyatigorsk, where 1,500,000 gallons of wine are made annually. Live-stock breeding is widely engaged in, and fishing is an important source of income, especially at the mouth of the Terek. Bees are generally kept, and yield every year nearly half a million sterling worth of honey and wax. Melons, cucumbers and sunflowers are extensively grown. The railway, which formerly stopped at Vladikavkaz, has been continued from the Beslan station, near Vladikavkaz, to Petrovsk on the Caspian Sea, and thence to Baku.

TERENCE. Our knowledge of the life of the celebrated Latin playwright, Publius Terentius Afer, is derived chiefly from a fragment of the lost work of Suetonius, *De viris illustribus*, preserved in the commentary of Donatus, who adds a few words of his own. The prologues to the comedies were among the original sources of Suetonius; but he quotes or refers to the works of various grammarians and antiquaries—Porcius Licinus, Volcacius Sedigitus, Q. Cosconius, Nepos, Santra, Fenestella. There is uncertainty as to both the date of the poet's birth and the manner of his death. His last play was exhibited in 160 B.C., and shortly after its production he went abroad, "when he had not yet completed his twenty-fifth year." Cornelius Nepos is quoted for the statement that he was about the same age as Scipio Africanus the younger (born in 185 or 184 B.C.) and Laelius; while Fenestella, an antiquary of the later Augustan period, represented him as older than either. If Terence was born in 185, he published his six plays between the ages of eighteen and twenty-five. Even in an imitative artist such precocity of talent is remarkable, and the date is therefore open to legitimate doubt.

He is said to have been born in Carthage, and brought to Rome as a slave. At Rome he was educated like a free man in the house of Terentius Lucanus, a senator, by whom he was soon emancipated; whereupon he took his master's *nomen* Terentius, and thenceforward his name was Publius Terentius Afer, of which the last member seems to imply that he was not a Phoenician (*Poenus*) by blood. He was admitted into the intimacy of young men of the best families, such as Scipio, Laelius and Furius Philus; and he enjoyed the favour of older men of literary distinction and official position. In the circle of Scipio he doubtless met the historian Polybius, who was brought to Italy in 167. He is said to have owed the favour of the great as much to his personal gifts and graces as to his literary eminence; and in one of his prologues he declares it to be his ambition, while not offending the many, to please the "boni."

Terence's earliest play was the *Andria*, exhibited in 166 B.C. A pretty, but perhaps apocryphal, story is told of his having read the play, before its exhibition, to Caecilius (who, after the death of Plautus, ranked as the foremost comic poet), and of the generous admiration of it manifested by Caecilius. A similar instance of the recognition of rising genius by a poet whose own day was past is found in the account given of the visit of Accius to the veteran Pacuvius. The next play was the *Hecyra*, first produced in 165, but withdrawn in consequence of its bad reception, and reproduced in 160. The *Heauton Timorumenos* appeared in 163, the *Eunuchus* in 161, the *Phormio* in 161, and the *Adelphoe* in 160 at the funeral games of L. Aemilius Paullus. Of these six plays the *Phormio* and probably the *Hecyra* were drawn from Apollodorus, the rest from Menander. After bringing out these plays Terence sailed from Greek parts, either to escape from the suspicion of publishing the works of others as his own, or from the desire to obtain a more intimate knowledge of that Greek life which had hitherto been known to him only in literature and which it was his professed aim to reproduce in his comedies. The latter is the more probable motive, and we recognize in this the first instance of that impulse to visit the scenes familiar to them through literature which afterwards acted on many of the great writers of Rome. From this voyage Terence never returned. According to one account he was lost at sea, according to another he died at Stymphalus in Arcadia, and according to a third at Leucas, from grief at the loss by shipwreck of his baggage, containing a number of new plays which he had translated from Menander. An old poet quoted by Suetonius states that he was ruined in fortune through his intimacy with his noble friends. Another account speaks of him as having left behind him gardens, to the extent of about twelve acres, close to the Appian Way. It is further stated that his daughter married a Roman knight.

No writer in any literature, who has contented himself with so limited a function, has gained so great a reputation as Terence. He lays no claim to the position of an original artist painting from life or commenting on the results of his own observation. His art has no relation to his own time or to the country in which he lived. The chief source of interest in the fragmentary remains of Naevius, Ennius, Pacuvius, Accius and Lucilius is their relation to the national and moral spirit of the age in which they were written. Plautus, though, like Terence, he takes the first sketch of his plots, scenes and characters, from the Attic stage, is yet a true representative of his time, a genuine Italian, writing before the genius of Italy had learned the restraints of Greek art. The whole aim of Terence was to present a faithful copy of the life, manners, modes of thought and expression which had been drawn from reality a century before his time by the writers of the New Comedy of Athens. The nearest parallel to his literary position may be found in the aim which Virgil puts before himself in his *Bucolics.* He does not seek in that poem to draw Italian peasants from the life, but to bring back the shepherds of Theocritus on Italian scenes. Yet the result obtained by Virgil is different. The charm of his pastorals is the Italian sentiment which pervades them. His shepherds are not the shepherds of Theocritus, nor are they in any sense true to life. The extraordinary result obtained by Terence is that, while he has left no trace in any of his comedies of one sketching from the life by which he was surrounded, there is perhaps no more truthful, natural and delicate delineator of human nature, in its ordinary and more level moods, within the whole range of classical literature. His permanent position in literature is due, no doubt, to the art and genius of Menander, whose creations he has perpetuated, as a fine engraver may perpetuate the spirit of a great painter whose works have perished. But no mere copyist or verbal translator could have attained that result. Though without claims to creative originality, Terence must have had not only critical genius, to enable him fully to appreciate and identify himself with his originals, but artistic genius of a high and pure type. The importance of his position in Roman literature consists in this, that he was the first writer who set before himself a high ideal of artistic perfection, and was the first to realize that perfection in style, form, and consistency of conception and execution. Living in the interval between Ennius and Lucilius, whose original force and genius survive only in rude and inartistic fragments, he produced six plays, which have not only reached our time in the form in which they were given to the world, but have been read in the most critical and exacting literary epochs, and still may be read without any feeling of the need of making allowance for the rudeness of a new and undeveloped art.

While his great gift to Roman literature is that he first made it artistic, that he imparted to "rude Latium" the sense of elegance, consistency and moderation, his gift to the world is that through him it possesses a living image of the Greek society in the 3rd century B.C., presented in the purest Latin idiom. Yet Terence had no affinity by birth either with the Greek race or with the people of Latium. He was more distinctly a foreigner than any of the great classical writers of Rome. He lived at the meeting-point of three distinct civilizations—the mature, or rather decaying, civilization of Greece, of which Athens was still the centre; that of Carthage, which was so soon to pass away and leave scarcely any vestige of itself; and the nascent civilization of Italy, in which all other modes were soon to be absorbed. Terence was by birth an African, and was thus perhaps a fitter medium of connexion between the genius of Greece and that of Italy than if he had been a pure Greek or a pure Italian; just as in modern times the Jewish type of genius is sometimes found more detached from national peculiarities, and thus more capable of reproducing a cosmopolitan type of character than the genius of men belonging to other races.

The prologues to Terence's plays are of high interest. Their tone is for the most part apologetic, and indicates a great sensitiveness to criticism. He constantly speaks of the malevolence and detraction of an older poet, whose name is said to have been Luscius Lavinius or Lanuvinus. The chief charge which his detractor brings against him is that of *contaminatio*, the combining in one play of scenes out of different Greek plays. Terence justifies this practice by that of the older poets, Naevius, Plautus, Ennius, whose careless freedom he follows in preference to the "obscura diligentia" of his detractor. He recriminates upon his adversary as one who, by his close adherence to his original, had turned good Greek plays into bad Latin ones. He clears himself of the charge of plagiarizing from Plautus and Naevius. In another prologue he contrasts his own treatment of his subjects with the sensational extravagance of others. He meets the charge of receiving assistance in the composition of his plays by claiming as a great honour the favour which he enjoyed with those who were the favourites of the Roman people. But the gossip, not discouraged by Terence, lived and throve; it crops up in Cicero and Quintilian, and the ascription of the plays to Scipio had the honour to be accepted by Montaigne and rejected by Diderot.

We learn from these prologues that the best Roman literature was ceasing to be popular, and had come to rely on the patronage of the great. A consequence of this change of circumstances was that comedy was no longer national in character and sentiment, but had become imitative and artistic. The life which Terence represents is that of the well-to-do citizen class whose interests are commonplace, but whose modes of thought and speech are refined, humane and intelligent. His characters are finely delineated and discriminated rather than, like those of Plautus, boldly conceived. Delicate irony and pointed epigram take the place of broad humour. Love, in the form of pathetic sentiment rather than of irregular passion, is the chief motive of his pieces. His great characteristics are humanity and urbanity, and to this may be attributed the attraction which he had for the two chief representatives of these qualities in Roman literature—Cicero and Horace.

Terence's pre-eminence in art was recognized in the Augustan age; and Horace expresses this opinion, though not as his own, in these words (Epistles II. i. 59):—

"Vincere Caecilius gravitate, Terentius arte."

The art of his comedies consists in the clearness and simplicity with which the situation is presented and developed, and in the consistency and moderation with which his various characters play their parts. But his greatest attraction to both ancient and modern writers has been the purity and charm of his style. He makes no claim to the creative exuberance of Plautus, but he is entirely free from his extravagance and mannerisms. The superiority of his style over that of Lucilius, who wrote his satires a generation later, is immeasurable. The best judges and the greatest masters of style in the best period of Roman literature were his chief admirers in ancient times. Cicero frequently reproduces his expressions, applies passages in his plays to his own circumstances, and refers to his personages as typical representations of character.[1] Julius Caesar's lines on Terence, the "dimidiatus Menander," while they complain of lack of comic power, characterize him as "puri sermonis amator." Horace, so depreciatory in general of the older literature, shows his appreciation of Terence by the frequent reproduction in his *Satires* and *Odes* of his language and his philosophy of life. Quintilian applies to his writings the word *elegantissima*. His works were studied and learned by heart by the great Latin writers of the Renaissance, such as Erasmus and Melanchthon; and Casaubon, in his anxiety that his son should write a pure Latin style, inculcates on him the constant study of Terence. Montaigne[2] applies to him the phrase of Horace: "Liquidus puroque simillimus amni." He speaks of "his fine expression, elegancy and quaintness," and adds, "he does so possess the soul with his graces that we forget those of his fable." Sainte-Beuve devotes to him two papers of delicate and admiring criticism. He quotes Fénelon and Addison, "deux esprits polis et doux, de la même famille littéraire," as expressing their admiration for the inimitable beauty and naturalness of one of his scenes. Fénelon is said to have preferred him even to Molière. Sainte-Beuve calls Terence the bond of union between Roman urbanity and the Atticism of the Greeks, and adds that it was in the 17th century, when French literature was most truly Attic, that he was most appreciated. M. Joubert[3] applies to him the words, "Le miel attique est sur ses lèvres; on croirait aisément qu'il naquit sur le mont Hymette."

The chief manuscript of Terence is the famous *Codex Bembinus*, of the 4th or 5th century, in the Vatican. Another Vatican MS. of the 10th century contains illustrations based on an old tradition. Each play has an argument in metre by Sulpicius Apollinaris (2nd century of our era). We have also a valuable commentary (newly edited by P. Wessner) on five of the plays, derived chiefly from Euanthius and Donatus (both of the 4th century), and another of less importance by one Eugraphius.

The *editio princeps* was published at Strassburg in 1470. The most famous edition is that of Bentley, published at Cambridge in 1726. At present the best texts are those by K. Dziatzko (Leipzig, 1884), and A. Fleckeisen (Teubner, 2nd ed., 1898). Each of the plays has recently been edited with English notes.

For a conspectus of Terentian studies see Teuffel-Schwabe-Warr, *History of Roman Literature*, and Schanz's *Geschichte der römischen Litteratur* (3rd ed., 1907). Among critical estimates of Terence may be mentioned Sainte-Beuve's in *Nouveaux lundis* (3rd and 10th of August 1863), and Mommsen's in the *History of Rome*, book iv., chapter xiii.

Molière made large use of the *Phormio* in *Les Fourberies de scapin*, and the subject of *l'École des maris* is taken from the *Adelphoe*. Terence was translated into English verse by George Colman (1765). (W. Y. S.; E. H.*)

TERENTIANUS, surnamed MAURUS (a native of Mauretania), Latin grammarian and writer on prosody, flourished probably at the end of the 2nd century A.D. His references to Septimius Serenus and Alfius Avitus, who belonged to the school of "new poets" (*poetae neoterici* or *novelli*) of the reign of Hadrian and later, seem to show that he was a near contemporary of those writers. He was the author of a treatise (incomplete) in four books (written chiefly in hexameters), on letters, syllables, feet and metres, of which considerable use was made by later writers on similar subjects. The most important part of it is that which deals with metres, based on the work of Caesius Bassus, the friend of Persius. By some authorities Terentianus has been identified with the prefect of Syene mentioned in Martial (i. 86), which would make his date about a century earlier; others, again, who placed Petronius at the end of the 3rd century (a date no longer held), assigned Terentianus to the same period, from his frequent references to that author.

Best edition, by H. Keil, *Grammatici Latini*, vi.; with commentary by L. Santen (1825); see also Teuffel-Schwabe, *Hist. of Roman Literature* (Eng. tr.), 373*a*.

TERGESTE (mod. *Trieste*, *q.v.*), an ancient city of Istria, 26 m. by road E.S.E. of Aquileia, at the northern extremity of the peninsula of Istria, in a bay at the head of the Adriatic Sea. Its importance was in ancient days, as now, mainly due to its commerce as the outlet of Pannonia and Dalmatia. It is first mentioned about 100 B.C. as a village. In 52 B.C. it was attacked by barbarian tribes from the interior. In 33 B.C. Augustus during his Dalmatian wars built a wall and towers there, as an inscription records; in a medieval copy of it the emperor Frederick III. mentions his own restoration of the city walls for the fourth time in 1470. At this time it probably became a colony, as it certainly was in Pliny's days. It appears to have had an extensive territory assigned to it. The loftily situated cathedral of S. Giusto occupies the site of a Roman temple, some of the walls and columns of which may be seen in the tower Into the façade are built fragments of sepulchral reliefs. The church itself has a curious plan which is due to its having been formed out of two distinct churches standing side by side, which were united in the 14th century. Each of these is a basilica with ancient columns and mosaics in the apse. The southern church, S. Giusto, has a central dome. The so-called Arco di Riccardo is a half-buried Roman arch with Corinthian pilasters, possibly a triumphal arch, possibly connected with an aqueduct.

The museum contains inscriptions, mosaic pavements, &c., from the ancient town, of which no remains beyond those mentioned now exist above ground.

See Th. Mommsen in *Corp. inscr. Latin.* V. (1883), p. 53 sqq.; T. G. Jackson, *Dalmatia, Istria and the Quarnero* (Oxford, 1887), III., 343; G. Caprini, *Trieste* (Bergamo, 1906). (T. As.)

TERLIZZI, a town in Apulia, Italy, in the province of Bari, and 18 m. by steam tramway W. from that town, situated in the midst of a fertile plain, 627 ft. above sea-level. Pop. (1901) 23,394. It has a castle which at one time was very strong, and occasionally resorted to by the Emperor Frederick II. and afterwards by the Aragonese sovereigns. The walls and towers of the town remain, but the fosse has been turned into boulevards. Terlizzi has some trade in the wine and fruit of the district. Near it, in an ancient tomb, was found in 1745 a fine inkstand inlaid in silver.

TERM, an English word which has various meanings, all arising from its etymology (Lat. *terminus*), and the idea of limiting or defining.

A *term of years*, in English law, is the time during which an interest in an estate for life or for years is enjoyed, also the interest itself, because such an interest must determine at a definite time. If the interest be for life, it is an estate of freehold; if for years, only a personal interest in real estate, and so personalty, even though the length of the term—for instance, 1000 years—may far exceed in duration any possible life estate. A term of years is of two kinds—the first that created by an ordinary lease reserving a rent, as of a house or a building lease; the second that created by a settlement or a will, usually without rent reserved, for the purpose of securing payment of money, such as portions to younger children, by the owner of the land. Both kinds have been considerably affected by the Conveyancing Acts of 1881 and 1882, which enable a mortgagor or mortgagee in possession to make certain leases. Before 1845 provision was always made in conveyances for keeping on foot a term to attend the inheritance, as it was called—that is, for assigning the remainder of a term to trustees for the protection of the owner of the property against rent-charges or other incumbrances created subsequently to the term,

[1] See *Ep. ad Fam.* I. ix. 15, *Pro Caecina* 27, *Philippic II.* 15.
[2] *Essays* (trans. by C. Cotton), chap. lxvii.
[3] Quoted by E. Negrette in his *Histoire de la littérature latine*.

although the term had been satisfied—that is, the purpose for which the term has been created had been fulfilled. By the Assignment of Satisfied Terms Act 1845 the assignment of satisfied terms was rendered unnecessary. The Conveyancing Acts 1881 and 1882 give power to enlarge the unexpired residue of a long term in certain cases into the fee simple.

Terms, in the sense of a limited and certain period of time during which the law courts are open, used to affect only what were called in England the superior courts—that is, the king's bench, common pleas and exchequer. They were originally the leisure seasons of the year which were not occupied by great feasts or fasts of the Church or by agriculture. Their origin is no doubt to be traced back to the legislation of the early Christian emperors, the principle being adopted in England through the influence of ecclesiastical judges. Terms were regulated by many acts of parliament, the effect of which was to confine to a comparatively short period the time during which the courts could sit *in banco*—that is, for the decision of questions of law as distinguished from the decision of questions of fact. There were four terms, Hilary, Easter, Trinity and Michaelmas, the average duration of each being about three weeks. All legislation on the subject previous to 1873 is now merely of historical interest, for by the Judicature Act of that year terms were abolished so far as related to the administration of justice and sittings substituted. The previous subdivisions of the legal year were, however, retained, the dates of commencement and termination being somewhat changed. The Michaelmas sittings of the high court and court of appeal are now held from the 24th of October to the 21st of December, the Hilary sittings from the 11th of January to the Wednesday before Easter, the Easter sittings from the Tuesday after Easter week to the Friday before Whitsunday, and the Trinity sittings from the Tuesday after Whitsun week to the 12th of August, all dates inclusive. The old terms, with their duration as fixed by statute, are now kept alive only for the purpose of reference in all cases in which they are used as a measure of time. In the United States the terms or sittings of the courts are not limited to any fixed period of time, but vary according to the judges available and the amount of judicial business which is likely to come before the courts. The dining-terms at the Inns of Court also correspond in point of time with the old terms and not with the sittings.

In universities and schools the word *term* is used for the period during which instruction is given to the students or pupils. University and school terms differ from law terms and from each other both in period and duration. At the university of Cambridge the academic year is divided into three terms, Michaelmas, Lent and Easter; while at the university of Oxford there are four terms in the year, Michaelmas, Hilary, Easter and Trinity. School years now generally consist of three terms, divided by Christmas, Easter and Summer holidays, the old half-years having gradually been abolished. In higher educational institutions in the United States the university or college year is generally divided into three terms called either the Fall, Winter and Spring terms, or much less frequently the first, second and third terms. In some institutions, however, the so-called semester system has been adopted, the year being divided into two terms, so far as instruction is concerned, though even in these cases vacations at Christmas time and in the early spring divide the year into three parts, which are sometimes, though not in the usual or proper sense, called terms.

In Scotland terms are the days at which rent or interest is payable. They are either legal or conventional: the legal are Whitsunday and Martinmas; the conventional are fixed by agreement between the parties. Terms as times of court sittings were defined by 6 Anne c. 53, which fixed four terms—Martinmas, Candlemas, Whitsuntide and Lammas—for the now obsolete court of exchequer, to which the winter and summer sittings of the court of session now correspond.

TERMINAL FIGURES, also called "termini" or "terms," in architecture, figures of which the upper parts only, or perhaps the head and shoulders alone, are carved, the rest running into a parallelopiped, and sometimes into a diminishing pedestal, with feet indicated below, or even without them (see HERMAE).

TERMINATOR (from the Latin *terminare*, to limit), in astronomy, the bounding line beween light and darkness on the apparent disk of the moon or of a planet.

TERMINI IMERESE (anc. *Thermae Himeraeae*), a seaport town of Sicily, in the province of Palermo, 23 m. E.S.E. of it by rail. Pop. (1901) 20,633. It is finely situated on a promontory above its harbour, and it is possible that it was occupied by an early Phoenician settlement; as a town, however, it was not founded until 407 B.C. by the Carthaginians, after their destruction of Himera, in the vicinity of hot springs mentioned by Pindar (*Od.* xii. 19) which are still resorted to and are well fitted up (temp. 110° F.). It remained a Carthaginian colony, though thoroughly Greek[1] in character, until it was taken by Rome in the First Punic war. In the time of Cicero it was flourishing, though not of great importance. Augustus sent a Roman colony to it, and a Roman road ran from it to Catana. Its medieval castle was destroyed in 1860. The modern town presents no features of interest; there is a collection of antiquities and pictures, with a considerable number of Roman inscriptions. Scanty remains of buildings of Roman times (an amphitheatre and a so-called basilica) exist in the upper part of the town; and outside it on the S. are considerable remains of two aqueducts of the same period crossing a deep ravine. The surrounding district is fertile.

Four m. E. of Termini, about 1 m. W. of the railway station of Cerda, on an E. spur of the Monte S. Calogera, called Monte Castellaccio, is a Cyclopean wall, about 66 ft. long, 10 ft. thick, and 30 ft. high in the middle, blocking the only access to the summit of the spur, on the N.E. Fortifications in this style are very rare in Sicily.

See B. Romano, *Antichità Termitane* (Palermo, 1838); Mauceri, *Acropoli Pelasgica nei dintorni di Termini Imerese* (Palermo, 1896).
(T. As.)

TERMINUS, in Roman mythology, the god of boundaries, the protector of the limits both of private property and of the public territory of Rome. He was represented by a stone or post, set up in the ground with the following religious ceremonies. A trench was dug, in which a fire was lighted; a victim was sacrificed, and its blood poured into the trench; the body, upon which incense and fruits, honey and wine were thrown, was then cast into the fire. When it was entirely consumed, the boundary stone, which had been previously anointed and crowned with garlands, was placed upon the hot ashes and fixed in the ground. Any one who removed a boundary stone was accursed (*sacer*) and might be slain with impunity; a fine was afterwards substituted for the death penalty. On the 23rd of February (the end of the old Roman year) the festival called Terminalia, according to Wissowa a festival not of the god but of the boundary stones (*termini*), was held. The owners of adjacent lands assembled at the common boundary stone, and crowned their own side of the stone with garlands; an altar was set up and offerings of cakes, corn, honey and wine were made (later, a lamb or a sucking pig was sacrificed). The proceedings closed with songs to the god and a general merry-making, in which all the members of the family and the servants took part. A similar festival was also held at the old boundary of the Roman territory between the fifth and sixth milestones on the road to Laurentum. The custom of fixing the boundaries of property and the institution of the yearly festival were both ascribed to Numa. Another Sabine prince, Titus Tatius, had dedicated a stone to Terminus on the Capitoline hill. When Tarquinius Superbus desired to build a temple to Jupiter, the auguries forbade its removal, and it was enclosed within the walls of the new sanctuary, an indication of the immovability of such stones and of the permanence of the Roman territory. Terminus was probably in its origin only an epithet of Jupiter. The fact of the inclusion of his statue in the temple of Jupiter Capitolinus; the hole cut in the temple roof so that he might be worshipped in the open air as being, like Jupiter, a god of

[1] Agathocles was a native of Thermae.

the sky; and the later assumption of a Jupiter Terminus or Terminalis (cf. the Greek Ζεὺς ὅριος) support this view.

See Dion. Halic. ii. 74; Plutarch, *Numa*, 16, *Quaest. Rom.*, 15; Livy i. 55; Horace, *Epodes*, ii. 59; Ovid, *Fasti*, ii. 637, 677; Siculus Flaccus in *Gromatici veteres*, ed. Lachmann (1848); G. Wissowa, *Religion und Kultus der Römer* (1902); W. W. Fowler, *The Roman Festivals* (1899); G. Jourde, *Le Culte du dieu Terme* (Paris, 1886).

TERMITE, the name applied to a group of insects with four wings which are developed outside the body (a large proportion of the individuals become adult, however, without wings appearing at all). The wings are of nearly one size, of long, narrow form, of paper-like consistence, and in repose are placed flat on the back of the insect so that only one wing shows. After a short time the wings are shed, and only small stumps remain as evidence of the individual being a winged form. The mouth has strong mandibles. Formerly termites were classed as a part of the order Neuroptera, but more recently they have been separated by certain zoologists from the true Neuroptera, and associated with some other forms as an order Corrodentia. By Packard they have been associated with Mallophaga, and called Platyptera. They now constitute with the Embiidæ—a small and obscure family—the order Isoptera, of which about 300 species are known. Termites are more widely known as white ants, but as they are extremely different from true ants, and as they are rarely white, this designation is very deceptive, and should be abandoned.

Termites are found only in warm climates, where they are sometimes very destructive. They are vegetarian, but occasionally eat, or destroy, dry animal matter. The basis of their alimentary regimen is woody matter. Some of them make use of fungi growing in their abodes as food; some cut and store grass; others prepare a peculiar kind of food, which is stored in a tough, dry form, so that it has to be moistened before it can be eaten. Termites are social insects; many of them construct large edifices called termitaria and often spoken of as nests. A termitarium frequently contains an enormous number of individuals forming the society or colony. Termites are totally different in structure and development from all other social insects, but their social existence exhibits numerous analogies with that of the ants and other social Hymenoptera. The most remarkable of these analogies is that the reproduction of the species in each community is confined to a single pair, or to a very limited number of individuals. The members of one society or colony, however numerous or dissimilar they may be, are the descendants of a single pair. The colony is—so far as is known, and on this, as well as on many other points, authentic information is scanty—first started by a pair of winged individuals that cast their wings, secrete themselves in a suitable place, and produce young; the colony, however huge, being subsequently developed by the extreme fertility of the reproductive pair. Very little is known as to how long a colony endures, and, as there is great variety in the social conditions of different kinds of termites, it is probable that there is considerable difference as to the point in question. As a rule a family or colony has only a single termitarium, but there are cases in which a single family has several separate abodes, though usually only one of them is a real home containing reproductive individuals. The social life in termites, as well as in all other social insects, is clearly a development of the family life. It is accompanied by extraordinary modifications of the forms of the individuals constituting the society, and by a great division of labour. As regards the forms, or castes, termites differ totally from other social insects; in the latter case there are great differences between the males and females, and the whole of the castes are of the female sex, whereas in termites the males and females are extremely similar, and the castes are in no way correlative with sex. As the termite life is a family life, and as there is normally only a single pair of reproductive individuals in each community, it is easily comprehensible that if anything goes wrong with this pair, the community is at once thrown into a state of complete disorganization. But this misfortune is mitigated by a method which termites have of keeping individuals in an undifferentiated state, and of turning some of them speedily into reproductive individuals, whereby the community is restored to something like a natural condition of activity and growth.

Apart from the forms that are merely juvenile, the following kinds of adults are normally present in a colony: (1) workers, (2) soldiers, (3) winged individuals ready to leave the nest, (4) king and queen.

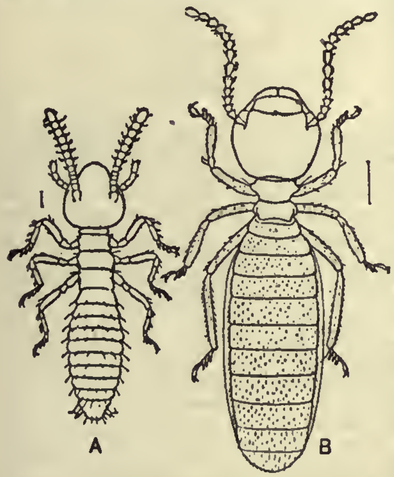


Fig. 1.—A, newly hatched termite; B, worker termite; *Termes nemorosus*.

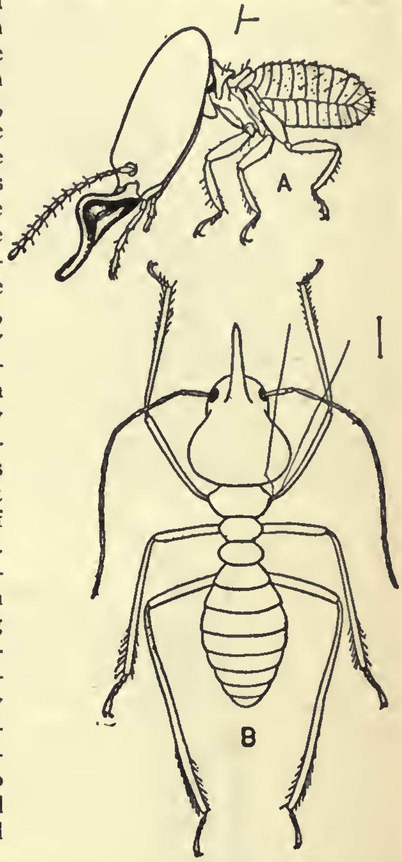


Fig. 2.—A, mandibulate soldier of *Termes nemorosus*; B, nasute soldier of *T. hospitalis*.

(1) The *worker* termite resembles the young in general appearance, and, like the young, has no trace of wings (fig. 1). The two segments behind the head are more contracted, so that head, thorax and abdomen are more differentiated than they are in the young. The colour too is different, the young being milky-white, whereas the adult worker is variously pigmented according to its species, but is never milky-white. The worker is generally blind, and in only a few species does it possess rudimentary eyes. The species of the group *Calotermitides* have no workers. In the other species the workers look after the eggs and young, and perform most, if not all, of the industrial work of the community. They are also, in some cases, effective combatants, though quite destitute of any special structures to suit them for this purpose. The sexual organs do not undergo development, but it has been satisfactorily ascertained that both sexes are represented amongst the workers. In certain species the workers seem to be dimorphic, so far as size is concerned, but this point has apparently been only very inadequately considered. Workers form a very large but variable proportion of the members of a community.

(2) The *soldier* termite is the most extraordinary feature of termite biology It is more varied than any of the other castes, so that most of the species of termites can be best distinguished by their soldiers. The chief feature of the soldier is an extraordinary development of the head, or of the head and mandibles. There are two very distinct kinds of soldiers: (*a*) the flat-headed or mandibulate soldier, and (*b*) the nasute or rostrate soldier (fig. 2). In the first kind the head is usually developed out of all proportion to the rest of the body; the mandibles are frequently enormous, and, being in many cases asymmetric, give the appearance of deformity. In the nasute soldier the head is thick or convex, and may be described as unicorn—that is to say, it is prolonged in the middle so as to form a single pointed horn; the mandibles are never largely developed. No species of termite has both mandibulate and nasute soldiers, although the reverse is sometimes still

stated in books. The soldiers of some species are, however, dimorphic to the extent that larger and smaller forms occur in the same nest without intermediates. In other cases soldiers of simply variable size exist. The soldier is blind and wingless, though in a few soldiers minute wing-rudiments can be detected. As in the worker, the development of the sex organs is arrested, but both sexes are represented. The function of the soldiers is probably, as stated by Haviland, defence. The mandibulate soldiers use their heads as blocks to stop gaps in the nests, and employ terrifying but somewhat theatrical devices, making threatening motions and producing noises by movements of the head and thorax. The nasute soldiers emit a fluid from the tip of the rostrum, and dab it upon their enemies with some skill. Soldiers are present in all species of termites except the South American genus *Anoplotermes*. It is a remarkable fact that in the group *Calotermitides* soldiers exist although there are no workers, but in this case the function of the soldier seems to be very much that of a worker. Grassi says that in *Calotermes flavicollis* all the individuals of a community work for the common welfare. Moreover, in the *Calotermitides* no very great development of the heads or mandibles occurs.

(3) *Adult or Winged Termite.*—Such of the young as do not become workers or soldiers grow and develop after the fashion usual in exopterygote insects. Moults take place, the wing-pads gradually increase in size, eyes appear, and finally pigmentation takes place, and the winged insect is perfected at the last moult (fig. 3). In prosperous colonies these winged insects are produced in large numbers and emerge at intervals as swarms. They have extremely feeble powers of flight, and apparently scarcely any other capability. They are a favourite food of a large number of animals, including even man. They have well-developed eyes and ocelli, and differ from all the other forms by their greater pigmentation. The function of these adults is to diffuse the species, and to favour crossing outside the family circle. Attainment of this second end is, in some cases, favoured by the fact that the whole of the individuals constituting a swarm consist of one sex only. This extraordinary fact is attested by Grassi, but has not yet received the attention it merits. If a termite colony be compared with a tree or plant, the winged forms, it is clear, functionally correspond to the flowers and seeds of the tree; indeed, Fritz Müller and Grassi go further, and conclude that the modes of diffusion and reproduction of termites are analogous to the modes of plants of continuing the species by means of cleistogamic as well as ordinary flowers. The force of this comparison will be better appreciated after the reader has made himself acquainted with the facts connected with the neoteinic forms of termites.

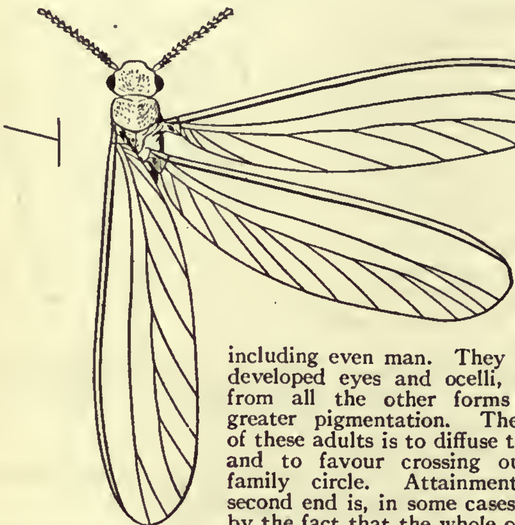


FIG. 3.—Adult Winged Termite: *T. nemorosus;* wings of the right-hand side expanded.

(4) *King and Queen.*—As a rule each community includes only a single pair of individuals apt for reproduction; these are the royal pair, or king and queen (fig. 4). They are adult termites that have shed the wings they formerly possessed. The queen usually undergoes an extraordinary increase in the size of the abdomen, which may be distended to many hundred times its original capacity (fig. 4, A). In many species the king and queen are confined in a royal cell, out of which they cannot move, though the workers, owing to their smaller size, can get in and out to tend them. In other cases the queen only is so imprisoned, the king being able to leave the cell. In still other cases neither king nor queen is effectually imprisoned. Much discrepancy of opinion exists as to the invariable presence of a king in each nest; this, however, is explained by Haviland's observation that the king is active and timid, and when a nest is opened seeks safety by running away and concealing himself, so that he is sometimes only discovered when the very last fragment of the nest is brought under scrutiny. Another point on which extremely diverse opinions are expressed is the copula of the sexes. It is usually stated that the swarming of termites is analogous to that of bees and ants, in which groups of insects the conjunction of the sexes takes place at this period, and at this period only. In the termites the reverse is the case. The swarming is not at all a nuptial flight; indeed, at that time the sexes are not apt for reproduction. Copulation only takes place after a pair have cast their wings and have established themselves together. It is repeated at intervals, and is thus quite dissimilar from the corresponding phenomenon in Hymenoptera. The male has no intromittent organs, so that copula during flight is impossible. Grassi has actually witnessed the act in subsequent life. Haviland is of opinion that in some cases the male fertilizes the eggs without connexion with the female.

(5) *Neoteinic and Substitution Forms.*—When a colony of termites is deprived of king and queen it can replace them by forms specially prepared. These substitution forms are of two kinds—(*a*) normal adult individuals, and (*b*) neoteinic forms. The latter may be described as unnatural kings and queens possessing reproductive powers, though the wings have never been developed and some other parts of the body have not taken on the fully adult state. Haviland removed the royal pairs from nests of *Termes malayanus*, and after three or four months again examined the nests: in three out of the five cases substitution pairs exactly resembling the original ones, with well-formed wing-stumps, were present; in the other two cases he failed to find the royal cell, and believes that the loss had not been repaired. In other species the bereavement is made good by means of neoteinic instead of normal individuals, and in certain species neoteinic forms are abundantly found. In the case of substitution forms there is usually more than one pair present in a colony, and sometimes numerous pairs exist. Grassi says that in Sicily the colonies of *Termes lucifugus* are kept up entirely by neoteinic kings and queens; in other words, the swarms are nearly or quite useless. The neoteinic forms are compared to cleistogamous flowers; and this curious case is parallel with that of a species of plant whose reproduction should be accomplished entirely by its cleistogamous flowers, though at the same time it produced perfect flowers in abundance. The condition recorded by Grassi is probably extremely exceptional. Fritz Müller found once a colony in which a true king was acting as consort to a considerable number of neoteinic queens, no true queen being present.

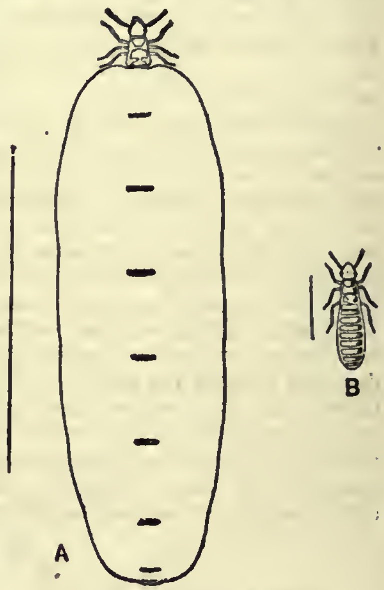


FIG. 4.—A, queen; B, king: *T. nemorosus.*

In order to understand the curious phenomena presented by the castes and variety of forms of a single species of termite, it is necessary to become acquainted with their food habits, which are very peculiar and may be described as communistic. Termites have the habit of eating their cast skins and even their dead companions, and in fact their system of keeping the nest clean seems to be that of eating the refuse of their own bodies till it no longer contains any digestible matter. This cannibalism is the more remarkable, as they will not eat other termites. The most curious part of their dietary is their complex system of feeding from the matters contained in the alimentary systems of their fellows. When a termite wishes food it strokes the body of another individual with its antennae, and the specimen thus caressed exudes from the posterior or from the anterior part of the body a drop of matter, which is eaten by the hungry one. The matter exuded from the posterior part of the body appears to be very different from that yielded by the mouth, so that there are at least two kinds of this excretory food. The proctodaeal food (that which comes from the posterior part of the body) is in great favour with adult termites, but so far as is known it is not used for feeding the newly born young, which are believed to be fed on matter elaborated in the bodies of the adult workers and communicated by their mouths. Subsequently the young take also proctodaeal food, and triturated vegetable matter.

Origin of the Castes.—When termites are hatched from the eggs none of the remarkable differences that are manifested in the individuals in subsequent life can be detected. The sexes are in termites extremely similar in external characters. When the young are hatched they all appear nearly exactly alike, though on careful examination the sexes can be distinguished.

But no other difference than that of sex can be detected. In the article ANT in the ninth edition of the *Encyclopaedia Britannica* it was stated that "the distinction between soldier and worker can be easily seen in the egg." This is contradicted by all modern observations, and is certainly erroneous. It is true that considerable difference of opinion exists as to when the distinction between soldier and worker first becomes evident, but all are agreed that it is not till after the growth is to some extent accomplished. The discrepancy that exists in opinions on this point is due to the facts: (1) that different species have been under observation; and (2) that the modification of the larva to form a soldier may begin at more than one period of the development even in the same species. It being ascertained that all termites begin as undifferentiated larvae, the question arises as to what causes the differentiation into castes. This question is the more important as two of the castes (the worker and soldier) do not at all resemble their parents. Grassi, from an examination of the individuals of a large number of nests of *Termes lucifugus*, arrived at the conclusion that all start as undifferentiated larvae, and that the regular development of *Termes* up to the perfect insect may undergo a deviation at various periods of life leading to the formation of workers, of neoteinic forms, or of soldiers, the last passing through the stage of the young worker. He attributes this deviation, which may take place at various periods, to the influence of food, and attaches special importance to the salivary food. The soldiers have no wings; nevertheless a larva, or young nymph that has the rudiments of wings, can be made into a soldier. Grassi has found juvenile specimens that have already assumed the soldier form, although they possess the rudiments of wings. It appears from his observations that the worker may be considered as a form with arrested development, and the soldier as a form with arrested and much diverted development, while the neoteinic forms are individuals in which the reproductive organs are perfectly developed, while some of the bodily structures have suffered arrest of development and even some amount of atrophy.

FIG. 5.—Termitarium of *Termes malayanus: f*, fungus-chamber; *c*, royal cell.

The soldier form of termite presents most difficult questions to the biologist, its special structures bearing no approximation to any characters possessed by the parents. Various theories have been proposed to account for this fact, but they are mere guesses. We may, however, mention that it is possible that soldiers and workers occasionally produce young. This has never been actually observed, but specimens have been found with the sexual organs partially developed, and F. Silvestri has recorded the occurrence of workers with some of the characters of the females, in South America, in a nest of *Termes strunchii*.

Termitaria.—There is nothing in which termites display more variety than in their dwellings. These are sometimes not constructions at all. The primitive *Calotermes flavicollis*—in which there is no worker—frequently inhabits rotten places in trees; at most it increases these a little by excavation, and modifies the passages by slight and imperfect barricades. In the case of this species the community never attains a greater number than one thousand individuals, and even this is comparatively rare. On the other hand, we have the huge solid structures, 10 or 20 ft. high, delineated by Smeathman with cattle standing on their summits. Saville Kent has observed termitaria in Australia 18 ft. high. In equatorial Africa termitaria are frequently 12 to 25 ft. high and sharp-pointed. As a rule large termitaria do not occur in considerable numbers in a restricted area, but there are exceptions even to this. At Somerset, Cape York, there is one of the most remarkable termite cities of the world. Viewed from the sea, it appears as if the plain for a mile or more in extent were covered with pointed pillars, varying, according to different accounts, from 6 to 13 ft. in height, broad at the base and tapering to the summit, forming regular symmetrical pyramids. In this part of Australia there is also found the "compass," "magnetic," or "meridian" termite, the mounds of which have somewhat the shape of a tombstone, and have always the same orientation, the wider face of the structure always extending north to south. It has been suggested that this is connected with the necessity of regulating the temperature or the amount of desiccation of the nest, but there is no evidence whatever on the point. A termitarium on being opened displays a vast number of irregular chambers separated by thin partitions (fig. 5, *f*), the royal cell being placed in the middle (fig. 5, *c*). The material used is of an earthy nature, but the interiors of many earthy termitaria are largely composed of woody fibre, the refuse proceeding from the alimentary canals of the insects being used for this purpose. A considerable number of the larger termites use fungi for their foodstuff. There are special chambers where these are cultivated, the matter on which the fungus is grown being of a woody nature and sponge-like in its structure. The fungi make their appearance as small globules. Probably the spores or mycelium are placed in the mass when it is formed by the termites; but very little is yet known as to this fungus and its mode of treatment by them.

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TERMONDE (Flemish *Dendermonde*), a town of Belgium in the province of East Flanders, situated 25 m. S.W. of Antwerp at the junction of the Dender and the Scheldt. Pop. (1904) 10,141. It is still one of the five fortified places in Belgium, although its defences are not modernized. It was before Termonde that Louis XIV. in 1667 was compelled to beat an ignominious retreat through its defenders opening the dikes and flooding the country. The church of Notre Dame contains two fine pictures by Van Dyck, and one masterpiece of Crayer's. The fonts are of the 12th century.

TERN (Norsk *taerne*, *tenne* or *tende;* Swedish *tärna;* Dutch *Stern*[1]), the name now applied generally to a group of sea-birds,

[1] "Starn" was used in Norfolk in the 19th century as a name for the bird commonly known as the black tern, thus confirming Turner, who, in 1544, describes what seems to have been the same

the sub-family Sterninae of the gulls or Laridae, but, according to P. J. Selby, properly belonging, at least in the Farne Islands, to the species known by the book-name of Sandwich tern, all the others being those called sea-swallows—a name still most commonly given to the whole group throughout Britain from their long wings, forked tail and marine habit. In F. Willughby's *Ornithologia* (1676), however, the word tern is used for more than one species, and, though it does not appear in the older English dictionaries, it may well have been from early times as general a name as it is now.

Setting aside those which are but occasional visitors to the British Islands, six species of terns may be regarded as indigenous, though of them one has ceased from ordinarily breeding in the United Kingdom, while a second has become so rare and regularly appears in so few places that mention of them must for prudence sake be avoided. This last is the beautiful roseate tern, *Sterna dougalli*; the other is the black tern, *Hydrochelidon nigra*, belonging to a genus in which the toes are only half-webbed, of small size and dark leaden-grey plumage. It is without doubt the *Sterna* of Turner, and in former days was abundant in many parts of the fen country,[1] to say nothing of other districts. Though nearly all its ancient abodes have been drained, and for its purposes sterilized these many years past, not a spring comes but it shows itself in small companies in the eastern counties of England, evidently seeking a breeding-place. All around the coast the diminution in the numbers of the remaining species of terns is no less deplorable than demonstrable.

The Sandwich tern, *S. cantiaca*—named from the place of its discovery, though it has long since ceased to inhabit that neighbourhood—is the largest of the British species, equalling in size the smaller gulls and having a dark-coloured bill tipped with yellow, and dark legs. Through persecution it has been exterminated in all its southern haunts, and is become much scarcer in those to which it still resorts. It was, however, never so abundant as its smaller congeners, the so-called common and the arctic tern—two species that are so nearly alike as to be beyond discrimination on the wing by an ordinary observer, and even in the hand require a somewhat close examination.[2] The former of these has the more southern range, and often affects inland situations, while the latter, though by no means limited to the Arctic circle, is widely distributed over the north and mostly resorts to the sea-coast. Yet there are localities where, as on the Farne Islands, both meet and breed, without occupying stations apart. The minute diagnosis of these two species cannot be briefly given. It must suffice here to state that the most certain difference, as it is the most easily recognizable, is to be found in the tarsus, which in the arctic tern is a quarter of an inch shorter than in its kinsman. The remaining native species is the lesser tern, *S. minuta*, one of the smallest of the genus and readily to be distinguished by its permanently white forehead. All the species already mentioned, except the black tern, have much the same general coloration—the adults in summer plumage wearing a black cap and having the upper parts of the body and wings of a more or less pale grey, while they are mostly lighter beneath. They generally breed in association, often in the closest proximity—their nests, containing three eggs at most, being made on the shingle or among herbage. The young are hatched clothed in variegated down, and remain in the nest for some time. At this season the parents are almost regardless of human presence and expose themselves freely.

At least half-a-dozen other species have been recorded as occurring in British waters, and among them the Caspian tern, *S. caspia*, which is one of the largest of the genus and of wide distribution, though not breeding nearer to the shores of England than on Sylt and its neighbouring islands, which still afford lodgings for a few pairs. Another, the gull-billed tern, *S. anglica*, has also been not infrequently shot in England. All these species are now recognized—though the contrary was once maintained—as inhabitants of North America, and many go much farther. *S. forsteri* is the North American, and *S. melanogaster* the Indian tern.

Terns are found all over the world, and among exotic forms may be particularly mentioned the various species of noddy (*q.v.*). Often confounded with these last are the two species called in books sooty terns (*S. fuliginosa* and *S. anaestheta*), but by sailors "egg-birds" or "wide-awakes" from their cry. These crowd at certain seasons in innumerable multitude to certain islands within the tropics, where they breed, and the wonderful assemblage known as "wide-awake fair" on the island of Ascension has been more or less fully described from very ancient times. W. Dampier in his voyage to New Holland in 1699 particularly described and figured the sooty tern (*Voyages*, iii. p. 142), discriminating it from the noddy, from which it had not before been distinguished. (A. N.)

species as "nostrati lingua sterna appellata." In at least one instance the word has been confounded with one of the old forms of the modern STARLING (*q.v.*). To Turner's name, repeated by Gesner and other authors, we owe the introduction by Linnaeus of *Sterna* into scientific nomenclature. "Ikstern" is another Dutch form of the word.

[1] It was known there as carr-swallow, carr-crow (corrupted into "scarecrow"), and blue dar (*qu.*=daw?).

[2] Linnaeus's diagnosis of his *Sterna hirundo* points to his having had an "arctic" tern before him; but it is certain that he did not suspect that specific appellation (already used by other writers for the "common" tern) to cover a second species. Some modern authorities disregard his name as being insufficiently definite, and much is to be said for this view of the case. Undoubtedly "*hirundo*" has now been used so indiscriminately for one species or the other as to cause confusion, which is perhaps best avoided by adopting the epithets of Naumann (*Isis*, 1819, pp. 1847, 1848), who, acting on and confirming the discovery of Nitzsch (who first detected the specific differences), called the southern species *S. fluviatilis* and the northern *S. macrura*. Temminck's name *S. arctica*, applied to the latter a year afterwards, has, however, been most generally used for it.

TERNATE, a small island in the Malay Archipelago, off the west coast of Halmahera, in 0° 48′ N., 127° 19′ E. It is nearly circular in form, with an area of about 25 sq. m., and consists almost entirely of a remarkable volcano (5400 ft.) formed of three superimposed cones. Frequent destructive eruptions have occurred. On the island is the small town of Ternate, which, in spite of its good harbour, carried on no considerable trade or shipping, and has only 3000 inhabitants. But it is the headquarters of the Dutch residency of Ternate, which exercises authority over the area of the ancient kingdoms of Ternate and Tidore. The residency consists of the following groups of islands: the Halmahera group, the Bachian and the Obi group, the Sula Islands, the islands near the western half of New Guinea (Gebeh, Vaigeu, Salawati, Misol, collectively called the Papuan Islands), the western half of New Guinea as far as 141° E., with the islands in Geelvink Gulf on the north coast of New Guinea (Schouten Islands, Yapen, &c.), along with others on the south coast. To this residency also belong the state of Banggai in East Celebes, and the Banggai Islands. The residency stretches from 2° 43′ N. to 5° 45′ S., and 121° to 141° E., with an area of 155,800 sq. m. The Dutch government exercises direct authority only over parts of Ternate, Halmahera, Bachian and Obi islands. Its rule over the other groups it carries on through the sultans of Ternate and Tidore (*q.v.*). Both the island and town of Ternate suffer from their isolation, and have never regained the importance they had in former centuries. Pop. of the whole residency (1905) 108,415. The inhabitants are of Malay race and Mahommedans in religion. The breaking up of the old government of the Moluccas tended to make Ternate perhaps the most important Dutch-Indian political centre of the archipelago east of Celebes. Nominally the sultan is still ruler, but virtually his powers were greatly curtailed by his conventions with the Dutch-Indian government, under which he surrendered, with the concurrence of his grandees, many of his former rights to the Dutch resident, who became the *de facto* governor of the easternmost colonial possessions of Holland, especially since the transfer of Dutch New Guinea in 1901. Among the rights surrendered by the sultan of Ternate to the Dutch were those of granting monopolies and mining concessions, now vested in the Dutch resident. The island of Bachian is worked by a kind of chartered company. For surrendered rights and privileges the sultan and his grandees received monetary compensations in the shape of annual subventions, and these also have been paid for the losses formerly incurred by the wilful destruction of the nutmeg plantations, carried out in order to enhance the value of this commodity and monopolize its cultivation. The restrictions on nutmeg-growing have long since been removed, and many plantations, with free labour, have been started in Ternate since 1885. It is a curious fact that Christianity has declined in Ternate in modern times, though it was an early stronghold and the number of Europeans settled there has materially increased.

TERNI (anc. *Interamna Nahars*), a town, episcopal see, and the seat of a sub-prefecture of the province of Perugia, Italy, situated among the Apennines, but only 426 ft. above sea-level, in the valley of the Nera (anc. *Nar*), from which the town took its distinguishing epithet, 5 m. below its junction with the Velino, and 70 m. N. by E. of Rome by rail. Pop. (1906) 20,230 (town), 33,256 (commune). It has important iron and steel works and iron foundries, at which armour-plates, guns and projectiles are made for the Italian navy, also steel castings, machinery and rails, a royal arms factory, and lignite mining. Terni lies on the main railway line from Rome to Foligno and Ancona, and is the junction for Rieti and Sulmona. Its most interesting buildings are the cathedral (17th century, with remains of the earlier 13th century façade), the church of S. Francesco (partly dating from the 13th century, with some frescoes of the 14th), and other old churches. Its antiquities include traces of the city walls of rectangular blocks of travertine, remains of an amphitheatre of the time of Tiberius, a temple, theatre and baths (?), and numerous inscriptions. Remains have also been found of a pre-Roman necropolis. The excavations and the objects found are described by A. Pasqui and L. Lanzi in *Notizie degli scavi*, 1907, 595 seq. Five miles to the east are the falls of the Velino (*Cascate delle Marmore*). Alike in volume and in beauty these take a very high place among European waterfalls; the cataract has a total descent of about 650 ft., in three leaps of 65, 330 and 190 ft. respectively. They owe their origin to M'. Curius Dentatus, who in 272 B.C. first opened an artificial channel by which the greater part of the Lacus Velinus in the valley below Reate was drained. They supply the motive power for the factories of the town.

Terni is the ancient *Interamna* (*inter amnes*, " between the rivers, " *i.e.* the Nar and one of its branches), originally belonging to Umbria, and founded, according to a local tradition preserved in an inscription, in the year 672 B.C. It is first mentioned in history as being, along with Spoletium, Praeneste and Florentia, portioned out among his soldiers by Sulla. Its inhabitants had frequent litigations and disputes with their neighbours at Reate in connexion with the regulation of the Velinus, the waters of which are so strongly impregnated with carbonate of lime that by their deposits they tend to block up their own channel. The first interference with its natural course was that of M'. Curius Dentatus already referred to. In 54 B.C. the people of Reate appealed to Cicero to plead their cause in an arbitration which had been appointed by the Roman senate to settle disputes about the river, and in connexion with this he made a personal inspection of Lake Velinus and its outlets. In the time of Tiberius there was a project for regulating the river and its outlets from the lake, against which the citizens of Interamna and Reate energetically and successfully protested (Tac. *Ann.* i. 79). Similar questions arose as the river formed fresh deposits during the middle ages and during the 15th and 16th centuries. A branch of the Via Flaminia passed from Narnia to Forum Flaminii, and is given instead of the direct line in the Antonine and Jerusalem itineraries. A road led from here to the Via Salaria at Reate. Interamna is also mentioned in Cicero's time as being the place where Clodius wished to prove that he was on the night when he was caught in Caesar's house at the celebration of the rites of the Bona Dea. The Emperor Tacitus and his brother Florianus were probably natives of Interamna, which also has been claimed as the birthplace of Tacitus the historian, but with less reason. During most of the middle ages and up till 1860 Terni was subject to the popes. It was the scene of the defeat of the Neapolitans by the French on the 27th of November 1798.

TERPANDER, of Antissa in Lesbos, Greek poet and musician. About the time of the Second Messenian war, he settled in Sparta, whither, according to some accounts, he had been summoned by command of the Delphian oracle, to compose the differences which had arisen between different classes in the state. Here he gained the prize in the musical contests at the festival Carnea (676–2 B.C.; Athenaeus, 635 E.). He is regarded as the real founder of Greek classical music, and of lyric poetry; but as to his innovations in music our information is imperfect. According to Strabo (xiii. p. 618) he increased the number of strings in the lyre from four to seven; others take the fragment of Terpander on which Strabo bases his statement (Bergk, 5) to mean that he developed the citharoedic nomos (sung to the accompaniment of the cithara or lyre) by making the divisions of the ode seven instead of four. The seven-stringed lyre was probably already in existence. Terpander is also said to have introduced several new rhythms in addition to the dactylic, and to have been famous as a composer of drinking-songs.

Fragments (the genuineness of which is doubtful) in T. Bergk, *Poetae Lyrici Graeci*, iii.; see also O. Löwe, *De Terpandri Lesbii aetate* (1869), who places him about 676 B.C.

TERPENES, in organic chemistry, the generic name of a group of hydrocarbons of the general formula $(C_5H_8)_n$, and the more important oxygen derivatives, mainly alcohols, aldehydes and ketones, derived from them. They may be classified into several distinct groups: *hemiterpenes*, C_5H_8; *terpenes* proper, $C_{10}H_{16}$; *sesquiterpenes*, $C_{15}H_{24}$; and *polyterpenes* $(C_5H_8)_n$. In addition to these, a series of open-chain olefine terpenes is known.

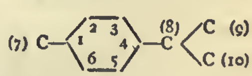
The chief sources of the terpenes and their derivatives are the essential oils obtained by the distillation or extraction by pressure of various plants, chiefly of the Coniferae and different species of *Citrus*. Certain of these oils consist very largely of hydrocarbons; for example, those of turpentine, citron, thyme, orange, pine-needle, goldenrod (from *Solidago canadensis*) and cypress, while others contain as their chief constituents various alcoholic and ketonic substances. With the exception of camphene, all the terpenes are liquids, boiling approximately between 160° and 190° C., so that it is almost impossible to separate them from the various essential oils by fractional distillation. In order to prepare the individual members pure, advantage is taken of the different physical properties of their derivatives. The terpenes all possess a characteristic odour and are fairly stable to alkalis, but are easily decomposed by acids or by heating to a sufficiently high temperature. Many polymerize readily, or are transformed into isomers by boiling with dilute alcoholic sulphuric acid. Some oxidize rapidly on exposure to air, passing into resinous substances. The formation of addition compounds with the halogens, halogen hydrides, and with nitrosyl chloride, is characteristic of many, whilst others unite readily with nitrogen peroxide. According to A. v. Baeyer (*Ber.*, 1895, 28, p. 648; 1896, 29, p. 10) the nitrosochlorides are not simple addition products, but bimolecular compounds or bisnitrosochlorides.

Hemiterpenes

The best known is Isoprene, C_5H_8, which is obtained on distilling caoutchouc or gutta-percha. It was synthesized by W. Euler (*Ber.*, 1897, 30, p. 1989) by distilling the addition compound of methyl iodide and 2·3·5-trimethylpyrollidine with caustic potash. It is an unstable liquid which boils at 33·5° C., and on heating rapidly polymerizes to dipentene, the same change being effected by hydrochloric acid. In ethereal solution it combines with bromine to form an unstable liquid dibromide; it also unites with one molecule of hydrobromic acid to form the same tertiary bromide as dimethylallylene; this points to its being β-methyldivinyl, $CH_2:C(CH_3)\cdot CH:CH_2$ (V. A. Mokiewsky, *Jour. Soc. Phys. Chim. Russ.*, 1900, 32, p. 207).

Terpenes Proper

The terpenes proper may be subdivided into the simple monocyclic terpenes and the more complex (usually bicyclic) terpenes. The monocyclic terpenes are hydro derivatives of paracymene. A. v. Baeyer proposed the following nomenclature: the dihydroparacymenes are called terpadienes, the tetrahydrocymenes becoming terpenes and the hexahydrocymene terpan, the carbon atoms being numbered as shown in the inset formula:



In the more complex terpenes the name camphene is retained, and camphane is used for the dihydrocamphene. G. Wagner (*Ber.*, 1894, 27, p. 1636 Anm.) designates the hexahydrocymenes menthans, the tetrahydrocymenes menthenes, and the dihydrocymenes menthadienes. The position of the double linking in the molecule is shown by the use of the symbol Δ followed by the number of the carbon atom immediately preceding it.

Monocyclic Terpene Group

Limonene, Δ1:8(9) terpadiene, $C_{10}H_{16}$, is known in three forms, namely *d*-limonene, *l*-limonene, and *i*-limonene or dipentene. *d*-Limonene is the chief constituent of oil of orange-rind, and is also found in oil of lemon and oil of bergamot. *l*-Limonene is found in oil of fir-cones and in Russian peppermint oil. Both are pleasant-smelling liquids, which boil at 175–176° C. They differ from each other only in rotatory power. Dry hydrochloric acid gas converts them into optically active limonene hydrochloride, while in the moist condition it gives dipentene dihydrochloride. When heated to a sufficiently high temperature they are converted into dipentene. Four optically active nitrosochlorides are known, two corresponding to each of the active limonenes, and these on heating with alcoholic potash are converted into *d*- and *l*-carvoxime. Dipentene (*i*-limonene) is found widely distributed in many essential oils, *e.g.* of camphor, Russian turpentine, cubebs, bergamot, cardamom, &c., and is also a product of the dry distillation of many vegetable resins. It may be produced by heating many terpenes (pinene, camphene, sylvestrene, limonene) for several hours at 250–270° C.; or by the polymerization of isoprene at 300° C. To obtain pure dipentene it is best to heat dipentene hydrochloride with anhydrous sodium acetate and glacial acetic acid (O. Wallach, *Ann. Chem. Pharm.*, 1887, 239, p. 3). It is a pleasant-smelling liquid, which boils at 175–176° C., and polymerizes on heating to high temperatures. When warmed with alcoholic sulphuric acid it yields terpinene, whilst concentrated sulphuric acid or phosphorus pentasulphide convert it into paracymene. Dipentene dihydrochloride, $C_{10}H_{16}\cdot 2HCl$, best prepared by passing a current of hydrochloric acid gas over the surface of a glacial acetic acid solution of dipentene, crystallizes in rhombic tables which melt at 50° C. and boil at 118–120° C. (10 mm.). It is apparently a *trans*-compound, for A. v. Baeyer (*Ber.*, 1893, 26, p. 2863) has obtained a *cis*-dihydrochloride of melting-point 25° (*circa*), by the action of hydrochloric acid on cineol.

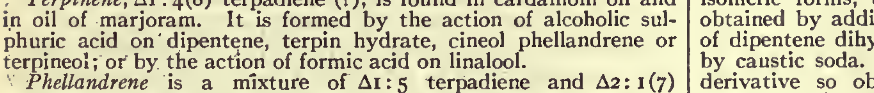
Terpinolene, Δ1:4(8) terpadiene, has not as yet been observed in essential oils. It is formed by the action of hot dilute sulphuric acid on terpineol, terpin hydrate and cineol. It is an inactive liquid boiling at 183–185° C., and is readily converted into terpinene by acids.

Terpinene, Δ1:4(8) terpadiene (?), is found in cardamom oil and in oil of marjoram. It is formed by the action of alcoholic sulphuric acid on dipentene, terpin hydrate, cineol phellandrene or terpineol; or by the action of formic acid on linalool.

Phellandrene is a mixture of Δ1:5 terpadiene and Δ2:1(7) terpadiene (pseudo-phellandrene) (F. W. Semmler, *Ber.*, 1903, 36, p. 1749). It is found as *d*-phellandrene in oil of water-fennel and oil of elemi, and as *l*-phellandrene in Australian eucalyptus oil and oil of bay. It is an exceedingly unstable compound, and must be extracted from the oils by distillation *in vacuo*. The hydrocarbons obtained from elemi oil and eucalyptus oil correspond to Δ1·5 terpadiene. A similar hydrocarbon was obtained by C. Harries and M. Johnson (*Ber.*, 1905, 38, p. 1832) by converting carvone hydrobromide into Δ6 terpenone-2, then, by phosphorus pentachloride, into chlor-2-phellandrene, which is finally reduced.

Sylvestrene, Δ1:8(9) meta-terpadiene, is found in Swedish and Russian oil of turpentine and in various pine oils. It boils at 175–176° C. and is dextro-rotatory. It is one of the most stable of the terpenes and gives a characteristic deep blue colour on the addition of a drop of sulphuric acid to its solution in acetic anhydride. On treating the hydrobromide with bromine in the presence of iodine, a product is obtained which on reduction yields meta-cymene (A. v. Baeyer and V. Villiger, *Ber.*, 1898, 31, p. 2067).

Carvestrene is obtained by the distillation of carylamine or vestrylamine hydrochloride (A. v Baeyer, *Ber.*, 1894, 27, pp. 3485 seq.). It is regarded by Baeyer as *i*-sylvestrene. It was synthesized by W. H. Perkin and G. Tattersall (*Proc. Chem. Soc.*, 1907, 22, p. 268) by the application of the Grignard reaction to the ethyl ester of γ-ketohexahydrobenzoic acid (1). By the action of magnesium methyl iodide this ester yields the lactone of γ-hydroxy-hexahydrometa-toluic acid, which is transformed by hydrobromic acid into the corresponding γ-bromo-hexahydro-meta-toluic acid. This latter substance by the action of pyridine yields tetrahydro-meta-toluic acid, the ester of which by magnesium methyl iodide is converted into Δ·1-meta menthenol-8 (2). The meta-menthenol on dehydration by potassium bisulphate yields carvestrene (3) of boiling-point 179–180° C.



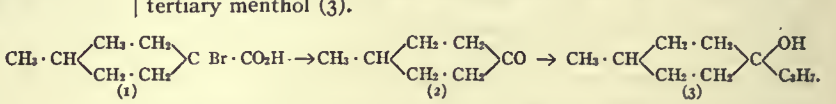
(1) (2) (3)

A synthetical monocyclic terpene, viz. 1-methyl-4-isopropyl dihydrocymene was prepared by A. v. Baeyer (*Ber.*, 1893, 26, p. 232). Succino-succinic ester is converted into the methyl isopropyl derivative, which on hydrolysis and elimination of carbon dioxide yields 1-methyl-4-isopropyldiketohexamethylene. This ketone is then reduced to the secondary alcohol, the hydroxyl groups replaced by bromine, and hydrobromic acid is then removed from the bromo-compound by boiling it with quinoline, leaving the terpene. It is a liquid which boils at 174° C. and shows a complete terpene character.

Alcohol and Ketone Derivatives

Menthol (terpan-ol-3), $C_{10}H_{20}O$. The *laevo* variety is the chief portion of oil of peppermint; it may be prepared by reducing the menthone obtained by E. Beckmann and M. Pleissner (*Ann.*, 1891, 262, p. 21) from pulegone hydrobromide with sodium and alcohol. It crystallizes in prisms which melt at 43° C. and boil at 212° C. It is readily oxidized by chromic acid to the corresponding ketone menthone. By the action of phosphorus pentoxide, or zinc chloride, it is converted into menthene, $C_{10}H_{18}$, and when heated with anhydrous copper sulphate to 250° C. it yields para-cymene. It is reduced by hydriodic acid and phosphorus to hexahydrocymene. The phosphorus haloids yield haloid esters of composition $C_{10}H_{19}Cl$, which, according to I. L. Kondakow (*Jour. prakt. Chem.*, 1899 [2], 60, p. 257) are to be regarded as tertiary esters; a similar type of reaction is found in the case of carvomenthol. A *d*-menthol has been prepared from the *i*-mixture obtained by reducing menthone with sodium. The mixture is benzoylated, and the liquid *d*-menthol benzoate separated and hydrolysed.

Tertiary menthol (terpan-ol-4), a liquid boiling at 97–101° C. (20 mm.), has been obtained by the hydrolysis of the ester prepared by heating menthene with trichloracetic acid (A. Reychler and L. Masson, *Ber.*, 1896, 29, p. 1844). It possesses a faint peppermint odour. W. H. Perkin, junr. (*Proc. Chem. Soc.*, 1905, 21, p. 255) synthesized it from 1·4 methyl*cyclo*hexanone: sodium carbonate converts α-bromhexahydro-para-toluic acid (1) into Δ·1-tetrahydro-para-toluic acid and α-oxyhexahydro-para-toluic acid, and the latter on treatment with dilute sulphuric acid yields 1·4-methyl*cyclo*hexanone (2), which by the action of magnesium isopropyl iodide and subsequent hydrolysis is converted into tertiary menthol (3).

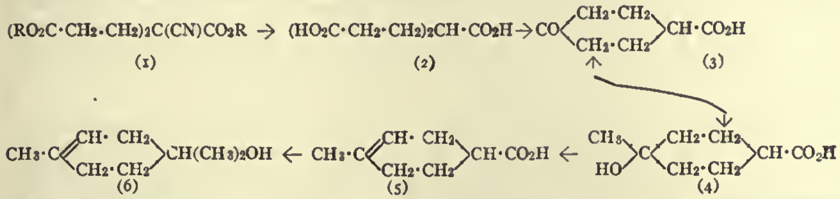


(1) (2) (3)

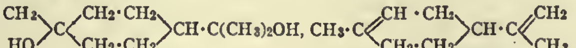
Terpin (terpan-diol 1·8), $C_{10}H_{18}(OH)_2$, is known in two stereoisomeric forms, *cis*-terpin and *trans*-terpin. The *trans*- form is obtained by adding silver acetate to a glacial acetic acid solution of dipentene dihydrochloride, filtering and neutralizing the filtrate by caustic soda. It is then extracted with ether, and the acetyl derivative so obtained is hydrolysed by alcoholic potash. It crystallizes in prisms, which melt at 156-158° C., and boil at 263–265° C. It is converted into terpineol by dilute sulphuric acid. The *cis*-compound melts at 104–105° C. and may be prepared by heating its hydrate. Terpin hydrate, $C_{10}H_{18}(OH)_2\cdot H_2O$, crystallizes in prisms which melt at 116° C. It is prepared by acting with dilute mineral acids on limonene or dipentene. When boiled with glacial acetic acid it is converted into terpineol, while concentrated hydriodic acid at 210° C. reduces it to hexahydrocymene. When heated with dilute sulphuric acid it gives a number of compounds, which may be considered as arising from the loss of one or two molecules of water from one molecule of terpin.

Cineol, $C_{10}H_{18}O$, is an inner oxide of terpin. It is found in the oils of wormseed, cajaput, eucalyptus, laurel, galanga, camphor and of lavender. It may be prepared by passing a current of dry hydrochloric acid gas into wormseed oil, the precipitated hydrochloride being then distilled in a current of steam (O. Wallach and W. Brass, *Ann.*, 1884, 225, p. 297). It is an inactive liquid, which boils at 176° C. The oxygen atom in the molecule does not appear to possess either an alcoholic, ketonic, aldehydic or acid function.

Terpineol (Δ1-terpen-ol-8), $C_{10}H_{17}(OH)$. The term "terpineol" has been used to denote what is now known to be a mixture of various isomeric alcohols. Liquid terpineols have been isolated from the oils of *Erigeron canadense*, of marjoram and of camphor. Liquid terpineol is generally prepared by the action of dilute sulphuric acid on terpin hydrate. It consists of a mixture of various isomers, from which a solid terpineol melting at 35° C. and an isomeric Δ·8(9) terpen-ol-1, melting at 32° C., have been isolated (K. Stephan and J. Halle, *Ber.*, 1902, 35, p. 2147. See also G. Bouchardat, *Comptes rendus*, 1887, 104, p. 996; 1895, 121, p. 141; Schimmel & Co., *Semi-annual Reports*, Oct. 1897, p. 11; J. Godlewsky, *Chem. Centralblatt*, 1899 (I.), p. 1241). Solid terpineol exists in active and racemic forms. The active form was obtained by F. W. Semmler (*Ber.*, 1895, 28, p. 2190) by replacing the halogen atoms in the active monohydrobromide of limonene by the hydroxyl group; it has also been obtained by the action of acetic acid on linalool. The racemic variety has been prepared by the action of formic acid on geraniol, and was synthesized by the following method (W. H. Perkin, junr., *Jour. Chem. Soc.*, 1904, 85, p. 654). γ-Cyanpentane tricarboxylic ester (1) (prepared by the action of cyanacetic ester on β-iodopropionic ester) is hydrolysed to pentane-αγε-tricarboxylic acid (2), which when boiled with acetic anhydride and distilled gives δ-ketohexahydrobenzoic acid (3). The ester of this acid, when treated with the Grignard reagent, yields δ-oxyhexahydrotoluic acid (4), which is converted into the corresponding brom-compound by fuming hydrobromic acid. This latter compound on treatment with dilute alkali or pyridine yields Δ·3-tetrahydro-para-toluic acid (5), the ester of which with magnesium and methyl iodide furnishes terpineol (6):—

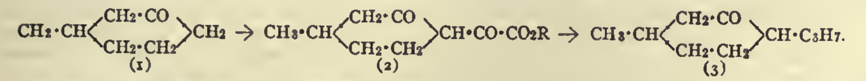


This synthesis determines the constitution of terpin (7) and of dipentene (8), since the former is produced by the action of 5 per cent. sulphuric acid on terpineol, and the latter by heating terpineol with acid sodium sulphate.



Terpineol adds on nitrosyl chloride to form a nitrosochloride, which on elimination of hydrochloric acid yields the oxime of an unsaturated oxyketone; this on boiling with acids is converted into inactive carvone. When reduced by the method of Sabatier and Senderens it forms hexahydrocymene (A. Haller, *Comptes rendus*, 1905, 140, p. 1303); when oxidized with Caro's reagent it yields trioxyhexahydrocymene (A. v. Baeyer and V. Villiger, *Ber.*, 1899, 32, p. 3625). For an isomeric terpineol (Δ·8(9) terpenol-1) see A. v. Baeyer, *Ber.*, 1894, 27, pp. 443, 815.

Menthone (terpan-one-3), $C_{10}H_{18}O$, occurs with menthol in oil of peppermint. It was first obtained by M. Moriya (*Jour. Chem. Soc.*, 1881, 39, p. 77) by oxidizing menthol with chromic acid mixture at 120° C., and was described as an inactive compound; but R. W. Atkinson (ibid., 1882, 41, p. 50) showed that when menthol was oxidized at 135° C. a strongly dextro-rotatory menthone was produced. For the preparation of *l*-menthone and *d*-isomenthone (Beckmann's *d*-menthone) see E. Beckmann, *Ann.*, 1889, 250, p. 325; 1891, 262, pp. 21 seq. The menthone obtained by Beckmann by the reduction of pulegone hydrobromide was shown by C. Martine (*Ann. chim. phys.*, 1904 (8), 3, p. 49) to be not completely identical with *l*-menthone; it is consequently designated P-menthone. An inactive menthone has been synthesized as follows. β-Methyl pimelic ester is converted by sodium ethylate into methyl-1-*cyclo*hexanon-3-carboxylic ester-4, into which the isopropyl group is introduced (also in position 4) by the action of isopropyl iodide and sodium ethylate. The ester is then hydrolysed, and carbon dioxide eliminated from the carboxyl group, when inactive menthone is obtained (A. Einhorn and L. Klages, *Ber.*, 1901, 34, p. 3793). It boils at 204–206° C., whereas Beckmann's menthones boil at 208° C. A. Haller and C. Martine (*Comptes rendus*, 1905, 140, p. 130) synthesized natural menthone from isopropyl iodide and the sodium derivative of methyl-1-*cyclo*hexanone-3. It has also been prepared by condensing methylhexanone with ethyl acetate, the resulting methyl-1-acetyl-4-*cyclo*hexanone-3 being converted into the isopropyl derivative, yielding acetylmenthone, which is then hydrolysed to menthone (G. Leser, *Comptes rendus*, 1902, 134, p. 1115). A. Koltz and L. Hesse (*Ann.*, 1905, 342, p. 306) convert methylhexanone (1) by means of ethyl oxalate and subsequent hydrolysis into methylhexanone oxalic acid (2), the isopropyl ester of which on treatment with a methyl alcohol solution of caustic potash yields *d*-menthone (3).



O. Wallach (*Ann.*, 1900, 312, p. 171) showed that the oximes of cyclic ketones are converted by phosphorus pentoxide into iso-oximes, which are readily decomposed by concentrated hydrochloric acid to yield aliphatic amino-acids; in this way menthone may be converted into ε-amido-decylic acid,

$$(CH_3)_2CH{\cdot}CH(NH_2){\cdot}(CH_2)_2{\cdot}CH(CH_3){\cdot}CH_2{\cdot}CO_2H.$$

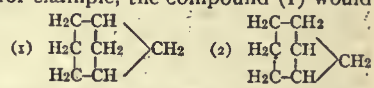
Diosphenol, $C_{10}H_{16}O_2$, which occurs in the essential oil of bucco leaves (*Borosma betulina*) may be synthesized by oxidizing oxymethylene menthone. Sodium in alcoholic solution reduces it to para-terpane-di-ol (2·3).

Pulegone (Δ 4(8)-terpenone-3), $C_{10}H_{16}O$, is an unsaturated ketone found in pennyroyal oil, from which it may be obtained by distillation *in vacuo*. It is a dextro-rotatory liquid which boils at 221–222° C. F. Tiemann (*Ber.*, 1897, 30, p. 22) synthesized it from citronellal by converting this compound into isopulegol acetate by acetic anhydride; this ester is hydrolysed, and the isopulegol oxidized to isopulegone, which on treatment with baryta yields pulegone. Pulegone reduces ammoniacal silver nitrate on long boiling. It is reduced by hydrogen to *l*-menthol. When heated with water to 250° C. it yields methyl-1-*cyclo*hexanone-3 and acetone. When methyl*cyclo*hexanone and acetone are condensed together in the presence of sodium methylate, an isomer of pulegone boiling at 215–216° C. is obtained. Pulegone combines with hydrobromic acid to form a hydrobromide, which on heating in methyl alcohol solution with basic lead nitrate is converted into isopulegone (Δ 8(9)-terpenone-3) (C. Harries and G. Röder, *Ber.*, 1899, 32, p. 3361). It is a laevo-rotatory liquid. A dextro-form (a mixture) is also obtained by the oxidation of isopulegol with chromic acid. On reduction it yields isopulegol and no menthol (cf. pulegone).

Carvone (Δ 6 : 8(9)-terpadiene-one-2), $C_{10}H_{14}O$, is an unsaturated optically active ketone which is found very widely distributed in nature. The dextro-form is the chief constituent of oil of caraway, and is also found in oil of dill; the laevo-form is found in oil of spearmint and kuromoji oil. The dextro-form is obtained practically pure by the fractional distillation of caraway oil; the laevo-form from the oils containing it, by first forming its addition compound with sulphuretted hydrogen, decomposing this by alcoholic potash, and distilling the product in a current of steam. It may be synthetically prepared from limonene nitrosochloride, alcoholic potash converting this compound into *l*-carvoxime, which on boiling with dilute sulphuric acid yields *l*-carvone; similarly terpineol nitrosochloride by the action of sodium ethylate yields oxydihydrocarvoxime, which on hydrolysis yields *i*-carvone. On heating with phosphoric acid carvone is converted into carvacrol (1-methyl-2-oxy-4-isopropylbenzene). Carvone is closely related to phellandrene, for C. Harries and M. Johnson (*Ber.*, 1905, 38, p. 1832), by reduction of carvone hydrobromide, obtained Δ 6-terpenone-2, which with phosphorus pentachloride gives chlor-2-α-phellandrene.

Bi-Cyclic Terpene Group

A nomenclature for the bicyclic hydrocarbons was devised by A. v. Baeyer (*Ber.*, 1900, 33, p. 3771). According to this system each hydrocarbon contains two tertiary carbon atoms, which are combined with each other three times, either directly or by means of other intervening carbon atoms, the combination forming a series of "bridges." These bridges are distinguished by numbers, denoting the number of carbon atoms contained in them, the direct union of the two tertiary carbon atoms being designated as 0; if one carbon atom intervenes, then the number 1 is used, and so on. Thus three numbers serve as the "characteristic" for the compound. Hydrocarbons of this class with five atoms of carbon are termed "*bicyclo*pentanes," with six atoms of carbon "*bicyclo*hexanes," &c. Thus, for example, the compound (1) would be called "*bicyclo*-(1 · 1 · 3)-heptane," and (2) would be "*bicyclo*-(0 · 1 · 4)-heptane."

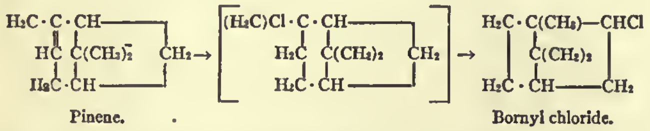


Thujene (tanacetene), $C_{10}H_{16}$, is a derivative of *bicyclo*-(0 · 1 · 3)-hexane. The name was first given to the hydrocarbon obtained by F. W. Semmler (*Ber.*, 1892, 25, p. 3345) on the dry distillation of thujylamine hydrochloride. It is a liquid which boils at 60–63° (14 mm.), and has been shown by L. Tschugaeff to be a monocyclic hydrocarbon, for which he proposes the name "isothujene." The true thujene was prepared by L. Tschugaeff (*Ber.*, 1900, 33, p. 3118) by heating the methyl xanthogenic ester obtained from thujyl alcohol. It is exceedingly unstable. The isomeric β-thujene was also obtained by the same investigator by the dry distillation of trimethylthujyl ammonium hydroxide. It boils at 150–151° C., and possesses a different rotatory power.

Sabinene, $C_{10}H_{16}$, also a *bicyclo*-(0 · 1 · 3)-hexane derivative, is found in oil of savine, from which it was first obtained by F. W. Semmler (*Ber.*, 1900, 33, p. 1455). On shaking with dilute sulphuric acid it yields terpinenol (Δ1-terpen-ol-4) (O. Wallach, *Ber.*, 1907, 40, p. 592).

Pinene, $C_{10}H_{16}$, derived from *bicyclo*-(1 · 1 · 3)-heptane, is found in many essential oils, and is the chief constituent of oil of turpentine; the *l*-variety is found in French oil of turpentine, the *d*-variety in Russian, American and Swedish oil of turpentine. Pinene is also a constituent of the oils of sage, lemon, eucalyptus, olibanum, bay, fennel, sassafras, rosemary and of valerian. The active varieties are obtained by the fractional distillation of the various oils of turpentine. The inactive variety is obtained by heating pinene nitrosochloride with an excess of aniline (O. Wallach, *Ann.*, 1889, 252, p. 132; 1890, 258, p. 243), or better with methylaniline (W. A. Tilden). The three varieties boil at 155–156° C. Pinene readily absorbs oxygen from the air, resinous products being formed, together with small quantities of formic and acetic acids.

Acid oxidizing agents convert it into terephthalic and terebic acids, whilst alkaline potassium permanganate in dilute solution oxidizes it to pinene glycol, $C_{10}H_{16}(OH)_2$, pinonic acid, $C_{10}H_{16}O_3$, pinic acid, $C_9H_{14}O_4$, &c., the products of the reaction varying according to the temperature (G. Wagner, *Ber.*, 1894, 27, p. 2270; F. Tiemann and F. W. Semmler, *Ber.*, 1895, 28, pp. 1344, 1778). Concentrated sulphuric acid converts it into camphene; and an alcoholic solution of sulphuric acid gives terpinene and terpinolene. When heated to 250–270° C. it yields dipentene; the moist halogen acids at ordinary temperature convert it into the dihalogen halides of dipentene. Dry hydrochloric acid gives pinene hydrochloride (artificial camphor), $C_{10}H_{17}Cl$, a white crystalline solid identical with bornyl chloride which melts at 131° C. Elimination of halogen hydride by means of a weak alkali (*e.g.* soap, silver acetate, &c.) converts it into camphene. Thus the conversion of pinene into its hydrochloride is probably accompanied by an intramolecular rearrangement—



Pinene. Bornyl chloride.

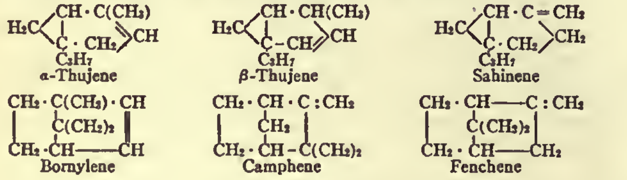
Nitric acid in aqueous alcoholic solution converts it into terpin hydrate. Pinene nitrosochloride, $C_{10}H_{16}NOCl$, was first obtained in 1874 by W. A. Tilden (*Jahresb.*, 1874 p. 214) from nitrosyl chloride and a mixture of pinene and chloroform. O. Wallach (*Ann.*, 1889, 253, p. 251) prepared it by the action of acetic acid and ethyl nitrite on oil of turpentine in presence of fuming hydrochloric acid. W. A. Tilden (*Jour. Chem. Soc.*, 1904, 85, p. 759) showed that strongly active pinene gives bad yields of the nitrosochloride, since, being bimolecular, its formation is retarded by the inversion of half of the terpene. The nitrosochloride melts at 115° C. (*circa*) and is a white pleasant-smelling powder. Alcoholic potash converts it into nitrosopinene, $C_{10}H_{16}NO$.

Bornylene, $C_{10}H_{16}$, derived from *bicyclo*-(1 · 2 · 2)-heptane, is prepared by heating bornyl iodide to 170° C. for several hours with a concentrated solution of alcoholic potash (G. Wagner, *Ber.*, 1900, 33, p. 2121), or by decomposition of the methyl esters of the *l*- and *d*-bornyl xanthates, the former yielding *d*-bornylene and the latter *l*-bornylene (L. Tschugaeff, *Chem. Centralblatt*, 1905, i., p. 94).

Camphene, $C_{10}H_{16}$, also a *bicyclo*-(1 · 2 · 2)-heptane derivative, is a constituent of the oils of citronella, camphor, ginger and of rosemary, and also of French and American oil of turpentine. It may be obtained by the action of sulphuric acid on pinene; by heating pinene hydrobromide or hydrochloride with sodium acetate or glacial acetic acid to 200° C.; or by heating bornyl chloride with aniline (O. Wallach, *Ber.*, 1892, 25, p. 916). According to Konowalow it is best prepared by heating borneol with a diluted sulphuric acid (1 · 2) for about 6–8 hours, between 60–100° C., with continual shaking, a yield of about 90 per cent. being obtained. The melting- and boiling-points of camphene vary slightly according to the sources from which it is obtained, the former being about 50° C. and the latter about 159–161° C. It is known in *d*-, *l*- and *i*- forms. It combines with hydrochloric acid to form a hydrochloride, which on reduction with sodium and alcohol yields camphene. Many different oxidation products may be obtained from camphene by varying the conditions of experiment (J. Bredt and W. Jagelki, *Ann.*, 1900, 310, p. 114; G. Wagner, *Ber.*, 1890, 23, p. 2311; S. Moycho and F. Zienkowski, *Ann.*, 1905, 340, p. 17; J. E. Marsh and J. A. Gardner, *Jour. Chem. Soc.*, 1891, 59, p. 648; 1896, 69, p. 74).

Fenchene, $C_{10}H_{16}$, a *bicyclo*-(1 · 2 · 2)-heptane derivative, is not found in any naturally occurring products. The hydrocarbon may be obtained by the reduction of fenchone and elimination of water from the resulting fenchyl alcohol, or by the elimination of halogen hydride from the fenchyl halogen compounds (O. Wallach, *Ann.*, 1892, 263, p. 145; 1898, 302, pp. 371 seq.).

The above *bicyclo*-terpene hydrocarbons are most probably best represented by the following formulae (pinene is given above):—



α-Thujene β-Thujene Sabinene

Bornylene Camphene Fenchene

Alcohol and Ketone Derivatives

Borneol (Borneo camphor), $C_{10}H_{17}OH$ occurs in the pith cavities of *Dryobalanops camphora*, and in the oils of spike and rosemary; esters are found in many fir and pine oils. It may be prepared by heating camphor with alcoholic potash (M. Berthelot, *Ann.*, 1859, 12, p. 363); or by reducing camphor in alcoholic solution with sodium (O. Wallach, *Ann.*, 1885, 230, p. 225; J. Bertram and H. Walbaum, *Jour. prak. Chem.* 1894 (2), 49, p. 12). L. Tschugaeff (*Chem. Centralblatt.* 1905 i., p. 94) obtains pure *d*-borneol as follows:—Impure *d*-borneol (containing isoborneol) obtained in the reduction of camphor is dissolved in xylene and converted into the sodium salt by metallic sodium. This salt is then turned into the xanthate, $C_{10}H_{17}OCS_2Na$, which with methyl sulphate yields the corresponding methyl ester. The unchanged isoborneol is removed by steam distillation, which also decomposes any methyl xanthate of isoborneol that may have been formed. The residue is crystallized and hydrolysed, when pure borneol is obtained. It behaves as a secondary alcohol. Nitric acid oxidizes it to camphor and when heated with potassium bisulphate, it gives camphene. With phosphorus pentachloride it forms a bornyl chloride, identical with pinene hydrochloride.

Isoborneol is a tertiary alcohol which may be obtained by dissolving camphene in glacial acetic acid, adding dilute sulphuric acid and heating to 50–60° C. for a few minutes, the isobornyl acetate so formed being then hydrolysed (J. Bertram and H. Walbaum, *loc. cit.*). It crystallizes in leaflets, which readily sublime. Chromic acid oxidizes it to camphor.

Thujone (tanacetone), $C_{10}H_{16}O$, is found in many essential oils. Oil of thuja contains chiefly α-thujone, and oil of tansy chiefly β-thujone. Oil of artemisia and oil of sage contain a mixture of the two, whilst oil of absinthe contains principally the β-variety. The two forms may be obtained by fractional distillation of the oils, followed by a fractional crystallization of their semicarbazones from methyl alcohol. α-Thujone is laevo-rotatory and when warmed with alcoholic potash it is partially converted into β-thujone. Sodium in the presence of alcohol reduces it to thujyl alcohol, which on re-oxidation is converted into β-thujone. The β-form is dextro-rotatory and is partially converted into the α-variety by alcoholic potash. When heated to 280° thujone is transformed into the isomeric carvotanacetone (Δ6-terpenone-2). On boiling with ferric chloride it yields carvacrol. Hot dilute sulphuric acid converts it into isothujone (dimethyl-1 · 2-isopropyl-3-*cyclo*pentene-1-one-5). Thujone behaves as a saturated compound and forms a characteristic tribromide. When heated with zinc chloride it yields hydropseudocumene. According to F. W. Semmler (*Ber.*, 1900, 33, p. 275; 1903, 36, p. 4367) it is to be considered as a methyl-2-isopropyl-5-*bicyclo*-(0 · 1 · 3)-hexanone-3.

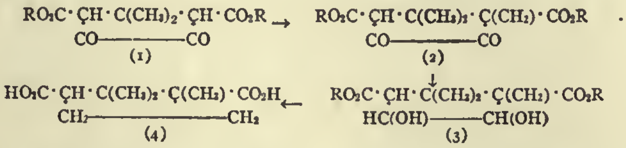
Carone, $C_{10}H_{16}O$, is a trimethyl-3 · 7 · 7-*bicyclo*-(0 · 1 · 4)-heptanone-2, obtained by acting with alcoholic potash on dihydrocarvone hydrobromide (A. v. Baeyer, *Ber.*, 1896, 29, pp. 5, 2796; 1898, 31, pp. 1401, 2067). It is a colourless oil, having the odour of camphor and peppermint, and boiling at 210° C. It is known in *d*-, *l*-, and *i*-forms. It does not combine with sodium bisulphite. When heated it is transformed into carvenone. It is stable to cold potassium permanganate solution, but on heating gives a dibasic acid, caronic acid, $C_6H_8(CO_2H)_2$, which Baeyer suggested was a *gem*-dimethyltrimethylene-1 · 2-dicarboxylic acid. This was confirmed by W. H. Perkin, junr. (*Jour. Chem. Soc.*, 1899, 75, p. 48) who synthesized the acid from dimethylacylic ethyl ester. This ester with ethyl malonate yields ethyldimethylpropanetricarboxylic ester, which on hydrolysis and subsequent heating is converted into ββ-dimethyl glutaric acid. The α-bromdimethyl ester of this acid when heated with alcoholic potash yields *cis*-, and *trans*-caronic acids. Eucarvone, $C_{10}H_{14}O$, is a trimethyl-3·7·7-*bicyclo*-(0·1·4)-heptene-3-one-2. O. Wallach (*Ann.*, 1905, 339, p. 94) suggests that the ketone possesses the structure of a trimethyl-1 · 4 · 4-*cyclo*heptadiene-5 · 7-one-2. Phosphorus pentachloride converts it into 2-chlorcymene (A. Klages, *Ber.*, 1899, 32, p. 2558).

Camphor, $C_{10}H_{16}O$, is a trimethyl-1 · 7 · 7-*bicyclo*-(1 · 2 · 2)-heptanone-2. The *d*-variety is found in the camphor tree (*Laurus camphora*), from which it may be obtained by distillation in steam. The *l*-variety is found in the oil of *Matricaria parthenium*. It crystallizes in transparent prisms which possess a characteristic odour, sublimes readily and is easily soluble in the usual organic solvents. It boils at 209° C. and melts at 176° C. (*circa*). The *d*-form may also be obtained by the distillation of calcium homocamphorate (A. Haller, *Bull. Soc. Chim.*, 1896 (3), 15, p. 324). When heated with phosphorus pentoxide it yields cymene, and with iodine, carvacrol. Nitric acid oxidizes it to camphoric acid, $C_8H_{14}(CO_2H)_2$, camphoronic acid, $C_9H_{14}O_6$, and other products. It forms an oxime with hydroxylamine which on dehydration yields a nitrile, from which by hydrolysis campholenic acid, $C_9H_{15}CO_2H$, is obtained. It combines with aldehydes to form alkylidene compounds, and yields oxymethylene compounds when subjected to the "Claisen" reaction. It does not combine with the alkaline bisulphites. It is readily substituted by chlorine and bromine; and with fuming sulphuric acid forms a camphor sulphonic acid. Sodium reduces it, in alcoholic solution, to borneol. When heated with sodium formate to 120° C. it is converted into bornylamine. Caro's acid converts it into campholid, and a compound $C_{10}H_{16}O_4$ (A. v. Baeyer and V. Villiger, *Ber.*, 1899, 32, p. 3630). When heated with concentrated sulphuric acid to 105–110° C. it yields carvenone and 4-aceto-1 · 2-xylol (J. Bredt, *Ann.*, 1901, 314, p. 371).

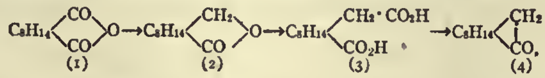
A vast amount of work has been done on the constitution of the camphor molecule. The earlier investigations on the ready formation of benzene derivatives by the breaking down of camphor led to the view that the molecule was a simple six-membered carbon ring. Subsequent research, however, showed that the formula proposed by J. Bredt (*Ber.*, 1893, 26, p. 3047), in which camphor is to be regarded as a *bicyclo*-heptane derivative, is correct. This formula is based on the fact that camphoronic acid yields trimethylsuccinic, isobutyric, and carbonic acids, and carbon on dry distillation, and Bredt suggested that it was an $\alpha\alpha\beta$-trimethylcarballylic acid,

$$HO_2C\cdot CH_2\cdot C(CH_3)(CO_2H)\cdot C(CH_3)_2CO_2H,$$

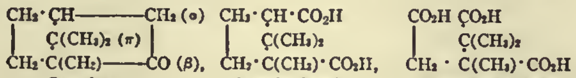
a conclusion confirmed by its synthesis (see below). The Bredt formula is also supported by the synthesis of *r*-camphoric acid by G. Komppa (*Ber.*, 1901, 34, p. 2472; 1903, 36, p. 4332). In this synthesis ethyl oxalate is condensed with $\beta\beta$-dimethyl glutaric ester, and the resulting diketoapocamphoric ester (1) is then methylated to diketocamphoric ester (2). The keto groups in (2) are converted in CH_2 groups as follows:—Sodium amalgam converts this ester into dioxycamphoric ester (3), which with hydriodic acid and phosphorus yields *r*-dihydrocamphoric acid. At 125° C. this compound combines with hydrobromic acid to form β-bromcamphoric acid, which on reduction with zinc and acetic acid yields *r*-camphoric acid (4):—



This series of reactions leads to a complete synthesis of camphor, since A. Haller (*Comptes rendus*, 1896, 122, p. 446) has shown that camphoric anhydride (1) on reduction yields campholid (2), which by the action of potassium cyanide and subsequent hydrolysis of the nitrile formed is converted into homocamphoric acid (3), the calcium salt of which yields camphor (4) on distillation:—



Thus camphor and its oxidation products are to be represented as



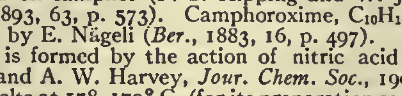
Camphor, Camphoric acid, Camphoronic acid.

Camphor yields three classes of halogen substitution derivatives known respectively as α, β and π compounds, the positions being shown in the formula above. The α compounds result by direct substitution, the β and π derivatives being formed in an indirect manner. Cyancamphor, $C_{10}H_{15}O\cdot CN$, is formed by passing cyanogen gas into sodium camphor, or by digesting sodium oxymethylene camphor with hydroxylamine hydrochloride (L. Claisen, *Ann.*, 1894, 281, p. 351).

π-Camphor sulphonic acid results from the action of fuming sulphuric acid on camphor (F. S. Kipping and W. J. Pope, *Jour. Chem. Soc.*, 1893, 63, p. 573). Camphoroxime, $C_{10}H_{16}O{:}NOH$, was first prepared by E. Nägeli (*Ber.*, 1883, 16, p. 497).

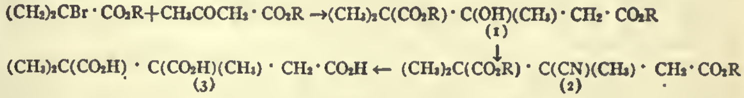
l-Camphor is formed by the action of nitric acid on *l*-borneol (W. J. Pope and A. W. Harvey, *Jour. Chem. Soc.*, 1901, 79, p. 76). *r*-Camphor melts at 178–179° C. (for its preparation see A. Debierne, *Comptes rendus*, 1899, 128, p. 1110; W. A. Noyes, *Amer. Chem. Jour.*; 1905, 27, p. 430).

Camphoric acid. Four optically active and two inactive forms of this acid are known. The most important is the *d*-form, which is produced by the oxidation of *d*-camphor with nitric acid. It crystallizes in plates or prisms which melt at 187° C. Potassium permanganate oxidizes it to oxalic acid and Balbiano's acid, $C_8H_{12}O_5$, together with small quantities of camphanic, camphoronic and trimethyl succinic acids. It yields two series of acid esters, the *allo*-esters (1), formed by the partial saponification of the neutral esters, and the *ortho*-esters (2), formed by heating the anhydride with alcohols or sodium alcoholates.



l-Camphoric acid results on oxidizing *l*-borneol or matricaria camphor. It melts at 187° C. *r*-Camphoric acid is formed on mixing alcoholic solutions of equimolecular quantities of the *d*- and *l*-acids, or by oxidizing *i*-camphor. It melts at 202–203° C.

Camphoronic acid, $C_9H_{14}O_6$. From a study of its distillation products J. Bredt (*Ber.*, 1893, 26, p. 3049) concluded that this acid was an $\alpha\alpha\beta$-trimethylcarballylic acid, a conclusion which was confirmed by its synthesis by W. H. Perkin, junr., and J. F. Thorpe (*Jour. Chem. Soc.*, 1897, 71, 1169):—Aceto-acetic ester is condensed with α-bromisobutyric ester, the resulting hydroxytrimethyl glutarate (1) converted into the chlor- and then into the corresponding cyan-trimethyl glutarate (2), which on hydrolysis with hydrochloric acid yields camphoronic acid (3) and some trimethyl glutaconic acid:—



Fenchone, $C_{10}H_{16}O$, is trimethyl-(2·7·7)-*bicyclo*-(1·2·2)-heptanone-3. It occurs in *d*- and *l*-forms, the former in oil of fennel and the latter in oil of thuja. It may be obtained from these oils by treating the fraction boiling between 190–195° C. with nitric acid and distilling the product in a current of steam. The fenchones are pleasant-smelling oils which boil at 192–193° C., and on solidification melt at 5–6° C. They do not combine with sodium bisulphite. They dissolve unchanged in cold concentrated hydrochloric and sulphuric acids, and are very stable; thus the monobromfenchone is only formed by heating the ketone with bromine to 100° C. under pressure (H. Czerny, *Ber.*, 1900, 33, p. 2287). On oxidation with potassium permanganate it yields acetic and oxalic acids together with dimethylmalonic acid. By the action of hot concentrated sulphuric acid it yields acetyl-ortho-xylene,

$$CH_3CO(4)C_6H_3(CH_3)_2(1\cdot 2)$$

(J. E. Marsh, *Jour. Chem. Soc.*, 1899, 75, p. 1058). When heated with phosphorus pentoxide to 115–130° C. it forms metacymene. Since it does not yield any oxymethylene compounds, it cannot contain the grouping—$CH_2\cdot CO$—in the molecule.

Hydrocarbons, $C_{10}H_{18}$, of the Terpene Series

Menthene, $C_6H_9(CH_3)(C_3H_7)$, is methyl-1-isopropyl-4-*cyclo*hexene-3. It is obtained by the action of anhydrous zinc chloride or copper sulphate on menthol (J. W. Brühl, *Ber.*, 1892, 25, p. 142), by boiling menthyl chloride with aniline (G. Wagner, *Ber.*, 1894, 27, p. 1636), by heating menthyl chloride with potassium phenolate (L. Masson, *Ber.*, 1896, 29, p. 1843), and by the dry distillation of the methyl ester of menthyl xanthate (L. Tschugaeff, *Ber.*, 1899, 32, p. 3333). It is a colourless liquid which boils at 167–168° C. When strongly heated with copper sulphate it yields cymene. According to Tschugaeff, the xanthate method alone gives a pure menthene of the above constitution, the menthene obtained from the dehydration of menthol being a *cyclo*hexene-4; and the one obtained by O. Wallach (*Ann.*, 1898, 300, p. 278) from *l*-menthylamine being a *cyclo*hexene-2.

Carvomenthene, $C_6H_9(CH_3)(C_3H_7)$, is probably methyl-1-isopropyl-4-*cyclo*hexene-1. It is prepared by heating carvomenthyl bromide with quinoline, or by heating carvomenthol with potassium bisulphate to 200° C. It is a liquid which boils at 175–176° C.

Camphane, $C_7H_{11}(CH_3)_3$ is 1·7·7-trimethyl-*bicyclo*-(1·2·2)-heptane. It is prepared by the action of sodium and alcohol on pinene hydriodide, or by reducing the hydriodide with zinc in acetic acid solution. It is a crystalline solid which melts at 153° C. and boils at 160° C.

Olefine Terpenes

Myrcene, $C_{10}H_{16}$, was first isolated by F. B. Power and C. Kleber from oil of bay (Schimmel & Co., *Bulletin*, April 1895, p. 11); it is also found in oil of sassafras leaves. It is obtained from bay oil by shaking the oil with a 5 per cent. solution of caustic soda, followed by fractionation *in vacuo*. It boils at 67–68° C. (20 mm.), and polymerizes when heated for some time. When oxidized by potassium permanganate it yields succinic acid. By the action of glacial acetic acid in the presence of dilute sulphuric acid, a liquid is produced, which on hydrolysis yields myrcenol, $C_{10}H_{18}O$, an alcohol which is probably an isomer of linalool (P. Barbier, *Comptes rendus*, 1901, 132, p. 1048). The hydrocarbon is probably to be considered as being $(CH_3)_2C : CH\cdot(CH_2)_2\cdot C(:CH_2)\cdot CH : CH_2$ (Enklaar, *Bulletin of Rouse-Bertrand fils*, Nov., 1906, p. 92). Ocymene is an isomer which can be extracted from the leaves of the basil. Enklaar (*loc. cit.*) represents it as $(CH_3)_2C : CH\cdot CH_2\cdot CH : C(CH_3)\cdot CH : CH_2$. Anhydro-geraniol, $C_{10}H_{16}$, the first olefine terpene isolated, was prepared in 1891 by F. W. Semmler; it is formed when geraniol is heated with potassium bisulphate to 170° C.

Alcohols, Aldehydes and Ketones

d-*Citronellol*, $C_{10}H_{19}OH$ or $CH_3\cdot C(:CH_2)\cdot(CH_2)_3\cdot CH(CH_3)\cdot(CH_2)_2OH$, or 2·6 dimethyl-octene-1-ol-8 occurs in Réunion geranium oil and was first prepared by F. D. Dodge (*Amer. Chem. Jour.*, 1889, 11, p. 463) by reducing the corresponding aldehyde (*d*-citronellal). It is an odorous oil which boils at 117–118° C. (17 mm.). Oxidation by chromic acid mixture converts it into citronellal, whilst a more drastic oxidation with potassium permanganate yields acetone and β-methyladipic acid.

l-*Rhodinol*, $C_{10}H_{19}OH$ or $(CH_3)_2C:CH\cdot(CH_2)_2\cdot CH(CH_3)\cdot(CH_2)_2\cdot OH$, or 2·6 dimethyl-octene-2-ol-8, occurs in the essence of geranium and of rose. It is a structural isomer of citronellol (P. Barbier and L. Bouveault, *Comptes rendus*, 1896, 122, pp. 529, 673; *Bull. Soc. Chim.*, 1900, [3], 23, p. 459), and its inactive form has been synthesized from ethyl heptenone. It is an oil of strong rose odour, which boils at 110° C. (10 mm.). Chromic acid mixture oxidizes it to rhodinal and rhodinic acid, whilst by drastic oxidation it yields acetone and β-methyladipic acid.

Geraniol, $C_{10}H_{17}OH$, or $(CH_3)_2C:CH\cdot(CH_2)_2\cdot C(CH_3):CH\cdot CH_2OH$, 2·6 dimethyl-octadiene-2·6-ol-8, is found in the oils of geranium, citronella, neroli, petit-grain, spike, ylang-ylang, and in Turkish and German rose oil. It is prepared from the oils by treating them with alcoholic potash and then fractionating *in vacuo*. The geraniol fraction is then mixed with freshly dried calcium chloride and the mixture allowed to stand *in vacuo* at a low temperature, when the compound $C_{10}H_{18}O\cdot CaCl_2$ separates out. This is washed with absolute ether and finally decomposed by water, when pure geraniol is liberated (O. Jacobsen, *Ann.*, 1871, 157, p. 232; J. Bertram and E. Gildemeister, *Jour. prak. Chem.*, 1897 (2), 56, p. 507). It may also be prepared by reducing the corresponding aldehyde (citral) with sodium amalgam. It is a colourless, pleasant-smelling oil, which boils at 230° C. Oxidation converts it into citral and geranic acid, $(CH_3)_2C:CH\cdot(CH_2)_2\cdot C(CH_3):CH\cdot CO_2H$. By shaking it with 5 per cent. sulphuric acid it yields terpin hydrate, and when heated with concentrated alcoholic potash to 150° C. it is converted into dimethylheptenol (P. Barbier, *Comptes rendus*, 1899, 128, p. 110). Geraniol may be converted into linalool by distilling a faintly alkaline solution of acid geranyl phthalate with steam.

Nerol, $C_{10}H_{17}OH$, was obtained in 1902 from neroli oil by A. Hesse and O. Zeitschel (*Jour. prak. Chem.*, 1902 (2), 66, p. 481); it also is found in petit-grain oil. It boils at 226–227° C. (755 mm.), and has a distinctive rose odour. It is inactive and is to be regarded as a stereo-isomer of geraniol. It does not form a compound with calcium chloride. It combines with four atoms of bromine to form a characteristic tetrabromide. It is formed (along with other products) by the action of acetic acid on linalool (O. Zeitschel, *Ber.*, 1906, 39, p. 1780) and also by the reduction of citral-*b*.

Linalool, $C_{10}H_{17}OH$, or $(CH_3)_2C:CH\cdot(CH_2)_2\cdot C(CH_3)(OH)\cdot CH:CH_2$, is 2·6-dimethyloctadiene-2·7-ol-6. *d*-Linalool was first found in coriander oil, and *l*-linalool in oil of linaloe. It is also found in oil of bergamot, petit-grain, lavender, neroli, spike, sassafras leaves and lemon, either in the free condition or as esters. It is a pleasant-smelling liquid which boils at 197–199° C. (according to its source). The inactive variety can be prepared from geraniol, this alcohol on treatment with hydrochloric acid yielding a mixture of chlorides, which when digested with alcoholic potash are transformed into *i*-linalool (F. Tiemann and F. W. Semmler, *Ber.*, 1898, 31, p. 832). It is oxidized by chromic acid to citral. When shaken for some time with dilute sulphuric acid it yields terpin hydrate.

Citronellal, $C_{10}H_{18}O$, is the aldehyde of citronellol. It is a constituent of many essential oils, and was first discovered in citronella oil by F. D. Dodge (*Amer. Chem. Jour.*, 1889, 11, p. 456); it is also found in eucalyptus oil and in lemon-grass oil. It is a dextrorotatory liquid which boils at 203–204° C. It is readily reduced by sodium amalgam to citronellol, and oxidized by ammoniacal silver oxide to citronellic acid. Potassium permanganate oxidizes it to acetone and β-methyladipic acid. It forms a dimethyl acetal, $C_{10}H_{18}(OCH_3)_2$, which on oxidation with potassium permanganate yields a dioxydihydro-citronellaldimethyl acetal,

$$CH_3\cdot C(CH_2OH)(OH)\cdot(CH_2)_3\cdot CH(CH_3)\cdot CH_2\cdot CHO,$$

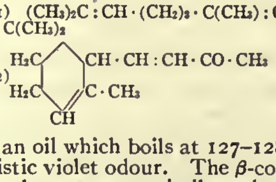
which must possess the above composition, since on further oxidation by chromic acid it yields a keto-aldehyde of the constitution $CH_3CO(CH_2)_3\cdot CH(CH_3)\cdot CH_2\cdot CHO$ (C. D. Harries and O. Schauwecker, *Ber.*, 1901, 34, p. 2981); this reaction leads to the formulation of citronellal as a dimethyl-2·6-octene-1-al-8. Citronellal is readily converted into an isomeric cyclic alcohol *isopulegol* ($\Delta 8(9)$-terpenol-3) by acids or acetic anhydride (F. Tiemann, *Ber.*, 1896, 29, p. 913). It combines with sodium bisulphite, giving a normal bisulphite and also a mono- and dihydrosulphonic acid.

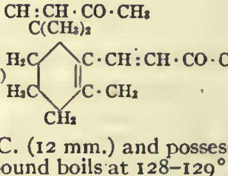
Geranial (citral), $C_{10}H_{16}O$, is the aldehyde corresponding to geraniol. It occurs in the oils of lemon, orange, lemon-grass, citronella, bay, verbena, and in various eucalyptus oils. It may be obtained from the oils by means of its bisulphite compound, provided the operation is carried out at low temperature, otherwise loss occurs owing to the formation of sulphonic acids. Synthetically it may be produced by the oxidation of geraniol with chromic acid mixture, or by distilling a mixture of calcium formate and calcium geraniate. Its aldehydic nature is shown by the facts that it forms an alcohol on reduction, and that on oxidation it yields an acid (geranic acid) of the same carbon content. The position of the ethylene linkages in the molecule is proved by the formation of addition compounds, by its products of oxidation (acetone, laevulinic acid), and by the fact that on warming with potassium carbonate solution it yields methyl heptenone and acetaldehyde (F. Tiemann, *Ber.*, 1899, 32, p. 107). On fusion with potassium bisulphate it forms para-cymene. It combines with β-naphthylamine and pyruric acid, in alcoholic solution, to form the characteristic citryl-β-naphthocinchonic acid, $C_{23}H_{23}NO_2\cdot\frac{1}{2}H_2O$, which is useful for identifying citral. The crude citral obtained from essential oils is a mixture of two ethylene stereoisomers which are designated as citral-*a* and citral-*b* (F. Tiemann and M. Kerschbaum, *Ber.*, 1900, 33, p. 877). Citral-*a* boils at 110–112° C. (12 mm.) and citral-*b* at 102–104° C. The structural identity of the two forms has been confirmed by C. Harries (*Ber.*, 1907, 40, p. 2823), who has shown that their ozonides (prepared from the citrals by the action of ozone on their solution in carbon tetrachloride) are quantitatively decomposed in both cases into acetone, laevulinic aldehyde and glyoxal. Lemon-grass oil contains 73 per cent. of citral-*a* and 8 per cent. of citral-*b*. Citral combines with sodium bisulphite to form a normal bisulphite compound, a stable dihydrosulphonate, an unstable dihydrosulphonate and a hydromonosulphonate (F. Tiemann, *Revue gén. de chim. pure et appl.*, 1, 16, p. 150). Citral condenses readily with acetone, in the presence of alkalis, to form pseudo-ionone (see *Ionone*, below).

The compounds of the citral series are readily converted into cyclic isomers by acids, the ring closing between the first and sixth carbon atoms in the chain. Two series of such compounds exist, namely the α and β series, differing from each other in the position of the double linkage in the molecule. The constitution of the α-series is determined by the fact that on oxidation they yield isogeronic acid, which can be further oxidized to $\beta\beta$-dimethyladipic acid; the β-series in the same way yielding geronic acid and $\alpha\alpha$-dimethyladipic acid. The *cyclo*citrals themselves cannot be obtained direct from citral by the action of acids, since under these conditions para-cymene results, but they are prepared by boiling citrylidenecyanacetic ester with dilute sulphuric acid and subsequent hydrolysis of the cyclic ester with caustic potash (F. Tiemann, *Ber.*, 1900, 33, p. 3719), or citral may be condensed with primary amines to the corresponding aldehydeimino compounds, which are then isomerized by concentrated acids, the amine group being hydrolysed at the same time (German Patent, 123747 (1901)).

Ionone, $C_{13}N_{20}O$. By condensing citral with acetone F. Tiemann (*Ber.*, 1893, 26, p. 2691) obtained pseudo-ionone (1), an oil of boiling-point 143–145° C. (12 mm.), which on boiling with sulphuric acid is converted into a mixture of the isomeric α- and β-ionones (2 and 3)

(1) $(CH_3)_2C:CH\cdot(CH_2)_2\cdot C(CH_3):CH\cdot CH:CH\cdot CO\cdot CH_3$

(2) 

(3) 

α-Ionone is an oil which boils at 127–128° C. (12 mm.) and possesses a characteristic violet odour. The β-compound boils at 128–129° C. (10 mm.) and possesses a similar odour. They are largely used in perfumery. An isomer of ionone is irone, the odoriferous principle of the iris root. It boils at 144° C. (16 mm.). When heated with hydriodic acid and phosphorus it yields the hydrocarbon irene, $C_{13}H_{18}$ (F. Tiemann, *loc. cit.*).

Sesquiterpenes

Cadinene, $C_{15}H_{24}$, is found in the oils of cade (from the wood of *Juniperus oxyeldrus*), cubeb, patchouli, galbanum, cedar-wood and juniper. It may be obtained by fractionating oil of cade, converting the crude hydrocarbon into its dihydrochloride and decomposing this by boiling with aniline. It is an oil which boils at 274–275° C. and decomposes on exposure. *Caryophyllene* is found in oil of cloves and in oil of copaiba balsam. Various other sesquiterpenes have been described, *e.g.* zingiberene (from essence of ginger), cedrene (from oil of cedar-wood), santalene (from oil of sandal-wood), humulene and clovene.

Of the sesquiterpene alcohols pure *santalol*, $C_{15}H_{26}O$, has been obtained from essence of sandal-wood by conversion into the acid phthalic esters and saponification of these by potash (Schimmel & Co., *Bulletin*, April 1899, p 41). A mixture of two alcohols is thus obtained, one boiling at 165–167° C. (13 mm.) and the other at 173° C. They are distinguished by their different optical activities, one being practically inactive, the other strongly laevo-rotatory (see also M. Guerbet, *Comptes rendus*, 1900, 130, p. 417; *Bull. Soc. Chim.*, 1900 (3), 23, p. 540). Caryophyllene alcohol is obtained from oil of cloves; by elimination of water it yields clovene, $C_{15}H_{24}$, a liquid which boils at 261–263° C.

Many di- and tri-terpenes have been described, but as yet are not thoroughly characterized.

References.—Gildemeister and Hoffman, *The Volatile Oils* (Milwaukee, 1900); R. Meldola, *The Chemical Synthesis of Vital Products* (London, 1904); F. W. Semmler, *Die aetherischen Oele* (Leipzig, 1906); G. Cohn, *Die Riechstoffe* (Brunswick, 1904); J. M. Klimont, *Die synthetischen und isolirten Aromatica* (Leipzig, 1899); and F. Heusler, *Die Terpene* (Brunswick, 1896). For camphor see A. Lapworth, *Brit. Assoc. Rep.* for 1900, and O. Aschan, *Die Konstitution des Kamphers* (Brunswick, 1903). (F. G. P.*)

TERRACE (Fr. *terrace*, *terrasse*, from It. *terraccia*, *terrazza*, Lat. *terra*, earth), a raised platform of earth; in geology the term is used of level horizontal ridges on the side of a slope, formed by volcanic action, or more usually by the action of water; they are thus frequent along the shores of lakes or by rivers; on the sea-shore they are generally known as "raised beaches." The term is used in architecture of an artificial platform in front of a building, which is utilized as a promenade; sometimes, when the building is erected on an elevation, there may be a series of terraces rising one above the other, with flights of steps leading from one to the other, as in the Villa D'Este at Tivoli; or there may be a single terrace raised high above the ground and supported on arches, as the terrace to the Adelphi buildings in the Strand, or the river front at Somerset House, or in France at the castles at Amboise and St Germain-en-laye, or again a low terrace like that in front of the Houses of Parliament at Westminster overlooking the Thames, which is 670 ft. long and 35 ft. wide. The terraces of the gardens at Isola Bella on the Lago Maggiore are known as hanging gardens (*Hortus pensilis*), and were similar to those which were built by the Assyrian king at Babylon. Though properly applied to a row of buildings on a raised level, the word is often used of any row of houses.

TERRACINA (Lat. *Tarracina*, Volsc. *Anxur*), a town and episcopal see of the province of Rome, Italy, 76 m. S.E. of Rome by rail (56 by the Via Appia), 40 ft. above sea-level. Pop. (1901) 7597 (town), 10,995 (commune). Its position, at the point where the Volscian Hills reach the coast, leaving no space for passage between them and the sea, commanding the Pomptine Marshes (*urbs prona in paludes*, as Livy calls it) and possessing a small harbour, was one of great strategic importance; and it thus appears very early in Roman history. It appears in 509 B.C. as under Roman supremacy, but is not included in the list of the Latin league of 499 B.C. In 406 it was stormed by the Romans, lost in 402, recovered in 400, unsuccessfully attacked by the Volscians in 397, and finally secured by the establishment of a colony of Roman citizens in 329 B.C. As such it frequently appears in history. The construction of the Via Appia in 312 B.C. added to its importance: the road at first crossed the hill at the back of the promontory by a steep ascent and descent. An attempt was made in 184 B.C. to get round it by an embankment thrown out into the sea: but it was probably not until early in the imperial period that a cutting in the rocks at the foot of the promontory (Pisco Montano) finally solved the problem. The depth of the cutting is indicated by marks on the vertical wall at intervals of 10 Roman ft.—figures enclosed in large swallow-tail tablets—the lowest mark, 3 or 4 ft. above the present road, is CXX. Not far off are mineral springs by the coast (*Neptuniae aquae*), known to the Romans and still in use—except one containing arsenic which was blocked up both by the ancients and again in 1839 as a precaution. The two roads met some few miles E. of Tarracina, and the Via Appia then traversed the pass of Lautulae, between the mountains and the Lake of Fondi, where the Samnites defeated the Romans with loss in 315 B.C. This pass, the frontier between the Papal States and the kingdom of Naples, was also fortified in modern days. It was probably in consequence of the cutting just mentioned that some of the more important buildings of the imperial period were erected in the low ground by the shore, and near the small harbour. The construction of the coast road, the Via Severiana, from Ostia to Tarracina, added to the importance of the place; and the beauty of the promontory with its luxuriant flora and attractive view had made it frequented by the Romans as early as 200 B.C. Galba and Domitian possessed country houses here. It appears in the history of the Gothic wars, and Theodoric is said to have had a palace here. It was sacked in 409 and 595. In 872 John VIII. brought it under the domination of the Holy See.

The picturesque modern town occupies the site of the old; the present piazza is the ancient Forum, and its pavement of slabs of travertine with the inscription "A. Aemilius A. F.," in letters once filled in with bronze, is well preserved. It is supported by massive arched substructures, which extend under the surrounding houses. The cathedral of SS. Pietro e Cesareo, fronting upon it, is ensconced in a temple of Rome and Augustus, part of the side wall of which, with engaged columns, is still visible. The vestibule, in the Cosmatesque style, is supported by ten ancient columns resting upon recumbent lions, with a mosaic frieze upon them. The brick campanile has small columns with little pointed arches. The interior has a fine Cosmatesque pulpit supported by ancient columns resting on lions, a Paschal candlestick of 1245, and a good pavement of the same period with beasts and dragons. The sacristy contains a carved wooden nuptial chest of the 10th or 11th century. There are also remains of the town wall in the "polygonal" style, and above the town are several massive platforms for supporting buildings, in a more archaistic form of this style; these may well belong to the Roman period, and the latter even to the empire. The summit of the promontory (748 ft.) is reached by the old line of the Via Appia, which is flanked by tombs and by remains of an ancient defensive wall with circular towers (currently attributed to Theodoric, but probably a good deal earlier in date). The summit is occupied by a massive terrace, supported by arcades of fine *opus incertum* (traditionally, but wrongly, called the palace of Theodoric) on all sides except the E., and commanding a magnificent view seaward over the coast and over the Pomptine Marshes. On the terrace, as was ascertained in 1894, stood a Corinthian temple of the early imperial period, 110 by 65 ft.; the cella was decorated internally with engaged half-columns, and contained the pedestal for the statue of the deity, according to some authorities Venus, but more probably Jupiter Anxur worshipped as a child—a theory confirmed by the discovery of many curious leaden toys, like those made for dolls' houses at the present day, in the *favissae* on the E. of the temple. Of the lower town by the harbour, which had buildings of some importance of the imperial period (amphitheatre, baths, &c.), little is now visible, and its site is mainly occupied by a new quarter built by Pope Pius VI., who restored the Via Appia through the Pomptine Marshes. Close by it in the S.W. is a group of huts inhabited in winter by labourers from the Abruzzi, as is the case in many other parts of the Campagna. Of the ancient harbour constructed by Antoninus Pius (M. R. de la Blanchère in *Mélanges de l'école française de Rome*, i. 322; 1881) insignificant remains exist, and it is largely silted up. Close to it is the small modern port. Near the amphitheatre was found in 1838 the famous statue of Sophocles now in the Lateran museum. The commune of Terracina includes a considerable extension of territory towards the N.W. with much undergrowth (*macchia*) valuable for charcoal burning, and a considerable extent of pasture and arable land. The ancient aqueduct, bringing water some 35 m. from the slopes of the Volscian Hills, has been repaired and is in use. Three miles to the N.W., at the foot of the Monte Leano, was the shrine of the nymph Feronia, where the canal following the Via Appia through the marshes ended. Along these 3 m. of the Via Appia are numerous ancient tombs, and the fertile valley to the N.E. was thickly populated in Roman days.

See M. R. de la Blanchère, *Terracine* (Paris, 1884). (T. As.)

TERRACOTTA. *Greek.*—The use of clay amongst the Greeks was very varied and extensive, but we are here only concerned with one aspect of it, that in which the clay was baked without any glaze, whether employed for utilitarian or ornamental purposes. The Greek term for this is γῆ ὀπτή, "baked earth"; the word πηλός when applied to worked clay signifies "sun-dried" only. Among the manifold purposes to which terracotta was put by the Greeks may be mentioned parts of public and private buildings, such as bricks, roof tiles, drain and flue tiles, and architectural ornaments; tombs and coffins; statues and statuettes, for votive or sepulchral purposes or for the decoration of houses; imitations of metal vases and jewelry; and such everyday objects as spindle whorls, theatre tickets, lamps, braziers and domestic utensils. It also supplied the potter with moulds and the sculptor with models of works of art, especially in bronze.

Use in Architecture.—In architecture terracotta was extensively employed for roof tiles and other decorative details, as has been shown by many recent discoveries, especially at Olympia. In the Heraion we have the oldest example of a terracotta roof. A 6th-century temple at Thermon in Acarnania is also constructed of wood and terracotta, with painted terracotta slabs in wooden frames for metopes. The generic term for a roof tile was *κέραμος*, and these are classified as flat square tiles (*στεγαστῆρες* or *σωλῆνες*) and semi-cylindrical covering tiles (*καλυπτῆρες*). Other varieties of ornamental tiles used in buildings are (1) the covering slabs along the raking-cornice (*γεῖσον*) of the pediment; (2) the *κυμάτιον* or cornice above the *γεῖσον*; (3) the cornice along the sides with lions' head spouts to carry off rain-water; (4) the *ἀκρωτήρια* or antefixal ornaments surmounting the side-tiles. These latter varieties were usually enriched with decoration in colour, the *κυμάτιον* being painted with elaborate patterns of lotos-and-honeysuckle or Greek key-pattern, in red, blue, brown and yellow, curvilinear patterns being restricted to curved, rectilinear to flat surfaces. The antefixal ornaments were usually modelled in the form of an anthemion or palmette, but were sometimes adorned with reliefs or sculptured groups, as in the case of the temple of Zeus at Olympia, which has figures of Victory along the cornice. The British Museum has an interesting series of 6th-century date from Capua, with gorgons' heads, female busts, and other subjects in relief, and others come from an early 5th-century temple at Civita Lavinia. Many coloured roof tiles have been found at Olympia.

In Sicily and southern Italy a fashion prevailed of nailing slabs of terracotta over the surface of the stonework (a legacy from the epoch of wooden buildings which required protection from the weather). These were ornamented with lotos-and-honeysuckle and other patterns, sometimes in relief but always richly coloured. They occur at Olympia in the Treasury of Gela, by a Sicilian architect, and also in a temple at Selinus. The best example of this practice is the temple at Civita Lavinia already cited, the remains of which belong partly to the 6th, partly to the 4th century B.C.

Sculpture.—The subject of Greek sculpture in terracotta is a large one, and only its brief outlines can be given here. Of large or life-size statues comparatively few examples are known, and they can only be said to be common in Cyprus, where marble was difficult to procure; they are also more frequent in Italy, as will be seen later. But the use of clay for the reproduction of the human figure was one of the earliest instincts of the race, and may be traced back as far as archaeological records exist, to the days of the Minoan and Aegean supremacies. Terracotta figures of a very primitive character have been found in Crete, in Melos and at Olympia, and one series of figures from Petsofa in Crete is remarkable for the very modern fashions of head-dress and costumes. Terracotta figures of more advanced style have also been found in Rhodes and other places dating from the Mycenaean period.

Greek traditions on the subject go back to one Butades of Sikyon, a potter who was credited with the invention of modelling clay in relief; and the Samian sculptors Theodorus and Rhoikos, who lived about the end of the 7th century B.C., were said to have been the first to use clay models for statues. As they were supposed to have introduced hollow casting in bronze, it was obviously for this purpose that they employed clay. But this material was later superseded by wax, and for marble statues was not used until Roman times.

The small terracotta figures used as ornaments or household gods, buried in tombs or dedicated in temples, trace their pedigree from the prehistoric examples already mentioned. They have been found in large numbers on nearly all the well-known sites of antiquity, the most fruitful being Tanagra in Boeotia, Myrina in Asia Minor, Rhodes, the Cyrenaica, Athens, Sicily, and some of the towns of southern Italy. They are also found in Cyprus and Sardinia, where, as to some extent in Rhodes, they follow a peculiar development, under the domination of Phoenician influence, and many of the earlier types have a markedly oriental character. But in the Greek terracottas we may trace a steady development from the primitive types which correspond to the *ξόανα* of primitive Greek religion, and for the most part represent actual deities, down to the purely *genre* figures of Tanagra and other Hellenistic products of highly-developed beauty. For beauty and charm the palm has by general consent been given to the Tanagra figures of the 4th and 3rd centuries B.C. which were known in antiquity as *κόραι* or "maidens," from the presence of seated or standing types of girls in various attitudes. The makers of these figures were known as *κοροπλάσται* or *κοροπλάσοι*, and are spoken of in literature, together with their wares, with some contempt.

Manufacture.—The processes employed in the manufacture of terracottas are five in number: (1) the preparation of the clay; (2) moulding; (3) retouching; (4) baking; and (5) colouring and gilding. The last named, though not essential, was almost universal in some form or another.[1]

The clay used for the statuettes varies greatly in different localities, and this is an important criterion for distinguishing the different sites of manufacture. It ranges in colour from a deep red (as in the brick-like terracottas of Naukratis) to a pale buff or drab as in Cyprus, and the fired product is generally softer than that of the painted vases. It was prepared by washing the local clay free from all granular substances and then kneading it with the aid of water. The modelling was done by hand in the case of the earlier figures, and small objects such as toys and dolls, which are solid; the clay was worked up into a mass with the fingers, the marks of which may often be seen. Subsequently the use of moulds became universal, the final touches being given to the figure either with the fingers or with a graving tool. The finer statuettes, such as those of Tanagra, are invariably moulded, and the better examples show traces of very careful retouching. The advantage of moulding was that the "walls" of the figure could be reduced to a very regular thickness, obviating the danger of shrinkage in the baking; it also rendered them very light, and permitted great accuracy in detail. A model (*πρότυπος*) was first made in terracotta with modelling tools, from which the mould (*τύπος*) was taken, also in terracotta and usually in two pieces, which were then baked to a considerable hardness. From this mould the figure was made by smearing it with layers of clay until a sufficient thickness was reached, leaving the figure hollow. The back was made separately, either from a mould or by hand, and then fitted carefully to the front, the seam or join being run up with soft clay. The base was usually left open, and a vent hole was left in the back, which aided the clay to dry and to be re-fired without cracking, and was also used sometimes for suspending the figure when finished. The heads and arms were usually moulded separately, and attached or luted to the body with soft clay. Greek moulds for statuettes are somewhat rare, but there are examples known from Kertch, Smyrna, Girgenti and Tarentum; the British Museum has a series from the last-named site (Pl. I. fig. 3). Most of these are for small figures only.

The shrinkage of the clay as it dried permitted the figure to be drawn easily from the mould, and the reproduction was then ready for retouching. It is obvious, from a glance at any collection of terracottas, that there is a great similarity between the various examples of any one type, and that many are virtually, if not actually, replicas of one another. This of course was due to the fact that only a limited number of moulds were used, corresponding to the various types. The minute differences between them, which constitute the charming variety found amongst these figures, and prevent monotony even where the type is constant, were obtained by the process of retouching, as well as by varying the pose of the head or limbs, or by differences of attributes and colourings. Actual retouching by a skilled modeller is seldom found except in the finer examples.

The process of baking required great care and attention, for if no allowance were made for the evaporation of moisture, or if too great a degree of temperature were reached, the result was disastrous. The clay was ensured against drying too rapidly by preliminary exposure to air and sunshine, while the temperature employed in firing was low even lower than that used for painted vases.

The colouring of the baked statuettes was fairly universal, the chief exceptions being some of the more archaic examples, and many of the Roman period. The surface on which the colours was laid was formed by a white slip or *engobe* of a creamy colour and consistency, with which the whole front of the figure was coated. This when dry became very flaky and has often fallen off, carrying the colours with it, though most statuettes retain at least traces of this treatment with slip. It is very unlikely that this slip-coating was fired at all. On the white slip-facing opaque

[1] Clever forgeries of Greek terracotta figures are now being produced both in France and Italy. Admitted copies are also made in Berlin and Vienna, but these are generally so inferior in artistic merit as not to deceive any one who knows the genuine article.

FIG. 1.—ETRUSCAN SARCOPHAGUS, 2nd century B.C.

FIG. 2.—ARCHAIC RELIEF FROM RHODES, about 480 B.C.

FIG. 3.—MOULD FOR TERRACOTTA FIGURE, FROM TARENTUM.

TERRACOTTA

FIG. 4.—GREEK TERRACOTTA STATUETTES.
1–3, from Tanagra (3rd century B.C.), 4–7, from Rhodes and Sicily (Archaic period).

FIG. 5.—VASE WITH TERRACOTTA FIGURES FROM SOUTHERN ITALY, 2nd century B.C.

FIG. 6.—ROMAN BAS-RELIEF FOR MURAL DECORATION.

colours were painted in *tempera* colours. The colouring was usually conventional, and only aimed at imparting a pleasing appearance to the figure. It was necessarily applied after the firing, as many of the pigments used would have been altered or destroyed at the firing temperature of the body. The tints were body-colours, applied without shading, and red, blue, yellow and black are those most commonly employed, the white slip serving for the nude parts and generally also for the ground-work. Blue and red were especially favoured for drapery, as in many of the Tanagra figures; the red ranging from scarlet to pink or rose purple. Black was only used for the eyes or details of features; yellow (varying to deep brown) for the hair, and also for jewelry. Gilding is rare but was frequently employed in later times for terracotta imitations of jewelry. In the primitive terracottas and those of Cyprus or other centres which adhered to primitive methods, the decoration is in stripes of *matt* black and red paint applied in a conventional manner to human figures and animals alike. True glazes or enamels are occasionally found, as for instance in the later terracottas of Sicily, where they are employed both for drapery and for flesh colours.

Greek terracotta statuettes have been discovered in tombs, on the sites of sanctuaries, and in private houses. The tomb-finds are scattered all over the Mediterranean littoral, and the chief sites have already been noted; among the sanctuaries we may cite Olympia, the Acropolis at Athens, the *temenos* of Demeter at Knidos, the temples at Naukratis in the Egyptian Delta, many sites in Cyprus, and temples at Selinus in Sicily and Tarentum. The purposes for which these statuettes were used, (*a*) for religious rites, (*b*) in daily life, (*c*) in funeral ceremonies, have been the subject of much debate. Since the same types and subjects are common to each of these classes of discoveries it is obvious that the terracottas cannot have been intended for one purpose alone even if their primary significance was religious. Numerous theories have been advanced on this subject, some authorities having maintained that their meaning was exclusively religious or mythological, that they originally corresponded to the Egyptian *ushabti*, and that these religious types were afterwards adopted for ordinary human figures symbolizing the life of the deceased beyond the tomb. The gradual change in popular taste from figures of deities to figures of a *genre* type is unquestionably a feature of the development of this branch of art, but that the development was affected by religious ideas is more open to doubt. It is more probable that it followed the lines of artistic evolution, and that the continued use of terracottas as votive or funeral offerings became more or less a convention. In fact, the identity of the types, under whatever circumstances they are found, seems to indicate that the significance was given to them by the purchaser, who would decide for himself whether he offered them to some appropriate deity, deposited them in the tomb of some relative, or kept them for use and decoration in his own house.

Subjects and Types.—The earliest beginnings of the statuettes proper show, as might be expected in primitive Greek art, a very limited range of subjects. As in other materials, so also in clay, the female deity reigns supreme. The primitive Hellenic type of goddess adopts two forms, both derived from an original in wood, the board-form *σανίς*, and the column form *κίων* or *ξόανον*, both of which we find also in sculpture. The limbs are wanting, or are at best rudimentary, the figure terminating below in a spreading base. Both types are found in Rhodes, but on the mainland of Greece the columnar type died out after the Mycenaean period, and only the board-type remained, this being specially popular in Boeotia, where both standing and sitting figures occur, painted in the same style as the local vases. This type was adhered to for the bodies of figures even when the head was modelled in a more advanced style of art. The column-type is also well exemplified in Cyprus. The standing and seated goddesses are the two principal types in archaic Greek art (Pl. II. fig. 4), and are widely distributed and of universal popularity; though the conception of the goddess may vary with the locality, the types are almost identical, and the attributes are but slightly varied. A certain proportion of these deities are differentiated as nature-goddesses, either as a nude goddess in a shrine or a seated figure with a child in her lap who may be described as the Earth-Mother. Both types are of oriental origin. Another common archaic type is the funeral mask or bust, hollow at the back, which is found both in central Greece and Rhodes. Being almost always feminine it seems probable that these are not images of the deceased, but the Chthonian goddesses Demeter and Persephone, playing in the tombs the rôle of protectress against evil influences. We may also mention here the little figures of animals, women and children variously occupied, and jointed dolls (*νευρόσπαστα*) which can only have served the purpose of children's toys. In Athens, Melos and Rhodes, many of these have been found in children's graves. The evidence of finds and other indications seems to show that these archaic types were not affected by the rapid development of Greek art in the 5th century, but continued in vogue until the end of that period. Certainly there are very few terracottas of developed style which can be assigned to an earlier period than the 4th century, and many figures of archaic type can be shown from the contents of the tombs in which they are found not to be earlier than the 5th century B.C. The reason for this is probably hieratic. Owing to their religious associations old conventional types continued in use, whereas painted vases and the majority of sculptures of a higher class were not affected by such considerations. Therefore we are not surprised when we come to the later terracottas of the fine period, or 4th century, to find the standing and seated feminine types still prominent. But the change in style is also accompanied by a change in conception, and in place of the goddess we now have the Greek lady—in place of the mythological the *genre*. The transformation was quite a simple one, and it needed little change to convert a nursing goddess into a mother with her little one, or a Persephone holding a flower into a girl of Tanagra. The change in fact was artistic rather than religious; an evolution rather than a revolution. The figures were still placed in tombs and shrines, though the old associations were less strongly felt.

In order to know what were the characteristics of the best Greek work in terracotta we must turn our attention to its most typical products, the Tanagra statuettes (Pl. II. fig. 4). Here we have an almost unlimited variety of feminine figures illustrating the daily life of Greek women. In most cases the arms are more or less concealed by the mantle which is drawn closely across the figure, even covering the hands; but many hold a fan, a mirror, a wreath, or a theatrical mask in one hand, while with the other they gather together the folds of their draperies. The long tunic or *chiton* and the mantle or *himation*, which all without exception wear, formed the typical dress of the Greek matron and girl; and to this was added for outdoor wear a large shady hat. The seated types follow on the same lines, but are not so common. These figures range in date from about 350 to 200 B.C., and their inspiration is probably drawn rather from the painting than the sculpture of the period. The terracottas of Eretria in Euboea and of Myrina in Asia Minor stand next in artistic merit, but are of more markedly Hellenistic character; they are freer from ancient tradition, but tend to degenerate into exaggeration of pose and conception. Here the types of divinities so conspicuously absent at Tanagra reappear; in particular Eros or Cupid, the one deity who universally caught the popular taste in the Hellenistic age, and in the many representations of whom we see the prototypes of the Pompeian Amoretti; Aphrodite, Dionysos and Victory are also popular themes. At some times the Tanagra types are repeated here, as, with varying artistic success, in other parts of the Mediterranean littoral.

Though no other Greek site has produced terracottas of such artistic merit as the two just discussed, there are others where the art enjoyed great popularity, either for a comparatively brief period or through the whole history of Greek art. Some of these centres of manufacture have already received mention or at least allusion, but we may briefly call attention to a few others. From Sicily we possess a complete series, from archaic to later times, the earlier being best represented at Selinus, where a great variety of richly coloured figures have been found; there are also many fine heads of 5th century style, and later figures of Aphrodite, Eros and other deities imitating the later types of Hellenistic art. At Naukratis in the Egyptian Delta the later terracottas are strongly influenced by Egyptian ideas, and figures like Bes and Horus are found in conjunction with orientalized Aphrodite-types. In the Cyrenaica on the north coast of Africa the influence of Tanagra is apparent, but the style is for the most part degenerate. The terracottas of Tarentum stand apart from those of other sites, being markedly funereal in character; many represent Dionysos reclining at a banquet. Elsewhere in Southern Italy the types correspond to those of Sicily and other Mediterranean sites.

Terracotta work in relief, apart from definitely architectural examples, is almost limited to two small classes, both belonging to the beginning of the 5th century. These groups, known respectively as "Melian" and "Locrian" reliefs, consist of small plaques, possibly intended to be inserted in the walls of temples or shrines. The subjects of the Locrian reliefs, which mostly relate to the myth and cult of Persephone, seem to indicate that they at least were of a votive character. They occur at Locri in Southern Italy, and similar examples dedicated to Athena have been found on the Acropolis at Athens. The Melian reliefs exhibit a wider scope of subjects, mainly mythological; the work is exceedingly delicate and refined in character. Some are simple plaques; others have the figures cut out without background, or only the outer contours. They have been found on various Greek sites, the majority in Melos (Pl. I. fig. 2).

There is a class of vases which comes rather under the heading of terracotta than of pottery, from its technical character and general appearance. These are found at Canosa, Calvi, Cumae and elsewhere in Southern Italy, and belong to the Hellenistic period (Pl. II. fig. 5). They combine in a marked degree the characteristics of the vase and the statuette, some being vases with moulded reliefs or small figures in the round attached; others actual figures or colossal heads modelled in vase form, with the addition of mouth, handle and base. They are often of gigantic size, and do not appear to have served any practical purpose; probably they were made specially for the tomb. They are covered with a white slip like the statuettes, and are often richly coloured. Some even have subjects painted in some permanent process like encaustic. The form usually adopted is that of a spherical vase with a flat handle on the top and three tall mouths.

Etruscan Terracotta Work.—Some features of terracotta work are peculiar to the people of Etruria, who employed this material both for finer works of art and for more utilitarian purposes. Several ancient writers speak of their preference for clay and their skill in its use. Pliny attributes its introduction to Corinthian refugees in the 7th century, and states that the art of modelling in clay was brought to perfection in Italy, and especially in Etruria. Certainly for their statues the Etruscans appear to have preferred clay to other materials (except perhaps bronze), and also for use in architecture. The Romans employed Etruscan artists to decorate their temples, and the statue of Jupiter on the Capitol was made by Volca of Veii about 500 B.C., in clay painted vermilion, as was also the chariot on the pediment of the temple. For the decoration of temples terracotta remained in use even down to Roman times; these buildings being usually of wood covered with slabs of terracotta, like the early Greek buildings discussed in the preceding section. Remains of temples with terracotta decoration of this kind have been found at Cervetri (Caere), at Alatri, and at Civita Castellana (Falerii), as well as at Civita Lavinia (*v. supra*). Other remains of terracotta decorations come from Conca (Satricum), Orvieto, Pitigliano and Luni, where the pediment of the temple has the figures of Olympian deities, muses and the slaughter of Nïobids, all executed in terracotta on a large scale. The date of these sculptures is about 200 B.C. At Alatri and Falerii the decoration consists of a complete system of terracotta plating over the woodwork of the roofs and architraves, ornamented with patterns in relief or painted and surmounted with carved antefixal ornaments. Some of the *antefixae* from Cervetri are very effective examples of sculpture and exhibit in a marked degree the influence of Ionic Greek art, due to the Hellenic elements with which the civilization of Caere and the Campanian cities was permeated.

The form of monument which best exhibits the Etruscan fondness for terracotta as a material for sculpture is the sarcophagus, of which some remarkable archaic examples exist, and a considerable number of later date. Among the former the most conspicuous example is the well-known Castellani sarcophagus in the British Museum, dating from the end of the 6th century B.C. The sides are decorated with friezes of figures in relief, and on the cover is a group of a man and a woman reclining, executed in the round life-size. These figures are undoubtedly genuine native work, and in the obvious inability of the sculptor to achieve success in working in the round they contrast strongly with the reliefs, which are truly Hellenic in style if not in subject. There are similar examples in the Louvre, and in the Museo Papa Giulio at Rome.

The later sarcophagi which belong to the 3rd century B.C. follow on the same lines. They invariably consist of a rectangular body or coffer with sculptured reliefs on the front and sides, and a flat cover on which reclines a figure representing the deceased person. They were used for holding the ashes of the dead. Usually they are of small size, measuring not more than 18 by 12 by 12 in., but some are large enough for a body to lie in at full length. The reliefs freely modelled in the style of later Etruscan art are often of a funerary character, representing the last farewell to the dead in the presence of Charon and other death-deities; others have mythological subjects, such as the combat of Eteokles and Polyneikes; the slaying of the dragon by Kadmos; or the parting of Admetos and Alkestis. They are usually painted *in tempera* on a white ground, the bright colouring having a very vivid effect.

By far the finest examples of this class are one from Cervetri, now in the British Museum, and another very similar in the Archaeological Museum at Florence, with which were found coins of about 150 B.C. The former (Pl. I. fig. 1) is shown by its inscription to be the tomb of one Seianti Thanunia, whose life-size effigy adorns its cover; a most realistic example of Etruscan portrait-sculpture in perfect preservation, richly coloured, and adorned with jewelry. The dimensions of this sarcophagus are 6 ft. by 2 ft. by 1 ft. 4 in.; it has no reliefs on the front but a simple pattern of pilasters and quatrefoils. Owing to its great size the figure of the lady was shaped in two halves, the joint being below the hips. The Florence sarcophagus represents a lady of the name of Larthia Seianti.

Roman Terracotta Work.—The uses of clay among the Romans were much the same as amongst the Greeks and Etruscans, in architecture and sculpture, as well as for other purposes; the main differences were that in some cases its use was more extensive in Rome, in others less; and generally that the products of Roman workshops are inferior to those of earlier times. But the technical processes are in the main those previously employed. The Romans divided the manufacture of objects in clay into two classes: *opus figulinum* for fine ware made from *argilla* or *creta figularis* and *opus doliare* for tiles and common earthenware. Of their use of tiles and bricks in architecture this is not the place to speak, except for the ornamental architectural details which come strictly under the heading of terracotta.

Ornamental tiles followed much on the lines of those used in Greece, whether roof-tiles or antefixal ornaments, though the latter are both simpler and inferior in design. Terracotta was largely used at Pompeii for this purpose, and also for gutters and well mouths. A characteristic feature of Pompeian houses is the trough-like gutter which formed an ornamental cornice to the *compluvium* or open skylight of the *atrium* and peristyle; these were adorned with spouts in the form of masks or animals' heads, through which the rain-water fell from the gutters into the *impluvium*. Some good examples of roof-tiles and antefixal ornaments have also been found at Ostia.

Terracotta mural decoration was also largely employed by the Romans for the interior and exterior of their buildings; in the form of slabs ornamented with reliefs hung on the walls or round the cornices. Cicero speaks of fixing the bas-reliefs (*typos*) "on the cornice of his little atrium." These slabs usually measure about 18 by 9 to 12 in., and have nearly all been found in Rome, though isolated examples occur in other places. There is a series of 160 in the British Museum (Pl. II. fig. 6), whole or fragmentary—nearly all of which were collected at Rome by Charles Towneley—and there is another large collection in the Louvre. Others from the Baths of Caracalla are in various museums at Rome.

These reliefs were pressed in moulds, as is shown by the frequent repetition of certain subjects with at most only slight differences; moreover the relief is low, with sharp and definite outlines such as a mould would produce. They were sometimes retouched before baking, hence the variations. Reliefs entirely modelled are much rarer, but some examples exist, of considerable artistic feeling and freedom. Circular holes are left in the slabs for the plugs by which they were attached in their places. The clay varies in quality and appearance, and in tone ranges from a pale buff to a dark reddish-brown. Traces of colouring are sometimes found; backgrounds of a light blue, and figures or more commonly details such as hair being painted red, yellow, purple or white. These colours are painted *in tempera*, and their use is purely conventional. The slabs are usually ornamental, with cornices of egg-pattern and palmettes, or with an edging of open-work.

The figures are mostly in low relief, grouped with large, flat surfaces between in the manner of contemporary Roman art; in some cases the whole groundwork is composed of patterns of scroll-work or foliage, more or less conventionalized. The compositions consist either of narrow friezes with rows of Cupids or masks, or groups of two or three figures resembling temple-metopes. The style is in general bold and vigorous, and being essentially architectural it is not devoid of dignity and beauty. The known examples fall into two groups according to their treatment: (*a*) The naturalistic style, corresponding to the so-called "Hellenistic" reliefs of Augustan art; (*b*) the conventional, not to say archaistic, corresponding to the classicist tendencies of another school of Augustan artists represented by the "New Attic" reliefs. Both groups find close parallels in the metal-work and pottery of this period, to which date they may therefore be assigned.

The subjects cover a very wide field. Many are no doubt inspired by well-known works of art; others are closely related to the "New Attic" types, including dancing and frenzied *maenads* or the seasons. Others again, reflecting the spirit of the time, reproduce Egyptian landscapes. Scenes from the circus or arena, or quasi-historical subjects, such as triumphs over barbarians, again illustrate favourite themes of Roman Imperial art. Of mythological subjects, the most popular are Dionysiac scenes, Satyrs gathering and pressing grapes, and Victory slaying a bull; while heroic legends are also represented. Of a more conventional type are figures of Cupids carrying wreaths, priestesses sacrificing, or single figures surrounded by elaborate scrolls.

Roman Sculpture in Terracotta.—Frequent allusions in classical writers indicate that the ancient statues of the Romans were mostly of terracotta, and Pliny notes that even in his day statuettes of clay were still preferred for temples. There are also references to *signa fictilia* placed on pediments of buildings such as the Capitoline temple. As noted in the previous section, during the greater part of the Republic, Rome was indebted for these to Etruscan artists, but the style of the figures was probably more Greek than Etruscan. In 493 B.C. Gorgasus and Damophilus of Himera in Sicily ornamented with terracotta reliefs and figures the temple of Ceres (now Santa Maria in Cosmedin). Towards the end of the Republic modellers in clay are mentioned, such as Possis, who imitated grapes and other fruit, and the sculptor Arcesilaus. But their work in this material appears to have been confined to models for sculpture or metal work, and the invasion of the masterpieces of Greek art and the general adoption of marble by sculptors led to the neglect of terracotta as a medium of the glyptic arts. Few statues of any size in this material now exist, but there is an interesting series in the British Museum, found in a well near Porta Latina at Rome in 1767, restored by Nollekens, and acquired by Charles Towneley. Some terracotta figures of considerable size were found at Pompeii, having formed the cult-statues of a temple; others were employed for adorning gardens, like the series from Rome just mentioned. Terracotta figures were also employed as architectural members of the caryatid type. All these belong to the Augustan and succeeding period, or at least are not later than the reign of Nero.

Terracotta statuettes similar in style to those of Greece are also found in houses and tombs of the Roman period or as votive offerings on sacred sites. They were known to the Romans as *Sigilla*, and were used as presents, or placed in the *lararia* or domestic shrines. Some 200 were found in the poorer quarters of Pompeii, implying that they took the place of the marble and bronze figures which the wealthier inhabitants alone could afford. At the festival of Sigillaria, part of the December Saturnalia, terracotta figures and masks were in great demand. Originally these were votive offerings to Saturn, but later the custom degenerated into that of giving them as presents to friends or children, a practice indulged in by the Emperors Hadrian and Caracalla.

The makers of these figures were known as *sigillarii* or *figuli sigillatores*, and they lived in the *Via Sigillaria*. Their social position appears to have been very low; but it must be remembered that they were chiefly patronized by the poorer classes; probably many of them were slaves. The technical processes which they employed were practically those of the Greek craftsmen. Large figures were made from models (*proplasmata*) and built up on a wooden frame-work known as *crux* or *stipes*; but the smaller ones were made from moulds. The range of subjects is much the same as in the later Greek terracottas. At Pompeii *genre* figures predominate, such as gladiators, athletes and slaves, and in general there is a preference for portraits and grotesques. On the whole these late works have little artistic merit. Votive figures have been found at Praeneste on the site of the temple of Fortune, and also at Nemi and Gabii.

This industry also extended from Rome to the provinces, and terracotta statuettes of local make have been found even in Britain, as at Richborough, Colchester and London. In Gaul in particular, and in the Rhine district, there were very extensive manufactures of terracottas after the conquest of Julius Caesar in 58 B.C. They were made by local craftsmen for the Roman colonists, who introduced their own types of design. The principal centre of manufacture was the district of the Allier in Central France. Potteries have been found at Moulins, as well as in other parts of France, in Belgium and Alsace, and along the Rhine. The figures found in the Allier district are made of a peculiar white clay, the technique resembling that of Roman work, but the modelling is heavy and often barbaric. Numerous moulds have also come to light which show that the figures were made in two pieces; on the exterior of these moulds the potters' names have frequently been scratched (to indicate ownership). Names appear on the figures as well as on the moulds, and many of these are of Gaulish origin. The commonest names are those of Pistillus of Autun, Rextugenus, a potter of north-west France, and Vindex of Cologne. The subjects include divinities, *genre* figures, and animals; among the former the pre-eminent type is that of a Nature-Goddess, characterized either as Venus Genetrix or as a Mother with a Child (*κουροτρόφος*). Both in subject and in artistic character these statuettes appear to have been largely influenced by the *Graeco-Egyptian* art of Alexandria during the Hellenistic period. They appear to have been used for domestic and funerary purposes and as votive offerings.

After the downfall of the Roman Empire in the west, the artistic use of terracotta was abandoned for many centuries, though, here and there, both in Italy and in the districts that had been once Roman provinces, decorated terracotta work was carried on sporadically both in parts of France and of Germany. The true renaissance of its use came during the 14th and 15th centuries, when it was adapted once more to architectural service in the Gothic buildings of northern Italy and of Germany. In Germany the mark of Brandenburg is especially rich in buildings enriched with modelled terracotta. The church of St Catherine in the town of Brandenburg is decorated in the most lavish way with delicate tracery and elaborate string-courses and cornices enriched with foliage all modelled in clay; the town-hall of Brandenburg is another instance of the same use of terracotta. At Tangermünde, the church of St Stephen and other buildings of the beginning of the 15th century are wonderful examples of this method of decoration; the north door of St Stephen's especially being a masterpiece of rich and effective moulding. In northern Italy this use of terracotta was carried to an equally high pitch of perfection. The western façade of the cathedral of Crema, the communal buildings of Piacenza, and S. Maria delle Grazie in Milan are all striking examples of the extreme splendour of effect that can be obtained by terracotta work. The Certosa near Pavia is a gorgeous specimen of the early work of the 16th century; the two cloisters are especially magnificent. Pavia itself is very rich in terracotta decoration, especially the ducal palace and the churches of S. Francesco and S. Maria del Carmine. Some delicate work exists among the medieval buildings of Rome, dating from the 14th and 16th centuries, as, for example, the rich cornices of the south aisle of S. Maria in Ara Coeli, *c.* 1300; the front of S. Cosimato in Trastevere, built *c.* 1490; and a once very magnificent house, near the Via di Tordinone, which dates from the 14th century.

With the revival of terracotta as an adjunct to medieval architecture we find the sculptors of the Italian renaissance turning to this material, as a medium for the production of reliefs, busts, and even groups of many life-sized figures—again following the practice of classic times. Much of the Florentine terracotta sculpture of the 15th century is among the most beautiful plastic work the world has ever seen, especially that by Jacopo della Quercia, Donatello, and the sculptors of the next generation.[1] For life, spirit, and realistic truth, combined with sculpturesque breadth, these pieces are masterpieces of invention and manipulation. The portrait busts are perfect models of iconic sculpture. In some respects the use of burnt clay for sculpture has great advantages over that of marble; the soft clay is easily and rapidly moulded into form while the sculptor's thought is fresh in his mind, and thus works in terracotta often possess a spirit and vigour which can hardly be reproduced in laboriously finished marble. In the 16th century a more realistic style was introduced, and this was heightened by the custom of painting the figures in oil colours. Many very clever groups of this kind were produced by Ambrogio Foppa (Caradosso) for S. Satiro at Milan and by Guido Mazzoni and Begarelli (1479–1565) for churches in Modena. These terracotta sculptures are unpleasing in colour and far too pictorial in style; but those of Begarelli were enthusiastically admired by Michelangelo. The introduction of enamelled reliefs in terracotta which is so closely associated with the Florentine sculptor Luca della Robbia and his descendants, is specially treated in the article DELLA ROBBIA (*q.v.*).

From these two centres the development of architectural terracotta gradually spread over western Europe. The German school influenced the work done in the Low Countries and finally in England, where it also met the direct influence of the Italian school due to the invasion of England by Italian artists such as Torrigiano and others who were invited to England during the reigns of Henry VII. and Henry VIII. It is only in the eastern and southern counties of England that we find instances of the terracotta work of this period, and much of it is so un-English in style that most authorities consider it was not made in England at all but was imported from Holland or Flanders. Essex possesses the finest examples; such as those to be found in the Manor House at Layer Marney, and a richly-decorated terracotta tomb in the church at the same place, both dating from the reign of Henry VIII.

In the Collegiate Church at Wymondham in Norfolk there are very large and elaborate sedilia with canopied niches all of terracotta of the same period and apparently of the same manufacture. The unsettlement which followed the Reformation in England and continued during the Stuart period seems to have put an end to this imported art, and it is only in modern times that we find a revival of architectural terracotta work in England.

France.—Another offshoot from the fertile plains of northern Italy was implanted in France during the 16th century. Many sculptors from northern and central Italy were attracted to France by Francis I. and his successors, and, among other arts, they introduced the making of artistic terracottas. The most famous name in the lists of these Italian artists is that of Girolamo della Robbia (see article DELLA ROBBIA), who executed, in 1529, the enamelled terracotta for the decoration of the "Petit Château de Madrid" in the Bois de Boulogne, Paris, for Francis I.[2] Many other Italian artists of lesser repute imported their arts into France, and the British Museum possesses an embossed tile bearing the head of St John the Baptist, encircled by a Gothic inscription, which was evidently made at Lyons during the 16th century. The very mould of this tile, together with other subjects of similar type, was excavated at Lyons and, while it is probable that the workmanship was Italian, the style of the modelling is entirely French in character.

Spain.—At about the same period the Italian modellers or sculptors carried the art into Spain, and many extraordinary works are still extant in various Spanish churches remarkable for their vivid realism and for a too pictorial style which degrades them from their true rank as architectural decoration.

During the 17th and 18th centuries the architectural use of terracotta again fell away owing to the increasing use of marble, but that the art still survived in other forms is shown by the portrait busts of Dwight (17th century), though they were made in stoneware and not in unglazed terracotta; and the charming little statuettes and groups made in Lorraine and the adjacent parts of France by Guibal, Cyfflé and Lemire, sculptors employed at some of the pottery factories of the period.

It should be mentioned that during the 18th century ordinary clay had fallen into disrepute, but the porcelain figures made at Meissen, Sèvres and other continental factories show how persistent the vogue of figure-modelling in clay had become—though the clay was porcelain clay and not ordinary terracotta (see CERAMICS).

Modern.—During the last fifty years there has been throughout Europe a great revival in the manufacture of terracotta, both glazed and unglazed. We have in England, for example, some very important buildings, such as the Natural History Museum, the Albert

[1] The Victoria and Albert Museum has a splendid and representative collection of these Italian terracottas.

[2] This last and most extensive of the works in terracotta executed by the Robbia family was destroyed during the French Revolution in 1792, but exact drawings of it are still in existence showing all the necessary details.

Hall, and the Royal College of Science, all in South Kensington, London, which illustrate to perfection the English terracotta work of the mid-Victorian period. The Rijks Museum at Amsterdam, and many important buildings in the north of Germany, in Belgium and in France, display the increasing use of baked clay for architectural purposes.

The effort of all terracotta makers during recent times has been to produce a building material capable of resisting the acids and soot contained in the atmosphere of our great towns. Technically many of the leading manufacturers in England and the continental countries have been very successful in this effort, as they are able to produce building materials of pleasant colour and texture which are practically acid-resisting. Critics of this modern development of terracotta as a building material frequently complain of the want of truth in the lines of cornices, door or window jambs, &c. For this default the manufacturer is not so much to blame as are those modern architects who design a building for stone construction and then decide to have it executed in terracotta. The shrinkage of clay both in drying and firing is well known, and it is this shrinkage which causes large pieces of terracotta to twist or become crooked. When our modern architects shall have realized that the details of a building must be designed specially for the material that is to be used in its construction, terracotta will come into its own again as a decorative building material. The present method of constructing buildings in reinforced concrete, faced with glazed or unglazed terracotta, will afford the architects of the 20th century an unrivalled opportunity for the use of this material.

Collections.—The Louvre, British Museum, and the museums of Berlin and Athens have remarkably fine collections of the Greek and Roman terracottas, and many provincial museums, such as those of Florence, Perugia, Rome, Naples, Nîmes and Arles, have also collections of importance. The best collections of Greek terracotta figures are in the British Museum, the Louvre and the museums of Berlin and Athens; but a large number of the finest Greek terracotta figures are in private collections. In the Victoria and Albert Museum there is a remarkable collection of fine Florentine terracottas of the best periods.

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(W. B.*; H. B. WA.)

TERRAMARA (from Ital. *terra marna*, "marl"), the name given by archaeologists[1] to a type of primitive culture mainly of the early bronze age, but stretching back into the later stone age. This civilization is represented by a number of mounds, formerly thought (*e.g.* by Venturi) to be sepulchral, but really the remains of human habitations, analogous to shell heaps (*q.v.*) or kitchen middens. They are found chiefly in north Italy, in the valley of the Po, round Modena, Mantua and Parma. A summary of early results as to these mounds was published by Munro (*Lake Dwellings*) in 1890, but scientific investigation really began only with the excavation of the terramara at Castellazzo di Fontanellato (province of Parma) in 1889. From this and succeeding investigations certain general conclusions have been reached. The terramara, in spite of local differences, is of typical form; it is a settlement, trapezoidal in form, built upon piles on dry land protected by an earthwork strengthened on the inside by buttresses, and encircled by a wide moat supplied with running water. The east and west sides are parallel, and two roads at right angles divide the settlement into four quarters. Outside are one or two cemeteries. Traces of burning which have been found render it probable that, when the refuse thrown down among the piles had filled the space, the settlement was burned and a new one built upon the remains. The origin of the terramara type is not definitely ascertained. The most probable inference, however, is that these settlements were not built to avoid the danger of inundation, but represent a survival of the ordinary lake dwelling.

The remains discovered may be briefly summarized. Stone objects are few. Of bronze (the chief material) axes, daggers, swords, razors and knives are found, as also minor implements, such as sickles, needles, pins, brooches, &c. There are also objects of bone and wood, besides pottery (both coarse and fine: see CERAMICS), amber and glass-paste. Small clay figures, chiefly of animals (though human figures are found at Castellazzo), are interesting as being practically the earliest specimens of plastic art found in Italy.

The occupations of the terramara people as compared with their neolithic predecessors may be inferred with comparative certainty. They were still hunters, but had domesticated animals; they were fairly skilful metallurgists, casting bronze in moulds of stone and clay; they were also agriculturists, cultivating beans, the vine, wheat and flax. According to Prof. W. Ridgeway (*Who were the Romans?* p. 16; and *Early Age of Greece*, i. 496) burial was by inhumation: investigation, however, of the cemeteries shows that the bodies were burned and the ashes placed in ossuaries; practically no objects were found in the urns.

Great differences of opinion have arisen as to the origin and ethnographical relations of the terramara folk. Brizio in his *Epoca Preistorica* advances the theory that they were the original Ibero-Ligurians who at some early period took to erecting pile-dwellings. Why they should have done so is difficult to see. Some of the terremare are clearly not built with a view to avoiding inundation, inasmuch as they stand upon hills. The rampart and the moat are for defence against enemies, not against floods, and as Brizio brings in no new invading people till long after the terramara period, it is difficult to see why the Ibero-Ligurians should have abandoned their unprotected hut-settlements and taken to elaborate fortification. There are other difficulties of a similar character. Hence Pigorini regards the terramara people as an Aryan lake-dwelling people who invaded the north of Italy in two waves from Central Europe (the Danube valley) in the end of the stone age and the beginning of the bronze age, bringing with them the building tradition which led them to erect pile dwellings on dry land. These people he calls the Italici, to whom he attributes also the culture known as *Villanova* (*q.v.*). This view

[1] Since the International Congress of Prehistoric Archaeology at Bologna in 1871, when the shortened form *terramara* (plur. *terremare*) was adopted.

is regarded as falling in with discoveries (somewhat incomplete, it is true) in Hungary and Bosnia.

AUTHORITIES.—All the evidence is collected by T. E. Peet, *The Stone and Bronze Ages in Italy and Sicily* (Oxford, 1909), xiv. and xviii., which gives illustrations and references to the more important literature; this work supersedes all previous works on the *terremare*. Prof. Pigorini's article, "Le più antiche civiltà dell' Italia," in *Bullettino di paletnologia italiana*, xxix., is classical. See also the works of Montelius, Modestov, and Ridgeway (*Early Age of Greece*, vol. i.). (J. M. M.)

TERRANOVA, a town of Sicily, on the S. coast, in the province of Caltanisetta, 74 m. by rail and 41 m. direct E.S.E. of Girgenti. Pop. (1901) 22,019. The poorly built modern town contains no buildings of interest or importance; it stands on a sand-hill near the sea, with a fertile plain (the ancient *Campi Geloi*) to the N. of it. It has some trade but no port, only an open roadstead. It almost certainly occupies the site of the ancient Gela (*q.v.*). Outside it on the E. are scanty remains of a Doric temple (480–440 B.C.?) of which a single pillar only remains, which was still standing in the 18th century (height about 26½ ft., lower diameter 5⅝ ft.); here some painted decorative terracottas have been found (see Orsi in *Atti del Congresso di Scienze Storiche*, Rome, 1904, v. 188). Between it and the modern town the stylobate of a large temple was found in 1906. This seems to have been constructed towards the end of the 7th century B.C. on the site of a still earlier edifice. The stylobate measures 115 by 58 ft. A large number of decorative terracottas were found, among them a small helmeted head of Athena: her name recurs upon the lip of a large *pilhos*, and it is probable that the temple was dedicated to her. There is no trace of any object that can be dated after the end of the 6th century B.C., and it is therefore probable that this temple was destroyed when the other was constructed, and that the latter also was dedicated to Athena. On the W. of the town, on the Capo Soprano, was the ancient necropolis, where many tombs of the Greek period have been discovered; the objects found, including many fine Attic vases, are partly in private collections at Terranova itself, partly in foreign museums, while the results of later excavations, including some large terracotta sarcophagi, are in the museum at Syracuse.

See Orsi in *Notizie degli scavi*, 1901, 307; 1902, 408; 1907, 38.

TERRANOVA PAUSANIA, a seaport of Sardinia, in the province of Sassari, situated on the E. coast, 14 m. S.W. of Golfo Aranci, and 72 m. E. of Sassari by rail, and in the innermost recess of the sheltered gulf of Terranova. Pop. (1901) 4348. It occupies the site of the ancient Olbia (*q.v.*), and until the traffic was transferred to Golfo Aranci, was the port of embarkation for Italy, as in ancient times. There is some trade in cork and charcoal. The place is low-lying and malarious. The only building of interest is the Romanesque church of S. Simplicio, once the cathedral, which as it stands dates probably from the 11th century. It was the seat of the *giudici* of Gallura, sent here by the Pisans in the 11th century (but probably the native *giudici* resided at Tempio), and of an episcopal see, united in 1506 with that of Ampurias. The name Pausania is the consequence of an error; it is a corruption of Fausiana, a town and episcopal see of Sardinia mentioned by Gregory the Great, the site of which is in reality uncertain.

TERRE HAUTE, a city and the county-seat of Vigo county, Indiana, U.S.A., on the eastern bank of the Wabash river, about 186 m. S. by E. of Chicago and about 73 m. W. by S. of Indianapolis. Pop. (1890) 30,217; (1900) 36,673, of whom 1520 were negroes and 2952 foreign-born; (1910, census) 58,157. Land area (1906), 8·25 sq. m., of which nearly one-third had been annexed since 1890 and a considerable part since 1900. It is served by the Chicago & Eastern Illinois, the Cleveland, Cincinnati, Chicago & St Louis, the Evansville & Indianapolis, the Evansville & Terre Haute, the Southern Indiana, the Vandalia and several electric interurban railways. It is finely situated on high ground 60 ft. above the river level, and has wide, well-paved streets shaded by oaks and elms. It is the seat of the Indiana State Normal School (1870), which had in 1909 a library of about 50,000 volumes, 52 instructors and an average term enrolment of 988 students, and of the Rose Polytechnic Institute, which was founded in 1874 by Chauncey Rose (1794–1877), was opened in 1883, offers courses in mechanical, electrical, civil and chemical engineering and in architecture, and in 1909 had 22 instructors and 214 students. About 4 m. W. of Terre Haute is St Mary-of-the-Woods (founded in 1840 by the Sisters of Providence, and chartered in 1846), a school for girls. The Emeline Fairbanks Memorial Library (1882) contained 30,000 volumes in 1910, housed in a building erected in 1903 by Mr Crawford Fairbanks in memory of his mother. Terre Haute's industrial and commercial importance is largely due to its proximity to the valuable coal-fields of Clay, Sullivan, Park, Vermilion, Greene and Vigo counties. The total value of its factory product in 1905 was $29,291,654; both in 1900 and in 1905 it ranked second among the manufacturing cities of the state. It is the largest distilling centre in the state and one of the largest in the country, the value of the output of this industry in 1905 being more than half the total value of the city's factory product for the year. The value of the glass product in 1905 was 4·4 per cent. of the value of all factory products of the city, and 1·6 per cent. of the value of all glass manufactured in the United States.

The first settlers at Terre Haute built their cabins near Fort Harrison, which was erected by command of Governor William Henry Harrison in the winter of 1810–11. In 1812 the fort was successfully defended against an attack of the Indians by its commandant Captain Zachary Taylor, and in 1817 was abandoned. After the close of the War of 1812 the town grew rapidly and became an important commercial centre, owing to its river connexions and to the fact that the National (or Cumberland) Road crossed the Wabash here. Terre Haute was incorporated as a town in 1838, became a city in 1853 (under a general state law of June 1852), received a special city charter in 1899, in 1905 was organized as a city of the third class, and became a city of the second class in 1909.

TERRELL, a city of Kaufman county, Texas, U.S.A., about 32 m. E. of Dallas. Pop. (1890) 2988; (1900) 6330 (1517 negroes); (1910) 7050. Terrell is served by the Texas & Pacific and the Texas Midland railways. The city is the seat of Wesley College (Methodist Episcopal, South), until 1909 the North Texas University School, and of the North Texas Hospital for the Insane (1885), and has a Carnegie library. It is situated in a rich farming region. The city has a cotton compress and cotton-gins, and various manufactures. The Texas Midland railway has shops and general offices here. Terrell, named in honour of Robert A. Terrell, an early settler, was founded in 1872 and was chartered as a city in 1874.

TERRISS, WILLIAM (1847–1897), English actor, whose real name was William Charles James Lewin, was born in London on the 20th of February 1847. After trying the merchant service, medicine, sheep-farming in the Falkland Isles, and tea-planting in Bengal, in 1867 he took to the stage, for which his handsome presence, fine voice and gallant bearing eminently fitted him. His first appearance in London was as Lord Cloudrays in Robertson's *Society*, at the old Prince of Wales's theatre. He quickly came into favour in "hero" parts, and appeared at the principal London theatres from 1868 onwards. In 1880 he joined Irving's company at the Lyceum, playing such parts as Cassio and Mercutio, and in 1885 he acted there with Mary Anderson, as Romeo to her Juliet, &c. He was then engaged to take the leading parts in Adelphi melodrama, and it was in this capacity that for the rest of his career he was best known, though he occasionally acted elsewhere, notably with Irving at the Lyceum. His last appearance was in *Secret Service*. On the 16th of December 1897, as he was entering the Adelphi theatre, he was stabbed to death by a madman, Richard Arthur Prince. Terriss married Miss Isabel Lewis, and his daughter Ellaline Terriss (Mrs Seymour Hicks) became a well-known actress in musical comedy, in association with her husband Edward Seymour Hicks (*b.* 1871), proprietor of the Aldwych and Hicks theatres in London.

See Arthur J. Smythe, *The Life of William Terriss* (London, 1898).

TERRY, EDWARD O'CONNOR (1844–), English actor, was born in London, and began his stage career in a small and struggling way in the provinces. Between 1868 and 1875 he was the leading comedian at the Strand theatre, London, but it was not till he joined Hollingshead's company at the Gaiety in 1876 that he became a public favourite in the burlesques produced there during the next eight years. With Nellie Farren, Kate Vaughan and Royce, he made the fortune of this house, his eccentric acting and singing creating a style which had many imitators. In 1887 he went into management, opening Terry's theatre, where his production of Pinero's *Sweet Lavender* was a great success. But in subsequent years he was only occasionally seen at his own theatre, and made many tours in the provinces and in Australia, America and South Africa. Off the stage he was well known as an ardent Freemason, and an indefatigable member of the councils of many charities and of public bodies.

TERRY, ELLEN ALICIA (1848–), English actress, was born at Coventry on the 27th of February 1848. Her parents were well-known provincial actors, and her sisters Kate, Marion and Florence, and her brother Fred, all joined the theatrical profession, and her own first appearance on the stage was made on the 28th of April 1856, under the Keans' management, as the boy Mamilius in *The Winter's Tale*, at the Princess's theatre, London. Two years later she played Prince Arthur in *King John* with such grace as to win high praise. From 1860 to 1863 and again from 1867 to 1868 she acted with various stock companies. During this period she played, on the 26th of December 1867, for the first time with Henry Irving, being cast as Katharine to his Petruchio in Garrick's version of *The Taming of the Shrew* at the Queen's theatre. When quite a girl she married G. F. Watts the painter, but the marriage was soon dissolved. Between 1868 and 1874, having married E. A. Wardell, an actor whose professional name was Charles Kelly, she was again absent from the stage, but she reappeared in leading parts at the Queen's theatre under Charles Reade's management. On the 17th of April 1875 she played Portia for the first time in an elaborate revival of *The Merchant of Venice* under the Bancrofts' management at the old Prince of Wales's theatre. This was followed by a succession of smaller triumphs at the Court theatre, culminating in her beautiful impersonation of Olivia in W. G. Wills's dramatic version of Goldsmith's *Vicar of Wakefield*, in 1878, the result of which was her engagement by Henry Irving as his leading lady for the Lyceum theatre, and the beginning of a long artistic partnership, in the success of which Miss Terry's attractive personality played a large part. Her Shakespearean impersonations at the Lyceum were Ophelia in 1878, Portia in 1879, Desdemona in 1881, Juliet and Beatrice in 1882, Viola in 1884, Lady Macbeth in 1888, Katherine, in *Henry VIII.*, and Cordelia in 1892, Imogen in 1896, and Volumnia, in *Coriolanus*, in 1901. Other notable performances were those of the Queen in Wills's *Charles I.* in 1879, Camma in Tennyson's *The Cup* in 1881, Margaret in Wills's *Faust* in 1885, and the title-part in Charles Reade's one-act play *Nance Oldfield* (1893), Rosamund in Tennyson's *Becket* (1893), Madame Sans-Gêne in Sardou's play (1897), and Clarisse in *Robespierre* (1899). With the Lyceum company she several times visited the United States. In 1902, while still acting with Sir Henry Irving, she appeared with Mrs Kendal in Beerbohm Tree's revival of *The Merry Wives of Windsor*, at His Majesty's theatre, and she continued, after Sir Henry Irving's death, to act at different theatres, notably at the Court theatre (1905) in some of G. Bernard Shaw's plays. In 1906 her stage-jubilee was celebrated in London with much enthusiasm, a popular subscription in England and America resulting in some £8000 being raised. In 1907 Miss Terry married James Carew, an American actor.

Her sister Marion Terry (b. 1856) became only less distinguished on the English stage than herself; and her brother Fred Terry (b. 1865) also became a leading actor, and a successful manager in association with his wife, the actress Julia Neilson.

See Charles Hiatt, *Ellen Terry and her Impersonations* (1898); Clement Scott, *Ellen Terry*.

TERSTEEGEN, GERHARD (1697–1769), German religious writer, was born on the 25th of November 1697, at Mörs, at that time the capital of a countship belonging to the house of Orange-Nassau (it fell to Prussia in 1702), which formed a Protestant *enclave* in the midst of a Catholic country. After being educated at the gymnasium of his native town, Tersteegen was for some years apprenticed to a merchant. He soon came under the influence of Wilhelm Hoffman, a pietistic revivalist, and devoted himself to writing and public speaking, withdrawing in 1728 from all secular pursuits and giving himself entirely to religious work. His writings include a collection of hymns (*Das geistliche Blumengärtlein*, 1729; new edition, Stuttgart, 1868), a volume of *Gebete*, and another of *Briefe*, besides translations of the writings of the French mystics. He died at Mühlheim in Westphalia on the 3rd of April 1769.

See Hymns, and the article by Eduard Simons in Herzog-Hauck, *Realencyklopädie*, vol. xix. (ed. 1907).

TERTIARIES (Lat. *tertiarii*, from *tertius*, third), associations of lay folk in connexion with the Mendicant Orders. The old monastic orders had had attached to their abbeys confraternities of lay men and women, going back in some cases to the 8th century. The Confraternity Book of Durham is extant and embraces some 20,000 names in the course of eight centuries. Emperors and kings and the most illustrious men in church and state were commonly confraters of one or other of the great Benedictine abbeys. (On this subject see article by Edmund Bishop in *Downside Review*, 1885.) The confraters and consorors were made partakers in all the religious exercises and other good works of the community to which they were affiliated, and they were expected in return to protect and forward its interests; but they were not called upon to follow any special rule of life.

Although something of the kind existed among the Humiliati in the 12th century, the institution of Tertiaries arose out of the Franciscan movement. It seems to be certain that St Francis at the beginning had no intention of forming his disciples into an Order, but only of making a great brotherhood of all those who were prepared to carry out in their lives certain of the greater and more arduous of the maxims of the Gospel. The formation of the Franciscan Order was necessitated by the success of the movement and the wonderful rapidity with which it spread. When the immediate disciples of the saint had become an order bound by the religious vows, it became necessary to provide for the great body of laity, married men and women, who could not leave the world or abandon their avocations, but still were part of the Franciscan movement and desired to carry out in their lives its spirit and teaching. And so, probably in 1221, St Francis drew up a Rule for those of his followers who were debarred from being members of the order of Friars Minor. At first they were called "Brothers and Sisters of the Order of Penance"; but later on, when the Friars were called the "First Order" and the nuns the "Second Order," the Order of Penance became the "Third Order of St Francis"—whence the name Tertiaries: this threefold division already existed among the Humiliati.

In 1901 Paul Sabatier published a "Rule of Life of the Brothers and Sisters of Penance," which probably contains, with additions, the substance of the original Rule of 1221. It prescribes severe simplicity of dress and of life, and certain abstinences and prayers and other religious exercises, and forbids the frequentation of the theatre, the bearing of arms and the taking of oaths except when administered by magistrates. In 1289 Nicholas IV. approved the Third Order by a Bull, but made some alterations in the Rule, and this form of the Rule remained in force until our own day.

Immediately on its establishment in 1221 the Third Order spread with incredible rapidity all over Italy and throughout western Europe, and embraced multitudes of men and women of all ranks from highest to lowest. Everywhere it was connected closely with the First Order, and was under the control of the Friars Minor.

In time a tendency set in for members of the Third Order to live together in community, and in this way congregations were formed who took the usual religious vows and lived a fully organized religious life based on the Rule of the Third Order with supplementary regulations. These congregations are the "Regular Tertiaries" as distinguished from the "Secular Tertiaries," who lived in the world, according to the original idea. The Regular Tertiaries are in the full technical sense "religious," and there have been, and are, many congregations of them, both of men and of women.

There can be little doubt, whatever counter claims may be set up, that the Third Order was one of St Francis' creations, and that his Third Order was the exemplar after which the others were fashioned; but at an early date the other Mendicant Orders formed Third Orders on the same lines, and so there came into being Dominican Tertiaries, and Carmelite, and Augustinian, and Servite, and also Premonstratensian and many others. These followed the same lines of development as the Franciscan Tertiaries, and for the most part divided into the two branches of regular and secular Tertiaries. The Rules of the various Third Orders have proved very adaptable to the needs of modern congregations devoted to active works of charity; and so a great number of teaching and nursing congregations of women belong to one or other of the Third Orders.

The Franciscan Third Order has always been the principal one, and it received a great impetus and a renewed vogue from Leo XIII., who in 1883 caused the Rule to be recast and made more suitable for the requirements of devout men and women at the present day. In consequence it is estimated that the number of lay Franciscan Tertiaries now exceeds two millions.

BIBLIOGRAPHY.—The most serviceable authority on the Franciscan Tertiaries is probably Max Heimbucher, *Orden und Kongregationen* (1907), ii. §§ 103, 104, 105, where an ample bibliography is supplied. The same work gives information on the other Tertiaries at the end of the sections on the various Orders. Similarly information will be found in Helyot, *Histoire des Ordres religieux* (1714), after the chapters on the different Orders. Heimbucher names Tachy, *Les Tiers Ordres* (1897), and Adderley and Marson, *Third Orders* (1902). (E. C. B.)

TERTIARY, in geology, the time-division which includes the Eocene, Oligocene, Miocene and Pliocene periods, in other words, it is the earlier portion of the Cainozoic era. By some authorities the term Tertiary is made to embrace in addition to the foregoing periods those of the Quaternary (Pleistocene and Holocene), *i.e.* "Tertiary" is made the equivalent of Cainozoic. On logical grounds there is much in favour of this interpretation; but having in view the state of geological literature, it is certainly better to restrict the use of the term in the manner indicated above. Tertiary rocks were among the latest to receive the careful attention of geologists, and the name was introduced by G. Cuvier and H. Brongniart in 1810 (*Essai sur la géographie minéralogique des environs de Paris*, 1810–11, 1st ed.).

Deshayes (1830) worked out the percentages of recent fossils found at several horizons in those strata, and upon this Sir C. Lyell (1852) founded the main periods, viz. the Eocene with 3½ per cent. of recent forms, Miocene 17 per cent., Pliocene 35 to 50 per cent. Subsequent investigations naturally modified the numerical values upon which this nomenclature was based, but without altering the order of the periods. Later, E. Beyrich introduced the Oligocene period, and some geologists recognize a Palaeocene or early Eocene period. European geologists very generally use the grouping adopted by R. Hörnes:—

Younger Tertiary = Neogene (Miocene, Pliocene).

Older Tertiary = Palaeogene (Palaeocene, Eocene, Oligocene).

The great number and variety of mammalian remains has made it possible for the Tertiary rocks to be classified by their means: see A. Gaudry, *Les enchaînements du monde animal—mammifères Tertiaires* (1878); W. B. Dawkins, *Q. J. Geol. Soc. Lond.* (1880); Forsyth Major, *Geol. Mag.* (London, 1899); and H. F. Osborn, J. L. Wortman, G. F. Matthew, for western North America, *Bull. Am. Mus. Nat. Hist.*, xii. (1899).

During the Tertiary era the geographical configuration of the globe was steadily approaching that of the present day; but in the earlier part of the time there still existed the great equatorial ocean "Tethys," and there is evidence that East India and Africa, Australia and Asia, north Europe and North America were probably severally united by land connexions. As the period advanced, along the very line that had been occupied by the nummulitic sea (Tethys) the crust began to be folded up, giving rise to the Alps, Carpathians, Caucasus, Himalayas and other mountains, some of the early Tertiary marine formations being now found raised more than 16,000 ft. above the present level of the sea. Associated with these crustal movements were enormous outpourings of volcanic materials.

The faunal aspect of the Tertiary periods differs strikingly from that of preceding Secondary or Mesozoic; in place of the great saurian reptiles we find the rapid development and finally the maximum expansion of mammals. Snakes and true birds advanced rapidly towards their modern position. In the seas, bony fish and crab-like decapods increased in numbers and variety, while pelecypods and gasteropods took the prominent place previously occupied by ammonites and belemnites, and, leaving behind such forms as *Rudistes*, *Inoceramus*, &c., they gradually developed in the direction of the modern regional groups. In the plant world, the dicotyledonous angiosperms gradually assumed the leading rôle which they occupy to-day.

The climate in northern latitudes seems to have passed from temperate to sub-tropical, with minor fluctuations, until at the close a rapid lowering of temperature ushered in the glacial period. (J. A. H.)

TERTULLIAN (*c.* 155–*c.* 222), whose full name was QUINTUS SEPTIMIUS FLORENS TERTULLIANUS, is the earliest and after Augustine the greatest of the ancient church writers of the West. Before him the whole Christian literature in the Latin language consisted of a translation of the Bible, the *Octavius* of Minucius Felix (*q.v.*)—an apologetic treatise written in the Ciceronian style for the higher circles of society, and with no evident effect for the church as a whole, the brief Acts of the Scillitan martyrs, and a list of the books recognized as canonical (the so-called Muratorian fragment). Whether Victor the Roman bishop and Apollonius the Roman senator ever really made an appearance as Latin authors is quite uncertain. Tertullian in fact created Christian Latin literature; one might almost say that that literature sprang from him full-grown, alike in form and substance, as Athena from the head of Zeus. Cyprian polished the language that Tertullian had made, sifted the thoughts he had given out, rounded them off, and turned them into current coin, but he never ceased to be aware of his dependence on Tertullian, whom he designated as κατ' ἐξοχήν, his master (Jer., *De vir. ill.* 53). Augustine, again, stood on the shoulders of Tertullian and Cyprian; and these three North Africans are the fathers of the Western churches.

Tertullian's place in universal history is determined by (1) his intellectual and spiritual endowments, (2) his moral force and evangelical fervour, (3) the course of his personal development, (4) the circumstances of the time in the midst of which he worked.

(1) Tertullian was a man of great originality and genius, characterized by the deepest pathos, the liveliest fancy, and the most penetrating keenness, and was endowed with ability to appropriate and make use of all the methods of observation and speculation, and with the readiest wit. His writings in tone and character are always alike "rich in thought and destitute of form, passionate and hair-splitting, eloquent and pithy in expression, energetic and condensed to the point of obscurity." His style has been characterized with justice as dark and resplendent like ebony. His eloquence was of the vehement order; but it wins hearers and readers by the strength of its passion, the energy of its truth, the pregnancy and elegance of its expression, just as much as it repels them by its heat without light, its sophistical argumentations, and its elaborate hair-splittings. Though he is wanting in moderation and in luminous warmth, his tones are by no means always harsh; and as an author he ever aspired with longing after humility and love and patience, though his whole life was lived in the atmosphere of conflict. Tertullian both as a man and as a writer had much in common with the apostle Paul.

(2) In spite of all the contradictions in which he involved

himself as a thinker and as a teacher, Tertullian was a compact ethical personality. What he was he was with his whole being. Once a Christian, he was determined to be so with all his soul, and to shake himself free of all half measures and compromises with the world. It is not difficult to lay one's finger upon very many obliquities, self-deceptions and sophisms in Tertullian in matters of detail, for he struggled for years to reconcile things that were in themselves irreconcilable; yet in each case the perversities and sophisms were rather the outcome of the peculiarly difficult circumstances in which he stood. It is easy to convict him of having failed to control the glowing passion that was in him. He is often outrageously unjust in the substance of what he says, and in manner harsh to cynicism, scornful to gruesomeness; but in no battle that he fought was he ever actuated by selfish interests. What he did was really done for the Gospel, as he understood it, with all the faculties of his soul. But he understood the Gospel as being primarily an assured hope and a holy law, as fear of the Judge who can cast into hell and as an inflexible rule of faith and of discipline. Of the glorious liberty of the children of God he had nothing but a mere presentiment; he looked for it only in the world beyond the grave, and under the power of the Gospel he counted as loss all the world could give. He well understood the meaning of Christ's saying that He came not into the world to bring peace, but a sword: in a period when a lax spirit of conformity to the world had seized the churches he maintained the "vigor evangelicus" not merely against the Gnostics but against opportunists and a worldly-wise clergy. Among all the fathers of the first three centuries Tertullian has given the most powerful expression to the terrible earnestness of the Gospel.

(3) The course of Tertullian's personal development fitted him in an altogether remarkable degree to be a teacher of the church. Born at Carthage of good family—his father was a "centurio pro consularis"—he received a first-rate education both in Latin and in Greek. He was able to speak and write Greek, and gives evidence of familiarity alike with its prose and with its poetry; and his excellent memory—though he himself complains about it—enabled him always to bring in at the right place an appropriate, often brilliant, quotation or some historical allusion. The old historians, from Herodotus to Tacitus, were familiar to him, and the accuracy of his historical knowledge is astonishing. He studied with earnest zeal the Greek philosophers; Plato in particular, and the writings of the Stoics, he had fully at command, and his treatise *De Anima* shows that he himself was able to investigate and discuss philosophical problems. From the philosophers he had been led to the medical writers, whose treatises plainly had a place in his working library. But no portion of this rich store of miscellaneous knowledge has left its characteristic impress on his writings; this influence was reserved for his legal training. His father, whose military spirit reveals itself in the whole bearing of Tertullian, to whom Christianity was above everything a "militia," had intended him for the law. He studied in Carthage, probably also in Rome, where, according to Eusebius, he enjoyed the reputation of being one of the most eminent jurists. This statement derives confirmation from the *Digest*, where references are made to two works, *De Castrensi Peculio* and *Quaestionum Libri VIII.*, of a Roman jurist named Tertullian, who must have flourished about 180 A.D. In point of fact the quondam advocate never disappeared in the Christian presbyter. This was at once his strength and his weakness: his strength, for as a professional pleader he had learned how to deal with an adversary according to the rules of the art—to pull to pieces his theses, to reduce him *ad absurdum*, and to show the defects and contradictions of his statements,—and was specially qualified to expose the irregularities in the proceedings taken by the state against the Christians; but it was also his weakness, for it was responsible for his litigiousness, his often doubtful shifts and artifices, his sophisms and *argumentationes ad hominem*, his fallacies and surprises. At Rome in mature manhood Tertullian became a Christian, under what circumstances we do not know, and forthwith he bent himself with all his energy to the study of Scripture and of Christian literature. Not only was he master of the contents of the Bible: he also read carefully the works of Hermas, Justin, Tatian, Miltiades, Melito, Irenaeus, Proculus, Clement, as well as many Gnostic treatises, the writings of Marcion in particular. In apologetics his principal master was Justin, and in theology proper and in the controversy with the Gnostics, Irenaeus. As a thinker he was not original, and even as a theologian he has produced but few schemes of doctrine, except his doctrine of sin. His special gift lay in the power to make what had been traditionally received impressive, to give to it its proper form, and to gain for it new currency. From Rome Tertullian visited Greece and perhaps also Asia Minor; at any rate we know that he had temporary relations with the churches there. He was consequently placed in a position in which he could check the doctrine and practice of the Roman church. Thus equipped with knowledge and experience, he returned to Carthage and there laid the foundation of Latin Christian literature. At first, after his conversion, he wrote Greek, but by and by Latin almost exclusively. The elements of this Christian Latin language may be enumerated as follows:—(i.) it had its origin, not in the literary language of Rome as developed by Cicero, but in the language of the people as we find it in Plautus and Terence; (ii.) it has an African complexion; (iii.) it is strongly influenced by Greek, particularly through the Latin translation of the Septuagint and of the New Testament, besides being sprinkled with a large number of Greek words derived from the Scriptures or from the Greek liturgies; (iv.) it bears the stamp of the Gnostic style and contains also some military expressions; (v.) it owes something to the original creative power of Tertullian. As for his theology, its leading factors were—(i.) the teachings of the apologists; (ii.) the philosophy of the Stoics; (iii.) the rule of faith, interpreted in an anti-Gnostic sense, as he had received it from the Church of Rome; (iv.) the Soteriological theology of Melito and Irenaeus; (v.) the substance of the utterances of the Montanist prophets (in the closing decades of his life). This analysis does not disclose, nor indeed is it possible to discover, what was the determining element for Tertullian; in fact he was under the dominion of more than one ruling principle, and he felt himself bound by several mutually opposing authorities. It was his desire to unite the enthusiasm of primitive Christianity with intelligent thought, the original demands of the Gospel with every letter of the Scriptures and with the practice of the Roman church, the sayings of the Paraclete with the authority of the bishops, the law of the churches with the freedom of the inspired, the rigid discipline of the Montanist with all the utterances of the New Testament and with the arrangements of a church seeking to set itself up within the world. At this task he toiled for years, involved in contradictions which it took all the finished skill of the jurist to conceal from him for a time. At last he felt compelled to break off from the church for which he had lived and fought; but the breach could not clear him from the contradictions in which he found himself entangled. Not only did the great chasm between the old Christianity, to which his soul clung, and the Christianity of the Scriptures as juristically and philosophically interpreted remain unbridged; he also clung fast, in spite of his separation from the Catholic church, to his position that the church possesses the true doctrine, that the bishops *per successionem* are the repositories of the grace of the teaching office, and so forth. The growing violence of his latest works is to be accounted for, not only by his burning indignation against the ever-advancing secularization of the Catholic church, but also by the incompatibility between the authorities which he recognized and yet was not able to reconcile. After having done battle with heathens, Jews, Marcionites, Gnostics, Monarchians, and the Catholics, he died an old man, carrying with him to the grave the last remains of primitive Christianity in the West, but at the same time in conflict with himself.

(4) What has just been said brings out very clearly how important in their bearing on Tertullian's development were the circumstances of the age in which he laboured. His activity

as a Christian falls between 190 and 220, a period of very great moment in the history of the Catholic church; for within it the struggle with Gnosticism was brought to a victorious close, the New Testament established a firm footing within the churches, the "apostolic" rules which thenceforward regulated all the affairs of the church were called into existence, and the ecclesiastical priesthood came to be developed. Within this period also falls that evangelical and legal reaction against the political and secular tendencies of the church which is known as Montanism. The same Tertullian who had fortified the Catholic church against Gnosticism was none the less anxious to protect it from becoming a political organization. Being unable to reconcile incompatibles, he broke with the church and became the most powerful representative of Montanism in the West.

Although Tertullian's extant works are both numerous and copious, our knowledge of his life is very vague. He cannot have been born much later than about 150. His activity as a jurist in Rome must fall within the period of Commodus; for there is no indication in his writings that he was in Rome in the time of Marcus Aurelius, and many passages seem to preclude the supposition. The date of his conversion to Christianity is quite uncertain; there is much in favour of the years between 190 and 195. How long he remained in Rome after becoming a Christian, whether he had attained any office in the church before leaving Rome, what was the date of his visit to Greece—on these points also we remain in ignorance. It is certain that he was settled in Carthage in the second half of 197, the date of his writing his *Apologeticus* and (shortly afterwards) his two books *Ad nationes*; we also know that he became a presbyter in Carthage and was married. His recognition of the Montanistic prophecy in Phrygia as a work of God took place in 202–203, at the time when a new persecution broke out. For the next five years it was his constant endeavour to secure the victory for Montanism within the church; but in this he became involved more and more deeply in controversy with the majority of the church in Carthage and especially with its clergy, which had the support of the clergy of Rome. As Jerome writes (*De vir. ill.* 53): "Usque ad mediam aetatem presbyter fuit ecclesiae Africanae, invidia postea et contumeliis clericorum Romanae ecclesiae ad Montani dogma delapsus." On his breach with the Catholic church, probably in 207–208, he became the head of a small Montanist community in Carthage. In this position he continued to labour, to write, and to assail the lax Catholics and their clergy until at least the time of Bishop Calixtus in the reign of Elagabalus. The year of his death is uncertain. Jerome (*ut sup.*) says: "Fertur vixisse usque ad decrepitam aetatem." That he returned at last to the bosom of the Catholic church is a mere legend, the motive of which is obvious; his adherents after his death continued to maintain themselves as a small community in Carthage. Although he had left the church, his earlier writings continued to be extensively read; and in the 4th century his works, along with those of Cyprian, were the principal reading of Western Christians, until they were superseded by those of Jerome, Ambrose, Augustine and Gregory. Jerome has included him in his catalogue of Christian "viri illustres," but only as a Catholic to whom reference should be made with caution.[1]

The works of Tertullian, on the chronology of which a great deal has been written, and which for the most part do not admit of being dated with perfect certainty, fall into three classes—the apologetic, defending Christianity against paganism and Judaism; the polemical dogmatic, refuting heresies and heretics; and the ascetic or practical, dealing with points of morality and church discipline. In point of time also three periods can be readily distinguished, the years 202–203 and 207–208 constituting the divisions. Some of the books he wrote have unfortunately disappeared—in particular the *De spectaculis*, *De baptismo*, and *De virginibus velandis* in Greek; his works in Latin on the same subjects have survived.

I. *Works dating from before 202–203.*—To this class belong the *Apologeticus* (197) and the two books *Ad nationes*, *De spectaculis*, *De idololatria*, *De cultu feminarum Libri II.*, *De testimonio animae* (written soon after the *Apologeticus*), *Ad martyres* (perhaps the earliest of all), *De baptismo haereticorum* (now lost), *De baptismo*, *De poenitentia*, *De oratione* (the last three written for catechumens), *De patientia*, *Ad uxorem Libri II.*, *De praescriptione haereticorum*, and *Adv. Marcionem* (in its first form). The *Apologeticus*, which in the 3rd century was translated into Greek, is the weightiest work in defence of Christianity of the first two centuries. It disposes of the charges brought against Christians for secret crimes (incest, &c.) and public offences (contempt of the State religion and high treason), and asserts the absolute superiority of Christianity as a revealed religion beyond the rivalry of all human systems.

[1] Compare also the judgment of Hilary and of Vincent of Lerins, *Commonit.*, 24.

Respecting its relation to the *Octavius* of Minucius Felix much has been written; to the present writer it seems unquestionable that Tertullian's work was the later. Of great moment also is the *De praescriptione haereticorum*, in which the jurist is more clearly heard than the Christian. It is the chief of the dogmatic or polemical works, and rules the accuser out of court at the very opening of the case. The *De spectaculis* and *De idololatria* show that Tertullian was already in a certain sense a Montanist before he formally went over to that creed; on the other hand, his *De poenitentia* proves that his earlier views on church discipline were much more tolerant than his later. To learn something of his Christian temper we must read the *De oratione* and the *De patientia*. The *De baptismo* is of special interest from the archaeological point of view.

II. *Works written between 202–203 and 207–208.*—*De virginibus velandis*, *De corona militis*, *De fuga in persecutione*, *De exhortatione castitatis*, *De scorpiace* (a booklet against the Gnostics, whom he compares to scorpions; it is written in praise of martyrdom), *Adversus Hermogenem*, *De censu animae adv. Hermogenem* (lost), *Adv. Valentinianos*, *Adv. Apelleiacos* (lost), *De paradiso* (lost), *De fato* (lost), *De anima* (the first book on Christian psychology), *De carne Christi*, *De resurrectione carnis*, and *De spe fidelium* (lost), were all written after Tertullian had recognized the prophetic claims of the Montanists, but before he had left the church.

III. *Works later than 207–208.*—To this period belong the five books *Adv. Marcionem*, his main anti-Gnostic work (in the third form—the first of the five was written in 207–208), *Ad Scapulam* (an admonition to the persecuting proconsul of Africa, written soon after 212), *De pallio* (a defence of his wearing the pallium instead of the toga), *Adv. Praxean* (his principal work against the Monarchians), and *Adv. Judaeos*, chaps. ix.–xiv. of which are a completion by another and less skilful hand. The latest extant works of Tertullian (all after 217) are his controversial writings against the laxity of the Catholics, full of the bitterest attacks, especially upon Calixtus, the bishop of Rome; these are *De monogamia*, *De jejunio*, *De pudicitia*, and *De ecstasi Libri VII.* (lost). The arguments against the genuineness of some of the above writings do not seem to the present writer to have weight. It is quite possible that Tertullian was the author of the *Acta perpetuae et felicitatis*, but he did not write the *Libellus adv omnes haereses* often appended to *De praescriptione;* or the poems *Adv. Marcionem*, *De Sodoma*, *De Jona*, *De Genesi*, *De judicio Domini;* or the fragment *De execrandis gentium diis;* or the *De Trinitate* and *De cibis Judaicis* of Novatian.

Editions.—For the MSS. see E. Preuschen in A. Harnack, *Geschichte der altchristl. Literatur*, i. 675–7. Of printed collections the chief are the *editio princeps* by Beatus Rhenanus (Basel, 1521), Migne, *Patr. Lat.* i.–ii. (Paris, 1844); Fr. Oehler (3 vols., Leipzig, 1851–4); and A. Reifferscheid and G. Wissowa in the *Corpus scriptorum eccl. Lat.* (Pars i., Vienna, 1890). Editions of the separate books are almost innumerable.

Translations.—German by K. A. H. Kellner (2 vols. Cologne, 1882) and selections in *Bibliothek der Kirchenväter* (1869, 1872); English by S. Thelwall and others in *Ante-Nicene Fathers*, iii. and iv., and (apologetic and practical writings) by C. Dodgson in *Library of the Fathers*, x. (Oxford, 1842).

Literature.—Fr. Oehler's third volume contains a collection of early dissertations. See also A. Hauck, *Tertullian's Leben und Schriften* (Erlangen, 1877); J. M. Fuller in *Dict. Chr. Biog.*, iv. 818–864; E. Nolldechen, *Tertullian* (Gotha, 1890); P. Monceaux, *Histoire littéraire de l'Afrique chrétienne*, vol. i. (Paris, 1901); T. R. Glover, *The Conflict of Religions in the Early Roman Empire*, chap. x. (London, 1909); and the various Histories of Dogma and Church Histories.

For a complete bibliography see G. Krüger, *Hist. of Early Christian Literature* (Eng. tr. New York and London, 1897); Herzog-Hauck, *Realencyk. für prot. Theologie*, xix.; and O. Bardenhewer, *Patrology* (Eng. tr. Freiburg im Breisgau and St Louis, 1908). A large number of earlier monographs on special points are cited in the 9th edn. of the *Ency. Brit.* (A. Ha.; X.)

TERUEL, a province of north-eastern Spain, formed in 1833 from part of the ancient kingdom of Aragon; bounded on the N. by Saragossa, E. by Tarragona, S.E. and S. by Castellon de la Plana and Valencia, S.W. by Cuenca, and W. by Guadalajara. Pop. (1900) 246,001; area 5720 sq. m. In the centre of the province rise the Sierras of Gudar and San Just; in the south-west and west are the lofty Albarracin range, the Montes Universales, and the isolated ridges of Palomera and Cucalon. Outliers of the Castellon and Tarragona highlands extend along the eastern border. The northern districts belong to the Ebro basin. In the west there are a few peaks, such as the Cerro de San Felipe and Muela de San Juan, which exceed 5000 ft. in altitude and are covered with snow for many months; but the highest point is Javalambre (6568 ft.) in the south. The sierras give rise to several large rivers, the principal being the Tagus (*q.v.*); the Guadalaviar, which rises in the Montes Universales and flows south-east to enter the Mediterranean at Valencia; the Jiloca, which flows north from the lake of Cella to join the Jalón at Calatayud; the Guadalope, Martin and Matarraña, tributaries of the Ebro.

Notwithstanding the fertile character of the plains and the abundance of mineral wealth, the trade of the province is unimportant and civilization in a backward state, owing to the lack of means of transport, want of enterprise and imperfect communication with the outer world. Much land is devoted to pasture that could be cultivated. Extensive forests with fine timber are neglected, as are some important coal beds in the eastern districts. The chief products are corn, wine, oil, cheese, fruits, timber, flax, hemp, silk, wool and saffron, together with cattle, sheep and swine; while in the busier centres some slight manufacture of coarse cloth, paper, leather, soap, pottery and esparto goods is carried on. The only railway is the line from Murviedro, on the Gulf of Valencia, to Calatayud.

TERUEL, the capital of the Spanish province of Teruel; on the left bank of the river Guadalaviar, at its confluence with the Alfambra, and on the Murviedro-Calatayud railway. Pop. (1900) 10,797. The older part of Teruel is a walled city with narrow gloomy streets and crumbling medieval houses, but modern suburbs have been built outside the walls. Some of the numerous churches are worth seeing, with their paintings by the 17th-century artist Antonio Visquert. In the cloisters of San Pedro lie the remains of the celebrated "lovers of Teruel," Juan de Marcilla and Isabella de Segura, who lived in the 13th century and whose pathetic story has formed the subject of numerous dramas and poems by Perez de Montalban, Yaquë de Salas, Hartzenbusch and others. The cathedral dates from the 16th century. The great aqueduct of 140 arches was erected in 1555–60 by Pierre Bedel, a French architect. Teruel has several good hospitals and asylums for the aged and children, an institute, a training school for teachers, primary schools, a public library, an athenaeum, a meteorological station, and a large prison. The see was created in 1577, and forms part of the archiepiscopal province of Saragossa.

TERVUEREN, a small town of Belgium in the province of Brabant, midway between Brussels and Louvain. Pop. (1904) 4017. It contained an ancient abbey and a hunting château belonging to the dukes of Brabant. The fine park of Tervueren is really part of the forest of Soignies. The Colonial Museum and World's Colonial School are established here, and Tervueren is connected with Brussels by a fine broad avenue, traversed by an electric tramway as well as by carriage and other roads, and between 6 and 7 m. in length.

TERZA RIMA, or "third rhyme," a form of verse adapted from the Italian poets of the 13th century. Its origin has been attributed by some to the three-lined ritournel, which was an early Italian form of popular poetry, and by others to the sirventes of the Provençal troubadours. The *serventese incatenato* of the latter was an arrangement of triple rhymes, and unquestionably appears to have a relation with terza rima; this connexion becomes almost a certainty when we consider the admiration expressed by the Tuscan poets of the 13th century for the metrical inventions of their forerunners, the Provençals. In Italian, a stanza of terza rima consists of three lines of eleven syllables, linked with the next stanza, and with the next, and so on, by a recurrence of rhymes: thus aba, bcb, cdc, ded, &c., so that, however long the poem is, it can be divided nowhere without severing the continuity of the rhyme. Schuchardt has developed an ingenious theory that these successive terzinas are really chains of ritournels, just as ottava rima, according to the same theory, is a chain of rispetti. There were, unquestionably, chains of interwoven triple rhymed lines before the days of Dante, but it was certainly he who raised terza rima from the category of folk-verse, and gave it artistic character. What this character is may best be seen by an examination of the austere and majestic lines with which the *Inferno* opens, no more perfect example of terza rima having ever been composed:—

"Nel mezzo del cammin di nostra vita
  Mi retrovai per una selva obscura,
Che la diritta via era smarrita.
  Ahi quanto a dir qual'era è cosa dura
Questà selva selvaggia ed aspra e forte,
  Che nel pensier rinnova la paura!"

It is impossible, however, to break off here, since there is no rhyme to *forte*, which has to be supplied twice in the succeeding terzina, where, however, a fresh rhyme, *trovai*, is introduced, linking the whole to a still further terzina, and so on, indefinitely. The only way in which a poem in terza rima can be closed is by abandoning a rhyme, as at the end of Canto I of the *Inferno*, where no third rhyme is supplied to *Pietro* and *dietro*. Boccaccio wrote terza rima in close following of Dante; but it has not been a form very frequently adopted by Italian poets. Nor has the extreme difficulty of sustaining dignity and force in these complicated chains of verse made writers in other languages very anxious to adventure on terza rima. In the age of Elizabeth, Samuel Daniel employed it in his "Epistle to the Countess of Bedford," but he found no followers. Probably the most successfully sustained poem in terza rima in the English language is Mrs Browning's *Casa Guidi Windows* (1851). The Germans have always had an ambition to write in terza rima. It was used by Paul Schede, a writer of whom little is known, before the close of the 16th century, and repeatedly by Martin Opitz (1597–1639), who called the form *drittreime*. Two centuries and a half later, W. Schlegel had the courage to translate Dante in the metre of the Italian; and it was used for original poems by Chamisso and Rückert. Goethe, in 1826, addressed a poem in terza rima to the praise of Schiller, and there is a passage in this metre at the beginning of the second part of *Faust*.

See Hugo Schuchardt, *Ritournell und Terzine* (Halle, 1875).
(E. G.)

TESCHEN (Czech, *Těšin;* Polish, *Cieszyn*), a town of Austria, in Silesia, 50 m. S.E. of Troppau by rail. Pop. (1900) 19,142, of which over half is German, 43 per cent. Polish and the remainder Czech. It is situated on the Olsa, a tributary of the Oder, and combines both Polish and German peculiarities in the style of its buildings. The only relic of the ancient castle is a square tower, dating from the 12th century. There are several furniture factories and large saw-mills.

Teschen is an old town and was the capital of the duchy of Teschen. It was at Teschen that Maria Theresa and Frederick II. signed, in May 1779, the Peace, which put an end to the war of Bavarian succession. The duchy of Teschen belonged to the dukes of Upper Silesia, and since 1298 it stood under the suzerainty of Bohemia. It became a direct apanage of the Bohemian crown in 1625 at the extinction of the male line of its dukes, and since 1766 it bore the name of Saxe-Teschen, owing to the fact that Prince Albert of Saxony, who married a daughter of Maria Theresa, received it as part of his wife's dowry. In 1822, it was bestowed on the Archduke Charles, the victor of Aspern; it was inherited by his eldest son, and, at his death, in 1895 it passed into the hands of his nephew, the Archduke Frederick.

TESSELLATED (Lat. *tessellatus*,), formed of *tessellae*, or small *tesserae*, cubes from half an inch to an inch square like dice, of pottery, stone, marble, enamel, &c. (See PAVEMENT and MOSAIC.)

TESSIN, CARL GUSTAF, COUNT (1695–1770), Swedish statesman, son of a great architect, Nicodemus Tessin, began his public career in 1723, at which time he was a member of the Holstein faction. In 1725 he was appointed ambassador at Vienna, and in that capacity counteracted the plans of the Swedish chancellor, Count Arvid Horn, who was for acceding to the Hanoverian Alliance. During the *riksdags* 1726–27 and 1731 he fiercely opposed the government, and his wit, eloquence and imposing presence made him one of the foremost protagonists of the party subsequently known as "The Hats" (see SWEDEN: *History*). From 1735 to 1736 he was again Swedish ambassador at Vienna. During the *riksdag* of 1738 he was elected marshal of the diet and contributed more than anyone else to overthrow the Horn administration the same year. On the division of the spoil of patronage he chose for himself the post of ambassador extraordinary at Paris, and from 1739 to

1742 delighted Versailles with his brilliant qualities of *grand seigneur*, at the same time renewing the traditional alliance between France and Sweden which had been interrupted for more than sixty years. His political ability, however, was by no means commensurate with his splendid social qualities. It was his sanguine credulity which committed the "Hats" to their rash and unconsidered war with Russia in 1741–42, though in fairness it must be added that Tessin helped them out of their difficulties again by his adroitness as a party leader and his stirring eloquence. He gained his arm-chair in the senate as a reward for his services on this occasion. In 1743 Tessin composed the long outstanding differences between Sweden and Denmark in a special mission to Copenhagen. In 1744 he was sent at the head of an extraordinary embassade to Berlin to escort to Stockholm Frederick the Great's sister, Louisa Ulrica, the chosen bride of the Swedish crown-prince, Adolphus Frederick. As *overhofmarskalk* of the young court, Tessin speedily captivated the royal pair. He also succeeded in withdrawing the crown-prince from beneath the influence of the Russian empress Elizabeth, to whom Adolphus Frederick owed his throne when he became king of Sweden in 1751, thereby essentially contributing to the maintenance of the independence of Sweden. From 1746 to 1752 Tessin was president of the chancellery, as the Swedish prime minister was called in those days. His "system" aimed at a *rapprochement* with Denmark with the view of counterbalancing the influence of Russia in the north. It was a dignified and prudent policy, but his endeavour to consolidate it by promoting a matrimonial alliance between the two courts alienated the Swedish crown-prince, who, as a Holsteiner, nourished an ineradicable hatred of everything Danish. As, moreover, on the accession of Adolphus Frederick in 1751, Tessin refused to countenance any extension of the royal prerogative, the rupture between him and the court became final. On the occasion of the coronation (1752) he resigned the premiership, and in 1754 the governorship of the young crown-prince Gustavus also, spending the rest of his days at his estate at Åkerö. Tessin was one of the most brilliant personages of his day, and the most prominent representative of French culture in Sweden. He was also a fine orator, and his literary style is excellent.

His principal works are his autobiographical fragments (1st ed. Stockholm, 1819), *Tessin och Tessiniana; K. G. Tessin's Dagbok* (Stockholm, 1824), both of them extracts from his voluminous MS. memoirs in 29 volumes; and his famous *En gammal mans bref til en ung Prins* (Stockholm, 1753; English editions, 1755 and 1756), addressed to his pupil, afterwards Gustavus III., one of the most delightful books for the young that ever saw the light.

See R. Nisbet Bain, *Gustavus III. and his Contemporaries* (London, 1895), vol. i; Bernhard von Beskow, *Minne af Grefve K. G. Tessin* (Stockholm, 1864); Bernhard Elis Malmström, *Sveriges politiska historia från Konung Karl XII.'s dod till statshvälfningen*, 1772 (Stockholm, 1893–1901). (R. N. B.)

TEST ACTS. The principle that none but persons professing the established religion were eligible for public employment was adopted by the legislatures of both England and Scotland soon after the Reformation. In England the Acts of Supremacy and Uniformity and the severe penalties denounced against recusants, whether Roman Catholic or Nonconformist, were affirmations of this principle. The Act of 7 Jac. I. c. 2 provided that all such as were naturalized or restored in blood should receive the sacrament of the Lord's Supper. It was not, however, until the reign of Charles II. that actual receiving of the communion of the Church of England was made a condition precedent to the holding of public offices. The earliest imposition of this test was by the Corporation Act of 1661 (13 Car. II. st. 2, c. 1), enacting that, besides taking the oath of allegiance and supremacy and subscribing a declaration against the Solemn League and Covenant, all members of corporations were within one year after election to receive the sacrament of the Lord's Supper according to the rites of the Church of England. This act was followed by the Test Act of 1672 (25 Car. II. c. 2). The immediate cause of the Test Act (the full title of which is "An act for preventing dangers which may happen from popish recusants") was the king's declaration of indulgence, dispensing with laws inflicting disabilities on Nonconformists. This act enforced upon all persons filling any office, civil or military, the obligation of taking the oaths of supremacy and allegiance and subscribing a declaration against transubstantiation, and also of receiving the sacrament within three months after admittance to office. The act did not extend to peers; but in 1678 30 Car. II. st. 2 enacted that all peers and members of the House of Commons should make a declaration against transubstantiation, invocation of saints, and the sacrifice of the mass—a special exception being made in favour of the duke of York. The provisions of the Test Act were violated by both Charles II. and James II. on the ground of the dispensing power claimed by the Stuart kings. In the well-known case of *Godden* v. *Hales* (11 State Trials, 1166), an action for penalties under the Test Act brought against an officer in the army, the judges decided in favour of the dispensing power—a power finally abolished by the Bill of Rights. After a considerable number of amendments and partial repeals by the legislature of the acts of 1661, 1672 and 1678, and of acts of indemnity to protect persons under certain circumstances from penalties incurred under the Test Act, the necessity of receiving the sacrament as a qualification for office was abolished by 9 Geo. IV. c. 17, and all acts requiring the taking of oaths and declarations against transubstantiation, &c., were repealed by the Roman Catholic Relief Act of 1829 (10 Geo. IV. c. 7). This general repeal has been followed by the special repeal of the Corporation Act by the Promissory Oaths Act 1871, of the Test Act by the Statute Law Revision Act 1863, and of the act of 1678 by an act of 1866 (29 & 30 Vict. c. 19). Religious tests remained in the English universities until 1871, in Dublin University until 1873, and the Scottish universities until 1889. To be a member of the Church of England was a necessary condition precedent for holding most university or college offices by the Act of Uniformity of 1662, and such offices were not affected by the Toleration Act of 1688 and the Roman Catholic Relief Act of 1829. In 1871 the University Tests Act abolished subscriptions to the articles of the Church of England, all declarations and oaths respecting religious belief, and all compulsory attendance at public worship in the universities of Oxford, Cambridge and Durham. There is an exception confining to persons in holy orders of the Church of England degrees in divinity and positions restricted to persons in holy orders, such as the divinity and Hebrew professorships.

Scotland.—A religious test was imposed immediately after the Reformation. By 1567, c. 9, no one was to be appointed to a public office or to be a notary who did not profess the Reformed religion. The Scottish Test Act was 1681, c. 6, rescinded by 1690, c. 7. Renunciation of popery was to be made by persons employed in education (1700, c. 3). A motion to add, after the 18th article of union, an exemption of Scotsmen from the sacramental test in the United Kingdom was negatived by the Scottish parliament. A similar fate awaited a proposal that while a sacramental test was in force in England all persons in public office in Scotland should subscribe their adhesion to the Presbyterian Church government. By 1707, c. 6, all professors, principals, regents, masters or others bearing office in any university, college or school in Scotland were to profess and subscribe to the Confession of Faith. All persons were to be free of any oath or test contrary to or inconsistent with the Protestant religion and Presbyterian Church government. The reception of the communion was never a part of the test in Scotland as in England and Ireland. The necessity for subscription to the Confession of Faith by persons holding a university office (other than that of principal or professor of theology) was removed by 16 & 17 Vict. c. 89. The act provided that in place of subscription every person appointed to a university office was to subscribe a declaration according to the form in the act, promising not to teach any opinions opposed to the divine authority of Scripture or to the Confession of Faith, and to do nothing to the prejudice of the Church of Scotland or its doctrines and privileges. All tests were finally abolished by an act of 1889 (52 & 53 Vict. c. 55).

Ireland.—An oath of allegiance was required by the Irish Act of Supremacy (2 Eliz. c. 1). The English Act of 3 Will. & M. c. 2 substituted other oaths and enforced in addition from peers, members of the House of Commons, bishops, barristers, attorneys and others a declaration against transubstantiation, invocation of the Virgin Mary and the saints, and the sacrifice of the mass. By the Irish Act of 2 Anne, c. 6, every person admitted to any office, civil or military, was to take and subscribe the oaths of allegiance, supremacy, and abjuration, to subscribe the declaration against transubstantiation, &c., and to receive the Lord's Supper according to the usage of the Church of Ireland. English legislation on the subject of oaths and declarations was adopted in Ireland by Yelverton's Act, 21 & 22 Geo. III. c. 48, § 3 (Ir.). These provisions were all repealed by the Promissory Oaths Act 1871. The Roman Catholic Relief Act of 1793 (33 Geo. III. c. 21, Ir.) excepted Trinity College, Dublin, from its provisions, and tests existed in Dublin university until 1873. They were abolished as far as regarded certain scientific professorships in 1867 by 30 Vict. c. 9, and were finally abolished for the whole university by the University of Dublin Tests Act 1873, except as to professors of and lecturers in divinity.

United States.—By art. 6 of the constitution, "no religious test shall ever be required as a qualification to any office or public trust under the United States." A similar provision is generally included in the state constitutions.

TESTAMENTS OF THE THREE PATRIARCHS. This apocryphal work of the Hebrew Scriptures was first published by M. R. James (*The Testament of Abraham, the Greek Text now first edited with an Introduction and Notes. With an appendix containing extracts from the Arabic Version of the Testaments of Abraham, Isaac and Jacob, by Barnes, Texts and Studies*, ii. 2: Cambridge). The Greek testament of Abraham is preserved in two recensions from six and three MSS. respectively. This testament is also edited by Vassiliev in his *Anecdota Graeco-Byzantina*, 1893, i. 292–308 from a Vienna MS. already used by James. According to James, it was written in Egypt in the 2nd century A.D., and was translated subsequently into Slavonic (Tichonrawow, *Pamjatniki otretschennoi russkoi Literaturi*, 1863, i. 79–90), Rumanian (Gaster, *Proceedings of the Society of Biblical Archaeology*, 1887, ix. 195–226), Ethiopic and Arabic.

This testament deals with Abraham's reluctance to die and the means by which his death was brought about. As regards its origin James writes (*op. cit.*, p. 55): "The Testament was originally put together in the second century by a Jewish Christian: for the narrative portions he employed existing Jewish legends, and for the apocalyptic, he drew largely on his imagination." He holds that the book is referred to by Origen, *Hom. in Luc.* xxxv. With the exception of x.–xi. the work is really a legend and not an apocalypse.

To the above conclusions Schürer, *Gesch. des jüd. Volkes*, 3rd ed., iii. 252, takes objection. He denies the reference in Origen, and asserts that there are no grounds for the assumption of a partial Jewish origin. But the present writer cannot agree with Schürer in these criticisms, but is convinced that a large body of Jewish tradition lies behind the book. Indeed, Kohler (*Jewish Quarterly Review*, 1895, v. 581–606) has given adequate grounds for regarding this apocryph as in the main an independent work of Jewish origin subsequently enlarged by a few Christian additions.

An English translation of James's texts will be found in the *Ante-Nicene Christian Library* (Clark, 1897), pp. 185–201. The testaments of Isaac and Jacob are in part still preserved in Arabic and Ethiopic (see James, *op. cit.*, 140–161). (R. H. C.)

TESTAMENTS OF THE TWELVE PATRIARCHS. The Testaments of the Twelve Patriarchs (see APOCALYPTIC LITERATURE: *II. Old Testament*), are an important constituent of the apocryphal scriptures connected with the Old Testament, comprising the dying commands of the twelve sons of Jacob.

They "were written in Hebrew in the later years of John Hyrcanus—in all probability after his final victory over the Syrian power and before his breach with the Pharisees—in other words, between 109 and 106. Their author was a Pharisee who combined loyalty to the best traditions of his party with the most unbounded admiration of Hyrcanus. The Maccabean dynasty had now reached the zenith of its prosperity, and in its reigning representative, who alone in the history of Judaism possessed the triple offices of prophet, priest and king, the Pharisaic party had come to recognize the actual Messiah. To this John Hyrcanus, in whom had culminated all the glories and gifts of this great family, our author addresses two Messianic hymns. The writer already sees the Messianic kingdom established, under the sway of which the Gentiles will in due course be saved, Beliar overthrown, sin disappear from the earth, and the righteous dead rise to share in the blessedness of the living. Alas for the vanity of man's judgment and man's prescience! Our book had hardly been published, when Hyrcanus, owing to an injury done him by the Pharisees, broke with their party, and, joining the Sadducees, died a year or two later. His successors proved themselves the basest of men. Their infamy is painted in lurid colours by contemporary writers of the 1st century B.C., and by a strange irony the work, or, rather, fragments of the work of one of these assailants of the later Maccabees, has achieved immortality by finding a covert in the chief manifesto that was issued on behalf of one of the earlier members of that dynasty. This second writer singles out three of the Maccabean priest kings for attack, the first of whom he charges with every abomination; the people itself, he declares, is apostate, and chastisement will follow speedily—the temple will be laid waste, the nation carried afresh into captivity, whence, on their repentance, God will restore them again to their own land, where they shall enjoy the blessedness of God's presence and be ruled by a Messiah sprung from Judah. When we contrast the expectations of the original writer and the actual events that followed, it would seem that the chief value of his work would consist in the light that it throws on this obscure and temporary revolution in the Messianic expectations of Judaism towards the close of the 2nd century. But this is not so. The main, the overwhelming value of the book lies not in this province, but in its ethical teaching, which has achieved a real immortality by influencing the thought and diction of the writers of the New Testament, and even those of our Lord. This ethical teaching, which is indefinitely higher and purer than that of the Old Testament, is yet its true spiritual child, and helps to bridge the chasm that divides the ethics of the Old and New Testaments."[1]

In the early decades of the Christian era the text was current in two forms, which are denoted by H^{α} and H^{β} in this article and in the edition of the text published by the Oxford University Press. "The former of these was translated not later than A.D. 50 into Greek, and this translation was used by the scholar who rendered the second Hebrew recension into Greek. The first Greek translation was used by our Lord, by St Paul, and other New Testament writers. In the second and following centuries it was interpolated by Christian scribes, and finally condemned undiscriminatingly along with other apocryphs. For several centuries it was wholly lost sight of, and it was not till the 13th century that it was rediscovered through the agency of Robert Grosseteste, bishop of Lincoln, who translated it into Latin, under the misconception that it was a genuine work of the twelve sons of Jacob, and that the Christian interpolations were a genuine product of Jewish prophecy. The advent of the Reformation brought in critical methods, and the book was unjustly disparaged as a mere Christian forgery for nearly four centuries. The time has at last arrived for this book, so noble in its ethical side, to come into its own."[2]

Versions and MSS.—The two recensions[3] of the Hebrew original, to which we have already referred, were translated into Greek, the former being attested by the Greek MSS. *chi* and the latter by *a b d e f g*, which groups for the sake of brevity we designate as α and β. The Greek version was in turn rendered into Armenian in the 5th or 6th century. The rendering was made, except in a limited number of passages, from β. Of this version there are at least eleven MSS. known. Here again two types of text, A^{α} and A^{β}, are represented, but for the most part the differences originated within the Armenian. Finally about the 13th century the Slavonic Version was made from the β form of the Greek Version. Here

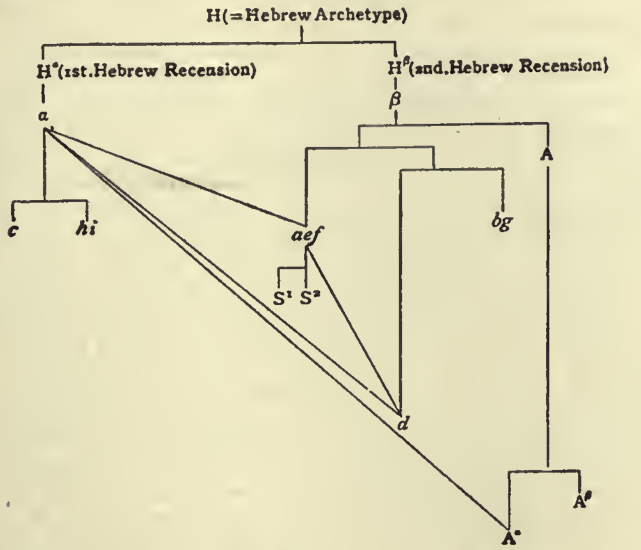
[1] From § 1 of the Introduction to R. H. Charles's *The Testaments of the Twelve Patriarchs, translated from the Editor's Greek Text* (A. & C. Black, 1908).

[2] From § 1 of the Introduction to R. H. Charles's *The Greek Versions of the Testament of the XII. Patriarchs* (Oxford University Press, 1908).

[3] Some of the evidence for this conclusion will be given later.

again we have two recensions S[1] and S[2], but the one may be on the whole reasonably described as an abbreviation of the other.

The relations of the above authorities are too complicated to be treated of here in detail, but they are represented on the subjoined diagram.



Original Language.—Apart from Grabe, till within the last fifteen years no notable scholar has advocated a Hebrew original. Nitzsch, Dillmann, Ritschl and Sinker are convinced that the book was not a translation but was written originally in Greek. To Kohler and Gaster belongs the honour of re-opening the question of the Hebrew original of the Testaments. Only the latter, however, offered any linguistic evidence. In his article[1] on the question he sought to establish a Hebrew original of all the Testaments and to prove that the Hebrew text of Naphtali which he had discovered was the original testament, and that the Greek Naphtali was a late and corrupt reproduction of it with extensive additions from other sources. But he failed in establishing either thesis. The subject was next taken in hand by R. H. Charles, who in a preliminary form in the *Encyclopaedia Biblica* (i. 241, 1899), and later, with considerable fullness, in his edition of the Greek text of the Testaments (1908), brought to light a number of facts that put the question of a Hebrew original beyond the range of doubt. We will now place a few of the grounds before the reader.

(*a*) *Hebrew constructions and expressions are to be found in every page. Though the vocabulary is Greek the idiom is frequently Hebraic and foreign to the genius of the Greek language.* Thus in T. Reub. vi. 11, ἐν αὐτῷ ἐξελέξατο = בו בחר. In T. Jud. xx. 4, ἐν στήθει ὀστέων αὐτοῦ—an utterly unmeaning phrase—becomes intelligible on retroversion—בלב עצמו, "on his very heart." In T. Benj. x. 11 κατοικήσετε ἐπ' ἐλπίδι ἐν ἐμοί = "ye shall dwell *securely* with me"; for here ἐπ' ἐλπίδι, as several times in the Septuagint, is a wrong rendering of לבטח.

(*b*) *Dittographic renderings in the Greek of the same Hebrew expression; also dittographic expressions in the Greek implying dittographs in the Hebrew.* See Introduction to R. H. Charles's Text, § 11.

(*c*) *Paronomasiae which are lost in the Greek can be restored by retranslation into Hebrew.* There are over a dozen of such instances.

(*d*) *Many passages which are obscure or wholly unintelligible in the Greek become clear on retranslation into Hebrew.* Of the large body of such passages (see *op. cit.* § 12) we will give only one. In T. Jud. ix. 3, we have the following impossible sentence, where Esau is referred to: ἤρθη νεκρὸς ἐν ὄρει Σιείρ, καὶ πορευόμενος ἐν Ἀνουίραμ ἀπέθανεν. Here a fragment of the Hebrew original, which has happily been preserved, reads נחלה, "wounded," where the Greek has νεκρὸς = נבלה, which is manifestly a corruption of the former.

In all the above cases there is no divergence among the MSS. and Versions. Yet the restorations are so many and so obvious that our contention might be taken for proven. But there is stronger evidence still, and this is to be found where the MSS. and Versions attest different texts, α standing generally in opposition to β, A (=Armenian Version), and S (=Slavonic Version). By means of this evidence we are able to prove not only that our book is from a Hebrew original, but that also the Hebrew existed in two recensions, H$^\alpha$ and H$^\beta$, which are the parents respectively of α and β (see diagram above).

[1] "The Hebrew Text of one of the Testaments of the XII. Patriarchs" (*Proceedings of the Soc. of Bibl. Archaeology*, December 1893, January 1894).

α and β are not, strictly speaking, Greek recensions; for their chief variations go back to diverse forms of text already existing in the Hebrew H$^\alpha$ and H$^\beta$. For the considerable body of evidence supporting this conclusion see the Introduction to R. H. Charles's Text, § 12. A couple of the many passages in which the variations in α and β are due to variations in H$^\alpha$ and H$^\beta$ will now be given. In T. Benj. xii. 2 α reads ἐκοιμήθη ὕπνῳ καλῷ and β A S[1] ἀπέθανε . . . ἐν γήρει καλῷ. Here ἐκοιμήθη and ἀπέθανε may be taken as renderings of the same Hebrew word, but ὕπνῳ καλῷ = בשינה טובה, an undoubted corruption of בשיבה טובה = "at a good old age." The same corruption invaded both Hebrew recensions in T. Zeb. x. 6; T. Dan. vii. 1; T. Ash. viii. 1; T. Jos. xx. 4, whereas in T. Iss. vii. 9 both recensions were right. In the late Hebrew text of Naph. i. 1 the correct Hebrew phrase is found. Again in T. Ash. vi. 6 α reads εἰσφέρει αὐτὸν εἰς ζωὴν αἰώνιον and β A S[1] παραμυθεῖται αὐτὸν ἐν ζωῇ. Here παραμυθεῖται = ינחם, a corruption of ינחה = εἰσφέρει. It is the soul of the righteous that is here spoken of, and α rightly says that the angel of peace "leads him into eternal life." The rightness of H$^\alpha$ is confirmed by T. Benj. vi. 1, which reads ὁ γὰρ ἄγγελος τῆς εἰρήνης ὁδηγεῖ τὴν ψυχὴν αὐτοῦ.

H$^\alpha$ and H$^\beta$, however, differed mainly from each other in words and phrases, as we infer from α and β. In some passages, however, the divergence is on a larger scale, as in T. Lev. ii. 7–iii. Notwithstanding these divergences, however, the great similarities between α and β oblige us to assume that the translator of H$^\beta$ used the Greek version of H$^\alpha$, or vice versa. That the former is the more likely we shall see presently. To the above we have a good parallel in the Book of Daniel; for the variations of its two chief Greek Versions—that of the Septuagint and of Theodotion—go back to variations in the Semitic.

Date of the Original Hebrew.—"The date of the groundwork of the Testaments is not difficult to determine. Thus Reuben (T. Reub. vi. 10–11) admonishes his sons: Πρὸς τὸν Λευὶ ἐγγίσατε ἐν ταπεινώσει καρδίας ὑμῶν ἵνα δέξησθε εὐλογίαν ἐκ τοῦ στόματος αὐτοῦ . . . ὅτι ἐν αὐτῷ ἐξελέξατο Κύριος βασιλεύειν ἐνώπιον παντὸς τοῦ λαοῦ. Here a high-priest who is also a king is referred to. Such a combination of offices naturally makes us think of the Maccabean priest-kings of the 2nd century B.C. The possibility of doubting this reference is excluded by the words that immediately follow:—καὶ προσκυνήσατε τὸ σπέρμα αὐτοῦ ὅτι ὑπὲρ ὑμῶν ἀποθανεῖται ἐν πολέμοις ὁρατοῖς καὶ ἀοράτοις· καὶ ἐν ὑμῖν ἔσται βασιλεὺς αἰώνιος. A similar statement is made in T. Sim. v. 5. Thus the high-priest is not only a high-priest and civil ruler, but also a warrior. That the Maccabean high-priests are here designed cannot be reasonably doubted. But the identification becomes undeniable, as further characteristics of this priestly dynasty come to light. It was to be a new priesthood and to be called by a new name (T. Lev. viii. 14 ἱερατείαν νέαν . . . ὄνομα καινόν). Now the Maccabean high-priests were the first to assume the title 'priests of the Most High God'—the title anciently borne by Melchizedek. But the praises accorded in this book could not apply to all the Maccabean priest-kings of the nation. As it was written by a Pharisee, it could not have been composed after the breach arose between John Hyrcanus and the Pharisees towards the close of the 2nd century B.C. Thus the period of composition lies between 153, when Jonathan the Maccabee assumed the high-priesthood, and the year of the breach of John Hyrcanus with the Pharisees; some time, therefore, between 153 and 107. But the date can be determined between closer limits. To one member of the Maccabean dynasty are the prophetic gifts assigned in our text (T. Lev. viii. 15) in conjunction with the functions of kingship and priesthood. Now, in all Jewish history the triple offices were ascribed to only one individual, John Hyrcanus. Hence we conclude that the Testaments were written between 137 and 107." But the limits of the date of composition be fixed still more definitely. For the text refers most probably to the destruction of Samaria, T. Lev. vi. 11. In that case the Testaments were written between 109 and 107 B.C.

Date of the Greek Version.—The α Version seems to have been translated first, indeed before A.D. 50; for it is twice quoted by St Paul. The first passage is in Rom. i. 32 οὐ μόνον αὐτὰ ποιοῦσιν ἀλλὰ καὶ συνευδοκοῦσιν τοῖς πράσσουσιν which is taken almost verbally from T. Ash. vi. 2, ὅτι οἱ διπρόσωποι δισσῶς †κολάσονται (*rd.* ἁμαρτάνουσι) ὅτι καὶ πράσσουσι τὸ κακὸν καὶ συνευδοκοῦσι τοῖς πράσσουσιν. Since *bg*, A omit the words ὅτι . . . πράσσουσιν, we conclude that, though it is now found in α, *adef*, S[1], it was originally wanting in β and probably also in H$_\beta$. For as we have already seen (see diagram above) *aef* were early influenced by α, and *d* is conflate in character. Hence in reality the passage was preserved only by α originally.

The second passage is the well-known one in 1 Thess. ii. 16, ἔφθασεν δὲ ἐπ' αὐτοὺς ἡ ὀργὴ (+τοῦ θεοῦ DEFG *it*, Vulg. *go*) εἰς τέλος, which is borrowed from T. Lev. vi. 11, ἔφθασεν δὲ (+ἐπ' β) αὐτοὺς ἡ ὀργὴ τοῦ θεοῦ εἰς τέλος.

Here β reads Κυρίου for τοῦ θεοῦ. The ἐπὶ is omitted by α through a simple scribal error.

On the ground of the above quotations we assume, therefore, that α was used by St Paul, and that H$^\alpha$ was therefore translated into Greek at latest before A.D. 50.

When H^{β} was translated we have no definite means of determining. It was in all likelihood done subsequently to H^{α}. The translator of H^{β} appears to have had the translation of H^{α} before him, and to have followed it generally unless where there were manifest divergencies between H^{α} and H^{β}.[1]

Jewish Additions to the Text.—(*a*) A large body of these additions can be classed under one head as written with a well-defined object and at a definite period. This period was about 70–40 B.C., and the object of the additions was the overthrow of the Maccabean high-priesthood, which in the 1st century B.C. had become guilty of every lewdness. T. Lev. x., xiv.–xvi.; T. Jud. xvii. 2–xviii. 1 (?), xxi. 6–xxiii., xxiv. 4–6; T. Zeb. ix.; T. Dan. v. 6–7, vii. 3 (?); T. Naph. iv.; T. Gad. viii. 2; T. Ash. vii. 4–7. These additions are identical in object and closely related in character and diction with the Psalms of Solomon.

(*b*) Other additions are of various dates and cannot be more than mentioned here, *i.e.*, T. Reub. ii. 3–iii. 2; T. Lev. xvii. 1–9; T. Zeb. vi. 4–6, vii.–viii. 3; T. Jos. x. 5–xviii.

Christian Additions to the Text.—These additions are to be found in most of the Testaments and were made at different periods. The existence of these Christian elements in the text misled nearly every scholar for the past four hundred years into believing that the book itself was a Christian apocryph. To Grabe, Schnapp and Conybeare belongs the credit of showing that the Christian elements were interpolations—to Conybeare especially of the three, since, whereas the two others showed the high probability of their contention on internal evidence, Conybeare proved by means of the Armenian Version that when it was made many of the interpolations had not yet found their way into the text. For a full treatment of these passages see R. H. Charles's *Testaments of the Twelve Patriarchs* (1908), Introd. § 20.

Influence on the New Testament.—We have already shown that St Paul twice quoted from the Greek text of the Testaments. These two passages in Rom. and 1 Thess. give but the very faintest idea of the degree of his indebtedness in thought and phraseology in several of his Epistles, especially that to the Romans. But of still greater interest are the passages in the Gospels which show the influence of the Testaments, and these belong mainly to the sayings and discourses of our Lord. We may mention two of the most notable of these. Thus Matt. xviii. 15, 35, which deal with the great question of forgiveness, are clearly dependent on our text.

Matt. xviii. 15. Ἐὰν δὲ ἁμαρτήσῃ ὁ ἀδελφός σου κατά σου, ὕπαγε ἔλεγξον αὐτὸν μεταξὺ σοῦ καὶ αὐτοῦ μόνου.	T. Gad. vi. 3. Ἐάν τις ἁμαρτήσει εἰς σέ εἰπὲ αὐτῷ ἐν εἰρήνῃ . . . καὶ ἐὰν . . . μετανοήσῃ ἄφες αὐτῷ.
35. Ἐὰν μὴ ἀφῆτε ἕκαστος τῷ ἀδελφῷ αὐτοῦ ἀπὸ τῶν καρδιῶν ὑμῶν.	vi. 6. Ἡσύχασον μὴ ἐλέγξῃς. . . .
	v. 7. Ἄφες αὐτῷ ἀπὸ καρδίας.

Next, the duty of loving God and our neighbour is already found in T. Dan. v. 3, which is the oldest literary authority which enjoins these two great commands. The form is infinitely finer in Matt. xxii. 37–39, but the matter is already in the Test. Dan. See Introd. § 26 to R. H. Charles's *Testaments of the Twelve Patriarchs.*

LITERATURE.—(*a*) *Texts.*—Sinker, *Testamenta XII Patriarcharum* (1869); [this work gives *b* in the text and *a* in the footnotes; subsequently (1879) Sinker issued an Appendix with variations from *cg*]; Charles, *The Greek Versions of the Testaments of the XII. Patriarchs from nine MSS., with the Variants from the Armenian and Slavonic Versions and the Hebrew Fragments* (1908). *Commentary.*—Charles, *The Testaments of the Twelve Patriarchs translated from the Editor's Greek Text* (1908). *Critical Inquiries.*—See Schürer, *G. J. V.* iii. 261–262: Charles, *The Test. XII. Patriarchs,* pp. xxxvi.–xli.

(R. H. C.)

TESTAMENTUM DOMINI ("TESTAMENT OF OUR LORD"). Extracts from the book which bears this title, contained in an 8th-century MS. at Paris, were published by Lagarde in 1856 (*Reliquiae iuris ecclesiastici antiquissimae 80–89*); and a Latin fragment, edited by Dr Montague James, appeared in 1893 (*Texts and Studies*, i. 154). The whole book was first published in Syriac in 1899, with a Latin translation by Mgr Rahmani, the Uniat Syrian Patriarch of Antioch. His text is that of a 17th-century MS. at Mosul, the colophon of which says that the Syriac text was translated from the original Greek "*a Jacobo paupere,*" evidently James of Edessa, in A.D. 687; but he makes use of other material, including an Arabic version made from a Coptic copy written in A.D. 927. The Mosul MS. contains the whole Bible in the Peshitto version, followed by the Syrian "Clementine Octateuch," *i.e.*, the collection of ecclesiastical law, in eight books, which was used by the Nestorians and Jacobites. Of this the *Testament* forms the first two books; and according to the title (which, apparently by an error, is made to apply to the whole eight books) it contains the "testament, or words which Our Lord spake to His holy Apostles when He rose from the dead." Plainly, it is one of that series of writings, claiming to embody the fundamental rules of the Church, which culminates in the Apostolical Constitutions (*q.v.*).

It falls into three distinct parts: an apocalyptic introduction (book i. chapters 1–18; the division into books, however, is clearly not original); a "church order" proper (i. 19–ii. 24); and a conclusion (ii. 25–27) of the same apocalyptic character as the introduction. (*a*) The *Introduction* professes to contain the record of the revelation of Himself by the Lord to His Apostles, with whom are Martha, Mary and Salome, on the evening after His resurrection. He is represented as unfolding to them, at their request, the signs of the end, and giving them instruction on various other topics. Incidentally, the fact becomes plain that this section is composed from the standpoint of Asia Minor and Syria, that it dates from soon after the time of Maximin (235–38) and Decius (249–51), and that it springs from a Christian community of a strictly puritan type. (*b*) The *Church Order* follows the general lines of the Canons of Hippolytus and similar documents. It describes the Church and its buildings (i. 19); the office of the bishop and his functions (i. 19–27); the mystagogic instruction (i. 28) common to this and the Arabic Didascalia, where it occurs in an earlier form, and based in part upon the Gnostic "Acts of Peter"; the presbyter (i. 29–32); the deacon (i. 33–38); confessors (i. 39); the "widows who have precedence in sitting" (i. 40–43), apparently the same persons who are spoken of elsewhere as "presbyteresses" (i. 35, ii. 19); the subdeacon (i. 44) and the reader (i. 45), the order of whose offices seems to have been inverted; virgins of both sexes (i. 46); and those who possess *charismata* or spiritual gifts (i. 47). Next come the regulations for the laity, including the whole course of preparation for and admission to baptism (ii. 1–8), confirmation (ii. 9), and the eucharist (ii. 10); after which there follows a series of miscellaneous regulations for Easter and Pentecost (ii. 11–12), the agape (ii. 13), the funds of the Church (ii. 17–20), the visitation of the sick (ii. 21), the use of psalmody (ii. 22), the burial of the dead (ii. 23), and the hours of prayer (ii. 24). (*c*) The *Conclusion* (ii. 25–27) brings us back to the injunctions of the Lord as to the keeping of these precepts, a special charge to John, Andrew and Peter, and a statement that copies of the Testament were made by John, Peter and Matthew, and sent to Jerusalem by the hands of Dositheaus, Sillas, Magnus and Aquila.

In all this there is much that is peculiar to or characteristic of the *Testament*. First and foremost is its ascription to the Lord Himself, which we can hardly be mistaken in regarding as an attempt to claim yet higher sanction than was claimed by the various compilations which were styled "apostolic." This fact alone would lead us to infer the pre-existence of certain of the latter. Again, the whole tone of the *Testamentum* is one of highly strung asceticism, and the regulations are such as point by their severity to a small and strictly organized body. They are "the wise," "the perfect," "sons of light"; but this somewhat Gnostic phraseology is not accompanied with any signs of Gnostic doctrine, and the work as a whole is orthodox in tone. They are set in the midst of "wolves," despised and slighted by the careless and worldly: there is frequent mention of "the persecuted," and of the duty of "bearing the cross." There appears to be no *locus poenitentiae* for serious sins excepting in the case of catechumens, and there is a notable "perfectionist" tone in many of the prayers. *Charismata*, and above all exorcisms, occupy a very important place: there is a vivid realization of the ministry of angels, and the angelic hierarchy is very complete. Great stress is laid upon virginity (although there is not a sign of monasticism), upon fasting (especially for the bishop), upon the regular attendance of the whole clerical body and the "more perfect" of the laity at the hours of prayer. The church buildings are very elaborate, and the baptistery is oblong, a form found apparently only here and in the Arabic Didascalia. Amongst the festivals mentioned are the Epiphany, Easter and Pentecost. With regard to the prayers, they are based upon forms common to this and other Church orders, but have many lengthy interpolations of an inflated and rhapsodic kind. The bishop appears to rank far above the presbyters (more conspicuously so, for example, than in the Canons of Hippolytus), and the presbyters are still divided into two classes, those who are more learned and those

[1] § 14 of the Introduction to R. H. Charles's *The Greek Versions of the Testaments of the XII. Patriarchs.*

who are of mature age. The deacons have functions in the Eucharist and about the altar which point to an early date; they have also much administrative work of an important kind, and especial provisions are made for the care of the sick and the dead, and the burial of those who perish by shipwreck. One of the deacons is to be chosen as "chief deacon" (*protodiaconus*, i. 19, *cf*. i. 34), and is charged with the care of pilgrims. There are no doorkeepers or singers, who begin to appear *circ*. A.D. 340. The honour given to confessors is very conspicuous, and points back to an early date. But remarkable above all is the position given to women. We have "widows having precedence" or presbyteresses, three in number, deaconesses, virgins, and widows who are in receipt of the alms of the Church; and the first-named occupy a place of very great dignity, which is almost unequalled elsewhere (excepting in the earlier form of the apocryphal and Montanistic *Acts and Martyrdom of Matthew*, where the relation of the πρεσβῦτι and deaconess corresponds with that of the *Testament*), and which was formally condemned by the Council of Laodicea in Phrygia.

What conclusion is to be drawn, then, as to the age and character of the *Testament?* Mgr Rahmani's view, that it is a work of the 2nd century, is universally discredited; nor has Funk's contention found acceptance, that it and the Canons of Hippolytus are alike derived ultimately from the eighth book of the *Apostolic Constitutions*. Some scholars think that the Apocalypse at the beginning is pre-Nicene (A.D. 250–325), and that it originates from Asia Minor, probably from Montanistic circles. Harnack formerly contended that this was an independent work, upon which the Church Order had been grafted, and that as a whole it dated from *circ*. A.D. 400. But the unity of thought and atmosphere is such as to show that the work is one whole (subject no doubt to a certain amount of redaction and interpolation), and that the apocalyptic part was composed as an introduction to the rest. As to the central portion (i. 19–ii. 24) it is a Church Order of the same kind as the Canons of Hippolytus (*c*. 220) and the Egyptian (*c*. 310) and Ethiopic (*c*. 335) Church Orders, standing nearer to the two latter than to the former, and especially to the Verona Latin Fragments, part iii. (*c*. 340), published in 1900 by Dr Hauler. The precise relation in which these documents stand to one another still remains in a measure doubtful, but it seems probable that they are based upon a lost Church Order, to which the Canons of Hippolytus stands nearest. [The Greek original of the *Testamentum* would seem to date from the middle of the 4th century, not long after 350. This is the view of T. Zahn and Dom Morin and also of Profs. Cooper and Maclean. It is possible that about 400 a later editor added a few paragraphs.]

Such redaction was indeed inevitable in the case of a work which has had a living history as part of a codex of Church law. It may be discerned in the interpolations in the prayers; possibly in the reference to the chief deacon, for elsewhere no single deacon is distinguished *by name* until the close of the 4th century; in the reference to the Epiphany, which is first heard of elsewhere at the beginning of the 4th century. The suggestion has been hazarded that this revision was due to the school of Apollinaris of Laodicea (died *circ*. A.D. 390).

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TESTAMUR, Latin for "we testify" or "certify" (*testari*). The name given in English universities to a certificate given to a student signifying that he has passed an examination, so called from the word with which the certificate begins.

TESTER (Fr. *têtière*, head-covering, from *tête*), anything placed horizontally over the head, as the sound-board of a pulpit, the flat boards over an old-fashioned bed, &c.

TETANUS (from Gr. τείνω, I stretch, on account of the tension of the fibres of the affected muscles), or LOCKJAW, a disease caused by the bacilli Tetani (see PARASITIC DISEASES). The home of these bacilli is the earth, and so it comes about that if a man is thrown off his bicycle and grazes his ungloved hand upon the road, or running without shoes cuts his foot, there is a considerable chance of the bacilli entering the wound and giving him lockjaw. It is popularly thought that wounds in the region of the thumb are most often followed by the disease, but this is not a fact. Wounds about the thumb are of common occurrence, but they are not, in proportion, more often the starting point of tetanus.

Acute traumatic tetanus is very deadly, and up to the present time nothing has been discovered to check or guide its almost certainly fatal course. It often picks out the young and vigorous as its victims—the athlete, for instance, who meets with some mishap in the field or on the road, the gardener who pricks his hand, the swimmer who cuts his foot, the wounded soldier on the field of battle. The violent muscular contractions are distressingly painful; and the brain remaining perfectly clear throughout, the unhappy individual feels that the vice-like gripping of his muscles is steadily exhausting him and bringing him down. The spasms of tetanus differ from those caused by the administration of strychnine in that the muscles are all the time hard from rigid contraction, the acute spasmodic attacks being superadded, as it were. In poisoning by strychnine the muscles are quite relaxed between the spasmodic attacks.

Tetanus may follow a mere prick or scratch or a severe surgical operation. It not seldom complicates burns, gunshot wounds and injuries caused by the untimely explosion of fireworks. It may be met with in the woman in child-bed or in the newly-born infant. But wherever it occurs it is due to the one cause—to the reception into some wounded surface of the specific germs.

In hot countries tetanus is more common and more acute than it is in temperate climes, and a case has been recorded in which a man in the West Indies cut his hand on a broken plate at dinner and was dead of tetanus before the day was out. It is easy to see that the germs are more likely to undergo virulent cultivation in warm earth than in cold. It was formerly the custom to speak of idiopathic tetanus—that is to say, of the disease occurring without any wound having been received. But modern teaching is to the effect that there must have been some wound, however slight, by which the germs found entrance. Rheumatic tetanus is as unreal a disease as that just mentioned. The germs themselves do not wander from the wound to multiply in the blood as in infecting diseases, but remaining at the wound elaborate a terribly poisonous substance (a toxin) which makes its way along the nerve-trunks to the spinal cord. Even prompt amputation, however, is likely to prove ineffectual as regards cure, for the germs in the wound have in this growth set free so virulent a poison (toxin) that the nerves of the voluntary muscles all over the body are hopelessly under its influence.

The first symptom of the disease is discomfort in the back of the neck; the man waking up in the morning, for instance, complains of "stiff neck" and of obscure pains, and wonders if he has been lying in a draught. Then the muscles of the jaw and of the face become affected, there being a difficulty in opening the mouth, and the corners of the mouth are drawn downwards and backwards, and fixed in that position (*risus sardonicus*). The jaw is so firmly set that it is impossible to pass anything between the teeth. All food, therefore, has to be fluid, and being poured into the pouch of the cheek, finds its way into the mouth by the serviceable gap which exists behind the wisdom-teeth. Soon, however, a difficulty in swallowing comes on because of the muscles of the throat being involved. The muscles of the abdomen becoming contracted are rigidly fixed, and on laying the hand upon the front of the abdomen they feel as "hard as a board." The muscles of the limbs are also attacked with fearful cramps, and, last of all, the muscles of the chest are involved. Though all these muscles are in a continuous state of contraction, spasmodic contractions, as already remarked, come on in addition, and occasionally with such distressing energy that the patient is doubled up forwards, backwards, or sideways, and, may be, some of the muscles tear across. The patient is bathed in perspiration, and sinks worn out and exhausted, or, perchance, slowly suffocated by the locking of the muscles of respiration.

As regards the prospect of recovery in tetanus it may be said that when the symptoms break out acutely within a week of the reception of an injury the prospect of recovery is extremely remote. If they occur within ten days the prospects are bad. But if there is an interval of three weeks or a fortnight before their occurrence the case may be regarded more hopefully.

In the treatment of tetanus the first thing to do is to try to make the wound by which infection has taken place surgically clean. For though a wound free from the germs of suppuration may be the incubating place of the bacilli of tetanus, still in most cases there is also an invasion of septic germs, and the double infection makes the action of the tetanic poison the more virulent. If the local conditions are such that it is impossible to cleanse the wound, the free use of the knife or of the cautery or of pure carbolic acid may be resorted to, or an amputation may be performed. But even the early amputation of the infected part may not avail for the reason that the germs in the wound have already set free a lethal dose of their toxin.

The wound having been cleansed the further treatment of the disease demands absolute quiet in a darkened room. There must be no slamming of the door, shaking of the bed, or the sudden bringing in of a light, for any act such as this might cause the outbreak of a violent spasm. Morphia may be given by the hypodermic syringe, and if the spasms are causing great distress chloroform may be administered; indeed, in certain severe cases it may be necessary to keep the patient almost continuously under its influence. If there is difficulty in swallowing fluid, rectal feeding must be resorted to. Though at present one is unable to speak enthusiastically or with confidence about the antitoxin treatment of lockjaw, still it is a method which should certainly be given trial—and that early. The tetano-antitoxin is prepared from the blood of animals which have been rendered immune to repeated injections of the poison elaborated by the cultivation of the tetanus bacilli. The bacilli themselves are not injected, the injections being rendered sterile. By passing the sterile injections into one of the lower animals the blood of that animal prepares an antidote to them known as an antitoxin.

The antitoxin may be injected into the nerve trunks or into the sheath of the spinal cord or of the brain. But inasmuch as the nerves and the nerve-cells are under the influence of the toxin before the antitoxin is administered—as evidenced by the occurrence of the symptoms—the injection-treatment has but a poor chance of producing a good effect. (E. O.*)

TETRADYMITE, a mineral consisting of bismuth telluride and sulphide, Bi_2Te_2S, also known as "telluric bismuth." Sometimes sulphur is absent and the formula is then Bi_2Te_3; traces of selenium are usually present. Crystals are rhombohedral, but are rarely distinctly developed; they are twinned together in groups of four; hence the name of the mineral, from the Greek, τετραδυμος, fourfold. There is a perfect cleavage parallel to the basal plane; and the mineral usually occurs in foliated masses of irregular outline. The colour is steel-grey, and the lustre metallic and brilliant. The mineral is very soft ($H=1\frac{1}{2}$) and marks paper; the specific gravity is 7·2 to 7·6. It was first found, in 1815, at Telemarken in Norway; crystals are from Schubkau near Schemnitz in Hungary. It often occurs in quartz associated with native gold. Other species very similar to tetradymite, but with different formulae, are: *joseite*, from San José near Marianna in Brazil; *grünlingite* (Bi_4S_3Te), from Caldbeck Fells in Cumberland; and *wehrlite*, from Hungary. (L. J. S.)

TETRAGRAMMATON (τέτταρα, four; γράμμα, letter), a Greek compound, found in Philo and Josephus, which designates the divine name composed of the four Hebrew letters J H V H (יהוה). The derivation and pronunciation of the Tetragrammaton is still doubtful. The form "Jehovah" (*q.v.*) used in some of the English Versions is an error which arose in the 16th century. It is now generally assumed that the word is the causative form (*hiph'il*) and should be pronounced Yahveh or Yahweh (accent on second syllable). The Jews quite early ceased to pronounce the Tetragrammaton, substituting (as the Books of Chronicles and the LXX translation already indicate) the word Lord (*'Adonai*). The priests continued to use the name in the Benediction of the People (Numbers vi. 22–27), and on the Day of Atonement the High Priest pronounced it (Leviticus xvi. 30) amidst the prostrations of the assembled multitude. It is recorded in the Talmud that Rabbis communicated the true pronunciation to their disciples once in seven years (*Qiddushin*, 71a). The Jews called the Tetragrammaton by a Hebrew denomination, *Shem Hammephorash* (שם המפורש), *i.e.* the distinctive excellent name. It was considered an act of blasphemy for a layman to pronounce the Tetragrammaton. This avoidance of the original name was due on the one hand to reverence and on the other to fear lest the name be desecrated by heathens. Partly in consequence of this mystery and partly in accord with widespread superstitions, the Tetragrammaton figures in magical formulae from the time of the Gnostics, and on amulets. Many a medieval miracle-worker was supposed to derive his competence from his knowledge of the secret of the Name.

TETRAHEDRITE, a mineral consisting typically of copper sulph-antimonite, Cu_3SbS_3, but often of complex composition. The copper is usually isomorphously replaced by variable amounts of silver, iron, zinc, mercury, lead or cobalt, and the antimony by arsenic or bismuth. In general, the formula is $R'_6X_2S_6+xR''_6X_2S_9$, where $R'=Cu$, Ag; $X=Sb$, As, Bi; $R''=Fe$, Zn, and x is a small fraction, often $\frac{1}{10}$ or $\frac{1}{5}$. Numerous special names have been applied to varieties differing in chemical composition; the arsenic compound, Cu_3AsS_3, is known as tennantite (after Smithson Tennant). The old German name *Fahlerz* includes both tetrahedrite and tennantite, and so does the term "grey copper ore" of miners. Tetrahedrite is an important ore of copper, the formula Cu_3SbS_3, corresponding with 57·5 per cent. of this metal; it is also largely worked as an ore of silver, of which element it sometimes contains as much as 30 per cent. Well-developed crystals are of frequent occurrence; they belong to the tetrahedral class of the cubic system, and their tetrahedral form is a very characteristic feature of the mineral, which for this reason was named tetrahedrite. Fig. 1

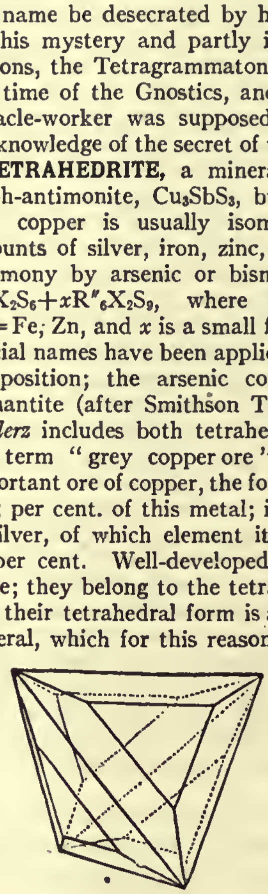


FIG. 1.

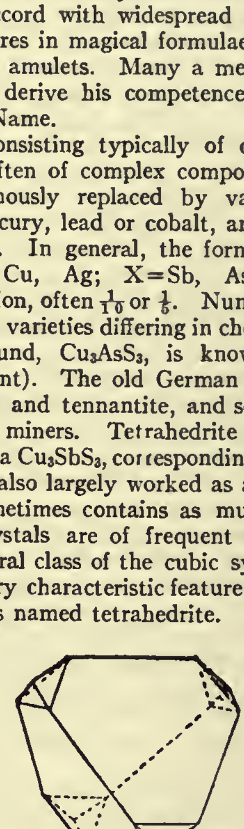


FIG. 2.

Crystals of Tetrahedrite.

shows a combination of a tetrahedron and a triakis-tetrahedron {211}, and fig. 2 a tetrahedron with the rhombic dodecahedron. Interpenetrating twinned crystals sometimes occur. The colour is steel-grey to iron-black, and the lustre metallic and brilliant. The streak is usually black; sometimes, however, it is dark cherry-red, and very thin splinters of the mineral then transmit a small amount of blood-red light. The hardness is $4\frac{1}{2}$, and the specific gravity varies with the composition from 4·4 to 5·1. There is no cleavage, and the fracture is conchoidal. The material is often very impure owing to intimate intermixture with chalcopyrite.

Tetrahedrite occurs in metalliferous veins associated with chalcopyrite, pyrites, blende, galena, &c. Fine groups of crystals, coated on their surface with brassy or brilliantly tarnished chalcopyrite, were formerly found at Herodsfoot mine, near Liskeard in Cornwall. Good crystals are also met with at Kapnik-Banya in Hungary, in the Harz, Peru, and other places. Tennantite occurs as small crystals of cubic or dodecahedral habit in many

Cornish copper mines, especially in the neighbourhood of Redruth: it is also found as small, brilliant crystals very rich in faces in the white crystalline dolomite of the Binnenthal in the Valais, Switzerland, and under the name binnite was long considered as a distinct species. (L. J. S.)

TETRAHEDRON (Gr. τέτρα-, four, ἕδρα, face or base), in geometry, a solid bounded by four triangular faces. It consequently has four vertices and six edges. If the faces be all equal equilateral triangles the solid is termed the "regular" tetrahedron. This is one of the Platonic solids, and is treated in the article POLYHEDRON, as is also the derived Archimedean solid named the "truncated tetrahedron"; in addition, the regular tetrahedron has important crystallographic relations, being the hemihedral form of the regular octahedron and consequently a form of the cubic system. The bisphenoids (the hemihedral forms of the tetragonal and rhombic bipyramids), and the trigonal pyramid of the hexagonal system, are examples of non-regular tetrahedra (see CRYSTALLOGRAPHY). "Tetrahedral co-ordinates" are a system of quadriplanar co-ordinates, the fundamental planes being the faces of a tetrahedron, and the co-ordinates the perpendicular distances of the point from the faces, a positive sign being given if the point be between the face and the opposite vertex, and a negative sign if not. If (u, v, w, t) be the co-ordinates of any point, then the relation $u+v+w+t=\mathrm{R}$, where R is a constant, invariably holds. This system is of much service in following out mathematical, physical and chemical problems in which it is necessary to represent four variables.

Related to the tetrahedron are two spheres which have received much attention. The "twelve-point sphere," discovered by P. M. E. Prouhet (1817–1867) in 1863, is somewhat analogous to the nine-point circle of a triangle. If the perpendiculars from the vertices to the opposite faces of a tetrahedron be concurrent, then a sphere passes through the four feet of the perpendiculars, and consequently through the centre of gravity of each of the four faces, and through the mid-points of the segments of the perpendiculars between the vertices and their common point of intersection. This theorem has been generalized for any tetrahedron; a sphere can be drawn through the four feet of the perpendiculars, and consequently through the mid-points of the lines from the vertices to the centre of the hyperboloid having these perpendiculars as generators, and through the orthogonal projections of these points on the opposite faces.

TETRARCH (τετράρχης), the ruler of a tetrarchy, that is, in the original sense of the word, of one quarter of a region. Such were the tetrarchies of Thessaly as reconstructed by Philip of Macedon and of Galatia before its conquest by the Romans (169 B.C.). In later times the title of tetrarch is familiar from the New Testament as borne by certain princes of the petty dynasties which the Romans allowed to exercise a dependent sovereignty within the province of Syria. In this application it has lost its original precise sense, and means only the ruler of part of a divided kingdom, or of a district too unimportant to justify a higher title. After the death of Herod the Great (4 B.C.) his realm was shared among his three sons: the chief part, including Judaea, Samaria and Idumaea, fell to Archelaus (Matt. ii. 22), with the title of ethnarch (Josephus, *Antiq.*, xvii. 11, 4); Philip received the north-east of the realm and was called tetrarch; and Galilee was given to Herod Antipas, who bore the same title (Luke iii. 1). These three sovereignties were reunited under Herod Agrippa from A.D. 41 to 44. In the same passage of Luke mention is made of Lysanias, tetrarch of Abilene near Damascus, in the valley of the Barada.

TETRASTOÖN (Gr. τέτρα-, four, and στοά, a portico), the term in architecture given to a rectangular court round which on all four sides is carried a covered portico or colonnade; the same as peristyle (*q.v.*).

TETRASTYLE (Gr. τέτρα-, four, and στῦλος, a column), the term in architecture given to a portico of four columns which forms the main front of a temple (*q.v.*).

TETRAZINES, in organic chemistry, a group of compounds containing the ring system

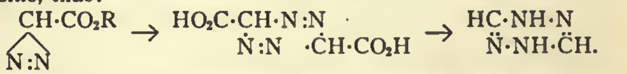
$$\begin{matrix}\mathrm{C{\cdot}N{\cdot}N}\\ \dot{\mathrm{C}}\mathrm{{\cdot}N{\cdot}}\dot{\mathrm{N}},\end{matrix}\ \text{or}\ \begin{matrix}\mathrm{C{\cdot}N{\cdot}N}\\ \dot{\mathrm{N}}\mathrm{{\cdot}N{\cdot}}\dot{\mathrm{C}},\end{matrix}\ \text{or}\ \begin{matrix}\mathrm{C{\cdot}N{\cdot}C}\\ \dot{\mathrm{N}}\mathrm{{\cdot}N{\cdot}}\dot{\mathrm{N}};\end{matrix}$$

only derivatives of the first two types are known. The members of the first series may be prepared by oxidizing osazones (*i.e.* dihydrazones of α-diketones), dihydrotetrazines resulting. Dihydro-derivatives of the second type are formed from hydrazine and imino-ethers (A. Pinner, *Ber.*, 1893, 26, p. 2126; 1894, 27, p. 984); these easily oxidize to the corresponding tetrazines, which are stable towards acids; their dihydro-derivatives, however, are decomposed, the group—NH·NH—being eliminated as hydrazine and replaced by oxygen, with consequent formation of the five membered oxybiazole ring. Concentrated acids convert the dihydro-tetrazines into isodihydrotetrazines, thus:—

$$\begin{matrix}\mathrm{R{\cdot}C{\cdot}NH{\cdot}NH}\\ \dot{\mathrm{N}}\mathrm{{\cdot}N\ {:}}\dot{\mathrm{C}}\mathrm{{\cdot}R}\end{matrix}\rightarrow\begin{matrix}\mathrm{R{\cdot}C{\cdot}NH{\cdot}N}\\ \dot{\mathrm{N}}\mathrm{{\cdot}NH{\cdot}}\dot{\mathrm{C}}\mathrm{{\cdot}R},\end{matrix}$$

the N-alkyl derivatives of which type may be prepared by the action of alcoholic potash and chloroform on aromatic hydrazines.

Much discussion has circulated about the decomposition of diazo-acetic ester, from which A. Hantzsch and O. Silberrad (*Ber.*, 1900, 33, p. 58) obtained what they considered to be a dihydrotetrazine, thus:—

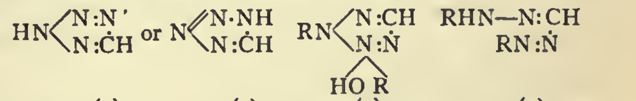


C. Bülow (*Ber.*, 1906, 39, pp. 2618, 4106), however, showed this substance to be an N-aminotriazole, which necessitates the first decomposition product being an acid (I.), the conversion into the

$$(\mathrm{I.})\ \begin{matrix}\mathrm{HO_2C{\cdot}C{\cdot}NH{\cdot}NH}\\ \dot{\mathrm{N}}\mathrm{{\cdot}N{:}\ }\dot{\mathrm{C}}\mathrm{{\cdot}CO_2H}\end{matrix}\rightarrow(\mathrm{II.})\ \begin{matrix}\mathrm{HO_2C{\cdot}C{-}N{\cdot}NH_2}\\ \dot{\mathrm{N}}\mathrm{{\cdot}N{:}}\dot{\mathrm{C}}\mathrm{{\cdot}CO_2H}\end{matrix}$$

triazole derivative (II.) being due to the ring opening on the addition of the elements of water and then closing again to the five-membered ring with elimination of water again. The decompositions of diazoacetic ester were then again examined by T. Curtius and his students (*Ber.*, 1907, 40, pp. 262, 350, 450, &c.), who showed that both triazole and tetrazine derivatives could be obtained from the bisdiazo-acetic acid which is formed by the action of alkali on diazo-acetic ester.

TETRAZOLES, in organic chemistry, a group of heterocyclic compounds, capable of existing in two isomeric series (formulae 1 and 2), although the methods of preparation do not always permit discrimination between the possible isomers. They are prepared by the action of nitrous acid on cyanamidrazone (dicyanophenylhydrazine) and hydrolysis of the resulting nitrile, from which J. A. Bladin by elimination of the phenyl group (by nitration, reduction, &c.) and of carbon dioxide obtained free tetrazole, $\mathrm{CH_4N_2}$; from amidines by the action of nitrous acid, followed by the reduction of the intermediately formed dioxytetrazotic acids with sodium amalgam; from amidoguanidine by diazotization, the diazonium nitrate on treatment with acetates or carbonates yielding aminotetrazole (J. Thiele, *Ann.*, 1892, 270, p. 1); from the action of nitrous acid on phenylthiosemicarbazide; and by the action of arylazoimides on aldehyde hydrazones (O. Dimroth, *Ber.*, 1907, 40, p. 2402). The tetrazoles behave as strong monobasic acids, and are exceedingly stable. A series of tetrazolium bases (formula 3) have been obtained by H. V. Pechmann (*Ber.*, 1894, 27, p. 2920) starting from formazyl compounds (formula 4), which are oxidized by means of amyl nitrite and hydrochloric acid. They are strong bases, which in aqueous solution absorb carbon dioxide readily. The free bases have not been isolated, but their salts are well-crystallized solids.



(1), (2). (3), (4).

TETSCHEN, a town of Bohemia, Austria, 83 m. N.N.E. of Prague by rail. Pop (1900) 9692, exclusively German. It is situated at the confluence of the Polzen with the Elbe, on the right bank of the latter river opposite Bodenbach (*q.v.*), with which it is connected by a chain bridge (1855) and two railway bridges. The handsome château of the counts of Thun (built in 1667–73 and restored in 1788), which occupies a rocky height above the town, was at one time fortified, and was a place of some importance during the Seven Years' War. It contains a magnificent library, with many valuable MSS. and fine collections of coins and armour. In addition to being the principal emporium for the Austrian traffic on the Elbe, Tetschen has a considerable industry, its products comprising chemicals, oil, soap, cotton stuffs, plaster of Paris, glazed and coloured paper, cellulose, beer, flour and preserved fish.

The town of Tetschen originally lay on the south side of the castle rock, but after its destruction by a flood, it was moved in 1059 to its present site. In 1305 it came into the hands of the knights of Wartenberg, who held it for two hundred years. In 1534 the Saxon lords of Bünau obtained it and introduced the Protestant religion, which was exterminated when, after the battle of the White Hill (1620) the Bünau family was driven out. The lordship was bought from them in 1628 by the Freiherr von Thun, by whose descendants, the Counts Thun, it is still held.

TETUAN (Tettāwan), the only open port of Morocco on the Mediterranean, a few miles S. of the Strait of Gibraltar, and about 40 m. E.S.E. of Tangier. Population about 25,000, of whom a fifth are Jews. It is picturesquely situated on the northern slope of a fertile valley down which flows the W. Martil, with the harbour of Tetuan, Martil, at its mouth. Behind rise rugged masses of rock, the southern wall of the Anjera country, practically closed to Europeans, and across the valley are the hills which form the northern limit of the still more impenetrable Rif. In point of cleanliness Tetuan compares favourably with most Moorish towns. The streets are fairly wide and straight, and several of the houses belonging to aristocratic Moors, descendants of those expelled from Spain, have fine courts surrounded by arcades, some with marble fountains and planted with orange trees. Within the houses the ceilings are often exquisitely carved and painted in Mauresque designs, such as are found in the Alhambra, and the tile-work for which Tetuan is known may be seen on floors, pillars and dados. The principal industries are tilework, inlaying with silver wire, and the manufacture of thick-soled yellow slippers, much-esteemed flintlocks, and artistic "towels" used as cape and skirt by Moorish country girls. The Jews live in a *mellah*, separated from the rest of the town by gates which are closed at night. The harbour of Tetuan is obstructed by a bar, over which only small vessels can pass, and the roadstead, sheltered to the N., N.W. and S., is exposed to the E., and is at times unsafe in consequence of the strong Levanter.

The present town of Tetuan dates from 1492, when the Andalusian Moors first reared the walls and then filled the enclosure with houses. It had a reputation for piracy at various times in its history. It was taken on the 4th of February 1860 by the Spaniards under O'Donnell, and almost transformed by them into a European city before its evacuation on the 2nd of May 1862, but so hateful were the changes to the Moors that they completely destroyed all vestiges of alteration and reduced the city to its former state. (K. A. M.*)

TETZEL, JOHANN (*c.* 1460–1519), preacher and salesman of papal indulgences, the son of Hans Tetzel, a goldsmith of Leipzig, was born there about 1460. He matriculated at the university in 1482, graduated B.A. in 1487, and in 1489 entered the Dominican convent at Leipzig. He early discovered his vocation as a preacher of indulgences; he combined the elocutionary gifts of a revivalist orator with the shrewdness of an auctioneer. He painted in lurid colours the terrors of purgatory, while he dwelt on the cheapness of the indulgence which would purchase remission and his prices were lowered as each sale approached its end. He began in 1502 in the service of the Cardinal-legate Raymond Peraudi; and in the next few years he visited Freiberg (where he extracted 2000 gulden in two days), Dresden, Pirna, Leipzig, Zwickau and Görlitz. Later on he was at Nuremberg, Ulm and Innsbruck, where he is said to have been condemned to imprisonment for adultery, but released at the intercession of the elector of Saxony. This charge is denied by his apologists; and though his methods were attacked by good Catholics like Johann Hass, he was elected prior of the Dominicans in Glogau in 1505.

Fresh scope was given to his activity in 1517 by archbishop Albrecht of Mainz. Albrecht had been elected at the age of twenty-four to a see already impoverished by frequent successions and payments of annates to Rome. He had agreed with Pope Leo X. to pay his first-fruits in cash, on condition that he were allowed to recoup himself by the sale of indulgences. Half the proceeds in his province were to go to him, half to Leo X. for building the basilica of St Peter's at Rome. Tetzel was selected as the most efficient salesman; he was appointed general sub-commissioner for indulgences, and was accompanied by a clerk of the Fuggers from whom Albrecht had borrowed the money to pay his first-fruits. Tetzel's efforts irretrievably damaged the complicated and abstruse Catholic doctrine on the subject of indulgences; as soon as the coin clinks in the chest, he cried, the soul is freed from purgatory. In June he was at Magdeburg, Halle and Naumburg; the elector of Saxony excluded him from his dominions, but Albrecht's brother, the elector Joachim of Brandenburg, encouraged him at Berlin in the hope of sharing the spoils, and by the connivance of Duke George of Saxony he was permitted to pursue his operations within a few miles of the electoral territory at Wittenberg. Luther was thus roused to publish his momentous ninety-five theses on the subject of indulgences on October 31, 1517 (see Luther).

Even Albrecht was shamed by Luther's attack, but he could not afford to relinquish his profits already pledged for the repayment of his debts; and Tetzel was encouraged to defend himself and indulgences. Through the influence of Conrad Wimpina, rector of Frankfurt, Tetzel was created D.D. of that university, and with Wimpina's assistance he drew up, in January 1518, a hundred and six theses in answer to Luther's. But the storm overwhelmed him: sober Catholics felt that his vulgar extravagances had prejudiced Catholic doctrine, and Miltitz, who was sent from Rome to deal with the situation, administered to him a severe castigation. He hid himself in the Dominican convent at Leipzig in fear of popular violence, and died there on the 4th of July 1519, just as Luther was beginning his famous disputation with Eck.

Many lives of Tetzel have been published on the Protestant and on the Catholic side, the most recent being Körner's (1880), K. W. Hermann's (2nd ed. 1883), and N. Paulus' (1899). See also *Allgemeine deutsche Biographie*; Gess's *Akten und Briefe zur Kirchenpolitik Herzog Georgs von Sachsen*, vol. i. (1905), Introd. pp. 76–8, &c.; H. Barge's *Andreas Bodenstein von Carlstadt* (2 vols. 1905); J. Janssen's *Hist. of the German People*, and *An meine Kritiker*; M. Creighton's *Hist. of the Papacy*, vol. vi.; and H. C. Lea's *Hist. of Auricular Confession and Indulgences* (3 vols., 1896). All the histories of the Reformation in Germany and all the lives of Luther deal at greater or shorter length with Tetzel; in the index to vol. ii. of the *Cambridge Mod. History* he is confused with a later Tetzel of Nuremberg. (A. F. P.)

TEUFFEL, WILHELM SIEGMUND (1820–1878), German classical scholar, was born at Ludwigsburg in the kingdom of Württemberg on the 27th of September 1820. In 1849 he was appointed extraordinary, in 1857 ordinary professor in the university of Tübingen, which post he held till his death on the 8th of March 1878. His most important work was his *Geschichte der römischen Litteratur* (1870; 5th ed. by L. Schwabe, 1890; Eng. tr. by G. C. Warr, 1900), which, although written in an unattractive style, is indispensable to the student, the bibliographical information being especially valuable. After the death of A. Pauly, the editor of the well-known *Real-Encyclopädie der classischen Altertumswissenschaft*, Teuffel, at first assisted by E. C. Walz, undertook the completion of the work, to which he also contributed numerous articles.

He was also the author of "Prolegomena zur Chronologie der horazischen Gedichte" (in *Zeitschrift für die Altertumswissenschaft*, 1842); *Charakteristik des Horaz* (Leipzig, 1842); *Horaz, eine litterar-historische Übersicht* (Tübingen, 1843), and of editions of the *Clouds* of Aristophanes (1856) and the *Persae* of Aeschylus (1866). His *Studien und Charakteristiken* (1871; 2nd ed., 1889) contain valuable contributions to the history of Greek and Roman literature. See S. Teuffel, *Wilhelm Teuffel* (1889); C. Bursian in *Biographisches Jahrbuch* (1878); F. Koldewey in *Allgemeine deutsche Biographie*, xxxvii.

TEUTOBURGER WALD, a mountain range of Germany, stretching N.W. to S.E., along the borders of the Prussian provinces of Hanover and Westphalia and through the principality of Lippe, for a distance of 70 m., with a width of 2 to 6 m. It consists of a well-marked main chain, accompanied in its central part by subsidiary ridges. It slopes up gradually towards the E., where it culminates in the Völmerstod (1536 ft.). The greater part of the range is densely wooded. The main chain is pierced by several deep gaps or "doors," through some of which important railways have been carried; *e.g.*, the line connecting Paderborn and Hanover, and that connecting Herford and Hamm. The chief geological formations belong to the Cretaceous system, backed towards the north and east by Jurassic and Triassic formations. The Teutoburger Wald was the scene of a famous battle in which Arminius at the head of the Cherusci destroyed three Roman legions under Quintilius Varus (A.D. 9). Mommsen has located the battle near the source of the Hunte, north of Osnabrück, and outside the range of hills; but most scholars prefer some site in the central part of the mountain-chain. In accordance with these latter views the Grotenburg (1263 ft.), 2½ m. S.W. from Detmold, has been crowned with a gigantic monument to Arminius Hermann, erected in 1838–41 and 1871–75, at a cost of £13,500. The work, which was designed by E. von Bandel, consists of a gigantic statue of the chieftain, 56½ ft. high, standing on an arched pediment 98 ft. high.

See H. Thorbecke, *Führer durch den Teutoburger Wald* (15th ed., Detmold, 1905); Wilisch, *Der Kampf um das Schlachtfeld im Teutoburger Walde* (*Neue Jahrbücher für das klassische Altertum*, May 1909).

TEUTONI, or TEUTONES, a tribe of northern Europe, who became known to the Romans in the year 103 B.C., when, according to the *Epitome* of Livy, together with the Ambrones they reinforced the Cimbri (*q.v.*) after their repulse from Spain by the Celtiberi. In 102 the Teutoni and Ambrones were totally defeated by Marius at Aquae Sextiae (see MARIUS, GAIUS). The racial affinities of the Teutoni have formed a matter of dispute amongst historians. Their name is Celtic in form, and many writers suppose that the Teutoni were really a Celtic tribe, a branch of the Helvetii. But a people of this name seems to have been mentioned by the early traveller Pytheas as inhabiting the coasts of the northern ocean in his time. Strabo and Velleius, moreover, classify them as Germani, and this is perhaps the more probable view, although apparently the distinction between Celt and Teuton was not clearly realized by some of the earlier historians. If the Teutoni really came from the same quarter as the Cimbri, it is possible that their name may have been preserved in that of the district called until recently Thyland or Thythsyssel in the extreme north-west of Jutland.

For authorities see CIMBRI; also Pliny, xxxvii. 35.

(F. G. M. B.)

TEUTONIC (GERMANIC) LANGUAGES,[1] a comprehensive term for a number of languages most of which are still spoken at the present time, namely English, Frisian, Dutch, Flemish, German (both High and Low) and the various Scandinavian languages (Swedish, Danish, Icelandic and the Norwegian dialects). The course of time has tended very largely to obscure the affinities between these languages, and in several cases they have been mutually unintelligible for many centuries. In their earliest known forms, however, they betray the most unmistakable traces of a common origin. To the languages enumerated above we have to add the now extinct Gothic, which in the 5th and 6th centuries was spoken over a large part of Europe.

Detailed accounts of the various Teutonic languages will be found in articles under the respective headings. Here it is possible only to give a brief summary of the chief characteristics of these languages as a group, and of the chief divergences noticeable in early times between the various members of the group. It should be noted at the outset that the written records of the various languages date from very different periods. Gothic is known to us almost entirely from Ulfilas' translation of the Bible, which dates from the 4th century. English written literature starts with the beginning of the 7th century, though earlier matter may be preserved in certain poems. The earliest known German and Dutch documents date from the 8th and 9th centuries respectively, while Frisian is practically unknown before the 13th century. Scandinavian written literature seems to have begun in the 12th century, but many poems are probably from two to three centuries older. In the North there are also a large number of inscriptions which are of great value for linguistic purposes. Most of them cannot be dated with certainty, but the forms of language which they present show all stages of development, from the type found in literary times back to one which is somewhat more archaic even than Gothic. It is probable that the earliest of them date from between the 3rd and 5th centuries. The inscriptions found in England and Germany are much fewer and less archaic. In the latter case, however, a good deal of linguistic evidence is available from the proper names and other Teutonic words which occur in early Latin and Greek writings. Much assistance may also be obtained from the loan-words borrowed by Teutonic languages from Latin and by other languages, especially Finnish and Slavonic, from Teutonic.

The Teutonic languages form a distinct and well-defined group of the Indo-European family. Their nearest affinities are on the one side with the Celtic and Italic (Latin, &c.) languages, and on the other with the Slavonic and Baltic languages. In regard to the fundamental distinction, however, by which the Indo-European languages as a whole fall into two main divisions, namely according to the treatment of certain guttural and palatal consonants, the Teutonic group belongs definitely, together with Celtic, Italic and Greek, to the western of these divisions.

The chief characteristic of the Teutonic languages as a whole lies in their treatment of the Indo-European explosive sounds. This characteristic, generally known as Grimm's Law, is due to sound-changes peculiar to Teutonic, though somewhat similar changes may be traced both in Armenian and Celtic. The most noteworthy phenomena are as follows:—

(1) The Indo-European voiced aspirates, *bh*, *dh*, *gh* (Lat. *f*, *f*, *h*; Gk. φ, θ, χ) became voiced spirants, ƀ, đ, ȝ. After nasals these spirants became explosives (*b*, *d*, *g*); and in the first two cases the same change took place initially, though hardly during the early centuries of our era, *e.g.* A.S. *beran*, O.N. *bera* : Lat. *fero*, Gk. φέρω; A.S. *stigan* : Gk. στείχω; O.N. *miöðr* (A.S. *medu*) : Gk. μέθυ.

(2) The I.-Eur. voiceless explosives, *p*, *t*, *k*, were preserved only after *s* (*t* also in the I.-Eur. groups *pt* and *kt*); *e.g.* A.S. *stede*, Goth. *staþs*: Gk. στάσις; Goth. *nahts*: Lat. *noctem*. In all other cases they became voiceless spirants, *f*, *þ*, χ, (*h*). These new sounds remained (i.) initially, *e.g.* A.S. *hwaet*, O.N. *hvat*: Lat. *quod*; A.S. *faeder*, O.N. *faðir* : Lat. *pater*; (ii.) in combination with other voiceless sounds, *e.g.* Goth. *saihs*, O.H.G. *sehs*: Lat. *sex*; Goth. *nahts*: Lat. *noctem*; (iii.) immediately after the (original) accent, *e.g.* Goth. *broþar*, A.S. *broðor* : Lat. *frater*, Gk. φράτηρ; Goth. *taihun*, O.H.G. *zehan*: Lat. *decem*, Gk. δέκα. In all other cases they became voiced spirants ("Verner's Law"), identical with those arising from I.-Eur. *bh*, *dh*, *gh* (see above); *e.g.* A.S. *faeder*: Lat. *pater*, Gk. πατήρ; A.S. *sweger*, O.H.G. *swigar* (mother-in-law): Gk. ἑκυρά.

(3) The I.-Eur. voiced (unaspirated) explosives, *b*, *d*, *g*, became voiceless, *p*, *t*, *k*; *e.g.* A.S. *etan* : Lat. *edere*; A.S. *aecer*, Goth. *akrs*: Lat. *ager*, Gk. ἀγρός.

Among other consonantal changes we may note especially the following:—

(4) ȝ*w* arising from I.-Eur. *ghw* or *kw* (see above) was reduced (except after nasals) before *u* (perhaps also before I.-Eur. *o*) to ȝ, and in all other cases to *w*; *e.g.* A.S. *guð* (war), O.H.G. *gund*: Gk. -φατος (cf. φόνος); A.S. *sniweð* (snows): Lat. *niuit*, Gk. νείφει.

(5) The I.-Eur. cons. group arising from combination of dental sound +*t* became *ss*, as in Celtic and Latin, *e.g.* A.S. *sess* (seat): *sittan*, Lat. *sedere* (cf. Sanscr. pp. *sattas*, Lat. *obsessus*).

[1] The following abbreviations are used: A.S. = Anglo-Saxon; O.H.G. = Old High German; O.N. = Old Norse; I.-Eur. = Indo-European. The symbol ":" denotes relationship between two forms or sets of forms.

(6) The treatment of I.-Eur. *s* was precisely parallel to that of the voiceless spirants *f*, *þ*, χ arising from I.-Eur. *p*, *t*, *k* (see above). It was preserved (i) initially, (ii) in combination with voiceless sounds, (iii) immediately after the (original) accent. In all other cases it became voiced (*z*). This voiced spirant subsequently became *r* in all Teutonic languages except Gothic, where however the distinction between voiced and voiceless spirants is not well preserved; *e.g.* A.S. *ceosan*, pp. *coren* (*géuso- guséno*): Gk. γεύομαι (cf. Lat. *gustus*); A.S. *snoru*, O.H.G. *snura* (daughter-in-law): Sanscr. *snušá*, Gk. νυός.

Most of the other consonantal changes are in the nature of assimilation.

(7) *ƀn*, *dn*, *ʒn* before the accent became *pp*, *tt*, *kk* (probably through the intermediate stage *bb*, *dd*, *gg*); *e.g.* A.S. *liccian*, O.H.G. *leckon* (from *liʒná-*): Gk. λιχνεύω (cf. Goth. *bi-laigon*).

(8) *ln* became *ll*; *e.g.* A.S. *full*, Goth. *fulls*: Lith. *pilnas*.

(9) *nw* became *nn*; *e.g.* A.S. *þynne*, O.N. *þunnr*: Lat. *tenuis*.

(10) *dl* became *ll*; *e.g.* A.S. *st(e)all*, O.N. *stallr*: Lat. *stabulum* (from *stadhlom*).

(11) In some combinations consonants are lost or new consonants developed; *e.g.* Goth. *sunja* (truth): Lat. *praesentia* (*-sntjā*); O.H.G. *hunno* (centurion) from *hundn-*, cf. Goth. *hund*: Lat. *centum*; A.S. *stream*, O.N. *straumr* from *sroum-*, cf. Gk. ῥεῦμα, Old Irish *sruaim*.

The following changes are found in all Teutonic languages, but took place apparently later than those enumerated above:—

(i) *n* was lost before χ (*h*), with compensatory lengthening of the vowel; *e.g.* A.S. *þōhte*, Goth. *þāhta* beside A.S. *þencean*, Goth. *þagkjan*.

(ii) Final explosives and nasals were lost; *e.g.* A.S. *wile*, Goth. *wili*: Lat. *uelit*; A.S. *ēa*, Goth. *ahwa*: Lat. *aquam*; Goth. *kustu*: Lat. *gustum*.

In its vowel-system the earliest known form of Teutonic did not differ greatly from the other I.-Eur. languages. Its chief peculiarities seem to have been as follows:—

(1) It had one vowel (*a*) corresponding to the two vowels *a*, *o* found in the other I.-Eur. languages; *e.g.* Goth. *akrs*, O.N. *akr*: Lat. *ager*, Gk. ἀγρός; Goth. *ahtau*, O.H.G. *ahto*: Lat. *octo*, Gk. ὀκτώ.

(2) It had also one vowel (*ō*) corresponding to the two vowels *ā*, *ō*, found in the other I.-Eur. languages, *e.g.* A.S. *brōðor*, Goth. *bro þar*: Lat. *frāter*, Gk. φράτηρ; A.S. *rōw* (rest), O.H.G. *ruowa*: Gk. ἐρω(ϝ)ή.

The other I.-Eur. vowels, *ĕ*, *ĭ*, *ŭ*, were preserved in the earliest Teutonic. Soon after the beginning of our era, however, *e* began to change to *i* before a nasal followed by a consonant, *e.g.* Ptol. Φίννοι (A.S. *Finnas*, O.N. *Finnar*) against Tac. *Fenni*. The diphthong *ei* became *ī*; *e.g.* A.S., O.H.G. *stīgan*, O.N. *stīga*: Gk. στείχω (the *ei* of Goth. *steigan* is merely graphic).

The reduced nasal sounds generally written *n̥*. *m̥*, arising from *en*, *ne*, *em*, *me*, &c., in unaccented syllables, became *un*, *um* (rarely *nu*, *mu*), *e.g.* A.S., Goth., &c. *un-* (negative prefix): Lat. *in-*, Gk. ἀ-, ἀν-; A.S., Goth. *hund*: Lat. *centum*, Gk. ἑ-κατόν. Similarly the reduced liquid sounds *r̥*, *l̥* became *ur*, *ul* (rarely *ru*, *lu*); *e.g.* A.S. *furh*: Lat. *porca*; Goth. *þulan*: Lat. *tollo*, Gk. τετλάμεν.

Accent.—In the I.-Eur. languages the position of the accent was originally free—*i.e.*, any syllable in the word could bear the chief accent—variation occurring very frequently, *e.g.* between different cases of the same noun. This freedom of position must have been retained in Teutonic at the time when voiceless spirants (*f*, *þ*, χ, *s*) became voiced (see above). Eventually, however, as in Gaelic (Irish) and at one time also in the Italic languages, the first syllable of every word came to bear the chief accent, the only noteworthy exceptions being certain compound words, more especially verbs compounded with prepositions, which were probably long regarded as more or less independent words. This system of accentuation was intimately connected with the principle of alliteration, the essential characteristic of early Teutonic poetry and the dominant factor in family nomenclature. Alliteration in family names certainly dates from the very beginning of the Christian era, *e.g.* the S-names in one of the princely families of the Cherusci frequently mentioned by Tacitus, and there is also some evidence that Teutonic poetry was alliterative by this time. It is probable, therefore, that the change in the system of accentuation took place not later than the 1st century B.C.

The description of the phonetic characteristics given above applies in general to the Teutonic group of languages as a whole. So far as one can judge from the proper names, &c., which occur in Latin works, the description would probably be true for the time about the beginning of the Christian era. Dialectical differences no doubt already existed, but few of them were so clearly marked that they can now be traced with anything like certainty. The language of the earliest Runic inscriptions does not differ very markedly from this type. The principal changes which we can now detect are as follows:—

(1) *e* became *i*, (i) in the unaccented syllable of dissyllabic and in the least accented syllables of polysyllabic words; *e.g.* *ðohtriz* (inscr.), O.N. *doetr*: Gk. θυγατέρες; (ii) in accented syllables when the following syllable contained *i*, *j*, or *u*; *e.g.* A.S. *mid(d)*, O.N. *miðr*: Lat. *medius*.

(2) *i* became *e* when the following syllable contained *a*, *ē*, *ō*; *e.g.* A.S., O.H.G. *wer*, O.N. *verr* (stem *wera-*): Lat. *uir*.

(3) *u* became *o* when the following syllable contained *a*, *ĕ*, *ō*; *e.g.* (1 sing. pret.) *worahtō* (inscr.), A.S. *wor(o)hte*, O.H.G. *wor(a)hta*: A.S. *wyrcean*, O.H.G. *wurchen*.

(4) *ē* became *ā* always; *e.g.* *-māriz* (inscr.): Goth. *-mers*.

(5) final *a*, *e*, were lost; *e.g.* (1, 3 sing. pret.) *was* (inscr.); cf. Gk. λέλοιπ-α, -ε.

(6) final long vowels were (in general) shortened (*ī*≥*i*, *ō*≥*u*); *e.g.* *liuōu* (inscr.). N. sing. fem. (cf. Gk. ἐχθρά).

(7) final nasals and explosives were lost; *e.g.* *worahtō*, 1 sing. pret. (cf. Gk. ἐτίθην).

These changes appear to have operated in all the northern and western Teutonic languages during the first four centuries of our era, except the change *ē*≥*ā*, which in the extreme west (Frankish) seems not to have taken place until the latter part of the 6th century. Several of them can be traced more or less clearly in Latin writings of the 1st century. The Gothic language, however, seems to have developed on quite different lines. The more important of its changes are as follows:—

(1) *e* became *i* always; *e.g.* *wigs* (road): A.S. *weg*. But *i* later became *e* (written *ai* in Ulfilas' orthography) before *r*, *h*; *e.g.* *hairdeis* (herdsman): O.H.G. *hirti*.

(2) *u* became *o* (written *au*) before *r*, *h*; *e.g.* *baurgs*: A.S. *burg*. (In Ulfilas' orthography the letters transcribed *e*, *o* are used for long vowels only.)

(3) *ai*, *au* became *ē*, *ō*; but the digraphs were still written.

(4) short vowels (except *u*) in final syllables were lost; *e.g.* *dags*, *gasts*: (N. inscr.) *daʒaz*, *-ʒastiz*.

(5) final nasals and explosives were lost; *e.g.* *sunu* (Acc. sing.): Sanscr. *sūnum*.

(6) final long vowels (including those which had become final through the last change) were (in general) shortened (*ī*≥*i*, *ō*≥*a*, *ē*≥*a*); *e.g.* *waurhta* (1 sing. pret.): (N. inscr.) *worahtō*; *liuba* (N. sing. fem.): (N. inscr.) *liubu*.

(7) voiced spirants when final (also before *s*) became voiceless; *e.g.* *baþ* (3 sing. pret. of *bidjan*).

All these changes appear to have taken place before or during the 4th century. The effect of them must have been to render the Gothic language hardly intelligible to a person who spoke a northern or western language, whereas during the same period there is little evidence for differences among the latter languages themselves. At a later date Gothic underwent further changes which do not appear in Ulfilas' version, or only to a slight extent.

(1) *i* became a close *e-* sound; *e.g.* *Venethae* (Jordanes), for *Winid-*.

(2) *u* became a close *o* sound: *e.g.* Ῥόγοι (Procopius): *Rugii*; later *o* became *a* in unaccented syllables; *e.g.* *ūraz* (for *-us*).

(3) *ē* became *ī*; *e.g.* *leikeis* for *lekeis* (not unfrequently in the MSS.).

(4) *ō* became *ū*; *e.g.* *sunjus* for *sunjos*.

The chief sound-changes in the northern and western languages seem to have taken place in the 6th and 7th centuries. Some of these changes were common to all the languages in question, some to English and Scandinavian, some to English and German, while others again occurred in only one of these languages or a portion of it.

I. Among the chief changes common to English, Scandinavian and German we may reckon (1) the loss of final *a* (in Scand. also before final consonants); *e.g.* A.S., O.N., O.H.G. *horn* (N. inscr. *horna*); (2) the loss of unaccented *i*, *u* after long syllables, *e.g.* A.S. *hond*, O.N. *hǫnd*, O.H.G. *hant*: Goth. *handus*; (3) the change *z*≥*r* before vowels or *g*; *e.g.* A.S. *dēor*, O.N. *dýr*, O.H.G. *tior*: Goth. (plur.) *diuza*.

II. Among the most important of the changes common to English and Scandinavian must be classed (1) the affection (*umlaut*) of vowels by the vowels (generally *i*, *u*) of following syllables; *e.g.* A.S. *cyn(n)*, O.N. *kyn*: O.H.G. *kunni*; A.S. *geofu*, O.N. *giof*: O.H.G. *geba*. In early German the only case of this kind was the affection of *a* by a following *i* and even this seems to have taken place much later. To the same category we must reckon (2) the early loss of *h* between sonants, *e.g.* A.S. *sēon*, *sīan*, O.N. *siá*: O.H.G. *sehan*; (3) the loss of *n* before *s*, *e.g.* A.S. *ōs*, O.N. *áss*: O.H.G. *Ans–*.

III. Among the chief changes common to English and German were the following: (1) The loss of final *z*; *e.g.* A.S. *daeg*, O.H.G. *tag*: O.N. *dagr* (N. inscr. *dazaz*). In short monosyllables, however, *z* became *r* in High German, as in Scandinavian; *e.g.* *mir* (Dat.): A.S. *mē*, O.-Sax. *mī*, O.N. *mér*, Goth. *mis*. (2) The change *z*>*r* before *d* (whereas assimilation took place in Scand.), *e.g.* A.S. *hord*, O.H.G. *hort*: O.N. *hodd*, Goth. *huzd*. (3) The change *đ*>*d* in all positions (in Scand. only initially and after *l*), *e.g.* A.S. *faeder*, O.-Sax. *fader* (O.H.G. *fater*): O.N. *faðir*. (4) The lengthening of all consonants (except *r*) before *j* (in Scand. only gutturals), *e.g.* A.S. *biddan*, O.H.G. *bitten*: O.N. *biðia*.

The sound-changes peculiar to English, Scandinavian and German are treated in the articles dealing with these languages. It should be noted that the Frisian dialects agree with English not only in the phenomena enumerated above, but also in a number of changes peculiar to these languages. Such are (1) the change *ā*>*ō* before nasals, *e.g.* A.S. *mōnað*, O.Fr. *mōnath*: O.H.G. *mānod*; (2) the change *ā*>*ǣ* (later *ē*) in other positions, *e.g.* A.S. *rǣd*, O.Fr. *rēd*: O.H.G. *rāt*; (3) the labialization of *a* before nasals, *e.g.* A.S. *mon*, *man*, O.Fr. *mon*, *man*: O.H.G. *man*; (4) the change *a*>*ae* (*e* in Fris.) in close syllables (also in open syllables before front vowels), *e.g.* A.S. *staef*, O.Fr. *stef*: O.H.G. *stap*; (5) the diphthongization of vowels before *h*, *e.g.* A.S. *cneoht*, O.Fr. *kniucht*: O.H.G. *kneht*; (6) the loss of *n* before *þ*, *e.g.* A.S. *ōðer*, O.Fr. *ōther*: O.H.G. *ander*; (7) the palatalization of gutturals before front vowels, *e.g.* A.S. *geldan*, *gieldan* (Engl. *yield*), O.Fr. *ielda*: O.H.G. *geltan*. The noteworthy differences between the two languages in early times seem to have been very few: (1) *a*, *e*, *i*, are diphthongized before *r* followed by a consonant in English, but not in Frisian, *e.g.* A.S. *earm*: O.Fr. *erm* (cf. Goth. *arms*); (2) the diphthong *ai* became *ā* in English everywhere, but in Frisian only in open syllables (*ē* in close syllables); *e.g.* A.S. *āð*: O.Fr. *ēth* (Goth. *aiþs*), but A.S., O.Fr. *āgun* (Goth. *aigun*); (3) the diphthong *au* became (*aeu*, then) *ēa* in English, but *ā* in Frisian, *e.g.* A.S. *ēage* (*ēge*): O.Fr. *āge* (Goth. *augo*); (4) *i* was labialized in Frisian, but not in English, before (original) *w* in the following syllable; *e.g.* O.Fr. *siunga*: A.S. *singan* (cf. Goth. *siggwan*). Frisian texts of the 13th and 14th centuries show many characteristic changes which must have rendered the language almost, if not wholly, unintelligible to an Englishman of the same period; but it is hardly probable that these changes were for the most part of any great antiquity.

Declension.—The I.-Eur. languages seem originally to have had three numbers and eight cases, though it is by no means clear that each of the latter had a distinct form in every class of stems. In Teutonic there is scarcely any trace of the dual in nouns. Of the cases all the early Teutonic languages preserved four, viz. the Nominative, Accusative, Genitive and Dative. The Vocative also was kept in Gothic and the Instrumental to a considerable extent in early German, while the earliest Anglo-Saxon preserved many traces of the locative.

The case endings are best preserved in the earliest Northern inscriptions and in Gothic. As an illustration we may take those of the I.-Eur. *o*-declension:—

	N. sing.	A.	G.	D.	N. plur.	A.	G.	D.
Goth.	*–s*	–	*–is*	*–a*	*–ōs*	*–ans*	*ē*	*–am*
N. inscr.	*–aʒ*	*–a*	*–as*	*–ē*			*–ō*	
cf. Greek	–ος	–ον				–ονς (–ους)	–ων	

As examples of the forms found in the inscriptions may be given N. *erilaz*, A. *staina*, G. *A(n)suʒisalas*, D. *Woduride*. In the other classes of stems also the declension conforms to the general I.-Eur. types. Whatever changes have taken place have usually tended towards simplification; thus there are but few traces of stem-variation (*ablaut*) between different cases of the same noun.

The treatment of adjectives was somewhat more peculiar. In addition to the old type of declension which conformed to that of the demonstrative pronoun and not, as in Greek and Latin, to that of substantives, almost every adjective was inflected also after the model of *n*-stems. This type of inflection occurs chiefly in conjunction with the demonstrative pronoun (definite article) and it is thought that its origin is to be found in substantival (appositional) usage.

Adjectives.

The comparative of adjectives is formed partly by a suffix *-izan-* (*e.g.* Goth. *sutiza*, A.S. *lengra*), which is apparently extended from the suffix *-ios-*, *-is-* found in the other I.-Eur. languages and probably to be compared with Gk. ἡδίων (from *swādisōn*), and partly by a suffix *-ōzan-* (*e.g.* Goth. *swinpoza*) which is peculiar to Teutonic. Similarly the superlative is formed partly by a suffix *-ista-* (*e.g.* Goth. *hauhists*, A.S. *lengest*) corresponding to *-isto-* in other I.-Eur. languages (*e.g.* Gk. ἥδιστος), and partly by a new formation *-ōsta-* (*e.g.* Goth. *armosts*).

Most of the I.-Eur. demonstrative pronouns are found in Teutonic, and the peculiarities of their inflection are in general well preserved. The most important are Goth. *is*, O.H.G. *er*: Lat. *is*; A.S. *he*: Lith. *szis*; Goth. *sa*, *so*, *þata*: Gk. ὁ, ἡ, τό. The last of these (as in Greek) has become a definite article in all except the Scandinavian languages. The interrogative pronouns

Pronouns.

are Goth. *hwas*, A.S. *hwā*: Sanscr. *kas*, and O.H.G. *hwer*: Lat. *quis*. The place of the relative pronoun is supplied by the demonstrative or by indeclinable forms. The inflection of the personal and reflexive pronouns is for the most part peculiar to Teutonic, *e.g.* Goth. 1 sing. N. *ik*, A. *mik*, G. *meina*, D. *mis*; 1 plur. N. *weis*, A.D. *uns* (*unsis*), G. *unsara*. The majority of these forms are common to all the Teutonic languages, though there is a variation between *-e* and *-i* which is probably due to accentual causes; *e.g.* A.S. *ic*, *mec*, *mē*; O.N. *ek*, *mik*, *mer*; O.H.G. *ih*, *mih*, *mir*.

Conjugation.—The Teutonic verb-system is simpler than that of most of the I.-Eur. languages. The old Middle Voice is preserved only in Gothic, where it is used as a passive. In the other Teutonic languages only one or two isolated forms remain. In place of the two old moods, Conjunctive and Optative, there is but one, which is generally called Conjunctive, though its forms are mostly of Optative origin. Again, there are only two tenses, Present and Preterite, the latter of which is derived partly from the I.-Eur. Perfect, partly from Aorist or Imperfect formations. A few old Perfects, however, which have no Presents, retain their original meaning and are generally known as Preterite-presents, *e.g.* Goth. *wait*, A.S. *wāt*, "I know": Gk. οἶδα. In place of the Future the Teutonic languages use either perfective verbs (generally compounded with a preposition) or a periphrasis consisting of the Infinitive with an auxiliary verb.

The conjugation of the Pres. Indic. Act. corresponds in general to that of most of the I.-Eur. languages, *e.g.* Goth. 1 sing. *baira*, 2 *bairis*, 3 *bairiþ*, 1 plur. *bairam*, 2 *bairiþ*, 3 *bairand*, cf. Gk. φέρω, Sanscr. *bharasi*, *bharati*, Gk. φέρομεν, φέρετε, φέροντι (φέρουσι). Gothic had also forms for the 1, 2 dual, *bairos*, *bairats*, which have not been satisfactorily explained. In the other languages there is scarcely any trace of the dual. The conjugation of verbs corresponding to the Greek verbs in -μι is preserved best in Old High German; *e.g.* 1 sing. *habē-m* (*-n*), 2 *habēs*, 3 *habēt*, 1 plur. *habēmēs*, 2 *habēt*, 3 *habēnt*, cf. Gk. 1 sing. τίθημι, Lat. 2 sing. *habēs*, 3 *habet*, 1 plur. *habēmus*, 2 *habētis*, 3 *habent*. A number of archaic forms are preserved in the "verb substantive," *e.g.* Goth. 1 sing. *im*, 2 *is*, 3 *ist*, 3 plur. *sind.*; O.N. 1 plur. *erum*; cf. Gk. 1 sing. εἰμί, 2 ἐσσί, εἶ, 3 ἐστί, 1 plur. ἐσμέν, 3 εἰσί. The forms of the Conjunctive (Optative) correspond in general to those of the other I.-Eur. languages; *e.g.* Goth. 2 sing. *bairais*, 3 sing. *bairai*; Gk. 2 sing. φέροις, 3 sing. φέροι. So also the Imperative, *e.g.* 2 sing. *bair*: Gk. φέρε; but the origin of the 3 sing. and 3 plur. forms in Gothic (*bairadau*, *bairandau*) is not quite clear. The Gothic Passive is conjugated as follows in the Pres. Indic.: 1, 3 sing. *bairada*, 2 sing. *bairaza*, 1, 2, 3 plur. *bairanda*; cf. Gk. 3 sing. φέρεται, 2 sing. φέρῃ (from φέρε(σ)αι), 3 plur. φέρονται.

The Preterite formations are of two types, usually termed "strong" and "weak." The latter belong to verbs whose past participle has a stem *-đa-* (I.-Eur. *-tó-*; see below), the former to the remaining verbs. The singular of the strong Preterite is derived from the I.-Eur. Perfect, while the plural, which in most verbs has a different stem, may come either from the Perfect or from Aorist formations. In the plural the endings were originally accented; hence many verbs show differences not only in the stem vowel but also in the consonants (by Verner's Law, see above) between the two numbers; *e.g.* A.S. sing. *waes*, *wearð*, plur. *wǣron*, *wurdon*. Reduplication is preserved in Gothic only in a limited number of verbs (*e.g.* *haldan*, pret. *haihald*); in the other languages it is rare. The inflection is as follows: Goth. 1 sing. *-bauþ*, 2 *-baust*, 3 *-bauþ*, 1 dual *-budu*, 2 *-buduts*, 1 plur. *-budum*, 2 *-buduþ*, 3 *-budun*; cf. Gk. 1 sing. οἶδα, γέγονα, 2 οἶσθα, 3 οἶδε, γέγονε, 1 plur. ἴσμεν, γέγαμεν. Except in Gothic and Scandinavian the 2 sing. has generally a form (originally Aorist) similar to the plur., *e.g.* A.S. *bude*. The stem of the Conjunctive also agrees with that of the plur., *e.g.* Goth. 1 sing. *-budjau*, 3 sing. *-budi*.

The "weak" Preterite seems originally to have arisen out of a periphrastic formation of which the second part consisted of Imperfect or Aorist forms of the verb seen in A.S. *dōn*, O.H.G. *tuon* (related to Gk. τίθημι), and probably identical with the Pret. A.S. sing. *dede* (*dyde*), plur. *dǣdon*; O.H.G. sing. *teta*, plur. *tātun*. The short reduplication-syllable, however, is lost in the sing., while the long syllable of the plur. (and dual) is preserved only in Gothic. The inflection of the Indic. is as follows:—

sing. Goth. 1 *nasida*, 2 *-des*, 3 *-da*; A.S. *nerede*, *-des*(*t*), *-de*, O.H.G. *nerita*, *-tōs*, *-ta*. O.N. *lagða* (early inscr. *-ō*), *-ir*, *-i*.

plur. 3 Goth. *nasidedun*, A.S. *neredon*; O.H.G. *neritun*; O.N. *lǫgðu*.

It is to be observed that the stem of the weak Preterite almost always conforms to that of the past participle. Such forms as Goth. pret. *waurhta* are probably derived from the past part. *waurhts* (stem *waurhta-*) on the analogy of pret. *nasida* beside past part. *nasiþs* (stem *nasida-*), where the resemblance between the two formations is due to the regular operation of the sound laws.

The inflection of the Conjunctive agrees with that of the strong Preterite, *e.g.* Goth. *nasidedjau*.

The Infinitive is formed from the present stem with an ending *-an* (*e.g.* A.S. *beran*), and probably was originally a case-form of a verbal noun. In the western languages we find also the Dative of a stem *-anja-* used after a preposition; *e.g.* A.S. *to cēosenne*, O.H.G. *zi nemanne*.

The Present Participle has a stem *-and-* (I.-Eur. *-ont-*) identical with the ending of the 3 plur. Indic., as in the other I.-Eur. languages; but the Participles in actual use were declined as *-an-* or *-ja-* stems, *e.g.* G. *bairanda*, A.S. *berende*. The unextended stem survives only in substantives, *e.g.* A.S. *wīgend*, "warriors." The stem of the Past Participle (Passive) is formed by the suffixes *-to-* and *-no-* (Teut. *-da-*, *-na-*), as in the other I.-Eur. languages. The former occurs as a living formation only in connexion with the verbs whose Present stem ends in *-ja-*, *-ō-*, *-ē-* (in Gothic also *-na-*); *e.g.* Goth. *nasiþs*, *salboþs* (: *nasjan*, *salbon*). The Past Participle in use with other classes of verbs has a stem *-ena-* or *-ana-*, the former in English and Scandinavian, the latter in Gothic and German; *e.g.* A.S. *borenn*, O.N. *borinn*, Goth. *baurans*, O.H.G. (*gi*)*boran*. Remains of old Participles in *-to-*, *-no-* formed otherwise than those in living use may be found in adjectives; *e.g.* A.S. (*e*)*ald* : *alan* (cf. Lat. *altus*), *full* : Lat. *pleo* (cf. Lith. *pilnas*).

The above sketch will suffice to show that in regard to morphology the Teutonic group of languages has many characteristic features which distinguish it from other languages of the same stock. On the other hand the morphological differences which exist among the Teutonic languages themselves are on the whole comparatively slight and due mainly to the operation of syncretism and other simplifying processes. In more recent times these processes have been carried still further, so that *e.g.* the Danish verb has lost all inflection of person and number, while distinction of gender has wholly disappeared in English. In the earlier stages of the Teutonic languages differences of phonology are more marked than those of morphology, and afford surer criteria for determining the relations of these languages to one another. It is customary among scholars to classify the whole group in three main divisions, an eastern or Gothic, a northern or Scandinavian, and a western which includes English, Frisian and German. We have noticed above that Gothic began at an early date to show marked divergences from the other languages. The Scandinavian languages also certainly underwent a considerable number of peculiar changes before the beginning of their literatures. But it is to be remembered that from the 6th century to the 9th the Scandinavian peoples were practically cut off from communication with other Teutonic nations by the Slavonic occupation of Mecklenburg and eastern Holstein. The earliest of the more striking sound-changes peculiar to Scandinavian, viz. the loss of initial *j-*, is not thought to have taken place before the 7th century, while the most characteristic features in its morphology, *i.e.* the development of the post-positive article and of the new medio-passive, belong in all probability to a later period. If we confine our attention to changes which probably took place before the middle of the 7th century it will be seen that the English and Frisian languages may fairly be described as lying about midway between Scandinavian and German, though they had already developed well-marked characteristics of their own. They are doubtless to be regarded as the representatives of the old language of the maritime districts, and it is probable that languages of this type were at one time spoken along the whole of the coast between the present frontiers of Belgium and Denmark. On the other hand the special characteristics of German in all probability developed in the interior and those of Scandinavian round the Baltic and the Cattegat. From the 8th century onwards the High German (southern) dialects of German differed greatly from those spoken further north owing to the operation of the changes generally known as the "second sound-shifting." The northern dialects, however (Old Saxon and Low Frankish), were essentially German, though both were more or less affected by Frisian influence.

The Gothic and Scandinavian languages have one or two characteristics in common, the most important of which is the treatment of intervocalic *j* and *w* in a number of words. In the former case we find Goth. *-ddj-* and O.N. *-ggi-*, whereas in German a diphthong developed; *e.g.* Goth. *twaddje* (Gen. of *twai*, "two"), O.N. *tveggia*: O.H.G. *zweio*. In the latter case both Goth. and Scand. had *ggw* (O.N. *ggv*), while a diphthong appears both in English and German, *e.g.* Goth. *triggws* ("true"), O.N. *tryggr*: A.S. *getrīowe*, *getrīewe*, O.H.G. *gitriuwi*. It may also be noted that Gothic and Scandinavian preserved the ending *-t* in the 2 sing. of the strong Preterite, while English and German had a different form with the stem of the plur. (see above). On the ground of these common characteristics some scholars hold that Gothic and Scandinavian are more closely related to one another than to the other Teutonic languages. But, whatever may have been the case originally—and the evidence is far from conclusive—it is clear that by the 4th or 5th century the Scandinavian languages had far more resemblance to English and German than to Gothic.

The languages of the Vandals, Gepidae and other eastern tribes seem to have been practically identical with Gothic. That of the Burgundians, so far as we can judge from the slight evidence at our disposal, had at least as much in common with southern German as with Gothic, which may be due to the fact that this tribe, though originally located in the basin of the Oder, had moved westwards by the 4th century. The early divergence of the eastern languages in general from those of the north and west is perhaps to be ascribed in part to the great extension southwards of the territories of the eastern tribes in the 3rd and 4th centuries. Yet it is not to be overlooked that all dialectical divergences within the Teutonic group seem to be of relatively recent origin, as compared, *e.g.*, with the special characteristics of some of the Greek dialects. Indeed there is scarcely one of them of which we can say with certainty that it dates from before the beginning of our era.

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(H. M. C.)

TEUTONIC ORDER, THE, or Teutonic Knights of St Mary's Hospital at Jerusalem (*Der deutsche Orden*, *Deutsche Ritter*) was one of the three great military and religious orders which sprang from the CRUSADES (*q.v.*). Later in birth than the Templars and Hospitallers, the Teutonic Order traces its first beginnings from the third Crusade. Already, indeed, in 1143 we hear of a hospital of Germans at Jerusalem, which Celestine II. places under the control of the Hospitallers, with the stipulation that the prior and servants alone shall necessarily be of German birth.[1] But it is amidst the privations and plague which attended the siege of Acre, during the third Crusade, that the first certain beginnings of the Order appear. In the winter of 1190–91 certain pious merchants from Bremen and Lübeck (towns with which the Order was still to be connected in the days of its later history) laid the foundations of a hospital in a

[1] Röhricht, *Geschichte des Königreichs Jerusalem*, p. 242.

vessel which they had drawn ashore.[1] Within a few years the foundation apparently became attached to the German Church of St Mary the Virgin at Jerusalem; and in March 1198 (there being present in the Holy Land a number of Germans, the relics of Henry VI.'s projected crusade), the great men of the army and the kingdom raised the brethren of the German Hospital of St Mary to the rank of an order of knights. The original members were thus ennobled; and henceforth it was the rule that only Germans of noble birth could join the Order. The Order was from the first, therefore, of a national character, unlike the cosmopolitan orders of the Templars and Hospitallers; but in other respects it was modelled upon the same lines, and shared in the same development. Like the knights of other orders, the Teutonic knights lived a semi-monastic life under the Augustinian rule; and in the same way they admitted priests and half-brothers (*servientes*) into their ranks. Like the other two orders, the Teutonic Order began as a charitable society, developed into a military club, and ended as something of a chartered company, exercising rights of sovereignty on the troubled confines of Christendom. Even in its last phase, the Order did not forget its original purpose: it maintained several great hospitals in its new home on the south-east shore of the Baltic, in addition to an *hôtel des invalides* at Marienburg for its sick or aged brethren.

For a hundred years (1191–1291) the headquarters of the Order were at Acre; nor was it until 1309 that, after a brief sojourn at Venice, the seat of government was transferred to Marienburg on the Vistula. But long before that date the Order had begun to find that its true work lay on the eastern frontiers of Germany. Perhaps it was Hermann von Salza, the first great grand master of the Order (1210–1239), who originally conceived the idea of transplanting the Order to the west. At any rate it was he who accepted the invitation of Andrew of Hungary that the Order should aid him with its resources against the Comans by whom he was threatened. In 1211 the Order received from the king the district of Burzenland in Transylvania. Towns arose and agriculture began to flourish; but seeking to make itself independent, the Order lost its lands, and disappeared from Transylvania. A new opportunity almost immediately arose on the banks of the Vistula. Here Christian, bishop of Prussia, who had received from the Polish duke of Masovia a part of Kulmerland as a fief, had founded the knightly Order of Dobrzin, and was attempting with its aid to subdue the heathens of Prussia. Unsuccessful in his attempt, he invited the Teutonic Order to come to the rescue, and bestowed on the Order Kulm and some of the frontier towns in his territory, with such lands as it should conquer (1228). Thus the Order took its place as the founder of one of the marks on the eastern frontier of Germany, and began to play its part in that *Drang nach Osten*, which is perhaps the vitally important thing in the history of Germany from the 12th to the 14th century. Since the days of Adolf of Holstein and Henry the Lion, a movement of German colonization, in which farmers from the Low Countries, merchants from Lübeck, and monks of the Cistercian Order all played their parts, had been spreading German influence from the Oder to the Vistula, from the Vistula to the Dwina—to Prague, to Gnesen, and even to Novgorod the Great. Of this movement the Teutonic Order became, along with the Hanse, the chosen representative. It was not, indeed, the first knightly Order to gird itself for the task. Besides the knightly Order founded by Christian, there was already another still farther east, which had served as Christian's model, the Knights of the Sword of Livonia. This was an order founded by Albert, 3rd bishop of Riga, in 1201, to serve as an instrument, under his control, for the conquest of the land. But in 1237 the Knights of the Sword were merged into the Teutonic Order, and Livonia became a province of the Order, with a master of its own under the grand master's control, just as, two years before, the Order had also absorbed the Knights of Dobrzin.

[1] Röhricht, *Geschichte des Königreichs Jerusalem*, p. 542. The relations of this new foundation to the German hospital mentioned in 1143 cannot be traced.

In 1229 the Order began the conquest of Prussia, founding fortresses at each step to rivet its conquests (for instance, at Thorn, named after Toron in Palestine), much as the Anglo-Normans had done in their conquest of Wales. Frederic II. gave the Order the rights of a prince of the Empire in its territories: Conrad of Masovia gave it the whole of Kulmerland in 1230; while in 1234 the Order established its independence of all authorities except the Papacy, by surrendering its territories to the Holy See and receiving them back again as a fief. The pope gave to those who joined in the work of the Order the privileges of Crusaders; and the knights, supported by numerous donations and large accessions to their ranks, rapidly increased their territories. By 1260 they ruled the eastern bank of the Vistula from Kulm to its mouth, and the northern shore of the Baltic from the mouth of the Vistula to Königsberg. Livonia they held after 1237; and during the 14th century they gained the Lithuanian territory of Samogitia, which lay between Livonia and their Prussian dominions, while they also added, to the west of the Vistula, Pomerellen and the Neumark (see under PRUSSIA). Already by the beginning of the 14th century these conquests had fundamentally changed the character of the Order. It lost any connexion with the East: after the fall of Acre in 1291, the grand master (whose seat had been at Acre, while the German master (*Deutschmeister*) had controlled the Order in Germany) moved first to Venice, and then, in 1308, to Marienburg on the Vistula. Again, with the accession of large territories, the Order became a governing aristocracy; the original care for the sick, and even the later crusading zeal of the period of conquest, gave way, when conquests were gained and administration was needed, to the problem, half military, half political, of governing a frontier state. The statutes of the Order were altered to suit the new conditions, and a whole system of administration arose. At Marienburg the grand master maintained a magnificent court; round him were the five great dignitaries of the Order, the Grand Commander, the Marshal, the Hospitaller, the Treasurer (*Tressler*) and the Keeper of the Wardrobe (*Trapier*) to see to the clothing of the Order. There was a *Landmeister* for Livonia, and another (the *Deutschmeister*) for the German province, with his seat at Mergentheim in Swabia. Over each of the twenty districts of the Order was set a commander (*Komtur*), with the brethren of his house at his side as advisers. The commander was bound by the advice of his brethren; and in the same way the general chapter of the Order, consisting of the landmeisters and the great dignitaries, formed an advisory board to the grand master in matters such as treaties and internal legislation. It was government by an aristocracy almost Venetian in character. The individual was merged in the Order: each brother must pray four times in the day, and four times at night, and he must at all times pay an unquestioning obedience to his superiors The Order was at once supreme ecclesiastical and political authority. There were no struggles of Church and State in its dominions: the state was also the church: the bishops and the canons of the four bishoprics (with the exception of Ermeland) were priests of the Order. The lay subjects of the Order consisted of two classes; on the one hand there were the conquered Prussians, in a position of serfdom, bound in time of war to serve with the brethren in foreign expeditions; on the other hand there were the German immigrants, both urban and rural, along with the free Prussians who had voluntarily submitted and remained faithful. The towns were large and flourishing; as many as sixty arose in the period between 1233 and 1416, including Thorn and Elbing, Danzig and Königsberg (named after Ottocar of Bohemia, who took part in the campaign during which it was founded). The towns possessed the rights of Magdeburg, or (like Elbing) those of Lübeck; the most important of them soon came to join the Hanseatic League. The Order only imposed customs duties: it levied no tolls within the land; and though its consent was necessary to any change in municipal ordinances, it allowed the towns a large amount of self-government. The concord of the Order with the towns and the Hanse was one great cause of its prosperity until the close of the 14th century; and the rupture of that concord in the 15th century was largely responsible for its fall.

This political and material strength enabled the Order to weather the storm by which the Templars were destroyed at the beginning of the 14th century. For a time, indeed, the Order lay under papal sentence of excommunication; but the transference of his seat to Marienburg at this time (1308) gave the grand master a basis from which he was able to make easy terms with the pope. Nor was the Order, during the 14th century, at all unfaithful to its original calling. Particularly under the grand master Winrich of Kniprode (1351–1382) it was the school of northern chivalry, engaged in unceasing struggle to defend and extend Christianity against the heathen Lithuanian. To the brilliant court of Marienburg, not only a school of chivalry, but under Winrich's predecessor Luther of Brunswick, a literary centre,[1] men came from all over Europe to win their spurs. John of Bohemia had fought by the Vistula: Henry of Bolingbroke was of the goodly company; Chaucer's perfect knight had travelled in "Pruce and Lettowe." The neo-chivalry of the 14th century, in which a fantastic love of adventure had displaced the finer and more ideal motives of the old chivalry, looked towards the Vistula and Marienburg.

At the height of its glory sudden and irretrievable ruin fell upon the Order. The conditions which had made possible its prosperity now disappeared. Externally, a Slavonic reaction came, and dealt heavy blows to the eastward advance of German civilization. The Hussite movement, a victorious expression of Czech nationality, is contemporaneous with the loss of German dominion in Prussia; the exodus of German students from Prague takes place a year before the defeat of the Order at Tannenburg. The particular danger from the Slavs of the north-east arose from the conversion of Lithuania, and the union of converted Lithuania to Poland. The conversion of Lithuania deprived the Order of its mission: the union of Lithuania to Poland robbed it of the security which it enjoyed while they were disunited, and gave new strength to Poland, a constant enemy to the Order which had deprived it of any outlet on the Baltic. Internally, too, the Order suffered. The Hussite wars, the feuds of Burgundian and Armagnac, the renewal of the Hundred Years' War, all prevented it from drawing new blood from the west. But above all it lost touch with its subjects. A religious order, largely composed of immigrants from abroad, could not permanently rule a state which had developed a national feeling of its own; and the native aristocracy, both of the towns and the country, revolted against its dominion. The rebellious elements allied themselves instinctively with the Poles, who thus found the absorption of the greater part of the lands of the Order an easy task. Commercial jealousy aided the process: the Order had alienated the towns by entering into competition with their trade; it had established a monopoly of amber and even, occasionally, of corn; and its agents were spread as far afield as Bruges. This commercial policy had indeed a deeper and more fatal effect than the alienation of the towns; it secularized still further the brethren of the Order, and made them financiers instead of soldiers. Their finances were indeed excellent; they kept regular accounts, and had already developed the modern principle of separating the civil list from the expenses of the government; but when they brought the tables of money-changers into the temple, they were doing as the Templars had done before them, and were likely to suffer as the Templars had suffered.

The first blow struck at the Order, if it did not destroy its power immediately, ruined its prestige for ever. The defeat which the Polish king Ladislaus inflicted upon the knights at Tannenberg in 1410 was crushing. It brought Ladislaus little immediate gain; but it stimulated the elements of unrest in Prussia to fresh activity. The discontented clergy, especially in Livonia; the towns, such as Danzig; the native aristocracy, organized in a league (the *Eidechsenbund*, or League of the Lizard), all sought to use their opportunity. It was in vain that the heroic grand master, Henry of Plauen (1410–1413) sought to stem the tide of disaster; he was deposed by the chapter of the Order for his pains. The success of the Hussite raids in Germany gave fresh confidence to the Slavs of Poland. The Order was at variance within itself; some of the houses of the brethren refused to obey the marshal, and the grand master quarrelled with the German master. Above all, there arose in 1440 the Prussian League (*Preussischer Bund*), in which the nobles and towns joined together, nominally for common protection of their rights, but really against the Order. The League naturally sympathized with Poland, not only because Poland was the enemy of the knights, but also because under Poland it hoped to enjoy the practical liberty which Polish anarchy already seemed to offer. The ultimate result was that in 1454 an embassy of the League offered Prussia to the Polish king, and that, after many years of war, the Peace of Thorn (1466) gave to Poland West Prussia, with Marienburg, Thorn, Danzig and other towns, in full possession, and, while leaving East Prussia to the Order, made the Order the vassals of Poland for the territory which it retained. Henceforth the grand master was to sit in the Polish diet on the left of the king, and half of the knights of the Order were to be Polish.

From 1466 to 1526 grand masters of the Order ruled in East Prussia as vassals of Poland. But the master of the Livonian province and the German master would not obey a Polish vassal, and went their own way; the German master took the grand master's place as a prince of the Empire. The brethren of East Prussia, however, still sighed for independence; and they pursued the policy of choosing German princes to be grand masters of the Order, in the hope of regaining liberty by their aid. Frederick of Saxony held the office from 1498 to 1511; and he was succeeded by the Hohenzollern Albert of Brandenburg-Anspach. When Lutheranism arose, it spread rapidly in Prussia; Albert himself came into contact with Luther, and turning Protestant he secularized his territories, and (1526) made them into an hereditary duchy, still held as a fief of the king of Poland. Few of the brethren resisted; and the Order quietly ceased from the land where for three hundred years it had had its being.

Henceforth the Teutonic Order lived in Germany and in Livonia. The master of the latter province had beaten off an attack of the Russians in 1502, and secured a fifty years' peace. But in 1561 another master followed the example of Albert, and received Courland as an hereditary fief from Poland. Henceforth the Order was confined to Germany alone. The German master—now grand master and German master in one—had his headquarters at Mergentheim in Swabia; the revenues of the states scattered throughout the twelve bailiwicks of Germany sustained him and his Order. The Order, clinging to its rights with the conservatism of an ecclesiastical corporation, still maintained its claims to East Prussia, and pressed them tenaciously even against the electors of Brandenburg themselves, when they inherited the land on the failure of Albert's descendants in 1618. The French Revolution finally deprived the Order of all its estates, and for a while of its existence. In 1801 the bailiwicks to the west of the Rhine were absorbed by France; in 1809 the Order was entirely suppressed, and its lands went to the secular principalities in which they lay. But in 1840 the Order was resuscitated in Austria, where it now exists as a semi-religious knighthood, closely connected with the Habsburgs.

It has remembered its earliest objects, and has of late years engaged during war in the ambulance service. "At the foot of sunny vineyards," says Treitschke, "the house of the Teutonic Order now stands at Botzen; on its door is still emblazoned the black cross—in the middle of the shield of the Habsburg-Lorrainers." Whatever its connexion with the Habsburgs, the Order has its real heirs in the Hohenzollerns of Prussia. When Frederic the Great gained West Prussia by

[1] Every house of the Order had two learned brethren, one learned in the law, one in theology. There were also elementary schools, and municipal foundations in which Latin was taught, in the dominions of the Order.

the first partition of Poland (1772), he was uniting together once more the dominions of the Order, sundered since 1466; and it is the kings of Prussia who have inherited the Order's task of maintaining German influence on the banks of the Vistula.

LITERATURE.—The article is chiefly based on H. von Treitschke's *Das deutsche Ordensland Preussens*, in *Historische und politische Aufsätze*, vol. ii. (Leipzig, 1871), and on J. Loserth, *Geschichte des späteren Mittelalters* (Munich and Berlin, 1903). Loserth gives a bibliography of authorities dealing with the history of the Order on pp. 131, 365 and 567–8. The original evidence is to be found in E. Strehlke, *Tabulae Ordinis Teutonici* (Berlin, 1869), and in *Scriptores rerum Prussicarum* (Leipzig, 1861–1870). J. Voigt has traced the history of the Order previous to 1526 in his *Geschichte Preussens* (Königsberg, 1827–1839), and he has dealt with the organization of the Order, and with its history in Germany from 1525 to 1858, in his *Geschichte des deutschen Ritterorden in seinen zwölf Balleien in Deutschland* (Berlin, 1857–1859). More recent writers are Lohmeier, *Geschichte Ost- und Westpreussens* (Gotha, 1880), and Prutz, *Geschichte Preussens* (Stuttgart, 1900). For monographs on the grand masters, the various territories, and the different epochs in the history of the Order see the references in Loserth's work. (E. BR.)

TEUTONIC PEOPLES, a comprehensive term for those populations of Europe which speak one or other of the various Teutonic languages, viz., the English-speaking inhabitants of the British Isles, the German-speaking inhabitants of Germany, Austria-Hungary and Switzerland, the Flemish-speaking inhabitants of Belgium, the Scandinavian-speaking inhabitants of Sweden and Norway and practically all the inhabitants of Holland and Denmark. To these we have to add small German and Flemish-speaking communities in Italy and France and somewhat larger German and Swedish populations in Russia. Outside Europe we have to include also the very numerous populations in America, Africa, Australasia, &c., which have emigrated from the same countries. The statement that the Teutonic peoples are those which speak Teutonic languages requires a certain amount of qualification on one side. In the British Isles, especially Ireland, there is (in addition to the Celtic-speaking elements) a considerable population which claims Celtic nationality though it uses no language but English; and further all Teutonic communities contain to a greater or less degree certain immigrant (especially Semitic) elements which have adopted the languages of their neighbours. On the other hand there does not appear to be any considerable population anywhere which claims Teutonic nationality without using a Teutonic language. We know indeed that France, Spain, Italy, &c., contained within historical times large populations which were Teutonic both by origin and by language, but these have now been completely absorbed. Similarly, there is no doubt that the inhabitants of England and of the German-speaking regions of the Continent are descended very largely from peoples which two thousand years ago spoke non-Teutonic languages. Yet on the whole the definition given above may be accepted as generally true for the present time.

It is to be observed that the term "Teutonic" is of scholastic and not of popular origin, and this is true also of the other terms ("Germanic," "Gothic," &c.) which are or have been used in the same sense. There is no generic term now in popular use either for the languages or for the peoples, for the reason that their common origin has been forgotten. In Tacitus's time, however, when the area occupied by the Teutonic peoples was, of course, considerably less than now, a consciousness of their relationship to one another was fully retained. He cites native poems which declared that the Inguaeones, Hermiones and Istaeuones—the three main branches of the Germani (see below)—were sprung from three sons of a certain Mannus (perhaps "Man"), who was himself the son of the god Tuisto the son of Earth; and in a Frankish document at least four centuries later we hear again of three brothers named Erminus, Inguo and Istio, from whom many nations were descended. In English documents also we find eponymous national ancestors grouped together in genealogical trees, and there is reason to believe that the common origin of the various Teutonic peoples was remembered to a certain extent until comparatively late in the middle ages.

The linguistic characteristics of the various Teutonic peoples have been dealt with under TEUTONIC LANGUAGES. In regard to physical features they present at the present time very many varieties both of stature and of pigmentation, though on the whole they are probably the tallest and fairest of European peoples. These characteristics are noted by a number of ancient writers in language which seems to show that they must at that time have been at least as pronounced as among any of the present Teutonic peoples. Moreover, the tallness and dolichocephaly which now specially mark the more northern peoples of the group appear very prominently in cemeteries of the migration period in Switzerland and other neighbouring countries. On the whole, however, the skeletons found in German and Scandinavian tombs dating even from the earliest period do not show any very remarkable differences from those of the present day. But whether we are justified in speaking of a Teutonic race in the anthropological sense is at least doubtful, for the most striking characteristics of these peoples occur also to a considerable extent among their eastern and western neighbours, where they can hardly be ascribed altogether to Teutonic admixture. The only result of anthropological investigation which so far can be regarded as definitely established is that the old Teutonic lands in northern Germany, Denmark and southern Sweden have been inhabited by people of the same type since the neolithic age, if not earlier.

The results of investigations in prehistoric archaeology are treated in the articles GERMANY and SCANDINAVIAN CIVILIZATION. As no Teutonic inscriptions are extant from before the 3rd or 4th centuries, it cannot be stated with absolute certainty what types of objects are characteristic of Teutonic civilization in the bronze and earliest iron ages. Yet throughout the bronze age it is possible to trace a fairly well-defined group of antiquities covering the basin of the Elbe, Mecklenburg, Holstein, Jutland, southern Sweden and the islands of the Belt, and archaeologists have conjectured with much probability that these antiquities represent the early civilization of the Teutonic peoples. The civilization was, of course, not wholly of native growth. Strong foreign influence, first Aegean and later Etruscan, can be distinguished; but the types introduced from the south have generally undergone considerable modification and expansion. The somewhat surprising degree of wealth and artistic skill of which many of even the earliest antiquities give evidence is probably to be explained by the importance of the amber trade. Both in eastern and in western Germany the objects found are of somewhat different types and seem to point to a lower standard of civilization. What peoples inhabited these regions can only be conjectured, but there is a certain amount of evidence from place-names—not altogether satisfactory—that the Celtic peoples at one time extended eastwards throughout the basin of the Weser. With the beginning of the iron age (perhaps *c.* 500–400 B.C.) Celtic influence becomes apparent everywhere. By this time, however, the great Celtic movement towards the south-east had probably begun, so that the Teutonic peoples were now cut off from direct communication with the centres of southern civilization.

1. *History*.—The first recognition that the inhabitants of Germany, Holland, &c., were a people distinct from their Celtic neighbours dates from about the middle of the 1st century B.C., when Caesar's conquest of Gaul rendered a knowledge of northern Europe more generally accessible to the Romans. Certain notices relating to individual Teutonic tribes come down from still earlier times. Thus there can be little doubt that the Cimbri (*q.v.*) and their allies, who invaded Illyricum, Gaul and Italy in the last years of the preceding century, were for the most part of Teutonic nationality. The Bastarnae also, who in the 3rd century B.C. invaded and settled in the regions between the Carpathians and the Black Sea, are said by several ancient writers to have been Teutonic by origin, though they had largely intermarried with the native inhabitants. Again, individual travellers from the time of Pytheas onwards had visited Teutonic countries in the north. In none of the early records, however, do we get any clear indication that the

Teutonic peoples were distinguished from the Celts. From the time of Caesar onwards the former were known to the Romans as "Germani," a name of uncertain but probably Gaulish origin. It is said to have been first applied to certain Belgic tribes in the basin of the Meuse, who may formerly have come from beyond the Rhine.

At the beginning of our era the Teutonic peoples stretched from the Rhine to the Vistula. Before Caesar's arrival in Gaul they had advanced beyond the former river, but their further progress in this direction was checked by his campaigns, and, though both banks of the river were occupied by Teutonic tribes throughout the greater part of its course, most of these remained in definite subjection to the Romans. The easternmost Teutonic tribe was probably that of the Goths, in the basin of the Vistula, while the farthest to the south were the Marcomanni and Quadi, in Bohemia and Moravia. These latter districts, however, had been conquered from the Boii, a Celtic people, shortly before the beginning of our era. Towards both the south and west the Teutonic peoples seem to have been pressing the Celts for some considerable time, since we are told that the Helvetii had formerly extended as far as the Main, while another important Celtic tribe, the Volcae Tectosages, had occupied a still more remote position, which it is impossible now to identify. How far the Teutonic peoples extended northwards at this time cannot be determined with certainty, but it is clear that they occupied at least a considerable part of the Scandinavian peninsula.

It has already been mentioned that the Teutonic peoples of this period seem to have been fully conscious of their common origin. What exactly the grouping into Inguaeones, Hermiones and Istaeuones was based upon can only be conjectured, though probably its origin is to be sought rather in religion than in political union. The name of the Hermiones, who are defined as "central" or "interior" peoples, is probably connected with that of the Irminsul, the sacred pillar of the Old Saxons. The Inguaeones again are defined as being "next to the ocean"; but the name can be traced only in Denmark and Sweden, where we find the eponymous hero Ing and the god Yngvi (Frey) respectively. It is likely that the name really belonged only to the peoples of the southern Baltic. Very probably there were many tribes which did not regard themselves as belonging to any of these groups. Tacitus himself records a variant form of the genealogy (see above), according to which Mannus had a larger number of sons, who were regarded as the ancestors of the Suebi, Vandilii, Marsi and others (see SUEBI, VANDALS). In two at least of these cases we hear of sanctuaries which were resorted to by a number of tribes. It is not to be doubted that such religious confederations were favourable to the existence of political unions. Generally speaking, however, each tribe formed a political unit in itself, and the combinations brought together from time to time in the hands of powerful kings were liable to fall to pieces after the first disaster.

For a few years at the beginning of the Christian era the part of Germany which lies west of the Elbe was under Roman government; but after the defeat of Varus (A.D. 9) the Rhine and the Danube formed in general the frontiers of the empire. Roman influence, however, made itself felt both by way of trade and especially by the employment of German soldiers in the auxiliary forces. In the age of national migrations—from the 4th to the 6th century—the territories of the Teutonic peoples were vastly extended, partly by conquest and partly by arrangement with the Romans. These movements began in the east, where we find the Goths ravaging Dacia, Moesia and the coast regions as early as the 3rd century. In the following century the Vandals settled in Pannonia (western Hungary), while the Goths occupied Dacia, which had now been given up by the Romans, and subsequently took possession also of large territories to the south of the lower Danube.

The 5th century was the time of the greatest national movements. In 406–9 the Vandals and other tribes invaded Gaul from the east and subsequently took possession of Spain and north-western Africa. Immediately afterwards the Visigoths invaded Italy and captured Rome; then turning westwards they occupied southern Gaul and Spain. The southern Suebic peoples, the Alamanni and Bavarians, extended their frontiers as far as the Alps probably about the same time. Not much later a considerable portion of northern Gaul fell into the hands of the Franks, and before the middle of the century the eastern part was occupied by the Burgundians. Several of these movements were due, without doubt, to pressure from the Huns, an eastern people who had conquered many Teutonic tribes and established the centre of their power in Hungary. Their empire, however, speedily broke up after the death of their king Attila in 453. The chief events of the latter part of the century were the conquest of the eastern part of Britain by the Angli, the invasion of Italy by the Ostrogoths and the complete subjugation of northern Gaul by the Franks. By this time, with the exception of Brittany and the southern part of the Balkan peninsula, practically the whole of southern and western Europe was under Teutonic government.

It is customary to attribute this great expansion partly to the increasing weakness of the Romans and partly to pressure of population in Germany. Both explanations may contain a certain amount of truth; but there is no doubt that the military strength of the Teutonic nations was far more formidable now than it had been in the time of the early empire. Not only is it clear, both from literary and archaeological evidence, that they were better armed (see below), but also their power was much more concentrated. Thus during the 1st century we hear of about a dozen different tribes in and around the lower part of the basin of the Rhine. In later times, with one or two possible exceptions, these were all included under the general term *Franci*, and by the end of the 5th century all had become subject to one king. Similar processes can be traced elsewhere, *e.g.* among the Alamanni and in the northern kingdoms. Their effect, of course, must have been to provide the kings with greater wealth and with larger permanent bodies of armed men. The motive force towards extension of territories was supplied by military ambition; especially we have to take account of the growth of a warlike spirit in the North, which was constantly driving young warriors to seek their fortunes in the service of continental princes. Where the movement was really of a migratory character it may generally be ascribed to external pressure, in particular from the Huns and the Avars.

The first half of the 6th century saw the subjugation of the Burgundian and Visigothic portions of Gaul by the Franks and the recovery of Africa by the Romans. This latter event was soon followed by the overthrow of the Ostrogothic kingdom; but not many years later Italy was again invaded by the Langobardi (Lombards), the last of the great Teutonic migrations. By this time the extension of Teutonic dominion towards the south and west had brought about its natural sequel in the occupation of the old Teutonic lands in eastern Germany, including even the basin of the Elbe, by Slavonic peoples. Before the end of the century Bohemia also and Lower Austria, together with the whole of the basins of the Drave and the Save, had become Slavonic countries.

The story of the succeeding centuries may briefly be described as in general a process of return to the ethnographical conditions which prevailed before the migration period. The Franks and the Langobardi remained in Gaul and Italy, but they gradually became denationalized and absorbed in the native populations, while in Spain Teutonic nationality came to an end with the overthrow of the Visigothic kingdom by the Moors, if not before. Yet throughout the west and south-west the Teutonic frontier remained from fifty to two hundred miles in advance of its position in Roman times. In south-eastern Europe also the Teutonic elements were swallowed up by the native and Slavonic populations, though a small remnant lingered in the Crimea until probably the 17th century. On the other hand the political consolidation of the various continental Teutonic peoples (apart from the Danes) in the 8th century led to the gradual recovery of eastern Germany together with Lower Austria and the greater part of Styria and Carinthia, though

Bohemia, Moravia and the basins of the Vistula and the Warthe have always remained mainly Slavonic. In the British Isles the Teutonic element, in spite of temporary checks, eventually became dominant everywhere. Lastly, from the very beginning of the 9th century bodies of Scandinavian warriors began to found kingdoms and principalities in all parts of Europe. The settlers, however, were not sufficiently numerous to preserve their nationality, and in almost all cases they were soon absorbed by the populations (Teutonic, Celtic, Latin or Slavonic) which they had conquered. Their settlements in Greenland and Canada likewise came to an end, but Iceland, which was formerly uninhabited, remained a Scandinavian colony. The permanent expansion of the Teutonic peoples outside Europe did not begin till the 16th century.

2. *Form of Government.*—From the evidence at our disposal it is difficult to determine how far the Teutonic peoples were under kingly government in early times. Tacitus speaks of tribes which had kings and tribes which had not, the latter apparently being under a number of *principes*. On nearer examination, however, it appears that kingship was intermittent in some tribes, while in others, which had no kings, we find mention of royal families. All such cases were perhaps peculiar to the western peoples; in the east, north and centre we have no evidence for kingless government. Further, while Tacitus represents the power of Teutonic kings in general, with reference no doubt primarily to the western tribes, as being of the slightest, he states that among the Goths, an eastern people, they had somewhat more authority, while for the Swedes he gives a picture of absolutism. It is quite in harmony with these statements that many Northern and probably all the Anglo-Saxon kingly families traced their origin to the gods. The Swedes, indeed, and some of the eastern peoples seem to have regarded their kings themselves as at least semi-divine (see below, § *Religion*). As the west was the side most open to foreign influence during the Roman period, it is likely that the form of government which prevailed here was less primitive than the other, especially as we know that kingship had by this time died out among the Gauls. In later times we very frequently find a number of "kings," generally belonging to one family, within the same tribe; and it is not improbable that the early *principes* were persons of similar position. The kingless state may therefore have arisen out of kingship through divisions of the royal power or through failure on the part of the leading men to agree on a head acceptable to all. On the other hand the conditions of the migration period were doubtless favourable to monarchical government, and from this time onwards kingship appears to have been universal, except among the Old Saxons and in Iceland.

Kingship.

The *concilium* or tribal assembly figures largely in Tacitus's account of the Germani, and he represents it as the final authority on all matters of first-rate importance. Further, it was here that the *principes* were chosen, serious charges brought against members of the tribe and youths admitted to the rights of warriors. The duties of opening the proceedings and maintaining order belonged not to the king but to the priests, from which we may probably infer that the gathering itself was primarily of a religious character and that it met, as among the Swedes in later times, in the immediate neighbourhood of the tribal sanctuary. Such religious gatherings were no doubt common to all Teutonic peoples in early times, but it may be questioned whether among the eastern and northern tribes they were invested with all the powers ascribed to them by Tacitus. After his time tribal assemblies are seldom mentioned, and though we hear occasionally, both in England and elsewhere, of a concourse of people being present when a king holds court on high days or religious festivals, there is no evidence that such concourses took part in the discussion of state affairs. Indeed, considering the greatly increased size of the kingdoms in later times, it is improbable that they were drawn from any except the immediately adjacent districts. When we hear of deliberations now they are those of the king's council or court, a body consisting partly of members of the royal family and partly of warriors old and young in the personal service of the king. Such bodies of course had always existed (see below) and exercised at all times a powerful influence upon the kings, frequently even forcing them into war against their own wishes. That they appear more prominently now than in earlier times is due to the fact that owing to the increased size of the kingdoms, they had become both more numerous and more wealthy. The principle of representation for the unofficial classes, *i.e.* for those not under the immediate lordship of the king, scarcely begins before the 13th century.

Tribal Assembly.

Of all the institutions of the Teutonic peoples probably none exercised a greater influence on their history than the *comitatus*. From Caesar we learn that it was customary at tribal assemblies for one or other of the chiefs to propose an expedition. He had generally no difficulty in gathering a following, and those who embraced his service were held bound to accompany him to the end, any who drew back being regarded as traitors. Incidents illustrative of this custom are of frequent occurrence in early history and tradition. Moreover, kings and other distinguished persons kept standing bodies of young warriors, an honour to them in time of peace, as Tacitus says, as well as a protection in war. Chiefs of known prowess and liberality attracted large retinues, and their influence within the tribe, and even beyond, increased proportionately. The followers (called by Tacitus *comites*, in England "thegns," among the Franks *antrustiones*, &c.) were expected to remain faithful to their lord even to death; indeed so close was the relationship between the two that it seems to have reckoned as equivalent to that of father and son. According to Tacitus it was regarded as a disgrace for a *comes* to survive his lord, and we know that in later times they frequently shared his exile. Perhaps the most striking instance of such devotion was that displayed at the battle of Strassburg in 357, when the Alamannic king Chonodomarius was taken prisoner by the Romans, and his two hundred *comites* gave themselves up voluntarily to share his captivity. In return for their services the chief was expected to reward his followers with treasure, arms and horses. If he were a king the reward might take the form of a grant of land, or of jurisdiction over a section of the population subject to him—in early times a village, in later, perhaps, a considerable district. Further, since the grantees as a rule naturally sent their sons into the service of their own lords, such grants tended to become hereditary, and in them we have the origin of the baronage of the middle ages. The origin of the earls or counts, on the other hand, is to be found in the governors of large districts (Tacitus's *principes*), who seem at first generally to have been members of the royal family, though later they were drawn from the highest barons.

3. *Social Organization.*—As far back as the time of Tacitus we hear of three social classes, viz. nobles, freemen and freedmen. The same classes are met with in later times, though occasionally one of them disappears, *e.g.* the nobility among the Franks and the freedmen (as a distinct class) in the Anglo-Saxon kingdoms, except Kent. Each of these classes was, to a large extent at least, hereditary and had separate rights and privileges of its own. Among the chief of these must be reckoned the wergeld or "man-price." When homicide took place vengeance was regarded as a sacred duty incumbent on the relatives, and sometimes at least the lord also, of the slain man; but, as in the case of any other injury, compensation could be made by a fixed payment. From the evidence of later custom it is probable that the normal payment for a freeman was a hundred head of cattle. The sums paid for members of the other classes were more variable; for the freedman, however, they were always lower, and for the noble higher, sometimes apparently three or four times as high. Similar gradations occur in the compensations paid for various injuries and insults, in fines and, among some tribes, in the value attached to a man's oath. There is a good deal of uncertainty in regard to both the exact position and the numbers of the nobles and freedmen of Tacitus's age. It is probable, however, that the latter, like

the *liti* or *lati* of later times, consisted not only of manumitted slaves but also of whole communities which had forfeited their liberty through unsuccessful warfare or other causes. In addition to these classes there was also a considerable population of slaves, who had no legal status or wergeld and were regarded as the property of their masters. In general, however, their lot seems to have struck the Romans as favourable, since they were not attached to their masters' households but lived in homes of their own, subject to fixed payments in corn, live stock and clothing.

Groups of family and kindred occupy a prominent position in the accounts of Teutonic society given by Caesar and Tacitus. It was regarded as a universal duty to afford protection to one's kinsmen, to assist them in the redress of wrongs and to exact vengeance or compensation in case of death. Hence to have a numerous kindred was a guarantee of security and influence. The large amounts fixed for the wergelds of nobles and even of freemen were paid no doubt, as in later times, not only by the slayer himself, but by every member of his kindred in proportion to the nearness or remoteness of his relationship; and in like manner they were distributed among the kindred of the slain. The importance of the kindred, however, was not limited to purposes of mutual protection. It appears also in the tenure of land, and according to Tacitus the tribal armies were drawn up by kindreds. As to the nature of these organizations the evidence is not altogether consistent. It is clear that agnatic succession prevailed among the princely families of the Cherusci, and the general account given in the *Germania* seems to imply that this type of organization was normal. On the other hand there are distinct traces of cognation not only in Tacitus's works but also in Northern traditions and more especially in the Salic law. On the whole it seems not unlikely that at the beginning of the Christian era the Teutonic peoples of the continent were in a state of transition from cognatic to agnatic organization.

Marriage.

All the usual forms of marriage were known, including marriage by capture and marriage by purchase. The latter appears most prominently in Kent and among the Old Saxons, Langobardi and Burgundians. In other nations, *e.g.* the Franks, we find the payment of a very small sum, which is often regarded as symbolic and as a relic of real purchase. Yet this explanation is open to question owing to the very early date at which the regulation appears, and to the fact that in the case of widows the sum specified had to be paid to relatives of the widow herself on the female side, and by preference to those of a younger generation. Again, Tacitus states that the presents of arms and oxen given by the bridegroom at marriage were made to the bride herself and not to her guardian, and such appears to have been the case in the North also from early times. It is not certain, therefore, that marriage by purchase was a universal and primitive Teutonic custom. Of the actual ceremonies practised at marriage not very much is known. It was preceded, however, by a formal betrothal and accompanied by a feast. Moreover, even among those peoples with whom purchase prevailed it was customary for the bridegroom to present the bride with a "morning-gift," which in the case of queens and princesses often took the form of considerable estates. There is no doubt that the marriages of heathen times were often of a kind which could not be permitted after the adoption of Christianity. Among these may be mentioned marriages with brothers' widows and stepmothers, the latter especially in England. Polygamy was known, but limited, both in early and late times, to persons of exceptionally high position, while of polyandry there is hardly any trace. Indeed, the sanctity attached to marriage seems to have struck the Romans as remarkable. On the other hand strife between persons connected by marriage appears to have been of extremely frequent occurrence, and no motive plays a more prominent part in Teutonic traditions.

4. *State of Civilization.*—It is a much disputed question whether the Teutonic peoples were really settled agricultural communities at the time when they first came into contact with the Romans, shortly before the beginning of our era. That agriculture of some kind was practised is clear enough from Caesar's account, and Strabo's statement to the contrary must be attributed to ignorance or exaggeration. But Caesar himself seems to have regarded the Germani as essentially pastoral peoples and their agriculture as of quite secondary importance, while from Tacitus we gather that even in his time it was of a somewhat primitive character. For not only was the husbandry co-operative, as in much later times, but apparently the ploughlands were changed from year to year without any recognition of a two-course or three-course system. Caesar, moreover, says that the clans or kindreds to whom the lands were allotted changed their abodes also from year to year—a statement which gives a certain amount of colour to Strabo's description of the Germani as quasi-nomadic. Yet there is good reason for believing that this representation of early Teutonic life was by no means universally true. We have evidence, both archaeological and linguistic, that the cultivation of cereals in Teutonic lands goes back to a very remote period, while the antiquity even of the ox-plough is attested by the rock-carvings at Tegneby in Bohuslän (Sweden), which are believed to date from early in the bronze age. Further, that the tribes were not normally of a migratory character, as Strabo seems to imply, is shown by the existence of sanctuaries of immemorial age and by frontier ramparts such as that raised by the Angrivarii against the Cherusci. It would seem that Julius Caesar encountered the Germani under somewhat abnormal conditions. Several of the tribes with which he came into collision had been expelled from their own territories by other tribes, and we are expressly told that Ariovistus's troops had not entered a house for fourteen years. Further, there is satisfactory evidence that the basin of the Rhine, perhaps also a considerable area beyond, had been conquered from Celtic peoples not very long before—from which it is probable that western Germany was still in a more or less unsettled condition. Indeed Caesar himself seems to have regarded the prevalence of the military spirit as the chief hindrance to the development of agriculture. From this time onwards it was from the west mainly that Roman civilization made its way into Germany; but in earlier ages, as we have already noticed, there are more abundant traces of civilization in the basin of the Elbe than in the districts farther to the west. Hence it is not so surprising as might at first sight appear that the remote Aestii, a non-Teutonic people settled about the mouth of the Vistula, are represented by Tacitus as keener agriculturists than any of the other inhabitants of Germany.

All ancient writers emphasize the essentially warlike character of the Germani. Yet Tacitus seems to represent their military equipment as being of a somewhat primitive type. Swords, helmets and coats of mail, he says, were seldom to be seen; in general they were armed only with huge shields, unwieldy spears and darts. Here again he appears to be thinking of the western tribes; for elsewhere he states that some of the eastern peoples were armed with short swords and round shields—which probably were of comparatively small size, like those used in later times. This latter type of equipment prevailed also in the North, as may be seen, *e.g.* from the figures of warriors on the inscribed golden horn found at Gallehus (Jutland) in 1734. The favourite method of attack was by a wedge formation (known later in the North as *svínfylking*), the point being formed by a chosen band of young warriors. Certain tribes, such as the Tencteri, were famous for their horsemen, but the Germani in general preferred to fight on foot. Sometimes also we hear of specially trained forces in which the two arms were combined. Naval warfare is seldom mentioned. The art of sailing seems to have been unknown, and it is probable that down to the 3rd century the only peoples which could truly be described as seafaring were those of the Baltic and the Cattegat.

There is no doubt that Roman influence brought about a considerable advance in civilization during the early centuries of our era. The cultivation of vegetables and fruit trees seems to have been practically unknown before this period, and almost all their names testify to the source from which they were derived. We may notice also the introduction of the mill in place of the quern which hitherto had been in universal use. In all such cases the tribes subject to the Romans, in the neighbourhood of the Rhine, were probably the chief channel by which Roman influence made its way, though account must also be taken of the fact that considerable numbers of warriors from remoter districts were attracted to serve in the Roman armies. Great improvements took place likewise in armour and weapons; the equipment of the warriors whose relics have been found in the Schleswig bog-deposits, dating from the 4th and 5th centuries, appears to have been vastly superior to that which Tacitus represents as normal among the Germani of his day. Yet the types, both in armour and dress, remained essentially Teutonic—or rather Celtic-Teutonic. Indeed, when in the course of time uniformity came to prevail over the greater part of Europe, it was the Teutonic rather than the Roman fashions which were generalized.

Writing. The antiquity of the art of writing among the Teutonic peoples is a question which has been much debated. Tacitus says that certain marks were inscribed on the divining chips, but it cannot be determined with certainty whether these were really letters or not. The national type of writing, generally known as Runic, must have been fully developed by the 4th century, when some of its letters were borrowed by Ulfilas (Wulfila) for his new alphabet (see GOTHS: § C.). Indeed, by this time it was probably known to most of the Teutonic peoples, for several of the inscriptions found in Jutland and the islands of the Belt can hardly be of later date. As to the source from which it was derived opinions still differ, some thinking that it was borrowed from the Romans a century or two before this time, while others place its origin much farther back and trace it to one of the ancient Greek alphabets. Many of the earliest inscriptions read from right to left, and the *βουστροφηδόν* type is also met with occasionally. It is clear both from literary and linguistic evidence that the character was chiefly used for writing on wood, but the inscriptions which have survived are naturally for the most part on metal objects—in Sweden, Norway and England also on monumental stones. In Germany very few Runic inscriptions have been found, and there is nothing to show that the alphabet was used after the 8th century. In England also it seems not to have lasted much longer, but inscriptions are far more numerous. On the other hand, in Scandinavian countries it continued in use through the greater part of the middle ages—in Gotland till the 16th century; indeed, the knowledge of it seems never to have wholly died out. In the course of time, however, it underwent many changes, and the earliest inscriptions must have been unintelligible for over a thousand years until they were deciphered by scholars within the last half century. The Roman alphabet first came into use among the western and northern Teutonic peoples after their adoption of Christianity.

5. *Funeral Customs.*—Icelandic writers of the 12th and 13th centuries distinguished between an earlier "age of burning" and a later "age of barrows," and the investigations of modern archaeologists have tended in general to confirm the distinction, though they have revealed also the burial-places of times antecedent to the age of burning. Throughout the stone age inhumation appears to have been universal, many of the neolithic tombs being chambers of considerable size and constructed with massive blocks of stone. Cremation makes its appearance first in the earlier part of the bronze age, and in the latter part of that age practically displaces the older rite. In the early iron age there is less uniformity, some districts apparently favouring cremation and others inhumation. The former practice is the one recognized by Tacitus. In the national migration period, however, it fell into disuse among most of the continental Teutonic peoples, even before their conversion, though it seems to have been still practised by the Heruli in the 5th century and by the Old Saxons probably till a much later period. It came into Britain with the Anglo-Saxon invaders and continued in use in certain districts perhaps until nearly the close of the 6th century. In Scandinavian lands the change noted by Icelandic writers may be dated about the 5th and 6th centuries, though inhumation was certainly not altogether unknown before that time. After the 6th century cremation seems not to have been common, if we may trust the sagas, but isolated instances occur as late as the 10th century. It is to be observed that cremation and the use of the barrow are not mutually exclusive, for cremated remains, generally in urns, are often found in barrows. On the other hand inhumation below the surface of the ground, without perceptible trace of a barrow, seems to have been the most usual practice during the national migration period, both in England and on the continent. A special form of funeral rite peculiar to the North was that of cremation on a ship. Generally the ship was drawn up on land; but occasionally we hear, in legendary sagas, of the burning ship being sent out to sea. Large ships containing human remains have sometimes been found in barrows of the viking age. Arms and ornaments are frequently met with, sometimes also horses and human remains which may be those of slaves, the belief being that the dead would have all that was buried with him at his service in the life beyond. Usage, however, seems to have varied a good deal in this respect at different times and in different districts.

6. *Religion.*—The conversion of the Teutonic peoples to Christianity was a gradual process, covering some seven centuries. The first to accept the new religion seem to have been the Goths, beginning about the middle of the 4th century, and the Vandals must have followed their example very quickly. In the course of the 5th century it spread to several other nations, including the Gepidae, Burgundians, Rugii and Langobardi. In all these cases the Arian form of Christianity was the one first adopted. The first conversion to the Catholic form was that of the Franks at the end of the 5th century. The extension of Frankish supremacy over the neighbouring Teutonic peoples brought about the adoption of Christianity by them also, partly under compulsion, the last to be converted being the Old Saxons, in the latter half of the 8th century. The conversion of England began in 597 and was complete in less than a century. In the north, after several attempts during the 9th century which met with only temporary success, Christianity was established in Denmark under Harold Bluetooth, about 940–960, and in Norway and Sweden before the end of the century, while in Iceland it obtained public recognition in the year 1000. Many districts in Norway, however, remained heathen until the reign of St Olaf (1014–1028), and in Sweden for half a century later.

The subsequent religious history of the various Teutonic peoples will be found elsewhere. Here we are concerned only with the beliefs and forms of worship which prevailed before the adoption of Christianity. For our knowledge of this subject we are indebted chiefly to Icelandic literary men of the 12th and 13th centuries, who gave accounts of many legends which had come down to them by oral tradition, besides committing to writing a number of ancient poems. Unfortunately Icelandic history is quite unique in this respect. In the literatures of other Teutonic countries we have only occasional references to the religious rites of heathen times, and these are generally in no way comparable to the detailed accounts given in Icelandic writings. Hence it is often difficult to decide whether a given rite or legend which is mentioned only in Icelandic literature was really peculiar to that country alone or to the North generally, or whether it was once the common property of all Teutonic peoples.

A number of gods were certainly known both in England and among many, if not all, the Teutonic peoples of the continent, as well as in the North. Among these were Odin (Woden), Thor (Thunor) and Týr (Ti); so also Frigg (Frig), the wife of Odin (see FRIGG, ODIN, WODEN, THOR, TÝR). Some scholars have thought that Balder, the son of Odin, was once known in Germany, but the evidence is at least doubtful. Heimdallr, the watchman of the gods and Ullr, the stepson of Thor, as well as Hoenir, Bragi and most of the other less prominent gods.

were also probably peculiar to the North, though Ullr at least was known in Denmark. Some of these deities may originally have been quite local. Indeed, such may very well have been the case with Frey, the chief god of the North after Thor and Odin. Tradition at all events uniformly points to Upsala as the original home of his cult. But it is probable that both he and his sister Freyia were really specialized forms of a divinity which had once been more widely known. Their father, Niörðr, the god of wealth, who is a somewhat less important figure, corresponds in name to the goddess Nerthus (Hertha), who in ancient times was worshipped by a number of tribes, including the Angli, round the coasts of the southern Baltic. Tacitus describes her as "Mother Earth," and the account which he gives of her cult bears a somewhat remarkable resemblance to the ceremonies associated in later times with Frey. This family of deities were collectively known as Vanir, and are said to have once been hostile to the Aesir, to whom Odin belonged. Their worship was generally connected with peace and plenty, just as that of Odin was chiefly bound up with war. Gefion was another goddess who may represent a later form of Nerthus. In her case tradition points distinctly to a connexion with Denmark (Sjaelland). On the other hand, the portraiture of Skaði, the wife of Niörðr, seems to point to a Finnish or Lappish origin. The rest of the northern goddesses are comparatively unimportant, and only one of them, Fulla, the handmaid of Frigg, seems to have been known on the continent.

Some of the deities known to us from German and English sources seem also to have been of a local or tribal character. Such doubtless was Fosite, to whom Heligoland was sacred. Saxnot (Seaxneat), from whom the kings of Essex claimed descent, was probably a god of the Saxons. Holda, who is known only from the folklore of later times, appears to have been a German counterpart of Nerthus. Ing, who is connected with Denmark in Anglo-Saxon tradition, was in all probability the eponymous ancestor of the Inguaeones (see above). His name connects him, too, with the god Frey, who was also called Yngvifreyr and Ingunarfreyr, and he must at one time have been closely associated with Nerthus. The relationship of Ing to the Inguaeones is paralleled by that of Irmin to the Hermiones (see above). He may be the deity whom Tacitus called "Hercules."

Some of these eponymous ancestors may be regarded as heroes rather than gods, and classed with such persons, as Skiöldr, the eponymous ancestor of the Danish royal family, who is not generally included in the Northern pantheon. But the line of division between the human and the divine is not very definite. The royal family of Norway claimed descent from Frey, and many royal families, both English and Northern, from Woden (Odin). Indeed, several legendary kings are described as sons of the latter. Sometimes, again, the relationship is of a conjugal character. Skiöldr, though hardly a god himself, is the husband of the goddess Gefion. So we find Freyia's priest described as her husband and Frey's priestess as his wife, and there is no reason for regarding such cases as exceptional.

If it is not always easy to distinguish between gods and heroes, there is still greater difficulty in drawing a line between the former and other classes of supernatural beings, such as the "giants" (O.N. *iötnar*, A.S. *eotenas*). Here again we have intermarriage. Skaði, the wife of Niörðr, and Gerðr, the wife of Frey, were the daughters of the giants Thiazi and Gymir respectively, though Skaði is always reckoned as a goddess. Loki also was of giant birth; but he is always reckoned among the gods, and we find him constantly in their company, in spite of his malevolent disposition. In general it may be said that the giants were regarded as hostile to both gods and men. Often they are represented as living a primitive life in caves and desolate places, and their character is usually ferocious. But there are exceptions even among the male giants, such as Aegir, whom we find on friendly terms with the gods. It is worth noting also that some of the leading families of Norway are said to have claimed descent from giants, especially from Thrymr, the chief opponent of Thor. In such cases there may be some connexion between the giants and the semi-civilized (Finnish or Lappish) communities of the mountainous districts. This connexion is more clear in the case of Thórgerðr Hölgabrúðr, who is known chiefly from the extreme veneration paid to her by Haakon, earl of Lade (+995). According to one story she was the daughter of Hölgi, the eponymous king of Halogaland (northern Norway); according to another she was the wife of Hölgi and daughter of Gusi, king of the Fins. She ought perhaps to be regarded rather as a goddess than as a giantess, but she is never associated with the other deities.

Another class of supernatural beings was that of the dwarfs. They were distinguished chiefly for their cunning and for skill in working metals. More important than these from a religious point of view were the elves (O.N. *alfar*, A.S. *ylfe*), who certainly received worship, at all events in the North. They are almost always spoken of collectively and generally represented as beneficent. In some respects, *e.g.* in the fact that they are often said to inhabit barrows, they seem to be connected with the souls of the dead. In other cases, however, they are hardly to be distinguished from spirits (the Icel. *landvaettir*, &c.), which may be regarded as *genii locorum*.

In addition to the above there were yet other classes of supernatural beings (see NORNS and VALKYRIES). Mention, however, must be made here of the *fylgiur* and *hamingiur* of Northern belief. These are of two kinds, though the names seem not always to be clearly distinguished. Sometimes the *fylgia* is represented as a kind of attendant spirit, belonging to each individual person. It may be seen, generally in animal form, in visions or by persons of second sight, but to see one's own *fylgia* is a sign of impending death. In other cases the *fylgiur* (or perhaps more correctly the *hamingiur*) apparently belong to the whole family. These generally appear in the form of maidens.

Human beings, especially kings and other distinguished persons, were not infrequently honoured with worship after death. In Sweden during the 9th century we have trustworthy record of the formal deification of a dead king and of the erection of a temple in his honour. In general the dead were believed to retain their faculties to a certain extent in or near the place where they were buried, and stories are told of the resistance offered by them to tomb-robbers. It would seem, moreover, that they were credited with the power of helping their friends (and likewise of injuring other people) very much in the same way as they had done in life. Hence the possession of the remains of a chief who had been both popular and prosperous was regarded as highly desirable.

The blessings which kings were expected to bestow upon their subjects, in life as well as after death, were partly of a supernatural character. Chief among them was that of securing the fertility of the crops. The prevalence of famine among the Swedes was attributed to the king's remissness in performing sacrificial functions; and on more than one occasion kings are said to have been put to death for this reason. Under similar circumstances Burgundian kings were deposed. In connexion with this attribution of superhuman powers, we may mention also the widespread belief that certain persons had the faculty of "changing shape," and especially of assuming the forms of animals.

Besides the various classes of beings to the worship of which we have already referred, we hear occasionally also of sacred animals. Tacitus tells of horses consecrated to the service of the gods, and of omens drawn from them, and we meet again with such horses in Norway nearly a thousand years later. In the same country we find the legend of a king who worshipped a cow. Besides the anthropomorphic "giants," mentioned above, Northern mythology speaks also of theriomorphic demons, the chief of which were Midgarðsormr, the "world-serpent," and Fenrisulfr, a monster wolf, the enemies of Thor and Odin respectively. These beings are doubtless due in part to poetic imagination, but underlying this there may be a substratum of primitive religious belief. In contrast with later Scandinavian usage Tacitus states that the ancient Germans had no images of the gods. But he does speak of certain sacred symbols which he defines elsewhere as figures of wild beasts. One of the chief objects of veneration among the Cimbri is said to have been a brazen bull.

Figures of animals, however, were not the only inanimate things regarded in this way. The Quadi are said to have considered their swords divine. More important than this was the worship paid, especially in the North, to rocks and stone cairns, while springs and pools also were frequently regarded as sacred in all Teutonic lands. But, on the whole, there is perhaps no characteristic of Teutonic religion, both in early and later times, more prominent than the sanctity attached to certain trees and groves, though it is true that in such cases there is often a doubt as to whether the tree itself was worshipped or whether it was regarded as the abode of a god or spirit. The sanctuaries mentioned by Tacitus seem always to have been groves, and in later times we have references to such places in all Teutonic lands. One of the most famous was that in or beside which stood the great temple of Upsala. Here also must be mentioned the Swedish Vårdträd or "guardian tree," which down to our own time is supposed to grant protection and prosperity to the household to which it belongs. One of the most striking conceptions of Northern mythology is that of the "world-tree," Yggdrasil's Ash, which sheltered all living beings (see Yggdrasil). The description given of it recalls in many respects that of a particularly holy tree which stood beside the temple at Upsala. For the idea we may compare the Irminsul, a great wooden pillar which appears to have been the chief object of worship among the Old Saxons, and which is described as "universalis columna quasi sustinens omnia."

The Northern sanctuaries of later times were generally buildings constructed of wood or other materials. A space apparently partitioned off contained figures of Thor or Frey and perhaps other gods, together with an altar on which burned a perpetual fire. In the main body of the temple were held the sacrificial feasts. The presiding priest seems always to have been the chief to whom the temple belonged, for there is no evidence for the existence of a special priestly class in the North. In England, however, the case was otherwise; we are told that the priests were never allowed to bear arms. There is record also of priests among the Burgundians and Goths, while in Tacitus's time they appear to have held a very prominent position in German society. Among all Teutonic peoples from the time of the Cimbri onwards we frequently hear also of holy women whose duties were concerned chiefly with divination. Sometimes, indeed, as in the case of Veleda, a prophetess of the Bructeri, during Vespasian's reign, they were regarded practically as deities. After the adoption of Christianity, and possibly to a certain extent even before, such persons came to be regarded with disfavour—whence the persecutions for witchcraft—but it is clear from Tacitus's works and other sources that their influence in early times must have been very great. In the North the sanctuaries called *hörgar* seem to have been usually under the charge of the wives and daughters of the household. But there is some evidence also for the existence of special priestesses at certain sanctuaries.

Of religious ceremonies the most important was sacrifice. The victims were of various kinds. Those offered to Odin (Woden) were generally, if not always, men, from the time of Tacitus onwards. Human sacrifices to Thor and the other gods are not often mentioned. Of animals, which were consumed at the sacrificial banquets, we hear chiefly of horses, but also of oxen and boars. At human sacrifices, however, dogs and hawks were often offered with the men. At all sacrifices it seems to have been customary to practise divination; in connexion with human sacrifice we have record of this rite from the time of the Cimbri. One barbarous custom which was regarded as a sacrifice was the dedication of an enemy's army to the gods, especially Odin. This custom, which is likewise known to have prevailed from the earliest times, involved the total destruction of the defeated army, together with everything belonging to them. In general the chief sacrificial festivals seem to have taken place at fixed times in the year, one in early or mid-autumn, another at mid-winter and a third during the spring. Sacrifices on an exceptionally large scale were held at Upsala and Leire every nine years, at the former place about the time of the spring equinox, at the latter in the early part of January. Besides these fixed festivals sacrifices could of course be offered in all time of public or private need. In the latter case resort was very frequently had also to sorcery and necromancy.

Mention has been made above of the belief that the dead retained a conscious existence in or near the place where they were buried, and that they were able to confer blessings upon their friends. Beside this belief, however, we find another which seems hardly to be compatible with it, viz., that the souls of the dead passed to the realm of Hel, who in Northern mythology is represented as the daughter of Loki. Again, those who had fallen in battle were supposed to go to Valhalla, where they became warriors in Odin's service. This last belief seems to have been connected at one time with the practice of cremation. In conclusion it must be mentioned that even the life of the gods was not to be for ever. A day was to come when Odin and Thor would fall in conflict with the wolf and the world-serpent, when the abode of the gods would be destroyed by fire and the earth sink into the sea. But the destruction was not to be final; in the future the gods of a younger generation would govern a better world. How far these beliefs were common to the Teutonic peoples as a whole cannot be determined with certainty. Some scholars hold that they were peculiar to the mythology of Norway and Iceland and that they arose at a late period, largely through Christian influence. But a serious objection to this view is presented by the fact that very similar ideas in some respects were current among the ancient Gauls.

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(*b*) *History and Ethnography.* K. Zeuss, *Die Deutschen und die Nachbarstämme* (Munich, 1837); K. Müllenhoff, *Deutsche Altertumskunde* (Berlin, 1870–1900); H. d'Arbois de Jubainville, *Les Premiers Habitants de l'Europe* (Paris, 1889–94); O. Bremer, "Ethnographie d. germ. Stämme" in H. Paul's *Grundriss d. germ. Philologie*, 2nd ed., vol. iii. (Strassburg, 1900); H. M. Chadwick, *The Origin of the English Nation* (Cambridge, 1907); G. Schütte, *Oldsagn om Godtjod* (Copenhagen, 1907); *Germanische Ethnographie.* See also Alamanni, Angli, Britain (Anglo-Saxon), Chatti, Cherusci, Cimbri, Denmark, Franks, Frisians, Germany (Ethnography and Early History), Goths, Heruli, Lombards, Netherlands, Norway, Saxons, Suebi, Sweden, Teutoni, Vandals.

(*c*) *Government, Social Organization and State of Civilization.* J. Grimm, *Rechtsaltertümer* (1828, 4th ed., Leipzig, 1899); F. Dahn, *Die Könige d. Germanen* (Munich, 1861–1905); G. Waitz, *Deutsche Verfassungsgeschichte* (Kiel, 1860; 3rd ed. 1880); M. Brunner, *Deutsche Rechtsgeschichte* (Leipzig, 1887); K. Weinhold, *Deutsche Frauen* (Vienna, 1851; 2nd ed. 1882); *Altnordisches Leben* (Berlin, 1856); R. Keyser, *Efterladte Skrifter* (ii. 1, 2, Christiania, 1867); A. Meitzen, *Siedelung u. Agrarwesen* (Berlin, 1895); F. B. Gummere, *Germanic Origins* (New York, 1892); K. Th. von Inama-Sternegg, K. von Amira, V. Gudmundsson and Kr. Kalund, articles

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(*d*) *Religion.* J. Grimm, *Deutsche Mythologie* (1st ed. 1835, 4th ed. Berlin, 1878); *Teutonic Mythology* (trans. by J. S. Stallybrass, London, 1883); K. Maurer, *Die Bekehrung des norwegischen Stammes zum Christentum* (Munich, 1855–56); W. Mannhardt, *Der Baumkultus der Germanen u. ihrer Nachbarstämme* (Berlin, 1875); H. Petersen, *Om Nordboernes Gudedyrkelse og Gudetro i Hedenold* (Copenhagen, 1876); H. Pfannenschmid, *Germanische Erntefeste* (Hanover, 1878); V. Jahn, *Die deutschen Opfergebräuche* (Breslau, 1884); E. H. Meyer, *Germanische Mythologie* (Berlin, 1891); W. Golther, *Handbuch d. germ. Mythologie* (Leipzig, 1895); P. Herrmann, *Deutsche Mythologie* (Leipzig, 1898); *Nordische Mythologie* (Leipzig, 1903); H. M. Chadwick, *The Cult of Othin* (Cambridge, 1899); E. Mogk, "Mythologie" in Paul's *Grundriss d. germ. Phil.* (vol. iii., see above); P. D. Chantepie de la Saussaye, *Geschiednis van den Godsdienst der Germanen* (Haarlem, 1900); *The Religion of the Teutons* (Boston, 1902); F. Kauffmann, *Balder: Mythus u. Sage* (Strassburg, 1902); E. H. Meyer, *Mythologie der Germanen* (Strassburg, 1903). (H. M. C.)

TEVIOT, ANDREW RUTHERFORD, Earl of (d. 1664), was the son of William Rutherford of Quarrelholes, Roxburghshire. His education was received in Edinburgh, and he took up the career of soldier of fortune. His services were given to the French government, which maintained regiments of Scottish mercenaries. On the restoration of Charles II., Rutherford was taken into employment by his own king on the recommendation of Louis XIV. of France. He had held a commission as lieutenant-general in France and had a high reputation for personal courage. Charles II. gave him the Scottish title of Lord Rutherford and the governorship of Dunkirk, which had been acquired by the Protector Oliver Cromwell. When Charles II. sold the town to France in 1662 Rutherford was consoled by the command of the 2nd or Tangier regiment, was made earl of Teviot in the peerage of Scotland, and was sent in 1663 as governor to Tangier. His tenure of office was very short, for on the 4th of May 1664 he allowed himself to be entrapped into an ambush by the Moors, who carried on incessant irregular warfare against the English garrison, and was killed, together with nineteen officers and nearly five hundred men of his garrison.

See W. F. Lord, *The Lost Possessions of England* (London, 1896).

TEVIOTDALE, the valley of the Teviot, Roxburghshire, Scotland. In a limited sense the word describes the stretch above Hawick (9 m.) and, in a wider sense, the whole vale, extending in a north-easterly direction from Teviothead nearly to the confines of the parish of Roxburgh, a distance of 23 m. It is sometimes incorrectly used as an alternative name for the shire, much of the area of which, in point of fact, lies outside the Teviot drainage basin. There are numerous points of interest in the dale. Henry Scott Riddell (1798–1870), the poet, was buried at Teviothead. Almost side by side in the churchyard are the obelisk near his grave and the memorial stone erected in the cemetery wall to John Armstrong of Gilnockie, the celebrated freebooter, who, along with several followers, was treacherously seized in 1530 and hanged at Caerlanrigg, in the immediate vicinity, by order of James V. Riddell is further commemorated by a monument on Dryden hill. Branxholm tower, the peel of Goldielands, and Harden castle (on Harden burn, a tributary of Northwick water) are spots familiar through the writings of Sir Walter Scott and many Border ballads. Five m. to the east of Hawick stands the hill of Ruberslaw (1392 ft.). Among the crags on its summit is the rock, still called "Peden's chair," from which Alexander Peden preached to conventicles of Covenanters. Below Hawick interest principally centres around Minto, Hassendean—the Hazeldean of Sir Walter Scott's song, "Jock o' Hazeldean"—and Ancrum.

TEWFIK PASHA (1852–1892), khedive of Egypt, son of the Khedive Ismail, was born on the 15th of November 1852. His mother was a fellah woman. Although the eldest son, he was not sent to Europe to be educated, like his younger brothers, but was left to grow up in his native country. In 1866 Ismail succeeded in his endeavour to alter the order of succession to the khediviate. The title, instead of passing to the eldest living male descendant of Mehemet Ali, was now to descend from father to son. Ismail sought this alteration mainly because he disliked his uncle, Halim Pasha, who was his heir-presumptive, and he is supposed to have imagined that he would be able to select whichever of his sons he pleased for his successor. But he found, after the change had been made, that the powers interpreted the new arrangement as applying strictly to the eldest son. Tewfik therefore became heir-apparent. He was given a palace near Cairo to live in, and for twelve years he passed an uneventful life, farming, and establishing a reputation for good sense and fair dealing with his fellah tenants. In 1878 he was appointed president of the council after the dismissal of Nubar Pasha. He held this office only for a few months; but this was long enough to show that, if he was unambitious and not particularly intelligent or energetic, he had the wisdom to refrain from taking a part in the intrigues which then formed the chief part of political life in Egypt. He went back to his estate, and settled down once more to a quiet country life. He was not left undisturbed for long. On the 26th of June 1879 Ismail, at the instance of Great Britain and France, was deposed by the sultan, who sent orders at the same time that Tewfik should be proclaimed khedive. The new viceroy was so little pleased by the news of his accession that he soundly boxed the ears of the servant who first brought the tidings to him. Egypt at that time was involved in financial and political troubles brought about by the policy of Ismail (*q.v.*), and the situation was made worse by the inaction of England and France for some months following Tewfik's accession. Tewfik's people were dissatisfied, his army disaffected; his advisers were nearly all of the adventurer class, with their own ends to gain; and he himself had neither the character of a strong ruler nor the experience that would have enabled him to secure an orderly administration of affairs. Disorder prevailed until November 1879, when the dual control was re-established by the governments of Great Britain and France. For over two years Major Baring (afterwards Lord Cromer), Mr (afterwards Sir) Auckland Colvin, and M. de Blignières practically governed the country, endeavouring to institute reforms while possessing no means of coercion. During all this time the disaffection in the Egyptian army was increasing. Tewfik has been blamed for his failure to take a firm line with the rebels, but his attitude was governed by his relations with Great Britain and France, and he was unable to control events. The dissatisfaction culminated in the anti-foreign movement headed by Arabi Pasha (*q.v.*), who had gained complete command of the army. In July 1882 the attitude of Arabi, who was carrying out defensive works on a large scale, made it necessary for the British admiral (Sir Beauchamp Seymour, afterwards Lord Alcester) to declare that he would bombard the forts of Alexandria unless they were handed over to him. Before the bombardment began it was suggested to Tewfik that he should leave the city and embark either upon a man-of-war belonging to one of the neutral powers, or in his own yacht, or in a mail steamer which was then in the port. His answer was, "I am still khedive, and I remain with my people in the hour of their danger." At his palace of Ramleh, 3 m. from the town, he was beyond reach of the shells, but his life was nevertheless imperilled. When the rebel soldiers attacked the palace he managed to make his escape and to reach another palace after passing through the burning streets of Alexandria. Here he was obliged to agree that a guard of British bluejackets should protect him from further risk. He showed his courage equally during the cholera epidemic at Alexandria in 1883. He had gone back to Cairo after the battle of Tel-el-Kebir, had consented to the reforms insisted upon by Great Britain, and had assumed the position of a constitutional ruler under the guidance of Lord Dufferin, the British special commissioner. When the cholera broke out, he insisted upon going to Alexandria. His wife accompanied him, and he went round the hospitals, setting an excellent example to the authorities of the city, and encouraging the patients by kind and hopeful words. In 1884 Sir Evelyn Baring went back to Egypt as diplomatic agent and consul-general of Great Britain. His first task was to demand that Tewfik should abandon the Sudan. Tewfik gave his consent with natural reluctance, but, having consented, he did everything he could to ensure the success of the policy which Baring had been sent to carry out. He behaved with equal propriety during the negotiations between Sir H. Drummond Wolff and the Turkish envoy, Mukhtar Pasha, in 1886. His position was not a dignified one—that of a titular ruler compelled to stand by while others discussed and managed the affairs of his country. The sultan was his suzerain; in Great Britain he recognized his protector: to the representative of each he endeavoured to show friendliness and esteem. As time went on his confidence in Baring increased, until at last he deferred to the British agent in almost everything. On occasion, however, he acted on his own initiative, as when in June 1888 he dismissed Nubar Pasha and summoned Riaz Pasha to form a ministry—an action influenced, nevertheless, by Tewfik's knowledge of the divergence of views between Nubar and the British agent. Baring encouraged Tewfik to show his activity in matters of administration, and he took a great interest in all matters connected with irrigation, education and justice. He was not a particularly strong man either in mind or in character, but he showed a genuine desire to govern his country for its own benefit. He understood the importance to Egypt of British assistance and support; his natural shrewdness made him accept the British conditions; his natural good feeling kept him from any inclination to intrigue. In private life he was courteous and amiable. He had no desire to keep up the unapproachable state of an oriental ruler. Indeed, in many ways his manners and habits were less oriental than European. He married in 1873 his kinswoman, Amina Hanem, with whom he lived very happily. She was his only wife and Tewfik was a strong advocate of monogamy. He died on the 7th to January 1892, at the Heluan palace near Cairo, and was succeeded by his eldest son, Abbas II. (*q.v.*).

A warm tribute to Tewfik's many admirable qualities was paid by Baring (Lord Cromer) in his report on the administration of Egypt for 1891 (see *Egypt*, No. 3, 1892, pp. 1 and 2).

TEWKESBURY, a market town and municipal borough in the Tewkesbury parliamentary division of Gloucestershire, England, 15½ m. N.E. of Gloucester by the Midland railway. Pop. (1901) 5419. It lies in a flat pastoral district, with low hills to the south, on the Warwickshire Avon, close to its junction with the Severn. The Severn is crossed by an iron bridge with a flattened arch of 170 ft. span, erected by Telford in 1824. Of the great Benedictine abbey, one of the richest foundations in England, refounded and enlarged by Sir Robert Fitz-Hamon in the 12th century on the site of an ancient hermitage and Saxon monastery, there only remain the gate and a few other fragments. The abbey church, however, consecrated in 1125, is a magnificent specimen of early Norman. This elaborate cruciform building consists of nave and side aisles, with transepts united by a grand central tower richly arcaded. The choir terminates in an apse and is surrounded by an ambulatory. One of the most remarkable features of the building is the unique western front, the central part of which is occupied by one vast arch extending from the ground to the roof. Originally it was filled in with Norman windows, but a Perpendicular window now occupies the space. The whole building underwent restoration in the Decorated period, and of this style it is one of the finest existing examples. The Norman windows in the nave were replaced, and stone groining was substituted for the carved wooden ceiling, a like transformation taking place in the transepts. The Norman columns in the choir still exist; but above them rises a grand superstructure of Decorated work. The elegant clerestory windows are of the 14th century, with stained glass of the same date. The ambulatory was rebuilt some distance farther out, and from it projected a beautiful series of chapels. The elaborate tombs include those of Sir Robert Fitz-Hamon, the De Spensers, Alan prior of Canterbury, Sir Guy de Brien, and the vault of George duke of Clarence (murdered in the Tower) and his wife Isabella. Edward, prince of Wales, slain after the battle of Tewkesbury (1471) by the Yorkists, is also buried in the church. Of the two organs, one, dating from the early 17th century, is of singularly beautiful tone. In the High Street there are several ancient timbered and gabled houses. Remains of an ancient wall have been discovered adjoining the town. There are a free grammar school (1625) and a number of charities and almshouses. Tewkesbury is chiefly dependent on its agricultural trade. Below the junction of the rivers there is a great lock and weir on the Severn, up to which the stream is sometimes reversed by the tidal bore. The borough is under a mayor, 4 aldermen and 12 councillors. Area, 2532 acres.

Remains of Roman encampments and roads prove that the earliest settlement near Tewkesbury (*Theotesburg*, *Theockesburia*, *Thooksburi*) of which we have evidence was a military encampment against the British. It was the site of a Saxon castle and monastery, and its position near navigable rivers led to the growth of a town, which was a borough with a market in 1087 when it was part of the royal domain. It was subsequently granted to Earl Robert of Gloucester, who granted a charter before 1107, which exempted the borough from certain tolls and from suit at the hundred court. Edward III. confirmed this charter in 1337, and made Tewkesbury free from tolls throughout England. The borough was incorporated by Elizabeth by a charter of 1574, which was confirmed in 1604, 1605, 1609 (when the manor and borough were sold to the corporation) and 1685, while the town was governed under the charter granted by William III. in 1698 until the corporation was remodelled in 1835, the modern government consisting of a mayor, 4 aldermen and 12 councillors. Tewkesbury returned two members from 1609 to 1867, when it lost one member, and in 1885 the representation was merged in that of the county. A fair on July 20 was granted in 1323, and fairs on September 21 and August 24 in 1440, and on April 25 in 1574. For the last May 3 was substituted in 1605, and two more fairs on June 11 and September 29 were granted in 1609. All these grants were confirmed by the charter of 1685. One fair only is now held, on October 10. It is a pleasure fair and a fair for hiring servants, and has lost the commercial importance of the early wool fairs. The long-existing provision trade along the four rivers declined through railway competition. Cloth-making lasted from the 11th century until the beginning of the 18th; gloving in the 17th century was followed by worsted-combing in the 18th. Cotton-thread lace-making, introduced in 1825, collapsed about 1862. Tewkesbury was once celebrated for the manufacture of mustard, which ceased to be important at the end of the 18th century. Stocking-frame knitting was the chief trade in 1830, but has been replaced by the boot and shoe trade. Tewkesbury was strategically important in the Wars of the Roses, and was the site of a battle in 1471, and in the Civil War was four times besieged.

See *Victoria County History, Gloucestershire*; James Bennet, *History of Tewkesbury* (1850); William Wyde, *History of Tewkesbury* (1798).

TEXARKANA, two adjoining cities forming one community, situated on either side of the boundary line between Arkansas and Texas, U.S.A., about 165 m. E. by N. of Dallas, Texas; Texarkana, county-seat of Miller county, Arkansas, pop. (1900) 4914, of whom 120 were foreign-born and 2078 were negroes; (1910) 5655; Texarkana, Bowie county, Texas, pop. (1900) 5256, of whom 192 were foreign-born and 1964 were negroes; (1910) 9790. Texarkana is served by the Kansas City Southern (Port Arthur Route), the Texas & Pacific (of which it is the eastern terminus), the St Louis, Iron Mountain & Southern (Iron Mountain Route, the southern terminus), and the St Louis South-Western (Cotton Belt Route) railways. The public buildings are two city halls, a well-designed Post Office, which stands on the state line and serves both cities, a county court house (on the Arkansas side), and a Federal court building (on the Texas side). The chief trade is in lumber (especially hard woods, such as white oak and ash), cotton, cotton-seed oil and hides. Natural gas is piped here from the Caddo gas-fields, about 48 m. S., in Louisiana. The first permanent settlement here was made in 1874; Texarkana, Texas, was incorporated in 1875, and Texarkana, Arkansas, in 1881.

TEXAS, a south central state of the United States of America, extending from lat. 26° 51′ N. to lat. 36° 39′ N. and from long. 93° 30′ W. to long. 106° 30′ W. A western projection is bounded N. by New Mexico, but the main portion of the state is bounded N. by Oklahoma, from which it is separated in part by the Red river; a northern projection (the Panhandle) is bounded E. by Oklahoma, but the main portion is bounded E. by Arkansas and Louisiana, the Sabine river separating it in part from Louisiana; on the S.E. the state is bounded by the Gulf of Mexico; on the S.W. by Mexico, from which it is separated by the Rio Grande; on the W. by New Mexico. Texas is much the largest state in the Union. Its length and breadth are nearly equal—about 750 m.—and its area is 262,398 sq. m., of which 3498 sq. m. are water surface.

Physical Features.—Texas is crossed by four physiographic provinces. In the S.E. are the West Gulf Plains, a part of the Coastal Plain province. Thence westward to the 100th meridian are the prairies, the south-westward extension of the Prairie Plain province. The Great Plains (really a plateau) comprise the W. half of the state, except a mountainous area in the W. part of the Panhandle, which belongs to the Basin Range province. The surface is principally a series of plains sloping S.E. from the high plateau or from the mountains in the W. to the low shore of the Gulf of Mexico. The mountains of the Basin Range region, known in Texas as the Trans-Pecos Province, rise in Guadalupe Peak near the border of New Mexico, to nearly 9000 ft. (the greatest elevation in the state), and the Great Plains have a maximum elevation in northern Texas exceeding 4000 ft., but from these heights the surface descends to sea level and the mean elevation of the state is about 1700 ft. The Gulf Plains have a coast line of about 400 m., and are bordered along the Gulf of Mexico by a series of long narrow islands and peninsulas, or sandbars, which have been formed by the waves breaking on the shelving shore. Padre, the longest of these islands, extends northward from the mouth of the Rio Grande more than 100 m. Back of the islands are the quiet waters of lagoons, and at the mouths of rivers are several shallow bays indenting the mainland; these bays were formed by only a slight subsidence of the land and the rivers are filling them with deposits of silt. For 20 m. or more inland in the N. and for 50 m. inland in the S. the Gulf Plains are low and flat, seldom rising as much as 100 ft. above the sea, but farther W. the surface is more broken and rises to a maximum elevation of about 700 ft. Along a line drawn approximately S.S.W. from the S.E. corner of Oklahoma, the N.W. part of the Gulf Plains merges with the Prairie Plains. The N.E. portion of the Texas Prairie Plains is only gently rolling, but the S. portion is quite rugged, and the W. half rises in a succession of scarps or steps to an elevation of 2500 ft., to the Great Plains region, which extends westward past the valley of the Pecos river. One of the scarps or steps is the result of a great fault or displacement of the earth's crust, and is known as the Balcones fault scarp; others are due to erosion and weathering of alternate layers of hard and soft rocks lying almost horizontal. South of the parallel of the S. boundary of New Mexico the Great Plains province is known as the Edwards Plateau; between the Edwards Plateau and the valley of the Canadian river, as the Llano Estacado, or Staked Plains; and N. of the Canadian Valley, as the North Plains. The E. and S. parts of the Edwards Plateau and the E. margin of the Llano Estacado have been much dissected by headward erosion of streams, but the central portion of the Edwards Plateau and nearly all of the Llano Estacado have a notably even surface rising slowly to the north-westward. In the S.E. corner of the Trans-Pecos Province is a smaller plain known as the Stockton Plateau, but the remaining portion of this province is traversed from N.E. to S.W. by isolated mountain ranges of the Basin Range or block mountain type.

The N. portion of the Panhandle is drained by the Canadian river eastward into the Arkansas. The S. portion of the Panhandle and a strip along the N. border of the state, E. of the Panhandle, is drained by the Red river south-eastward into the Mississippi. The rest of the state is drained S.E. directly into the Gulf of Mexico. The Rio Grande and its principal tributary, the Pecos, drain narrow basins in the S.W.; these two rivers and the Canadian river rise in the Rocky Mountains in Colorado and New Mexico, but all the other rivers by which the state is drained rise within its borders. The Red, the Brazos, the Colorado, the Guadalupe, and the Nueces rise on the E. or S.E. border of the Great Plains; the Sabine and the Trinity, on the Prairie Plains; and numerous small streams, on the Coastal Plain. In the Great Plains region and in the Trans-Pecos Province the rivers have cut deep canyons, and the character of the longer rivers in their upper courses varies from mere rivulets late in summer to swift and powerful streams during spring freshets. Most of the large Texas rivers have deposited great quantities of silt along their lower courses on the Coastal Plain, where the current is often sluggish and the banks are periodically overflowed. Texas has no large lakes; but freshwater lakes, which are fed either by streams or springs, are common on the Coastal Plain; the best known of them are Grand Lake in Colorado county, Clear Lake in Harris county, and Caddo Lake on the Louisiana border. On the Llano Estacado there are both freshwater and salt lakes, and there are a few salt lakes in the Trans-Pecos Province and near the mouth of the Rio Grande on the Coastal Plain.

The Texas Cretaceous is notably rich in the fossil remains of an invertebrate fauna and in the vicinity of Waco Cretaceous fossils of vertebrates have been obtained. Fossils of both vertebrates and invertebrates are also common in the Permian and Jurassic formations.

Fauna.—The varied fauna and flora of Texas may be classified in the following life-zones: the Canadian zone, on the highest parts of the Davis Mountains; the Transition zone, including high parts of the Davis, Chisos and Guadalupe mountains; the Upper Austral zone, Upper Sonoran division, in the Panhandle, E. of the Pecos Valley, and in the Staked Plain and Edwards Plateau; and the widely extending Lower Austral zone, covering most of the state and subdivided into the Lower Sonoran or arid western part, the Austroriparian, or humid eastern, and the narrow Gulf Strip, which is semi-tropical. Originally great herds of bison roamed over the Texas plains, and deer, bears and wolves were numerous, especially in the forests. Only a few of the larger wild animals remain, but the Texas fauna is still varied, for it includes not only many species common to northern and eastern United States but also several Mexican species. The few remaining bison are on a ranch near Goodnight, in Armstrong county, where they have been crossed with polled Angus cattle. White-tailed, Sonora, and grey mule-deer (*Odocoileus*) are found in the south-western counties; and there are a few antelope (*Antilocapra Americana*) in the west. Louisiana bears (*Ursus luteolus*) still inhabit the inaccessible canebrakes near the coast, and occasionally one is found farther west; and in the western mountains black (and cinnamon) bears, including the New Mexico black bear (*Ursus Americanus amblyceps*) still are found. Coyotes or prairie wolves (of which there is a local sub-species, *Canis nebracensis texensis*), grey wolves, prairie dogs (gophers), and jack rabbits are common on the plains; less common are the grey wolf or lobo (*Canis griseus*) and the timber wolf; and there are several species of foxes, including the swift. Cottontail rabbits, raccoons (including the Mexican variety), and squirrels are common in the forests. A few otters, beavers and minks are still found in eastern Texas. Opossums and skunks (several varieties of the *Mephitis* and several of the *Spilogale*, including *S. interrupta*, the prairie spotted skunk or "hydrophobia cat") are found in nearly all parts of the state. The peccary (*Tayassu angulatum*), the armadillo (*Tatu novemcinctum*), the civet-cat (*Bassariscus astutus flavus*), the Mexican bighorn (*Ovis mexicanus*) and the jaguar are Mexican species found in southern or south-western Texas. The Mexican cougar (*Felis hippolestes aztecus*) is found in the west. Other felines are the ocelot (*F. pardalis limitis*) and red and grey cats (*F. cacomitli*) in the south, the Texan lynx (*Lynx rufus texensis*) in the south-east, and the plateau wild cat (*L. baileyi*) in the west. There are several varieties of grasshopper mice (*Orychomys*), white-footed mice (*Peromyscus*), harvest mice (*Reithrodontomys*), rice-rats (*Oryzomys*), wood-rats (*Neotoma*), voles (*Microtus*), &c. Bats inhabit caves in Burnet, Williamson, Lampasas, Gillespie and other counties. The mocking-bird is the principal song bird and it and the lark-sparrow are common throughout the state. The snowy heron is a rare plume bird seen occasionally along the coast. The scissor-tailed flycatcher, or Texas bird of paradise, is common on the prairies and in the lightly wooded districts. The Texas screech-owl, the Texas woodpecker, and the road runner, or ground cuckoo, are found mostly in southern and south-western Texas. Among birds common in Texas as well as in the other Southern States are the cardinal, golden-fronted woodpecker, Mississippi kite, mourning-dove, and turkey-buzzard. In a narrow strip along the Gulf there are some Mexican or tropical birds, notably the caracara and two varieties of grackle (*Megaquiscalus*). The Texas Bob White or Texas quail is found principally in Texas and a few neighbouring states. The Texas game birds consist chiefly of plover, snipe, teal, mallard and wild geese. Texas has also the American coot or mud-hen and the pelican. Of reptiles there are the alligator, and several species each of turtles, lizards and snakes. Alligators are found in the low coast region and are especially numerous in the Nueces river. The painted box tortoise is common in the central part of the state; the snapping-turtle and the soft-shell turtle in most of the rivers and creeks; the Louisiana mud-turtle, in the coast marshes. The horned lizard, or horned toad (*Phrynosoma cornutum; P. hernandesi; P. modestum*), is the most common of Texas lizards, except in the western counties where the Texas rock lizards (*Sceloporus torquatus*; *S. clarkii*; *S. spinosus*; *S. consobrinus*; *S. dispar*) are numerous. The tree swift, or scaly lizard, is also an inhabitant of western and south-western Texas. The green lizard, the fence lizard and whip-tailed lizard (*Cnemidophorus gularis*; *C. sexlineatus*; *C. tesselatus*, &c.) are quite widely distributed. The Gila Monster (*Heloderma suspectum*), a poisonous lizard, whose bite is injurious but rarely, if ever, fatal to man, also occurs in the desert regions. The blow snake, or spreading adder (*Heterodon platyrrhinus*), black snake (*Bascanion constrictor*), coach whip (*Bascanion flagellum*), and prairie bull snake (*Pituophis*) are common; the diamond water snake (*Natrix fasciata*) is found along creeks; the king snake (*Lampropeltis getula*), in central and southern Texas; and the pilot snake (*Callopeltis obsoletus*), mostly in the woods of McLennan county. Among venomous snakes the harlequin, or coral snake (*Elaps fulvius*) is common along the coast; the copperhead (*Agkistrodon contortrix*) along the wooded banks of creeks and rivers; the cottonmouth (*Agkistrodon piscivorus*), in all parts of the state except the more arid districts; the "sidewiper," or massasauga (*Sistrurus catenatus consors*, sometimes called *Crotalophorus tergeminus*) and the ground rattlesnake (*Sistrurus miliarius*), in all sections. The green rattlesnake (*Crotalus molossus*) inhabits the valley of the Rio Grande; the plains rattlesnake (*Crotalus confluentus*), the north-western counties; the diamond rattlesnake (*C. adamanteus*), the wooded river bottoms; the Texas rattlesnake, western Texas and the southern coast counties; the banded rattlesnake, a few widely separated woodland districts. There are several varieties of the skink (*Eumeces*). Freshwater fish, consisting mostly of catfish, buffalo fish, bass, sunfish and drum, are common in the lower courses of the rivers. Oysters, clams, and shrimp abound along the coast, and there are more than 500 species of mollusks in the state. The boll-weevil, preying on the cotton, is the most noxious of the insects.

Flora.—The arboreal flora of Louisiana and Arkansas extends into north-eastern Texas, conformable with the Coastal Plain, where, immediately south of the Colorado river, the great pine belt of the Atlantic and Gulf coasts terminates. The flora of the Great Plains region, consisting principally of nutritious grasses, enters the north-western portion of the state and extends south to the Edwards Plateau and east into the Prairie Plains region. The peculiar plants of the Rocky Mountain plateaus penetrate into the Trans-Pecos region, which the north Mexican flora, including the *Agave lecheguilla*, a valuable commercial fibre, is found along the Rio Grande. The central region is a transition ground where these floras find representation generally in deteriorated and dwarfed species. The long-leaf pine is the dominant forest tree on the uplands of the Coastal Plain, north of the Colorado river, for 100 m. or more from the coast; farther inland and especially in the north-eastern corner of the state, it is succeeded by the short-leaf pine. Between the rising swells of long-leaf pine lands are impenetrable thickets of hawthorn, holly, privet, plane trees and magnolias. Loblolly pine, cypress, oaks, hickory, ash, pecan, maple, beech and a few other deciduous trees are interspersed among both the long-leaf and the short-leaf pines, and the proportion of deciduous trees increases to the westward. In the broad river valleys of the eastern part of the Prairie Plains region are forests and isolated groves consisting principally of pecan, cypress, cottonwood and several species of oak. Farther west two narrow belts of timber, consisting mostly of stunted post oak and black jack, and known as the Eastern and Western Cross Timbers, cross the prairies southward from the Red river, and a low growth of mesquite, other shrubs and vines are common in the eastern half of the Prairie Plains. The western half of these plains has only a few trees along the watercourses and some scraggy bushes of oak, juniper and cedar in the more hilly sections. In the canyons of the Edwards Plateau grow the pecan, live oak, sycamore, elm, walnut and cypress; on the hilly dissected borders of the same plateau are cedars, dwarf and scrubby oak, and higher up are occasional patches of stunted oak, called "shinneries." The upper slopes of some of the mountains in the Trans-Pecos region are clothed with forests of large pines, cedars and other trees. Smaller trees and shrubs grow farther down the same mountain slopes, but other mountains and the valleys are wholly destitute of trees. The entire valley of the Rio Grande, from El Paso to Brownsville, grows many species of cactus, and other prickly coriaceous shrubs. The low country along the coast is covered chiefly with grasses and rushes, but scattered over it are clumps of live oak, called "mottes." Grasses representing several species also cover most of the Great Plains, the uplands in the southern portion of the Coastal Plain, and the treeless portions of the Prairie Plains and the Trans-Pecos region.

Climate.—In the region of Galveston, along the northern section of the coast, where southerly or south-easterly winds from the Gulf prevail throughout the year, the climate is warm, moist and equable, but the moisture decreases westward and south-westward, and the equability, partly because of northerly winds during the winter months, decreases in all directions inland. The mean annual temperature decreases to the north-westward with an increase of both altitude and latitude, and ranges from 73° F. in the lower Rio Grande Valley to 55° F. in the northern portion of the Panhandle. The range between the mean of the maxima of the summer months (June, July and August) and the mean of the minima of the winter months (December, January and February) is only from 88° to 50° at Galveston, but at Mount Blanco, Crosby county, on the eastern border of the Llano Estacado, it is from 90° to 26°. During a period of twenty-six years (from January 1882 to December 1908) the greatest extremes that were recorded in the state by the United States Weather Bureau were 113° at El Paso in June 1883 and −16° at Amarillo, Potter county, in the Panhandle, in February 1899; within the same period the extremes at Galveston ranged only from 98° to 8°. Along the coast the average number of days during a year in which the temperature falls below freezing-point is only 3 or 4, but in the Panhandle this average is 111. January is the coldest month in nearly all parts of the state and July is the warmest. The mean temperature for January decreases from 59° at Brownsville, at the southern extremity of the state, to 36° at Amarillo in the Panhandle. The mean temperature for July is 85° both at Beeville, Bee county, in the southern coast region, and at Waco, much farther north but also farther inland; at Amarillo it falls to 76°. The average annual rainfall decreases quite regularly westward and south-westward from 47·6 in. at Galveston to 9·3 in. at El Paso. Along the coast the autumn months are the wettest and the spring months are the driest; for example, at Galveston the rainfall amounts to 5·7 in. in September and only 2·9 in. in April. In the middle, eastern and north-eastern parts of Texas the spring months are the wettest and the winter months are the driest; for example, at Waco the rainfall amounts to 4·5 in. in May and only 1·9 in. in December. In the western and south-western parts the summer months are the wettest and the spring months are the driest; thus, at El Paso the rainfall amounts to 2·2 in. in July and only 0·2 in. in April. The average annual snowfall for the state is about 5 in., ranging from 19 in. in the northern portion of the Panhandle to scarcely any along the coast and in the lower Rio Grande Valley. The prevailing winds are southerly or south-easterly throughout most of the state in spring and summer. Along the coast they continue in the same direction throughout the year, but inland they usually shift to the north or north-west either in autumn or winter.

Soils.—The Coastal Plain has for the most part a light sandy soil, but there is a fertile alluvium in the river bottoms and good clay soils on some of the uplands. The eastern part of the Prairie Plains is a belt known as the Black Prairie, and it has a rich black soil derived from Upper Cretaceous limestone; immediately west of this is another belt with a thinner soil derived from Lower Cretaceous rocks; a southern part of the same plains has a soil derived from granite; in a large area in the north-west the plains have a reddish clay soil derived from Permian rocks and a variety of soils—good black soils and inferior sandy and clay soils—derived from Carboniferous rocks. A very thin soil covers the Edwards Plateau, but on the Llano Estacado are brownish and reddish loams derived from the sediments of a Neocene lake.

Agriculture.—The total farm acreage was 125,807,017 acres in 1900, the total number of farms [1] being 351,085, their average acreage 358·3 acres, 84·9 per cent. being operated by white farmers. There were 11,220 farms of 1000 acres and more; 10,183 between 500 and 1000 acres; 115,393 between 100 and 500 acres; and 88,537 between 50 and 100 acres.

The production of Indian corn was 122,250,000 bu. in 1909 (valued at $92,910,000); the wheat crop, 5,050,000 bu. (valued at $5,959,000); the oat crop, 11,500,000 bu. (valued at $7,130,000); the rice crop, 9,894,000 bu. (valued at $7,717,000); the acreage under hay was 618,000, the crop being 587,000 tons and its value $6,985,000. Texas ranked first in 1899 among the states in the production and value of cotton, the acreage of which increased from 2,178,435 acres in 1879 to 6,960,367 acres in 1899, and the number of commercial bales from 805,284 in 1879 to 2,506,212 in 1899, when the total crop was valued at $96,729,304. The estimates for 1909 were 9,334,000 acres and 2,570,000 bales.

In the value of live stock on farms and ranges, Texas ranked seventh among the states in 1880 and second in 1900, with a value of $240,576,955. The value of all domestic animals on farms and ranges in 1900 was $236,227,934, Texas ranking second in this respect among the states. The censuses from 1860 to 1900 showed a far greater number of neat cattle on farms and ranges in Texas than in any other state or Territory; in 1900 the number was 7,279,935 (excluding spring calves); and in 1910 there were 8,308,000 neat cattle including 1,137,000 milch cows. In the number of horses the state ranked third in 1900, with 1,174,003 head—excluding colts—and in 1910 with 1,369,000 head. In the number of mules the state ranked first by a wide margin in 1900, with 474,737 head, and in 1910 with 702,000 head. In the number of swine the state ranked eighth in 1900 with 2,665,614 head, and third in 1910 with 3,205,000 head. In the number of sheep the state rose from fourth rank in 1880 to first in 1890, but dropped to tenth rank in 1900, when there were 1,439,940 head; in 1910

[1] Not including farms of less than three acres and of small productive capacity.

there were 1,909,000 sheep in the state. The wool product of the state in 1900 was 9,638,002 lb, and in 1910 was 8,943,750 lb washed and unwashed and 3,040,875 lb scoured. In the number of chickens (13,562,302 in 1900) the state ranked fifth, and in the number of ducks, geese and turkeys (1,299,044 in 1900), ranked first.

The cereals grow generally throughout the state, excepting in the arid western lands. The crop of Indian corn is especially large in a belt of counties beginning near the north-eastern corner of the state and extending in a south-westerly direction. Most of the rice is raised along the seaboard, in the south-eastern corner of the state. The largest crops of cotton are grown in the cereal-growing counties.

Forests and Timber.—About 64,000 sq. m., or 24 per cent. of the area of Texas, is estimated to be wooded. The area of yellow pine forests (the stand is estimated at 67,568·5 million ft.), and the lesser one of hardwood, together with considerable softwood, represent lumber-producing possibilities of much economic importance. The pine and hardwood areas occur chiefly in the north-eastern part of the state, and are bordered on the west by scattering growths of hardwood, extending as far westward as Austin. Sparse scrub timber, of little value except for posts, poles and rough beams and for fuel, occupies the region westward to approximately the longitude of the Pease river. Outside of these general areas, forest products are of relatively little value, the exceptions being the dense growths, in certain restricted areas, of live-oak, which is in demand for ship timbers; and scattering patches of hickory, which is requisite for certain manufactures. The pine and hardwood forests are of great economic value because of the density of their growth, and there are at hand the means of profitable development of this industry in the numerous watercourses which make logging cheap and expeditious. The maple, walnut, oak, ash, beech, elm, gum, sycamore, hickory and poplar, found on the southern slope of the Osage highlands, on the uplands about the source of the highlands and in the central portions of the Red river valley, are valuable for cabinet woods. The cut, consisting almost entirely of yellow pine, was valued in 1900 at $16,296,473.

Fisheries.—The value of the fisheries product of Texas increased from $286,610 (7,174,550 lb) in 1897 to $353,814 (8,044,404 lb) in 1902; and the amount of capital invested in the industry from $237,496 in 1897 to $373,724 in 1902, but the number of wage-earners employed decreased slightly—from 1199 in 1897 to 1144 in 1902. The values of the principal catches in 1902 were: red snapper, $103,398; oysters, $100,359; squeteague, $49,577, and channel bass, $39,525.[1]

Minerals.—The total value of the mineral products of Texas in 1890 was $1,986,679; in 1902, $6,981,532; in 1907, $19,806,458, and in 1908, $15,212,929—the valuations for the two years last named being those of the United States Geological Survey. By far the largest item in these totals after 1902 represented the value of petroleum. Little attention was paid to this resource until 1883; in 1890 the product was valued at only $227; and five years later it had increased to only $250. A good quality of oil—better in fact than the Ohio product, but not as good as that of Pennsylvania—was accidentally found at Corsicana, Navarro county, about 1894, and in 1898 it was discovered at a depth of 1040 ft. In 1901 an extraordinary "gusher" well was drilled near Beaumont, Jefferson county; in the nine days before this well was capped, it threw a stream of oil 160 ft. high, and poured out about 500,000 barrels. The development of the Hardin county field also began in 1902. As the result of these developments, the value of the oil product increased from $277,135 (546,070 bbls.) in 1898, to $871,996 (836,039 bbls.) in 1900; to $4,174,731 (18,083,658 bbls.) in 1902; and to $10,410,865 (12,322,696 bbls.) in 1907; it decreased to $6,700,708 (11,206,464 bbls.) in 1908. The value of the bituminous coal output was $465,900 (184,440 short tons) in 1890; $1,581,914 (968,373 short tons) in 1900; $2,778,811 (1,648,069 short tons) in 1907; and $3,419,481 (1,805,377 short tons) in 1908. The value of the product of limestones and dolomites in 1900 was $124,728; in 1902, $228,662; of sandstones and quartzites in 1900, $37,038; in 1902, $165,565; while the value of all stone produced in 1907 was $497,962, and in 1908, $659,574. Natural gas was discovered in Washington county in 1879, but was not commercially used in that vicinity until 1888. In 1902 gas was discovered in Jefferson county. Other minerals found in small quantities are copper, lead, zinc, iron ores, manganese ores and tin.

Manufactures.—The value of the manufactured products of Texas in 1905 was $150,528,389, the capital invested in manufacturing being $115,664,871, and the number of factories, 3158.

In the value ($14,005,324 in 1900[2] and $18,698,815 in 1905) of its cotton-seed oil and cake product Texas surpassed all other states. Flour and grist mill products advanced in value from $11,948,556 in 1900 to $22,083,136 in 1905. The values of other products in 1905 were as follows: slaughtering and meat packing (wholesale), $15,620,931; lumber and timber products (which employed the largest average number of wage-earners—13,332, or 27·2 per cent.), $16,278,240; cars and general shop construction and repairs by steam railway companies, $10,472,742; printing and publishing, $7,782,247; foundry and machine shop products, 1905, $4,952,827; malt liquors, $4,153,938; saddlery and harness, 1905, $3,251,525. The highest average quantity of rough milled rice per establishment in the United States in 1905 was for Texas, where seventeen establishments produced an average of 18,598,259 lb, valued, together with that of other rice products, at $4,638,867.

Transportation.—Until the middle of the 19th century transportation facilities remained practically undeveloped in Texas. In 1860 the steam railway mileage was 307 m.; in 1870, 711 m.; in 1880, 3244 m.; in 1890, 8709 m.; in 1905, 11,949 m.; in 1907, 12,877 m.; and in 1908, 13,066 m. Most of this mileage is in the eastern part of the state, the western and southern portions having slight railway facilities. The principal railway systems are the Southern Pacific, the Santa Fé, the Texas & Pacific and the Colorado & Southern. The inland waterways include the 25 ft. ship canal from the Gulf to Port Arthur (the Port Arthur Canal), opened in 1899, and transferred to the United States government in 1906; the Galveston and Brazos River canal, 29·5 m. long and of a ruling depth of 3 ft., also acquired by the government in 1902, and a privately owned canal, 9 m. long and from 6·5 ft. to 10 ft. deep, extending from Corpus Christi to Aransas Bay. Other important waterways which have been authorized by the United States government and on which work was proceeding in 1910 are canals from the Rio Grande river to the Mississippi river at Donaldsonville, Louisiana; and "a navigable channel depth of 5 ft. in a canal along the coast of Texas, underlying the lagoons lying between the islands and the mainland" to develop light navigation to points not reached by the railways. Another important undertaking is the deepening of the Trinity river to Dallas, a distance of 511 m., thereby affording a navigable waterway almost to the northern boundary of the state. Congressional appropriations for the survey, improvement and maintenance of waterways began in 1852; amounted to $15,055,688 between 1891 and 1896 inclusive, and $1,613,829 between 1897 and 1907; the total appropriated being $23,249,419. The ports of entry of Texas are Galveston, Corpus Christi, Eagle Pass, El Paso and Brownsville.

Population.—The population in 1880 was 1,591,749; in 1890, 2,235,523; in 1900, 3,048,710; and in 1910, 3,896,542.[3] Of the population in 1900, 94·1 per cent. was native born, 79·6 per cent. was white and 20·4 per cent. (or 620,722) was negro, or of negro descent. There were in 1900, 2,249,088 native whites, 179,357 persons of foreign birth, 836 Chinese, 470 Indians and 13 Japanese. Of the inhabitants born in the United States 130,389 were natives of Tennessee, 129,945 of Alabama, 90,584 of Mississippi, 77,950 of Georgia and 75,633 of Arkansas; and of the foreign-born 71,062 were Mexicans, 48,295 Germans, 9204 Bohemians, 8213 English, 6870 Austrians and 6173 natives of Ireland. Of the total population 471,573 were of foreign parentage—*i.e.* either one or both parents were foreign-born, and of those both of whose parents were foreign-born 70,736 were of German, 10,967 of Bohemian, 7759 of Irish and 6526 of Austrian parentage. In 1906 1,226,906 inhabitants of the state were members of religious societies. Of these 401,720 were Baptists; 317,495 Methodists; 308,356 Roman Catholics; 62,090 Presbyterians; 39,550 Disciples of Christ; 34,006 members of the Churches of Christ; 27,437 Lutherans; 14,246 Protestant Episcopalians; 7745 members of the German Evangelical Synod of North America, and 1856 Congregationalists. The principal cities are San Antonio, Houston, Dallas, Galveston, Fort Worth, Austin, the capital, Waco, El Paso, Laredo, Denison and Sherman.

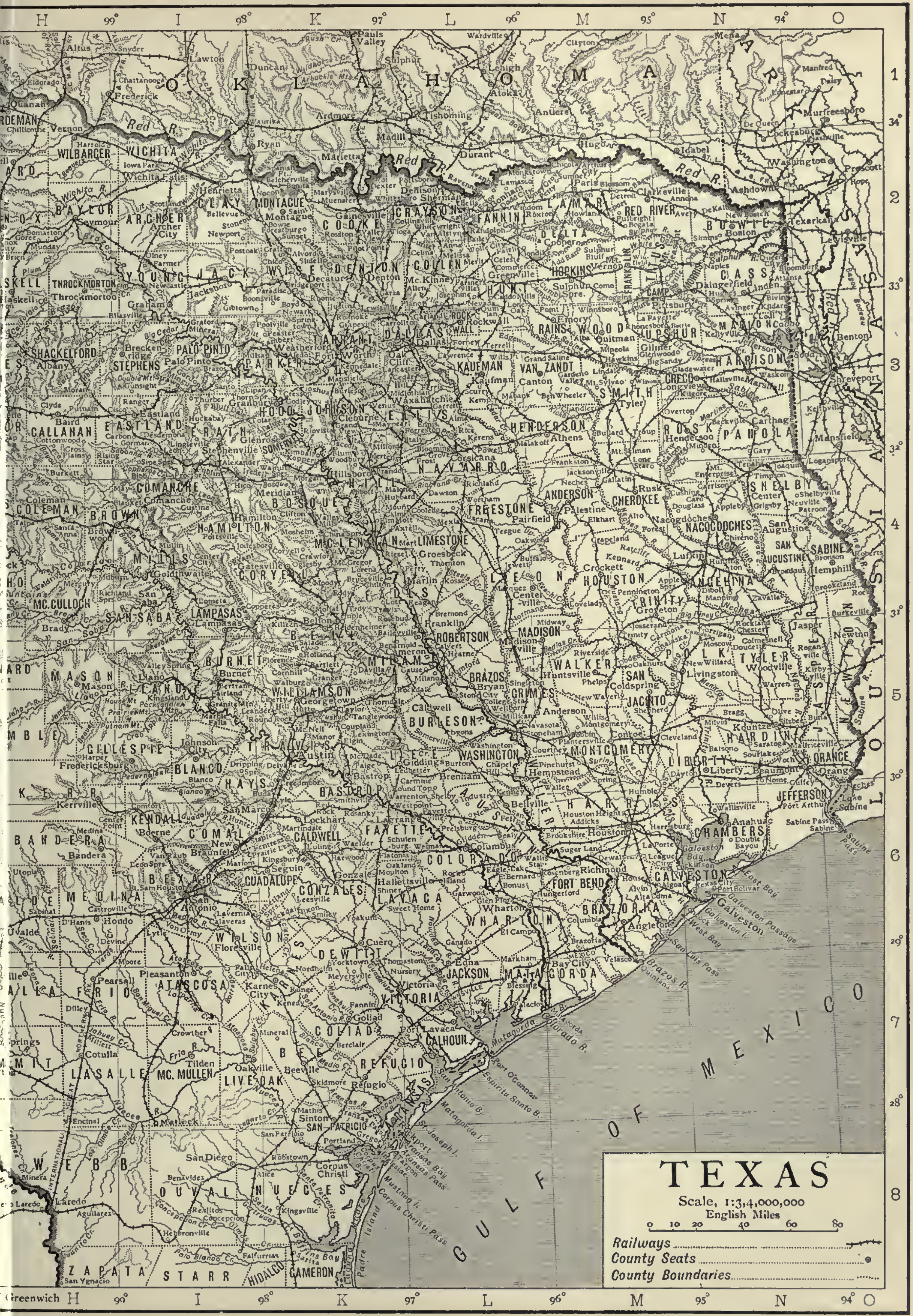
Administration.—Texas as a part of Mexico was governed under the constitution (1827) of the "Free State of Coahuila and Texas"; a separate constitution adopted in 1835 was never recognized by the Mexican government and never went into effect. The Texan Declaration of Independence, adopted in November 1835, was accompanied by a provisional constitution; and with the Declaration of Independence of March 1836 there were adopted an executive ordinance and a constitution. As a state of the United States Texas adopted a constitution in 1845, another in 1866, and a third in 1868, and is now

[1] Publications of the U.S. Commission of Fish and Fisheries. Part xxix., *Report of the Commissioner for the Year ending June* 30, 1903 (Washington, 1905).

[2] The statistics given in the text for 1900 from this point are for factory products and are thus comparable with those given for 1905; the special census of the latter year was limited to the manufactures under the factory system.

[3] In other census years the populations were: 1850 (the first under the United States), 212,592· 1860 604,215; 1870 818.579.


Part of Northern Texas
Scale, 1:1,700,000
English Miles
0 5 10 20 30
Continuation North
Same Scale
Longitude West 101° of Greenwich
Continuation South
Same Scale
Longitude West
O K L A H O M A
N E W M E X I C O
M E X I C O
GULF OF MEXICO
Llano Estacado
(Staked Plains)
DALLAM
SHERMAN
HANSFORD
OCHILTREE
LIPSCOMB
HARTLEY
MOORE
HUTCHINSON
ROBERTS
HEMPHILL
OLDHAM
POTTER
CARSON
GRAY
WHEELER
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
COLLINGSWORTH
PARMER
CASTRO
SWISHER
BRISCOE
HALL
CHILDRESS
HARDEMAN
HALE
FLOYD
MOTLEY
COTTLE
BAILEY
LAMB
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
YOAKUM
TERRY
LYNN
GARZA
KENT
STONEWALL
GAINES
DAWSON
BORDEN
SCURRY
FISHER
ANDREWS
MARTIN
HOWARD
MITCHELL
NOLAN
LOVING
WINKLER
ECTOR
MIDLAND
GLASSCOCK
STERLING
COKE
WARD
CRANE
UPTON
REAGAN
TOM GREEN
IRION
EL PASO
REEVES
JEFF DAVIS
PECOS
CROCKETT
SCHLEICHER
SUTTON
PRESIDIO
BREWSTER
TERRELL
VALVERDE
EDWARDS
KINNEY
MAVERICK
COOKE
GRAYSON
DENTON
COLLIN
HUNT
ROCKWALL
RAINS
TARRANT
DALLAS
KAUFMAN
VAN ZANDT
JOHNSON
ELLIS
HENDERSON
WEBB
DUVAL
NUECES
ZAPATA
STARR
HIDALGO
CAMERON
Amarillo
Dalhart
Canyon
Clarendon
Childress
Lubbock
Plainview
Big Spring
Midland
Pecos
El Paso
Marfa
Alpine
Ft. Davis
Del Rio
San Angelo
Sanderson
Ozona
Sonora
Eldorado
Gainesville
Sherman
Denton
McKinney
Greenville
Fort Worth
Dallas
Kaufman
Waxahachie
Cleburne
Laredo
Zapata
Rio Grande
Brownsville
Matamoros
Rio Grande
Pecos R.
Red R.
Canadian R.
Padre Island
Laguna Madre
A B C D E F G
1 2 3 4 5 6 7 8



Emery Walker sc.

governed under the constitution of 1876, with amendments of 1879, 1883, 1890, 1891, 1897, 1904 and 1906. All male citizens over twenty-one years of age and resident in the state for one year and in the county or election precinct for six months immediately preceding election (except paupers, idiots, lunatics, felons, United States soldiers, marines and seamen, and persons who have taken part, either as principal or second, in fighting a duel or in sending a challenge) have the right of suffrage. The constitution originally forbade the registration of voters, but an amendment of 1891 permits it in cities having a population of ten thousand or more, and the Australian ballot system was adopted in such cities by an act of the twenty-second legislature in 1892. An amendment to the constitution may be proposed by a two-thirds vote of all members elected to each house of the legislature, and is adopted if it is approved by a majority of the popular vote on the amendment.

The executive department consists of a governor, lieutenant-governor, secretary of state, comptroller of public accounts, treasurer, commissioner of the general land office, and attorney-general. Contrary to the usual custom in other states, the secretary of state is appointed by the governor. The other officials are elected by popular vote for two years' terms. The governor and lieutenant-governor must be, at the time of election, at least thirty years of age, citizens of the United States, and residents of the state for the preceding five years. The governor receives an annual salary of $4000 and the use of the governor's mansion. His functions are rather more extensive than those of the average American executive. In addition to the usual privilege of granting pardons and reprieves, he controls considerable patronage, and possesses a power of veto which extends to separate items in appropriation bills. A two-thirds majority in each house is necessary to override a veto.

The legislature of the state is composed of a Senate and a House of Representatives. The Senate consists of thirty-one members, chosen by popular vote for four years, one-half retiring every two years. Representatives are elected biennially. Their number, originally ninety-three, is determined by apportionment bills passed after the publication of each Federal census, but under the constitution it can never exceed one hundred and fifty. Senators and representatives must be at least twenty-six years old, citizens of the United States, qualified electors of the state, and residents of the state for two years, and of the district for one year, preceding the election. The unusual provision that two-thirds of each house shall constitute a quorum would probably prove inconvenient, if the political parties were approximately equal in strength. Bills for raising revenue may originate only in the House of Representatives, but may be amended or rejected by the Senate. Meetings of the legislature are biennial, although special sessions may be called by the governor.

The judicial system, revised by a constitutional amendment of 1891, consists of a supreme court of three members, elected for a term of six years, with civil jurisdiction only, largely appellate; a court of criminal appeals, of three members, elected for six years, with appellate jurisdiction in criminal cases; courts of civil appeals (number determined by the legislature) of three members each, elected for six years; district courts, each with one judge, elected for four years, with original jurisdiction in the more important civil and criminal (felony) cases and a limited appellate jurisdiction; county and justice of the peace courts with original jurisdiction in misdemeanours and petty civil cases. The commissioners' court of five members, including the presiding judge, attends to county business matters, the county being the unit of local government.

Miscellaneous Laws.—The long domination of Spain and Mexico exercised an influence on the institutions of the state, but it can easily be exaggerated. It must be remembered that during the colonial period the Spanish and Mexican population was never very large, that the first permanent Anglo-American settlement was not established until 1821, that there was ill-feeling between the two peoples almost from the very beginning, and that in fifteen years the Americans carried through a successful rebellion. The framework of the governments established in 1836–37 and 1845 was not essentially different from those with which the framers were familiar in the United States. But while this was true of the outward structure it was impossible to disregard entirely private rights based upon Spanish and Mexican legislation. In other words, the system of jurisprudence is the most striking example of Spanish influence. There was the same conflict between the English Common Law and the Roman Civil Law which had taken place in Louisiana a few years before (see LOUISIANA); but the result was different. Owing to the peaceful character of its acquisition and the relative strength of the Romance (French) element, Louisiana continued the use of the Civil Law. The Texas invaders, on the other hand, adopted the Common Law, but with the addition of many Civil Law principles. For example, the state has never made any distinction between law and equity, and it has always followed the Civil Law procedure by petition and answer.[1] The independent existence of Texas as a republic (1836–45) was also not without influence. By strengthening the feeling of local pride it added force to the states' rights sentiment, and it enabled the state on coming into the Union to retain possession of all its public lands. This vast domain has been utilized to provide homes for settlers, to encourage education, to subsidize railways, and to build the state capitol. There is a general land office at Austin under the charge of a commissioner. Among other features of interest the constitution forbids the suspension of the writ of *habeas corpus*, makes duelling a disqualification for holding office or exercising the right to vote, and authorizes the exclusion of atheists from office. There is also a clause which exempts from seizure for debt the homestead, not more than two hundred acres of land in the country, or a house of any value in a city or town on a lot or lots not exceeding five thousand dollars in value at the time of its designation as the homestead. The object is the protection of widows and orphans, but the right has been very much abused, and its abuse is in part responsible for the high rate of interest which prevails. State-wide prohibition of the sale of intoxicating liquors was voted down in 1887 and a local option law went into effect; in 1907, when there was no licence in 145 (out of 243) counties and licence only in parts of 51 other counties, a law was passed giving local option to parts of cities and towns. In 1908–09 there was an unsuccessful attempt to pass in the legislature a constitutional amendment providing for state-wide prohibition; the amendment was favoured by the Democratic state platform, but the hostility of the legislature to Governor Campbell, who favoured the amendment, secured its defeat.

Both husband and wife retain their separate title to the property which each owned before marriage and to that acquired after marriage by gift, devise or descent, and to the increase of all lands thus acquired, but the husband has the sole management both of his own and of his wife's separate property. However, should the husband neglect to sue for the recovery of any separate property of his wife she may, with the permission of the court, sue for it in her own name; or should the husband refuse to support his wife and educate her children as her fortune would warrant, the county court may in answer to her complaint require a fixed portion of the proceeds from her property to be paid to her. All property which either husband or wife acquires during the marriage, other than by gift, devise or descent, is their common property, and during coverture may be disposed of by the husband only; on the death of the husband the widow has one-half of the property, which they held in common. The causes for a divorce are cruelty, adultery, desertion for three years, or conviction after marriage of a felony and imprisonment in the state prison without being pardoned within one year after conviction; the plaintiff must reside in the county six months before beginning suit.

Education.—Educational matters are supervised by a state board, composed of the governor, comptroller and secretary of state, by a superintendent of public instruction, who is *ex officio* secretary of the board, by county superintendents (in counties having a school population of 3000 or more), by superintendents and boards of trustees in corporate towns and cities, and by school commissioners in the rural districts. The permanent public school fund is the largest of any state in the Union; in 1908 it included $38,406,222 in land notes, $15,136,808 in bonds, $7,915,257 (estimated) in leased lands, and $67,956 in cash awaiting investment. The invested fund is largely in Federal, state and county bonds. The revenue for schools in 1907–08 was $8,020,229, of which $2,761,651 was from the state tax, $2,080,159 from the local tax, $1,640,969 from the one dollar poll tax on males between the ages of twenty-one and sixty, $481,899 from a state occupation tax, $429,365 from county funds, and $105,806 from tuition fees. The state apportionment to the districts was $5 per capita of school population in 1906–07, and was $6 in 1907–08. In the latter year the total enrolment in public schools was 777,545, of whom 145,748 were negroes. Separate schools are maintained for white and negro children and impartial provision is made for both races. In 1839 the Congress of the Republic set apart fifty square leagues (221,420 acres) of land for the establishment of two universities. The state legislature approved this grant in 1858, added to the endowment one section (640 acres) out of every ten appropriated to encourage the building of railways, and provided that there should be one university instead of two. The Civil War and Reconstruction delayed the execution of the plan, and the university of Texas was not opened until September 1883. The main university is at Austin, and the medical department (established 1891) at Galveston. The state also supports, wholly or in part: the Agricultural and Mechanical College at College Station (opened in 1876; a land grant college under the Morrill Act of 1862), near Bryan, which has a course in textile engineering besides the courses usually given in state agricultural and mechanical

[1] For a full discussion of this question see E. W. Townes, *Quarterly of the Texas State Historical Association*, ii. 29–53, 134–151 (July and October 1898).

colleges; the Sam Houston Normal Institute (1879) at Huntsville, the North Texas State Normal (1901) at Denton, the South-west Texas Normal (1903) at San Marcos, the School of Industrial Arts for girls at Denton, and the Prairie View Industrial and Normal School (1876) for negroes near Hempstead. The system is not unified or organized: the university's department of education, the school for girls at Denton and the negro normal school all issue teachers' certificates, but are not under the control of the State Department of Education or the State Board of Education. The state library and museum are a part of the Department of Banking, Statistics, History and Insurance. Denominational schools are: Baylor University (Baptist; 1845), at Waco, with a medical department at Dallas; the East Texas Normal and Industrial Academy (Baptist; 1905), at Tyler; Trinity University (Cumberland Presbyterian; 1869), at Waxahachie; Austin College (Presbyterian; 1850), at Sherman; South-western University (Methodist Episcopal; 1873), at Georgetown, with a medical department at Dallas; the Polytechnic College (Methodist Episcopal, South; 1891), at Fort Worth; Texas Holiness College (Holiness; 1899), at Peniel, near Greenville; Texas Christian University (Christian; 1873 until 1895 at Thorp's Spring; until 1902 Add-Ran College), at Waco; St Edward's College (Roman Catholic, under the Congregation of the Holy Cross; 1885), at Austin; St Mary's University (1854; since 1884 under the Society of Jesus), at Galveston; St Basil's College (under the Basilian Fathers; 1899), at Waco; for girls, Baylor Female College (Baptist; 1845), at Belton; San Antonio Female College (Methodist Episcopal, South; 1894), at San Antonio; North Texas Female College (Methodist Episcopal, South; 1877), at Sherman; and the Academy of Our Lady of the Lake, under the Sisters of Divine Providence, at San Antonio; and for negroes Paul Quinn College (African Methodist Episcopal; 1881), at Waco; Tillotson College (Congregational; 1881), at Austin; Samuel Huston College (Methodist Episcopal; 1900), at Austin; Bishop College (Baptist; 1881), at Marshall; Wiley University (Methodist Episcopal; 1873), at Marshall; and Texas College (Coloured Methodist Episcopal; 1895), at Tyler.

Charitable and Penal Institutions.—Texas has done more than any other Southern state for the humane and scientific treatment of its dependent and defective classes. There are insane asylums at Austin (the State Lunatic Asylum), San Antonio (the South-western Insane Asylum), and Terrell (North Texas Hospital for the Insane); the Texas School for the Deaf (1857), an institution for deaf, dumb and blind coloured youths (1889), a School for the Blind (1856), and a home for dependent Confederate soldiers, at Austin, a state orphan home (1889) at Corsicana, an epileptic colony at Abilene, and a state reformatory (1889) for boys under seventeen years at Gatesville. A statute of 1899, authorized by a constitutional amendment of 1897, instituted a system of pensions for Confederate veterans. For this purpose $200,000 was appropriated during the fiscal year 1902–1903. The maximum permitted by the constitution is $250,000 per annum. The penitentiaries are at Huntsville and Rusk, and there is a reform school for juvenile offenders at Gainesville. The convict lease system in its most objectionable form was abolished in 1883, and convicts are now employed on state account or by private contract. There are several state farms in successful operation. Each of these institutions, penal and charitable, has its own superintendent and board of managers, appointed by the governor.

Finance.—The heavy debt incurred in the struggle with Mexico was paid out of the $10,000,000 received from the United States government under the Compromise of 1850. New loans were made during the Civil War, but they were repudiated by the constitution of 1866, and were made void by the Fourteenth Amendment to the Federal constitution. The extravagance of the Reconstruction governments resulted in the accumulation by 1876 of a debt of $4,792,394. The constitution of 1876 forbids the borrowing of money except to supply casual deficiencies of revenue (amount limited to $200,000 at a time), repel invasion, suppress insurrection, defend the state in war, or pay existing debts. The nominal amount of the public debt on the 1st of September 1908 was $3,989,400, but the figures are misleading, because, with the exception of $22,000 (held partly by counties), all of these obligations were in the permanent school fund or in funds for the University, the Agricultural and Mechanical College, and the various charitable institutions. Owing to a clause in the constitution forbidding the issue of bank charters, the financial business of the state was controlled by national and private banks until 1904, when the constitution was amended and provision was made for the incorporation of state banks under a system of state supervision, regulation and control, deposits being guaranteed as in the Oklahoma banking system.

History.—The history of Texas may be regarded as a step in the great struggle between England, France and Spain for the possession of America. The earliest explorations were made by the Spaniards, Cabeza de Vaca, 1528–36, and Francisco Vasquez de Coronado, 1540–42, but the first colony was that planted on Matagorda Bay in 1685 by the French under the Sieur de la Salle. This was, however, soon abandoned, and the field left to the Spanish. Beginning in 1690 they established several ecclesiastical, military and civil settlements known respectively as missions (Franciscan), presidios, and pueblos. In or near the city of San Antonio are the ruins of five missions built of stone; and missions were more numerous in east Texas, but they were built of wood and nothing remains to mark their location. In 1727 the territory, with vaguely defined limits, was formed into a province and named Tejas, or Texas, after the tribe or the confederacy of Tejas Indians. For more than a century the conditions were favourable for colonization. The French in Louisiana proved to be peaceable neighbours, and that province, both under French (to 1763) and under Spanish rule (1763–1803) served as a protection against the English. Spain failed to take advantage of the opportunity, however, and it was lost when the United States purchased Louisiana in 1803. Three abortive Anglo-American invasions during the first few years of the century indicated the future trend of events. The first, under Philip Nolan, in 1799–1801, was poorly supported, and was crushed without difficulty; the second, under Bernardo Gutierrez and Augustus Magee, 1812–13, captured San Antonio and defeated several Mexican armies, but was finally overpowered; the third, under James Long, an ex-officer of the United States army, 1819–21, was less formidable. The year 1821 marks a significant turning-point in the history. By the Florida treaty, finally ratified at that time, the claims of the United States to Texas, based on the Louisiana purchase, were given up, and the eastern and northern boundaries of the province were determined. They were to be, in general terms, the Sabine river, the 94th meridian (approximately), the Red river, the 100th meridian, the Arkansas river, and the 42nd parallel. So far as Spain was concerned this was only a form, inasmuch as Mexico, of which Texas formed a part, was just completing its long struggle for independence (1810–21). In that year also (December 1821) Stephen F. Austin established the first permanent Anglo-American settlement at San Felipe de Austin on the Brazos river. This was followed by an extensive immigration from the United States during the period of Mexican rule (1821–36). It is estimated that the population, exclusive of Indians, increased from four thousand in 1821 to ten thousand in 1827, and nearly twenty thousand in 1830. Most of the settlers came from the southern section of the Union and of course brought their slaves with them, but there is no evidence to show that their object was the territorial extension of slavery, or that the revolt against Mexico was the result of dissatisfaction with that country's anti-slavery policy. Texas was joined to Coahuila in 1827 to form a state of the Mexican federation. Although the attempt to force the Roman Catholic religion upon the people, the federal decree of 1830 forbidding further immigration from the states, and the reckless grants of land to Mexican favourites aroused some ill-feeling, the government on the whole was fairly liberal. The peace party, led by Stephen F. Austin, was able to restrain the more warlike followers of William H. Wharton and Henry Smith (1794–1851) until 1835, when Santa Anna overthrew the federal constitution of 1824 and established a dictatorship. A consultation of representatives from the various settlements met at San Felipe de Austin, October to November 1835. Under Austin's influence the delegates rejected an independence resolution and recommended a union with the Mexican Liberals for the restoration of the constitution of 1824. A provisional government was organized with Henry Smith as governor and James W. Robinson (d. 1853) as lieutenant-governor, Sam Houston as major-general of the armies of Texas; and Austin, Wharton and Branch T. Archer (1790–1858) were elected commissioners to seek aid in the United States. Hostilities had already begun. The Texans routed the Mexicans near Gonzales on the 2nd of October. About a hundred men under Colonel James Bowie and Captain J. W. Fannin defeated a Mexican force near Mission Conception on the 28th of October; and after a campaign of nearly two months Béjar was surrendered to them on the 11th of December.

In the Matamoras expedition the Texan forces were severely crippled on account of a quarrel between Governor Smith, who desired independence, and the majority of his council, who favoured union with the Mexican Liberals. The command was divided between Houston, who was supported by the governor, and two leaders, Frank W. Johnson and J. W. Fannin, who were appointed by the council. The Mexicans under Santa Anna captured the Alamo on the 6th of March 1836 and slaughtered its garrison of 183 men; on the 20th of the same month they captured Fannin and his force of 371 men, and a week later slaughtered all except twenty who escaped. Houston now assumed active command and retreated before Santa Anna until he reached the San Jacinto river, where he dealt the enemy a crushing blow and brought the war to an end; nearly all of Santa Anna's army were killed, wounded or taken prisoners, and even Santa Anna himself was captured the next day, while the Texans lost only two killed and twenty-three wounded. The weakness of the Mexican Liberals and the necessity of securing aid in the States led the Austin party to abandon their opposition to independence. A convention, assembled in the town of Washington on the 1st of March, adopted a declaration of independence on the 2nd and a republican constitution on the 17th. Houston was elected president in September 1836, and the independence of the republic was recognized in 1837 by the United States, Great Britain, France and Belgium. After a long conflict over the slavery question, the state was admitted into the Union under a joint resolution of Congress adopted on the 1st of March 1845,[1] on condition that the United States should settle all questions of boundary with foreign governments, that Texas should retain all of its vacant and unappropriated public lands, and that new states, not exceeding four in number, might be formed within its limits. The western boundary claimed by the republic was the Rio Grande to its source and the meridian of longitude from that point to the forty-second parallel, although as a political division of Mexico its limits never extended farther west than the Nueces and the Medina. The United States government asserted the Rio Grande claim and prepared to enforce it at the cost of war; at the same time the Mexican government considered annexation, regardless of the boundary question, a declaration of war by the United States. An army of 2000 men under Zachary Taylor (*q.v.*) arrived on the north bank of the Rio Grande, opposite Matamoras, on the 28th of March 1846. The Mexican commander, Pedro de Ampudia, demanded Taylor's withdrawal beyond the Nueces within twenty-four hours. He did not obey, and Mariana Arista, Ampudia's successor, opened hostilities. The Americans, outnumbered three to one, defeated the Mexicans in the battles of Palo Alto (May 8th) and Resaca de la Palma (May 9th). The war terminated in the treaty of Guadalupe Hidalgo (February 2, 1848) by which Mexico accepted the Rio Grande boundary. By the Compromise of 1850 Texas received $10,000,000 for its territory lying north and west of a line drawn from the 100th meridian to the Rio Grande, following 36° 30′ N., 103° W. and 32° N. The final step in the determination of the present boundaries of the state was taken in 1896, when the Supreme Court of the United States decided the Greer county case. Under the Florida treaty of 1819–21 a portion of the Red river was to be the northern boundary of Texas east of the 100th meridian, but as there are two branches of the river meeting east of the meridian the enclosed territory (Greer county) was in dispute. The decision of 1896 selected the southern branch and thus deprived Texas of a large tract of fertile land over which it had previously exercised jurisdiction.

In the crisis of 1860–61 Texas sided with the other Southern States in spite of the strong Unionist influence exerted by the German settlers and by Governor Sam Houston. An ordinance of secession was adopted February 1, 1861, and Governor Houston was deposed from office on March 16th. The state was never the scene of active military operations during the Civil War (1861–65), although it is interesting to note that the last battle of the conflict was fought on its soil, at Palmito, near Palo Alto, on the 13th of May 1865, more than a month after the surrender at Appomattox. In conformity with President Johnson's plan of reconstruction, a constitution recognizing the abolition of slavery, renouncing the right of secession, and repudiating the war debt was adopted in 1866, and J. W. Throckmorton, Unionist Democrat, was elected governor. When, in 1867, the Congressional plan of reconstruction was substituted, Texas was joined to Louisiana to constitute the fifth military district, and the first commander, General P. H. Sheridan, removed Throckmorton from office as "an impediment to reconstruction" and appointed E. M. Pease in his place. Delegates to a new constitutional convention were elected in 1868, the constitution framed by this body was ratified in November 1869, state officers and congressmen were elected the same day, the new legislature ratified the Thirteenth and Fourteenth Amendments, and on the 30th of March 1870 Texas was readmitted to the Union. But the state remained under the rule of negroes and carpet-baggers, supported by United States troops until the inauguration of Governor Richard Coke in 1874. It has since been consistently Democratic. The supremacy of the party was threatened for a time by the growth of Populism, but the danger was avoided by the acceptance of free silver, and the partial adoption of the Populist local programme. This surrender aroused strong opposition among the conservative or Cleveland Democrats, which culminated in the Hogg-Clark gubernatorial campaign of 1892. The victory of the Radicals resulted in the establishment of a railway rate commission, based upon a constitutional amendment of 1890 and a statute of 1891, the passage of an alien land law in 1891, which was declared unconstitutional and amended in 1892, the adoption of the Australian ballot system for cities and towns of more than 10,000 inhabitants (1892), the retirement of Roger Q. Mills from the United States Senate (1899) and the sending of free silver delegations to the national conventions of 1896 and 1900.

[1] This acquisition of foreign territory by joint resolution instead of by treaty was followed in the case of Hawaii in 1898.

Governors

Spanish Period (1690–1821)[2]

Domingo Terán de los Rios.
Don Gaspardo de Anaya.
Don Martin de Alarcón.
Marquis San Miguel de Aguayo.
Fernando de Almazan.
Melchior de Mediavilla y Arcona.
Juan Antonio Bustillos y Cevallos.
Manuel de Sandoval.
Carlos de Franquis.
Prudencio de Oribio de Basterra.
Justo Boneo.
Jacinto de Barrios y Jaûrequi.
Antonio de Martos y Navarrete.
Juan Maria Baron de Ripperda.
Domingo Cabello.
Rafael Pacheco.
Manuel Muñoz.
Juan Bautista Elgûezabal.
Antonio Cordero.
Manuel de Salcedo.
Juan Bautista Casas, provisional.
Manuel de Salcedo.
Christoval Dominquez.
Antonio Martinez.

Mexican Period (1821–36)[3]

Trespalacios.
Don Luciana Garcia, provisional.
Rafael Gonzales, provisional.
Victor Blanco.
José Maria Viesca.
José Maria Letona.
Francisco Vidauri y Villaseñor, provisional.
José Maria Goribar, Juan José Elguezebal, } rival claimants.
Augustin Viesca.
Henry Smith, provisional 1835–36

Period of the Republic (1836–46)[4]

David G. Burnet, provisional	1836
Sam Houston	1836–38
Mirabeau B. Lamar	1838–41
Sam Houston	1841–44
Anson Jones	1844–46

[2] Coahuila and Texas, 1690–1725, Texas alone 1725–1824.
[3] Coahuila and Texas, 1824–35.
[4] The state was annexed to the Union in 1845, but the government of the Republic continued in existence until early in 1846.

Period of Statehood (1846–)

James Pinckney Henderson, Democrat	. .	1846–47
George T. Wood,	„ . .	1847–49
P. Hansborough Bell,	„ . .	1849–53
Elisha M. Pease,	„ . .	1853–57
Hardin R. Runnels,	„ . .	1857–59
Sam Houston,	„ . .	1859–61
Edward Clark (lieutenant-governor, acting) Dem.		1861
Francis R. Lubbock, Democrat	. . .	1861–63
Pendleton Murray,	„ . . .	1863–65
Andrew J. Hamilton, provisional	. . .	1865–66
James W. Throckmorton, Conservative Democrat		1866–67
Elisha M. Pease, provisional	. . .	1867–70
Edmund J. Davis, Republican	. . .	1870–74
Richard Coke, Democrat	. . .	1874–76
Richard B. Hubbard, Democrat	. . .	1876–79
Oran M. Roberts,	„ . . .	1879–83
John Ireland,	„ . . .	1883–87
Lawrence S. Ross,	„ . . .	1887–91
James S. Hogg,	„ . . .	1891–95
Charles A. Culberson,	„ . . .	1895–99
Joseph D. Sayers,	„ . . .	1899–1903
Samuel W. T. Lanham,	„ . . .	1903–1907
Thomas M. Campbell,	„ . . .	1907–1911
O. B. Colquitt,	„ . . .	1911–

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On the administration: see the *Constitution of the State of Texas, with Amendments* (Austin, 1891); John and Henry Sayles, *Annotated Civil Statutes of Texas* (2 vols., St Louis, 1897); *The Session Laws*, Twenty-fifth to Twenty-ninth Legislature (Austin, 1897–1905); W. M. Gonge, *The Fiscal History of Texas* (Philadelphia, 1852), for the early financial history; O. M. Roberts in D. G. Wooten's history (see below), ii. 7–325, for an account of legislative and judicial history; and J. J. Lane in Wooten for the educational system. Some valuable statistics will be found in C. W. Raines, *Year-Book for Texas, 1901* (Austin, 1902).

An excellent guide to the history of the state is C. W. Raines, *Bibliography of Texas* (Austin, 1896). The best history of the state is George P. Garrison's *Texas* (Boston and New York, 1903), in the American Commonwealths series, but its treatment of the period since 1845 is too brief. John Henry Brown's *History of Texas from 1685 to 1892* (2 vols., St Louis, 1892) is a detailed, rather biased treatment, by an old Texas pioneer who had access to a large mass of unprinted material. The best of the older works and the basis for subsequent books on the period which it covers is Henderson Yoakum's *History of Texas from its first Settlement in 1685 to its Annexation to the United States in 1846* (2 vols., New York, 1856). See also David B. Edward, *The History of Texas* (Cincinnati, 1836), slightly pro-Mexican in sympathy; H. H. Bancroft, *History of Texas and the North Mexican States* (2 vols., San Francisco, 1884–89), valuable for authorities cited in the footnotes; and H. M. Williams, *Sam Houston and the War of Independence in Texas* (Boston and New York, 1893), the best life of Houston. Dudley G. Wooten (ed.), *A Comprehensive History of Texas, 1685–1897* (2 vols., Dallas, 1898), contains a reprint of Yoakum with notes and several chapters by various writers on Anglo-American colonization, the revolution against Mexico, the land system, the educational system, &c. A series of monographs dealing mostly with the period before 1845 will be found in *The Quarterly of the Texas State Historical Association* (Austin, 1897 sqq.). Among the manuscript treasures at Austin may be mentioned the diplomatic correspondence of the Republic in the state department, the Nacogdoches archives and the W. D. Miller papers in the state library, and the Bexar archives and the Guy M. Bryan (Austin) papers in the university.

TEXT (Lat. *textum*, woven fabric, from *texere*, to weave), a term which is applied with several varieties of meaning to the actual words of an author as written; it is thus used of the original composition as opposed to the commentary, paraphrase, notes, &c., written by others upon it, and to the written printed matter as opposed to the illustrations, diagrams, &c., accompanying it (see TEXTUAL CRITICISM below). A specific meaning is that of a passage of Scripture used as the subject of a sermon or discourse, as an argument or illustration in theological discussion or as a means of edification, exhortation or admonition. Technically the term is also applied to a particular form of writing in MSS. before the age of printing, and so, in composition, in such uses as "text-hand," "text-writer," &c. A "text-book" is a manual or handbook of instruction, such as is used by students as the standard book on the subject which they may be studying.

TEXTILE-PRINTING. "Textile" (see WEAVING) is a general name for all woven fabrics (Lat. *texere*, to weave), and the art of ornamenting such fabrics by printing on designs or patterns in colour is very ancient, probably originating in the East. It has been practised in some form, with considerable success, in China and India from time immemorial, and the Chinese, at least, are known to have made use of engraved wood-blocks many centuries before any kind of printing was known in Europe. That the early Egyptians, too, were acquainted with the art is proved not merely by the writings of Pliny but by the discovery, in the Pyramids and other Egyptian tombs, of fragments of cloth which were undoubtedly decorated by some method of printing.

The Incas of Peru, Chile and Mexico also practised textile-printing previous to the Spanish Invasion in 1519; but, owing to the imperfect character of their records before that date, it is impossible to say whether they discovered the art for themselves, or, in some way, learnt its principles from the Asiatics.

There is no doubt that India was the source from which, by two different channels, Europeans derived their knowledge of block-printing. By land its practice spread slowly westwards through Persia, Asia Minor and the Levant, until it was taken up in Europe—during the latter half of the 17th century. Almost at the same time the French brought directly by sea, from their colonies on the east coast of India, samples of Indian blue and white "resist" prints, and along with them, particulars of the processes by which they had been produced.

I. TECHNOLOGY

Textile-printing was introduced into England in 1676 by a French refugee who opened works, in that year, on the banks of the Thames near Richmond. Curiously enough this is the first print-works on record; but the nationality and political status of its founder are sufficient to prove that printing was previously carried on in France. In Germany, too, textile printing was in all probability well established before it spread to England, for, towards the end of the 17th century, the district of Augsburg was celebrated for its printed linens—a reputation not likely to have been built up had the industry been introduced later than 1676.

On the continent of Europe the commercial importance of calico-printing seems to have been almost immediately recognized, and in consequence it spread and developed there much more rapidly than in England, where it was neglected and practically at a standstill for nearly ninety years after its introduction. During the last two decades of the 17th century and the earlier ones of the 18th new works were started in France, Germany, Switzerland and Austria; but it was only in 1738 that calico-printing was first practised in Scotland, and not until twenty-six years later that Messrs Clayton of Bamber Bridge, near Preston, established in 1764 the first print-works in Lancashire, and thus laid the foundation of what has since become one of the most important industries of the county and indeed of the country. At the present time calico-printing is carried on extensively in every quarter of the globe, and it is pretty safe to say that there is scarcely a civilized country in either hemisphere where a print-works does not exist.

From an artistic point of view most of the pioneer work in calico-printing was done by the French; and so rapid was their advance in this branch of the business that they soon came to be acknowledged as its leading exponents. Their styles of design and schemes of colour were closely followed—even deliberately copied—by all other European printers; and, from the early days of the industry down to the latter half of the 19th century, the productions of the French printers in Jouy, Beauvais, Rouen, Alsace-Lorraine, &c., were looked upon as representing "all that was best" in artistic calico-printing. This reputation was established by the superiority of their *earlier* work, which, whatever else it may have lacked, possessed in a high degree the two main qualities essential to all good decorative work, viz., appropriateness of pattern and excellency of workmanship. If, occasionally, the earlier designers permitted themselves to indulge in somewhat bizarre fancies, they at least carefully refrained from any attempt to produce those pseudo-realistic effects the undue straining after which in later times ultimately led to the degradation of not only French calico-printing design, but of that of all other European nations who followed their lead. The practice of the older craftsmen, at their best, was to treat their ornament in a way at once broad, simple and direct, thoroughly artistic and perfectly adapted to the means by which it had to be reproduced. The result was that their designs were characterized, on the one hand, by those qualities of breadth, flatness of field, simplicity of treatment and pureness of tint so rightly prized by the artist; and, on the other, by their entire freedom from those meretricious effects of naturalistic projection and recession so dear to the modern mind and so utterly opposed to the principles of applied art.

Methods of Printing.

Broadly speaking textile-printing means the local application, to textile fabrics, of any colour in definite patterns or designs, but in properly printed goods the colour becomes part and parcel of the fibre, or, in other words, the latter is dyed so as to resist washing and friction. Textile-printing, then, may be looked upon as a form of dyeing; but, whereas in dyeing proper the whole fabric is uniformly covered with one colour, in printing one or more colours are applied to it in certain parts only, and in sharply defined patterns. In principle these two branches of textile colouring are closely allied, for the colouring matters used in each case are practically identical, but in practice the means whereby their respective objects are attained bear little or no resemblance to each other. In dyeing, for instance, it is sufficient, for the most part, to immerse the fabric in an aqueous solution of the dye-stuff, stirring it about constantly or otherwise manipulating it to prevent unevenness. In printing, however, the colour must be applied by special means—either by a wooden block, a stencil or engraved plates, or rollers—and thickened to prevent it from spreading, by capillary attraction, beyond the limits of the pattern or design. Many colours also contain, besides the colouring matter and thickening, all the substances necessary for their proper fixation on the cloth when the latter is simply passed through a subsequent process of steaming, and others again require to be subjected to many after treatments before they are thoroughly developed and rendered fast to light and washing.

There are five distinct methods at present in use for producing coloured patterns on cloth:—

(1) Hand block-printing.

(2) Perrotine or block-printing by machine.

(3) Engraved plate-printing.

(4) Engraved roller-printing.

(5) Stencilling, which although not really a printing process may be classed here as one.

(1) *Hand Block-Printing.*—This process, though considered by some to be the most artistic, is the earliest, simplest and slowest of all methods of printing.

The blocks may be made of box, lime, holly, sycamore, plane or pear wood, the latter three being most generally employed. They vary in size considerably, but must always be between two and three inches thick, otherwise they are liable to warp—a defect which is additionally guarded against by backing the wood chosen with two or more pieces of cheaper wood, such as deal or pine. The several pieces or blocks are tongued and grooved to fit each other, and are then securely glued together, under pressure, into one solid block with the grain of each alternate piece running in a different direction.

The block, being planed quite smooth and perfectly flat, next has the design drawn upon, or transferred to it. This latter is effected by rubbing off, upon its flat surface, a tracing in lamp-black and oil, of the outlines of the masses of the design. The portions to be left in relief are then tinted, between their outlines, in ammoniacal carmine or magenta, for the purpose of distinguishing them from those portions which have to be cut away. As a separate block is required for each distinct colour in the design, a separate tracing must be made of each and transferred (or "put on" as it is termed) to its own special block.

Having thus received a tracing of the pattern the block is thoroughly damped and kept in this condition by being covered with wet cloths during the whole process of "cutting." The block-cutter commences by carving out the wood around the heavier masses first, leaving the finer and more delicate work until the last so as to avoid any risk of injuring it during the cutting of the coarser parts. When large masses of colour occur in a pattern, the corresponding parts on the block are usually cut in outline, the object being filled in between the outlines with felt, which not only absorbs the colour better, but gives a much more even impression than it is possible to obtain with a large surface of wood. When finished, the block presents the appearance of flat relief carving, the design standing out like letterpress type.

Fine details are very difficult to cut in wood, and, even when successfully cut, wear down very rapidly or break off in printing. They are therefore almost invariably built up in strips of brass or copper, bent to shape and driven edgewise into the flat surface of the block. This method is known as "coppering," and by its means many delicate little forms, such as stars, rosettes and fine spots can be printed, which would otherwise be quite impossible to produce by hand or machine block-printing.

Frequently, too, the process of "coppering" is used for the purpose of making a mould, from which an entire block can be made and duplicated as often as desired, by casting. In this case the metal strips are driven to a predetermined depth into the face of a piece of lime-wood cut across the grain, and, when the whole design is completed in this way, the block is placed, metal face downwards, in a tray of molten type-metal or solder, which transmits sufficient heat to the inserted portions of the strips of copper to enable them to carbonize the wood immediately in contact with them and, at the same time, firmly attaches itself to the outstanding portions. When cold a slight tap with a hammer on the back of the lime-wood block easily detaches the cake of the type-metal or alloy and along with it, of course, the strips of copper to which it is firmly soldered, leaving a matrix, or mould, in wood of the original design. The casting is made in an alloy of low melting-point, and, after cooling, is filed or ground until all its projections are of the same height and perfectly smooth, after which it is screwed on to a wooden support and is ready for printing. Similar moulds are also made by burning out the lines of the pattern with a red-hot steel punch, capable of being raised or lowered at will, and under which the block is moved about by hand along the lines of the pattern.

In addition to the engraved block, a printing table and colour sieve are required. The table consists of a stout framework of wood or iron supporting a thick slab of stone varying in size according to the width of cloth to be printed. Over the stone table top a thick piece of woollen printer's blanket is tightly stretched to supply the elasticity necessary to give the block every chance of making a good impression on the cloth. At one end, the table is provided with a couple of iron brackets to carry the roll of cloth to be printed and, at the other, a series of guide rollers, extending to the ceiling, are arranged for the purpose of suspending and drying the newly printed goods. The "colour sieve" consists of a tub (known as the swimming tub) half filled with starch paste, on the surface of which floats a frame covered at the bottom with a tightly-stretched piece of mackintosh or oiled calico. On this the "colour sieve" proper, a frame similar to the last but covered with fine woollen cloth, is placed, and forms when in position a sort of elastic colour trough over the bottom of which the colour is spread evenly with a brush.

The *modus operandi* of printing is as follows:—The printer commences by drawing a length of cloth, from the roll, over the table, and marks it with a piece of coloured chalk and a ruler to indicate where the first impression of the block is to be applied. He then applies his block in two different directions to the colour on the sieve and finally presses it firmly and steadily on the cloth, ensuring a good impression by striking it smartly on the back with a wooden mallet. The second impression is made in the same way, the printer taking care to see that it fits exactly to the first, a point which he can make sure of by means of the pins with which the blocks are provided at each corner and which are arranged in such a way that when those at the right side or at the top of the block fall upon those at the left side or the bottom of the previous impression the two printings join up exactly and continue the pattern without a break. Each succeeding impression is made in precisely the same manner until the length of cloth on the table is fully printed. When this is done it is wound over the drying rollers, thus bringing forward a fresh length to be treated similarly.

If the pattern contains several colours the cloth is usually first printed throughout with one, then dried, re-wound and printed with the second, the same operations being repeated until all the colours are printed.

Many modifications of block-printing have been tried from time to time, but of these only two—"tobying" and "rainbowing"—are of any practical value. The object of "tobey-printing" is to print the several colours of a multicolour pattern at one operation, and for this purpose a block with the whole of the pattern cut upon it, and a specially constructed "colour sieve" are employed. The sieve consists of a thick block of wood, on one side of which a series of compartments are hollowed out, corresponding roughly in shape, size and position to the various objects cut on the block. The tops of the dividing walls of these compartments are then coated with melted pitch, and a piece of fine woollen cloth is stretched over the whole and pressed well down on the pitch so as to adhere firmly to the top of each wall; finally a piece of string soaked in pitch is cemented over the woollen cloth along the lines of the dividing walls, and after boring a hole through the bottom of each compartment the sieve is ready for use. In operation each compartment is filled with its special colour through a pipe connecting it with a colour box situated at the side of the sieve and a little above it, so as to exert just sufficient pressure on the colour to force it gently through the woollen cloth, but not enough to cause it to overflow its proper limits, formed by the pitch-soaked string boundary lines.

The block is then carefully pressed on the sieve, and, as the different parts of its pattern fall on different parts of the sieve, each takes up a certain colour which it transfers to the cloth in the usual way. By this method of "tobying" from two to six colours may be printed at one operation, but it is obvious that it is only applicable to patterns where the different coloured objects are placed at some little distance apart, and that, therefore, it is of but limited application.

Block-printing by hand is a slow process; it is, however, capable of yielding highly artistic results, some of which are unobtainable by any other means, and it is, therefore, still largely practised for the highest class of work in certain styles.

(2) *Perrotine-Printing.*—The "perrotine" is a block-printing machine invented by Perrot of Rouen in 1834, and practically speaking is the only successful mechanical device ever introduced for this purpose. For some reason or other it has rarely been used in England, but its value was almost immediately recognized on the Continent, and although block-printing of all sorts has been replaced to such an enormous extent by roller-printing, the "perrotine" is still largely employed in French, German and Italian works.

The construction of this ingenious machine is too complex to describe here without the aid of several detailed drawings, but its mode of action is roughly as follows:—Three large blocks (3 ft. long by 3 to 5 in. wide), with the pattern cut or cast on them in relief, are brought to bear successively on the three faces of a specially constructed printing table over which the cloth passes (together with its backing of printer's blanket) after each impression. The faces of the table are arranged at right angles to each other, and the blocks work in slides similarly placed, so that their engraved faces are perfectly parallel to the tables. Each block is moreover provided with its own particular colour trough, distributing brush, and woollen colour pad or sieve, and is supplied automatically with colour by these appliances during the whole time that the machine is in motion. The first effect of starting the machine is to cause the colour sieves, which have a reciprocating motion, to pass over, and receive a charge of colour from the rollers, fixed to revolve, in the colour troughs. They then return to their original position between the tables and the printing blocks, coming in contact on the way with the distributing brushes, which spread the colour evenly over their entire surfaces. At this point the blocks advance and are gently pressed twice against the colour pads (or sieves) which then retreat once more towards the colour troughs. During this last movement the cloth to be printed is drawn forward over the first table, and, immediately the colour pads are sufficiently out of the way, the block advances and, with some force, stamps the first impression on it. The second block is now put into gear and the foregoing operations are repeated for both blocks, the cloth advancing, after each impression, a distance exactly equal to the width of the blocks. After the second block has made its impression the third comes into play in precisely the same way, so that as the cloth leaves the machines it is fully printed in three separate colours, each fitting into its proper place and completing the pattern. If necessary the forward movement of the cloth can be arrested without in any way interfering with the motion of the blocks—an arrangement which allows any insufficiently printed impression to be repeated in exactly the same place with a precision practically impossible in hand-printing.

For certain classes of work the "perrotine" possesses great advantages over the hand-block; for not only is the rate of production greatly increased, but the joining up of the various impressions to each other is much more exact—in fact, as a rule, no sign of a break in continuity of line can be noticed in well-executed work. On the other hand, however, the "perrotine" can only be applied to the production of patterns containing not more than three colours nor exceeding five inches in vertical repeat, whereas hand block-printing can cope with patterns of almost any scale and containing any number of colours. All things considered, therefore, the two processes cannot be compared on the same basis: the "perrotine" is best for work of a utilitarian character and the hand-block for decorative work in which the design only repeats every 15 to 20 in. and contains colours varying in number from one to a dozen.

(3) *Engraved Copperplate-Printing.*—The printing of textiles from engraved copperplates was first practised by Bell in 1770. It is now entirely obsolete, as an industry, in England, and is only mentioned here because it is, to a slight extent, still used in Switzerland for printing finely engraved borders on a special style of handkerchief the centre of which is afterwards filled in by block-printing.

The presses first used were of the ordinary letterpress type, the engraved plate being fixed in the place of the type. In later improvements the well-known cylinder press was employed; the plate was inked mechanically and cleaned off by passing under a sharp blade of steel; and the cloth, instead of being laid on the plate, was passed round the pressure cylinder. The plate was raised into frictional contact with the cylinder and in passing under it transferred its ink to the cloth.

The great difficulty in plate-printing was to make the various impressions join up exactly; and, as this could never be done with any certainty, the process was eventually confined to patterns complete in one repeat, such as handkerchiefs, or those made up of widely separated objects in which no repeat is visible, like, for instance, patterns composed of little sprays, spots, &c.

(4) *Roller-Printing, Cylinder-Printing, or Machine-Printing.*—This elegant and efficient process was patented and worked by Bell in 1785 only fifteen years after his application of the engraved plate to textiles. It will probably remain a moot question as to whether he was the originator of the idea, but it is beyond doubt that he was the first man to put into practice the continuous printing of cloth from engraved copper rollers. Bell's first patent was for a machine to print six colours at once, but, owing probably to its incomplete development, this was not immediately successful, although the principle of the method was shown to be practical by the printing of one colour with perfectly satisfactory results. The difficulty was to keep the six rollers, each carrying a portion of the pattern, in perfect register with each other. This defect was soon overcome by Adam Parkinson of Manchester, and in 1785, the year of its invention, Bell's machine with Parkinson's improvement was successfully employed by Messrs Livesey, Hargreaves, Hall & Co., of Bamber Bridge, Preston, for the printing of calico in from two to six colours at a single operation.

What Parkinson's contribution to the development of the modern roller-printing machine really was is not known with certainty, but it was possibly the invention of the delicate adjustment known as "the box wheel," whereby the rollers can be turned, whilst the machine is in motion, either in or against the direction of their rotation.

In its simplest form the roller-printing machine consists of a strong cast iron cylinder mounted in adjustable bearings capable of sliding up and down slots in the sides of the rigid iron framework. Beneath this cylinder the engraved copper roller rests in stationary bearings and is supplied with colour from a wooden roller which revolves in a colour-box below it. The copper roller is mounted on a stout steel axle, at one end of which a cog-wheel is fixed to gear with the driving wheel of the machine, and at the other end a smaller cog-wheel to drive the colour-furnishing roller. The cast iron pressure cylinder is wrapped with several thicknesses of a special material made of wool and cotton—lapping—the object of which is to provide the elasticity necessary to enable it to properly force the cloth to be printed into the lines of engraving. A further and most important appliance is the "doctor"—a thin sharp blade of steel which rests on the engraved roller and serves to scrape off every vestige of superfluous colour from its surface, leaving only that which rests in the engraving. On the perfect action of this "doctor" depends the entire success of printing, and as its sharpness and angle of inclination to the copper roller varies with the styles of work in hand it requires an expert to "get it up" (sharpen it) properly and considerable practical experience to know exactly what qualities it should possess in any given case. In order to prevent it (the "doctor") from wearing irregularly it is given a to-and-fro motion so that it is constantly changing its position and is never in contact with one part of the engraving for more than a moment at a time. A second "doctor" of brass or a similar alloy is frequently added on the opposite side of the roller to that occupied by the steel or "cleaning" doctor; it is known technically as the "lint doctor" from its purpose of cleaning off loose filaments or "lint" which the roller picks off the cloth during the printing operation. The steel or "cleaning doctor" is pressed against the roller by means of weighted levers, but the "lint doctor" is usually just allowed to rest upon it by its own weight as its function is merely to intercept the nap which becomes detached from the cloth and would, if not cleaned from the roller, mix with the colour and give rise to defective work.

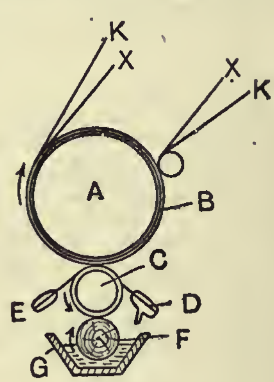


FIG. 1.

The working of the machine will be best understood by referring to the accompanying diagrammatic sketch of a single colour (fig. 1).

A is the cast iron pressure cylinder; B the lapping with which it is usually wrapped; C the engraved copper printing roller; D the steel "cleaning doctor"; E the brass "lint doctor"; F the colour-furnishing roller; G the colour-trough or "box" in which the latter (F) works partly immersed in colour; X an endless woollen blanket continually circulating between the cloth to be printed (K) and the cylinder A; and K the cloth in question. In operation, the cylinder A is screwed down with an even pressure into frictional contact with the roller C; the machine is then set in motion, turning in the direction indicated by the arrows; the cloth is now introduced between A and C and as it leaves the machine fully printed it is carried over a series of drying cylinders situated above and heated by steam. The printing roller C is the only part of the machine directly connected with the motor or main drive of the works through the cog-wheel on its axle—the "mandril"—all the other parts deriving their motion from *it*, either by friction as in the case of the cylinder or by a spur wheel as in that of the colour-furnishing roller. The mode of printing is almost self-evident; the roller C revolving in the direction of the arrow takes colour from the "furnisher" F, the excess is scraped off by the "doctor" G and, in continuing its course, it comes in contact with the cloth K, which being pressed by the cylinder A into the engraving abstracts the colour therefrom and of course receives an exact impression of the engraved pattern.

Larger machines printing from two to sixteen colours are precisely similar in principle to the above, but differ somewhat in detail and are naturally more complex and difficult to operate. In a twelve-colour machine, for example, twelve copper rollers, each carrying one portion of the design, are arranged round a central pressure cylinder, or bowl, common to all, and each roller is driven by a common driving wheel, called the "crown" wheel, actuated, in most cases, by its own steam-engine or motor. Another difference is that the adjustment of pressure is transferred from the cylinder to the rollers which work in specially constructed bearings capable of the following movements: (1) Of being screwed up bodily until the rollers are lightly pressed against the central bowl; (2) of being moved to and fro sideways so that the rollers may be laterally adjusted; and (3) of being moved up or down for the purpose of adjusting the rollers in vertical direction. Notwithstanding the great latitude of movement thus provided each roller is furnished with a "box-wheel," which serves the double purpose of connecting or gearing it to the driving wheel, and of affording a fine adjustment. Each roller is further furnished with its own colour-box and doctors.

With all these delicate equipments at his command a machine-printer is enabled to fit all the various parts of the most complicated patterns with an ease, despatch and precision which are remarkable considering the complexity and size of the machine.

In recent years many improvements have been made in printing machines and many additions made to their already wonderful capacities. Chief amongst these are those embodied in the "Intermittent" and the "Duplex" machines. In the former any or all of the rollers may be moved out of contact with the cylinder at will, and at certain intervals. Such machines are used in the printing of shawls and "sarries" for the Indian market. Such goods require a wide border right across their width at varying distances—sometimes every three yards, sometimes every nine yards—and it is to effect this, with rollers of ordinary dimensions, that "intermittent" machines are used. The body of the "sarrie" will be printed, say for six yards with eight rollers; these then drop away from the cloth and others, which have up to then been out of action, immediately fall into contact and print a border or "crossbar," say one yard wide, across the piece; they then recede from the cloth and the first eight again return and print another six yards, and so on continually.

The "Duplex" or "Reversible" machine derives its name from the fact that it prints both sides of the cloth. It consists really of two ordinary machines so combined that when the cloth passes, fully printed on one side from the first, its plain side is exposed to the rollers of the second, which print an exact duplicate of the first impression upon it in such a way that both printings coincide. A pin pushed through the face of the cloth ought to protrude through the corresponding part of the design printed on the back if the two patterns are in good "fit."

The advantages possessed by roller-printing over all other processes are mainly three: firstly, its high productivity—10,000 to 12,000 yds. being commonly printed in one day of ten hours by a single-colour machine; secondly, by its capacity of being applied to the reproduction of every style of design, ranging from the fine delicate lines of copperplate engraving and the small "repeats" and limited colours of the "perrotine" to the broadest effects of block-printing and to patterns varying in "repeat" from 1 to 80 in.; and thirdly, the wonderful exactitude with which each portion of an elaborate multicolour pattern can be fitted into its proper place, and the entire absence of faulty joints at its points of "repeat" or repetition—a consideration of the utmost importance in fine delicate work, where such a blur would utterly destroy the effect.

(5) *Stencilling.*—The art of stencilling is very old. It has been applied to the decoration of textile fabrics from time immemorial by the Japanese, and, of late years, has found increasing employment in Europe for certain classes of decorative work on woven goods for furnishing purposes.

The pattern is cut out of a sheet of stout paper or thin metal with a sharp-pointed knife, the uncut portions representing the part that is to be "reserved" or left uncoloured. The sheet is now laid on the material to be decorated and colour is brushed through its interstices.

It is obvious that with suitable planning an "all over" pattern may be just as easily produced by this process as by hand or machine printing, and that moreover, if several plates are used, as many colours as plates may be introduced into it. The peculiarity of stencilled patterns is that they have to be held together by "ties," that is to say, certain parts of them have to be left uncut, so as to connect them with each other, and prevent them from falling apart in separate pieces. For instance, a complete circle cannot be cut without its centre dropping out, and, consequently, its outline has to be interrupted at convenient points by "ties" or uncut portions. Similarly with other objects. The necessity for "ties" exercises great influence on the design, and in the hands of a designer of indifferent ability they may be very unsightly. On the other hand, a capable man utilizes them to supply the drawing, and when thus treated they form an integral part of the pattern and enhance its artistic value whilst complying with the conditions and the process.

For single-colour work a stencilling machine was patented in 1894 by S. H. Sharp. It consists of an endless stencil plate of thin sheet steel which passes continuously over a revolving cast iron cylinder. Between the two the cloth to be ornamented passes and the colour is forced on to it, through the holes in the stencil, by mechanical means.

(6) *Other Methods of Printing.*—Although most work is executed throughout by one or other of the five distinct processes mentioned above, combinations of them are not infrequently employed. Sometimes a pattern is printed partly by machine and partly by block; and sometimes a cylindrical block is used along with engraved copper-rollers in the ordinary printing machine. The block in this latter case is in all respects, except that of shape, identical with a flat wood or "coppered" block, but, instead of being dipped in colour, it receives its supply from an endless blanket, one part of which works in contact with colour-furnishing rollers and the other part with the cylindrical block. This block is known as a "surface" or "peg" roller. Many attempts have been made to print multicolour patterns with "surface" rollers alone, but hitherto with little success, owing to their irregularity in action and to the difficulty of preventing them from warping. These defects are not present in the printing of linoleum in which opaque oil colours are used—colours which neither sink into the body of the hard linoleum nor tend to warp the roller.

The printing of yarns and warps is extensively practised. It is usually carried on by a simple sort of "surface" printing machine and calls for no special mention.

Lithographic printing, too, has been applied to textile fabrics with somewhat qualified success. Its irregularity and the difficulty of printing "all over" patterns to "repeat" properly, have restricted its use to the production of decorative panels, equal in size to that of the plate or stone, and complete in themselves.

Engraving of Copper Rollers

The engraving of copper rollers is one of the most important branches of textile-printing and on its perfection of execution depends, in great measure, the ultimate success of the designs. Roughly speaking, the operation of engraving is performed by three different methods, viz. (1) By hand with a graver which cuts the metal away; (2) by etching, in which the pattern is dissolved out in nitric acid; and (3) by machine, in which the pattern is simply indented.

(1) Engraving by hand is the oldest and most obvious method of engraving, but is the least used at the present time on account of its slowness. The design is transferred to the roller from an oil-colour tracing and then merely cut out with a steel graver, prismatic in section, and sharpened to a bevelled point. It requires great steadiness of hand and eye, and although capable of yielding the finest results it is only now employed for very special work and for those patterns which are too large in scale to be engraved by mechanical means.

(2) In the etching process an enlarged image of the design is cast upon a zinc plate by means of an enlarging camera and prisms or reflectors. On this plate it is then painted in colours roughly approximating to those in the original, and the outlines of each colour are carefully engraved in duplicate by hand. The necessity for this is that in subsequent operations the design has to be again reduced to its original size and, if the outlines on the zinc plate were too small at first, they would be impracticable either to etch or print. The reduction of the design and its transfer to a varnished copper roller are both effected at one and the same operation in the pantograph machine. This machine is capable of reducing a pattern on the zinc plate from one-half to one-tenth

of its size, and is so arranged that when its pointer or "stylus" is moved along the engraved lines of the plate a series of diamond points cut a reduced facsimile of them through the varnish with which the roller is covered. These diamond points vary in number according to the number of times the pattern is required to repeat along the length of the roller. Each colour of a design is transferred in this way to a separate roller. The roller is then placed in a shallow trough containing nitric acid, which acts only on those parts of it from which the varnish has been scraped. To ensure evenness the roller is revolved during the whole time of its immersion in the acid. When the etching is sufficiently deep the roller is washed, the varnish dissolved off, any parts not quite perfect being retouched by hand.

(3) In machine engraving the pattern is impressed in the roller by a small cylindrical "mill" on which the pattern is in relief. It is an indirect process and requires the utmost care at every stage. The pattern or design is first altered in size to repeat evenly round the roller. One repeat of this pattern is then engraved by hand on a small highly polished soft steel roller, usually about 3 in. long and ½ in. to 3 in. in diameter; the size varies according to the size of the "repeat" with which it must be identical. It is then repolished, painted with a chalky mixture to prevent its surface oxidizing and exposed to a red-heat in a box filled with chalk and charcoal; then it is plunged in cold water to harden it and finally tempered to the proper degree of toughness. In this state it forms the "die" from which the "mill" is made. To produce the actual "mill" with the design in relief a softened steel cylinder is screwed tightly against the hardened die and the two are rotated under constantly increasing pressure until the softened cylinder or "mill" has received an exact replica in *relief* of the engraved pattern. The "mill" in turn is then hardened and tempered, when it is ready for use. In size it may be either exactly like the "die" or its circumferential measurement may be any multiple of that of the latter according to circumstances.

The copper roller must in like manner have a circumference equal to an exact multiple of that of the "mill," so that the pattern will join up perfectly without the slightest break in line.

The *modus operandi* of engraving is as follows:—The "mill" is placed in contact with one end of the copper roller, and being mounted on a lever support as much pressure as required can be put upon it by adding weights. Roller and "mill" are now revolved together, during which operation the projection parts of the latter are forced into the softer substance of the roller, thus engraving it, in intaglio, with several replicas of what was cut on the original "die." When the full circumference of the roller is engraved, the "mill" is moved sideways along the length of the roller to its next position, and the process is repeated until the whole roller is fully engraved.

Preparation of Cloth for Printing

Goods intended for calico-printing ought to be exceptionally well bleached, otherwise mysterious stains, and other serious defects, are certain to arise during subsequent operations. Particulars of bleaching will be found in the article Bleaching (*q.v.*).

The chemical preparations used for special styles will be mentioned in their proper places; but a general "prepare," employed for most colours that are developed and fixed by steaming only, consists in passing the bleached calico through a weak solution of "sulphated" or turkey red oil containing from 2½ per cent. to 5 per cent. of fatty acid. Some colours are printed on pure bleached cloth, but all patterns containing alizarine red, rose and salmon shades, are considerably brightened by the presence of oil, and indeed very few, if any, colours are detrimentally affected by it.

Apart from wet preparations the cloth has always to be brushed, to free it from loose nap, flocks and dust which it picks up whilst stored. Frequently, too, it has to be "sheared" by being passed over rapidly revolving knives arranged spirally round an axle, which rapidly and effectually cuts off all filaments and knots, leaving the cloth perfectly smooth and clean and in a condition fit to receive impressions of the most delicate engraving. Some figured fabrics, especially those woven in checks, stripes and "cross-overs," require very careful stretching and straightening on a special machine, known as a "stenter," before they can be printed with certain formal styles of pattern which are intended in one way or another to correspond with the cloth pattern. Finally, all descriptions of cloth are wound round hollow wooden or iron centres into rolls of convenient size for mounting on the printing machines.

Preparation of Colours

The art of making colours for textile-printing demands both chemical knowledge and extensive technical experience, for their ingredients must not only be properly proportioned to each other, but they must be specially chosen and compounded for the particular style of work in hand. For a pattern containing only one colour any mixture whatever may be used so long as it fulfils all conditions as to shade, quality and fastness; but where two or more colours are associated in the same design each must be capable of undergoing without injury the various operations necessary for the development and fixation of the others.

All printing pastes whether containing colouring matter or not are known technically as "colours," and are referred to as such in the sequence.

Colours vary considerably in composition. The greater number of them contain all the elements necessary for the direct production and fixation of the colour-lake. Some few contain the colouring matter alone and require various after-treatments for its fixation; and others again are simply "mordants" thickened. A mordant is the metallic salt or other substance which combines with the colouring principle to form an insoluble colour-lake, either directly by steaming, or indirectly by dyeing.

All printing colours require to be thickened, for the twofold object of enabling them to be transferred from colour-box to cloth without loss and to prevent them from "running" or spreading beyond the limits of the pattern.

Thickening Agents.—The thickening agents in most general use as vehicles in printing, are starch, flour, gum arabic, gum senegal and gum tragacanth, British gum or dextrine and albumen.

With the exception of albumen all these are made into pastes, or dissolved, by boiling in double or "jacketed" pans, between the inner and outer casings of which either steam or water may be made to circulate, for boiling and cooling purposes. Mechanical agitators are also fitted in these pans to mix the various ingredients together, and to prevent the formation of lumps by keeping the contents thoroughly stirred up during the whole time they are being boiled and cooled.

Starch Paste.—This is made by mixing 15 ℔ of wheat starch with a little cold water to a smooth creamy paste; a little olive oil is then added and sufficient water to bring the whole up to 10 gallons. The mixture is then thickened by being boiled for about an hour and, after cooling, is ready for use.

Starch is the most extensively used of all the thickenings. It is applicable to all but strongly alkaline or strongly acid colours. With the former it thickens up to a stiff unworkable jelly, while mineral acids or acid salts convert it into dextrine, thus diminishing its thickening power. Acetic and formic acids have no action on it even at the boil.

Flour paste is made in a similar way to starch paste. At the present time it is rarely used for anything but the thickening of aluminium and iron mordants, for which it is eminently adapted.

Gum arabic and gum senegal are both very old thickenings, but their expense prevents them from being used for any but pale delicate tints. They are especially useful thickenings for the light ground colours of soft muslins and sateens on account of the property they possess of dissolving completely out of the fibres of the cloth in the washing process after printing. Starch and artificial gums always leave the cloth somewhat harsh in "feel" unless they are treated specially, and are moreover incapable of yielding the beautifully clear and perfectly even tints resulting from the use of natural gums. Very dark colours cannot well be obtained with gum senegal or gum arabic thickenings; they come away too much in washing, the gum apparently preventing them from combining fully with the fibres. Stock solutions of these two gums are usually made by dissolving 6 or 8 ℔ of either in one gallon of water, either by boiling or in the cold by standing.

British gum or dextrine is prepared by heating starch. It varies considerably in composition—sometimes being only slightly roasted and consequently only partly converted into dextrine, and at other times being highly torrefied, and almost completely soluble in cold water and very dark in colour. Its thickening power decreases and its "gummy" nature increases as the temperature at which it is roasted is raised. The lighter coloured gums or dextrines will make a good thickening with from 2 to 3 ℔ of gum to one gallon of water, but the darkest and most highly calcined require from 6 to 10 ℔ per gallon to give a substantial paste. Between these limits all qualities are obtainable. The darkest qualities are very useful for strongly acid colours, and with the exception of gum senegal, are the best for strongly alkaline colours and discharges.

Like the natural gums, neither light nor dark British gums penetrate into the fibre of the cloth so deeply as pure starch or flour, and are therefore unsuitable for very dark strong colours.

Gum tragacanth, or "Dragon," is one of the most indispensable thickening agents possessed by the textile printer. It may be mixed in any proportion with starch or flour and is equally useful for pigment colours and mordant colours. When added to starch paste it increases its penetrative power, adds to its softness without diminishing its thickness, makes it easier to wash out of the fabric and produces much more level colours than starch paste alone. Used by itself it is suitable for printing all kinds of dark grounds on goods which are required to retain their soft clothy feel. A tragacanth mucilage may be made either by allowing it to stand a day or two in contact with cold water or by soaking it for twenty-four hours in warm water and then boiling it up until it is perfectly smooth and homogeneous. If boiled under pressure it gives a very fine smooth mucilage (not a solution proper), much thinner than if made in the cold.

Albumen.—Albumen is both a thickening and a fixing agent for insoluble pigments such as chrome yellow, the ochres, vermilion and ultramarine. Albumen is always dissolved in the cold, a process which takes several days when large quantities are required. The usual strength of the solution is 4 ℔ per gallon of water for blood albumen, and 6 ℔ per gallon for egg albumen. The latter is expensive and only used for the lightest shades. For most purposes one part of albumen solution is mixed with one part of tragacanth mucilage, this proportion of albumen being found amply sufficient for the fixation of all ordinary pigment colours. In special instances the blood albumen solution is made as strong as 50 per cent., but this is only in cases where very dark colours are required to be absolutely fast to washing. After printing, albumen-thickened colours are exposed to hot steam, which coagulates the albumen and effectually fixes the colours.

Formerly colours were always prepared for printing by boiling the thickening agent, the colouring matter and solvents, &c., together, then cooling and adding the various fixing agents. At the present time, however, concentrated solutions of the colouring matters and other adjuncts are often simply added to the cold thickenings, of which large quantities are kept in stock.

Colours are reduced in shade by simply adding more starch or other paste. For example, a dark blue containing 4 oz. of methylene blue per gallon may readily be made into a pale shade by adding to it thirty times its bulk of starch paste or gum, as the case may be. Similarly with other colours.

Before printing it is very essential to strain or sieve all colours in order to free them from lumps, fine sand, &c., which would inevitably damage the highly polished surface of the engraved rollers and result in bad printing. Every scratch on the surface of a roller prints a fine line in the cloth, and too much care, therefore, cannot be taken to remove, as far as possible, all grit and other hard particles from every colour.

The straining is usually done by squeezing the colour through fine cotton or silk cloths. Mechanical means are also employed for colours that are used hot or are very strongly alkaline or acid.

Styles of Printing

The widely differing properties of the hundreds of colouring matters now on the market give rise to many different styles of textile-printing. Generally speaking, these fall into the following four great divisions:—

(1) Direct printing.
(2) The printing of a mordant upon which the colour is afterwards dyed.
(3) The discharge style.
(4) The resist or reserve style.

The fact that each of these divisions is further sub-divided into many smaller divisions renders it out of the question to give more than a few typical examples of the various styles they include.

(1) *Direct Printing.*—This style is capable of application to almost every class of colour known. Its essential feature is that the colouring matter and its fixing agent are both applied to the fabric simultaneously. In some instances the fabric requires to be previously prepared for certain of the colours used along with those characteristic of the process; but this is one of many cases where two styles are combined, and it must be classed with the one which it most resembles.

(*a*) *Application of Mordant Dye-Stuffs.*—Mordant colours include both artificial and natural dye-stuffs (see also under Dyeing), the most important of all being *alizarine*, an artificial preparation of the colouring-principle of the madder root. With different metallic oxides alizarine forms different colour-lakes all exceedingly fast to light and soap. Aluminium mordant gives red and pink lakes; iron mordant, purples and lavenders; chromium yields maroons; and uranium gives grey shades. Mixture of iron and aluminium produce various tones of chocolate and brown.

In addition to alizarine the following are a few of the more important mordant dye-stuffs employed in textile-printing:—

Alizarine orange with aluminium and chrome mordants for orange and warm brown shades respectively; alizarine bordeaux, with alumina, for violets; alizarine blue with chrome and zinc for quiet blue shades; coeruleine and alizarine viridine for greens and olives with chromium mordants; gallocyanine, chrome violet blue, alizarine cyanines, &c., with chromium for various shades of blue and violet; alizarine yellows and anthracene brown for yellows and fawn shades respectively with either aluminium or chrome mordants. The natural dye-stuffs belonging to this series are chiefly: logwood, with chromium and iron mordants, for blacks; Persian berries and quercitron bark, with aluminium, tin and chromium mordants, for colours ranging from brilliant yellow to quiet old golds and browns; catechu, with chromium, for very fast dark browns; and, occasionally, in mixtures, sapan-wood, peach-wood, Brazil-wood, and divi-divi extracts with any of the above-mentioned mordants.

The mordants are mostly in the form of acetates which are stable in the cold but decompose during the steaming process, and combine as hydroxides with the colours, forming and fixing on the fabric the insoluble lake.

Alizarine reds and pinks are the most complicated of the mordant colours, requiring for their proper production the addition of brightening agents, such as oxalate of tin, oils, tartaric acid, and also acetate of lime. This also applies to alizarine orange, but all the other colours are very simple to compound and are stable for a long time after making. Reds, pinks and oranges are best prepared freshly each day; their constituents are liable to combine if the colour stands twenty-four hours before printing.

The following types of recipes will give some idea of the way in which colours are mixed:—

Red. 6½ gallons thick starch and tragacanth paste.
1¼ ,, alizarine (20 per cent. commercial paste).
1 ,, nitrate of alumina, 18° Tw.
½ ,, acetate of lime, 28° Tw.
¼ ,, oxalate of tin, 10° Tw.
½ ,, 10 per cent. solution of tartaric acid.

Pink. 6½ gallons starch-tragacanth paste.
1 ,, blue shade alizarine (20 per cent. paste).
1¼ ,, sulphocyanide of alumina, 18° Tw.
⅜ ,, acetate of lime, 28° Tw.
¼ ,, oxalate of tin.
½ ,, citrate of alumina, 40° Tw.

For reds and pinks the nitrate, sulphocyanide and citrate of alumina are generally preferred in practice to the acetate though the latter is also largely used. Oranges from alizarine orange are made similarly.

Purple. 9⅛ gallons starch paste.
⅛ ,, blue shade alizarine, 20 per cent.
½ ,, acetic acid.
⅛ ,, acetate of lime, 28° Tw.
⅛ ,, acetate of iron, 24° Tw.

Maroon. 5½ gallons paste.
1 ,, alizarine, 20 per cent.
¾ ,, acetate of chrome, 32° Tw.
⅜ ,, acetate of lime, 28° Tw.

Blues and the other colours are made by leaving out the lime in the last recipe and replacing the alizarine with another colour.

Alizarine Blue. ½ ℔ alizarine blue shade (powd.).
(*Light Shade.*) 1 gallon water.
3½ ,, thick paste.
1½ ,, acetate of chrome, 40° Tw.

Logwood and other natural colours are specially boiled.

Logwood Black.
15 ℔ starch.
10 ,, British gum.
4½ gallons water.
¾ ,, acetic acid.
1½ ,, logwood extract, 48° Tw.
⅜ ,, quercitron extract, 48° Tw.

Boil, cool and add:—
½ ℔ red prussiate of potash.
¼ gallon water.
2 ,, acetate of chrome, 40° Tw.
2 oz. chlorate of potash.

Quercitron Yellow. 1½ gallons quercitron extract, 48° Tw.
6½ ,, water.
11 ℔ starch.

Boil, cool and add:—
¾ gallon acetate of chrome, 30° Tw.

The proportions here given are liable to variations according to circumstances. Indeed, no two works employ quite the same recipes, although the proportion of mordant to dye-stuff is pretty generally known and observed.

After printing, the goods are dried, steamed for one hour, and then washed and finished.

(*b*) *Application of Basic Aniline Dye-Stuffs.*—These colours all form insoluble lakes with tannic acid; hence tannic acid is the common fixing agent of the group. Arsenic in combination with alumina also gives basic-colour lakes, but their poisonous character and their inferior fastness to most reagents considerably limit their application.

The more important basic dye-stuffs are: methylene blue, methyl violet, rhodamine, auramine yellow, safranine emerald green and indoine blue. Most of them are fairly fast to soaping, but towards the action of light they vary a good deal, methylene blue being perhaps as good as any, and the malachite greens the least stable.

Their application is simple. A solution of the colouring matter is added to the requisite quantity of starch paste or gum, and, when well mixed in, the tannin is added in the form of a solution also. If desired they may be boiled up like the extract dye-stuffs (logwood, &c.), but this is not necessary unless large quantities are required, when it would be more convenient to boil the whole at once than to mix small batches by hand.

Methylene blue will serve as a type of the method by which all basic colours are compounded.

Blue. 2 gallons methylene blue, 10 per cent. solution in water and acetic acid.
6 ,, thick starch paste.
1 ,, tragacanth mucilage.
1 ,, tannic acid solution, 50 per cent.

10 gallons.

All other basic colours are made up for printing in a similar way by replacing the blue with the required dye-stuff.

After printing, goods containing basic dyes are "steamed," and passed through a solution of tartar emetic, or other salt of antimony, whereby an insoluble double tannate of antimony and colouring matter is formed, which constitutes a much faster colour than the single tannate of the dye-stuff.

Basic colours may be printed along with "mordant" and albumen colours.

(*c*) *Application of Direct Dyeing Colours.*—These colours have a natural affinity for the cotton fibre and therefore require no mordant. They are not very "fast," however, and, though used enormously in the dyeing of plain shades, they find but little employment in printing except for the tinting of printed goods, and for the "crepon" style, where the colours must be able to withstand the action of caustic soda.

They are usually printed with the addition of a slightly alkaline salt (phosphate of soda) and sulphate of soda. Amongst the hundreds of direct colours equally suitable for printing mention may be made of erica for pinks; diamine sky-blue for blues; diamine violet, and diamine, chrysamine, chloramine and dianil yellows. In fact, most of the benzidine, diamine, dianil and Congo dye-stuffs can be used for printing, but with the exception of the yellows none of them will resist the action of light and washing to anything like the extent that "mordant" and basic colours will. The general formula for printing these colours is as follows:—

4 oz. colouring matter.
¼ gallon water.
¾ ,, starch or tragacanth thickening.
4 oz. phosphate of soda.
2 oz. sulphate of soda.

After printing, with direct colours, the goods are first steamed, then slightly washed in a weak tepid soap solution and finally finished.

(*d*) *Application of Pigment Colours.*—Before the introduction of coal-tar colours, pigments and lakes played a much more important part in textile-printing than they do at present, though they are still largely used for certain styles of work. They form a series of colours more difficult to work than those already mentioned, but very fast to soap and light.

Pigment colours, being insoluble mineral precipitates or lakes, can only be fixed on the fibre mechanically; consequently they require to be applied in conjunction with vehicles which cause them to adhere to the fabric in much the same way that paint adheres to wood.

Of these vehicles, albumen is the most important and the best. It forms a smooth viscous solution with cold water, mixes readily with all the colours used in pigment printing, and possesses the property of coagulating when heated to the temperature of boiling water. When cloth printed with colours containing albumen is passed through hot steam or hot acid solutions, as in the indigo discharge style, the albumen coagulates, forming a tough insoluble colloidal deposit, which firmly fixes on the fibre any colour with which it is mixed.

The colours chiefly employed in pigment printing are: chrome yellow and orange, Guignet's green or chrome green; artificial ultramarine; lamp black for greys; the various ochres for golds and browns; zinc oxide; vermilion and its substitutes, and occasionally lakes of the natural and artificial colouring matters. All these bodies are applied in exactly the same way and may be mixed together in any proportion to form compound shades. The amount of albumen necessary to fix them varies according to the depth of shade required (between 10 and 25 per cent. of the total weight of the made-up printing colour), and although it is usually considered in text-books as a thickening agent it is rarely used as such in practice on account of its expense. As a rule the colouring matter is beaten up into a smooth paste with the necessary quantity of a strong solution of albumen and then reduced to its proper strength by the addition of tragacanth mucilage or starch paste.

The main factor in the successful working of pigment colours is their fineness of division; the finer they are the better they print and the more beautiful is their quality of colour. If they are too coarse they give rise to innumerable defects, either by sticking in the engraving or by scratching the roller, or, if they print at all, by yielding uneven masses of colour, granular and speckled in appearance and quite unsaleable. Even when finally ground they are liable to clog the engraving of the rollers—a defect which is more or less successfully overcome by replacing the colour-furnishing roller in the printing machine by a revolving brush.

The following formula of dark ultramarine blue will serve as a type of all other pigment printing colours:—

24 lb artificial ultramarine.

Place in grinding machine and beat up gradually with
4½ gallons 40 per cent. blood albumen solution.
2½ ,, tragacanth mucilage, 8 oz. per gallon.
1/32 ,, ammonia.
1/16 ,, glycerin.
1/32 ,, turpentine.
1/16 ,, olive or cotton-seed oil.

Make to 8 gallons with tragacanth or water, and grind the whole until perfectly homogeneous.

The small quantities of ammonia, turpentine, glycerin and oil are added to prevent the colour from frothing during the printing process.

Chrome yellows and oranges are frequently mixed with a little cadmium nitrate to counteract the action of sulphuretted hydrogen on the lead salts.

The great disadvantage of pigment colours is that although extremely fast to light and soap they are liable to rub off, if the fabric is subjected to much friction in washing. They also impart considerable stiffness to the goods, and for these two reasons they are therefore restricted to the printing of small patterns, or are used for such styles as window-blinds where the stiffness is not objectionable. In very pale shades they are used for printing the grounds or "blotches" of multicolour patterns, the small quantity of albumen they then contain being insufficient to appreciably affect the softness of the cloth. In several discharge styles too—notably indigo—they find extensive use, and on the whole they constitute a most useful class of colours.

(*e*) *Application of Indigo.*—Indigo is printed on cloth by several different methods, the chief of which are: (1) Schlieper and Baum's glucose process; (2) the hydrosulphite process; and (3) the production of indigo on the fibre itself by means of Kalle's indigo salt and several other artificial preparations. The first and second processes depend upon the facts that indigo in presence of caustic alkalis may be converted into indigo-white by reducing agents, and that the indigo-white, being soluble in the alkali, penetrates into the fibres of the cloth, where it is subsequently re-oxidized to its original insoluble state.

In Schlieper and Baum's process (also known as the glucose process) the cloth is first prepared in glucose, and then printed with a colour containing finely ground indigo, caustic soda and dextrine thickening (also made with caustic soda). After printing, the cloth is "aged," that is, passed through damp steam for a few minutes to effect the reduction and solution of the indigo, and is then hung up in a cool chamber for a day or two, in order to re-oxidize the indigo-white to indigo by the action of the oxygen in the air. A wash in cold water finally completes the fixation of the indigo, and the cloth may then be soaped and finished as usual. The cloth is prepared by running through a box containing a 30 per cent. solution of glucose in water; the excess is squeezed out in a mangle, and the cloth dried. It is then printed with the following colours according to shade required:—

	Dark Blue.	Medium Blue.	Light Blue.
Alkaline dextrine paste	7½ gals.	8 gals.	8 gals.
Caustic soda, 38° Tw.	1 ,,	1¼ ,,	1¾ ,,
Indigo 20 per cent. paste . . .	1½ ,,	¾ ,,	¼ ,,
	10 gals.	10 gals.	10 gals.

The printed goods should be dried quickly, and "aged" as soon as possible to prevent the absorption of carbonic acid gas from the air, after which the operations already mentioned may be proceeded with at leisure.

The well-known blue and red pattern is produced by this process, the only difference being that, instead of white cloth, turkey red dyed cloth is used, the strong alkali dissolving out, or "discharging," completely the colour from those parts of the cloth upon which it falls, and leaving the indigo as a blue pattern on a red ground.

In the *hydrosulphite process*, which is much quicker than the preceding, the reducing agent, the indigo and the alkali are all printed together on unprepared white cloth. The goods are then "aged," and allowed to lie a short time, after which they are washed-off in cold water first, until the indigo is thoroughly re-oxidized, and then in hot water or soap.

The hydrosulphite printing colour is as follows:—

$\left\{\begin{array}{l}\text{200 parts hydrosulphite N.F. (or 100 of the concentrated product).}\\ \text{450 ,, alkaline dextrine paste.}\end{array}\right.$

$\left\{\begin{array}{l}\text{150 ,, indigo 20 per cent. paste (ground up in gum).}\\ \text{200 ,, alkaline dextrine paste.}\end{array}\right.$

Thickening $\left\{\begin{array}{l}\text{150 parts dextrine or British gum.}\\ \text{850 ,, caustic soda, 70° Tw.}\end{array}\right.$

Print, dry, "age" and wash off in a copious supply of cold water

The third process with Kalle's salt is not properly speaking the printing of indigo, but of a special preparation capable of forming indigo when treated with caustic alkalis. The salt is merely dissolved and thickened with gum or starch, printed, and then passed direct through a solution of caustic soda, when the indigo is immediately developed. Instead of being passed through the alkali, which is apt to cause the colour to run before it is properly developed, the cloth is more commonly printed with thickened caustic soda, whereby the indigo is equally well produced without any fear of "running."

Besides indigo, other vat dye-stuffs, such as indanthrenes, the algol, helindone and ciba colours, thioindigo scarlet, &c., are also printed largely at the present time, yielding colours of hitherto unattained fastness to washing and to light.

(*f*) *Insoluble Azo-Colours.*—These colours do not exist as such, but require to be produced on the fibre itself from their components. They form a range of exceedingly fast colours, including orange, red, pink, maroon, brown, chocolate, blue and black, and are produced by the combination of various diazo-bodies with phenols, the most important of which latter is β-naphthol (beta-naphthol).

In practice their application is briefly as follows:—The bleached cloth is prepared in a solution of β-naphthol in caustic soda (naphtholate of soda), then gently dried and printed with the thickened diazotized amine required to produce the desired shade. The printing colour must be cooled with ice to prevent its decomposition; hence such colours are sometimes known as "ice colours."

The two colours most extensively used are para-nitraniline red and α-naphthylamine maroon, both of which are bright fast colours, only equalled by turkey red and madder chocolate for general usefulness.

On β-naphthol prepare the following colours may be obtained:—

Red with paranitraniline.
Maroon with α-naphthylamine.
Orange with orthonitrotoluidine.
Pink with azo pink 2 B.
Chocolate with benzidine.
Brown with benzidine and orthonitrotoluidine.
Blue with dianisidine.
Black with dianisidine and benzidine.

Other naphthols and other bases give a still greater variety of shades.

The naphthol prepare requires to be freshly made, and the cloth prepared with it carefully dried, if good results are to be obtained.

Paranitraniline is made up for printing by dissolving in hydrochloric acid. Nitrite of soda is then added, and, after standing a short time to complete the reaction, the resulting diazo-solution is mixed with thickening, and acetate of soda is then added to neutralize any free mineral acid still remaining, the presence of which would prevent the formation of the colour.

In practice the following formulae have given good results:—

(1) Paranitraniline Red

Prepare the bleached cloth in:—

47 parts β-naphthol.
3 ,, naphthol R.
107 ,, caustic soda, 50° Tw.
400 ,, hot water.
10 ,, tartar emetic.
12 ,, tartaric acid.

Make up to 1000 parts with hot water.

The cloth is passed through a trough containing this solution, the excess is squeezed out between two wooden rollers, and the cloth is gently dried and then printed with:—

36 parts paranitraniline C.
100 ,, ice.
100 ,, hydrochloric acid, 30° Tw.
70 ,, water.

Mix and add quickly:

24 parts nitrite of soda, 93 per cent.
70 ,, water (cold).

And just before printing add further:

100 parts acetate of soda.
100 ,, ice in large pieces.
400 ,, tragacanth mucilage, 12 per cent.

Print, dry and wash.

A similar prepare without the naphthol R. may be used for α-naphthylamine maroons, the printing colour for which is made up as follows:—

36 parts α-naphthylamine.
93 ,, hydrochloric acid, 30° Tw.
171 ,, tragacanth mucilage.

Grind till perfectly smooth in a mill and then add:

100 parts ice.
20 ,, nitrite of soda of 93 per cent. strength.
80 ,, water.
400 ,, starch and tragacanth thickening.
25 ,, benzine.
75 ,, acetate of soda.
1000

Print, dry and wash.

Immediately these diazo-colour pastes come in contact with the naphthol-prepared cloth the colour itself is formed and fixed and requires no further treatment except that of washing to remove the naphthol from the unprinted parts of the cloth.

The other bases are diazotized in precisely the same way, the quantities of acid and nitrite of soda being varied according to the molecular weights of each base.

Several processes of printing azo-colours directly, without any previous preparation of the cloth, have been proposed, but they are not in general use as yet; those which have passed the experimental stage are not very successful on the large scale, and have, for the most part, been abandoned.

(*g*) *Application of Sulphur Dyes.*—Of late years the class of colours known as "sulphur colours" have assumed a prominent place in textile-printing. They are really direct dyeing colours, but their special properties entitle them to be classed apart from those usually known under this name.

There are now an enormous number of sulphur-colours on the market under many different names, but, as they are all similar in general properties, it is needless to mention more than one series. The "thiogen colours" of Meister, Lucius and Bruning will serve as well as any to exemplify the application of these dye-stuffs in printing. They comprise yellows, golds, browns, violets, blues, greys and blacks, all fairly, and some very, fast to light and soap, and, under proper conditions, easy of application to a variety of styles.

The general recipe for printing is as under:—

30 parts by weight of colouring matter.
50 ,, ,, ,, glycerin.
80 ,, ,, ,, water.
50 ,, ,, ,, china clay beaten up with
50 ,, ,, ,, water.
40 ,, ,, ,, concentrated hydrosulphite N.F., 50 per cent. solution.
700 ,, ,, ,, alkaline British gum thickening.
1000

This paste is printed on unprepared bleached cloth, gently dried and then passed through a rapid steam ager, in from 4 to 7 minutes in dry steam at 212° F. to 220° F. (or twice for 3 minutes), after which the cloth is passed in the open width through the washing and soaping machines, and finally dried up and finished.

The sulphur colours may be used in combination with the azo-colours, on naphthol-prepared cloth, for the production of multi-colour effects, and are eminently adapted also to the production of coloured discharges on paranitraniline red and the direct-dyeing colours.

(*h*) *Aniline Black.*—Aniline black was discovered and first used by Lightfoot in 1863. It is one of the fastest blacks known, and is equally useful for direct printing by itself, and for working along with printed mordants and discharge pastes. Aniline black is formed by the oxidation of aniline.

As a rule the oxidation of the aniline is brought about by means of sodium chlorate in presence of suitable oxygen carriers such as copper sulphide, vanadium chloride or potassium ferrocyanide. Copper and vanadium blacks are usually developed after printing by being aged in a moderately warm room for a day or two, when they become converted into "emeraldine," at which stage they are taken down, and passed through a hot solution of bichromate of potash to complete the oxidation of the aniline. Great care is required in printing these two blacks, as if overdried they take fire and have occasionally caused considerable damage to buildings in consequence. The blacks made with ferrocyanide, on the contrary, may be printed in conjunction with "steam" colours, and, after a preliminary passage through a rapid steam ager, and an ammonia "gassing" box, will withstand the long steaming necessary for alizarine colours.

A copper aniline black may be made as follows:—

15 ℔ starch.
8 ℔ British gum or dextrine.
5¼ gals. water.
4 ℔ chlorate of soda.
¼ gal. olive oil.

Boil, cool and add:

8 ℔ aniline salt.
3 ℔ aniline oil.
5 ℔ sulphide of copper (precipitate pressed to a 30 per cent. paste).
1 gal. water.

This black may be either hung to develop, which is the safer course, or, if printed in fine shirting patterns, it may be "aged" through steam for 2 to 3 minutes. Whichever method is adopted the printed cloth must afterwards be passed through hot bichromate —"chroming"—and then well washed.

The following ferrocyanide black works well in practice:—

10 lb starch.
2 lb British gum.
6 lb yellow prussiate (ferrocyanide) of potash.
7 gals. water.

Boil, turn off the steam, and add:
$2\frac{3}{4}$ lb chlorate of soda in powder.

Cool and add:
$8\frac{1}{4}$ lb aniline salt.

Print, age 4 minutes through the rapid ager, chrome, wash and soap. If printed with alizarine steam colours it must be passed through ammonia vapour after "ageing," and then be steamed for one hour before chroming and washing. Sometimes the chroming is omitted, but the colour is then apt to become green after a short time owing to the action of sulphur dioxide present in the air.

Aniline black is now used almost exclusively for printing along with mordants for the madder style, and for black ground goods that were formerly dyed with logwood on an iron mordant. Shirtings and all single-colour black dress goods are also executed in aniline black, which is faster to light, washing, and perspiration than any other black except some of the sulphur blacks.

(2) *Printing of Mordants*.—This, the second of the great styles of textile printing, was, at one time, the most extensively practised of all, and is still the most important for all classes of work where the fastest colours are required. It may be conveniently divided into two branches: (*a*) the madder style, and (*b*) the printing of other mordants such as chrome, tannic acid, β-naphthol, &c.

(*a*) *The Madder Style*.—In this style the only mordants used are those of aluminium and iron.

Aluminium alone yields various shades of red and pink when dyed up in madder, or its artificial competitor alizarine. Iron alone yields with the same dye-stuffs shades varying from black to the palest lavender. Iron and aluminium mordants in combination yield colours ranging in shade from claret through all gradations of bordeaux and maroon to the deepest chocolates, according to which of the two mordants predominates in the mixture. Browns and allied colours may be dyed on the same mordants with either nitroalizarine alone, or with alizarine itself mixed with dyewood extracts—logwood, Persian berry or quercitron bark, &c.

Both aluminium and iron mordants consist of the acetates of their respective metals. The iron mordant which gives the best results is known as "black liquor." It is a crude acetate containing a good deal of organic matter which appears to regulate the speed of its oxidation and so produce much more level colours than have ever been obtained from any other iron mordant.

Aluminium acetate in the pure state is also rarely employed, the crude commercial "red liquor" being found in practice to yield the best results, both as regards colour and ease of working. The "red liquors" vary considerably in composition, some being normal acetates, others basic acetates, some normal sulphate-acetates, others basic sulphate-acetates, but their mode of application is always the same, that is, they are thickened, printed, aged and dyed in alizarine. If they are too basic they decompose on boiling, or on dilution, and become utterly useless; but this rarely happens nowadays and need not be further gone into. Many difficulties occur in the printing of mordants and their subsequent dyeing, but if the following points are observed most of them may be surmounted; (1) after printing the cloth must be gently dried, otherwise the mordants become dehydrated or "burnt," and instead of dyeing up evenly they appear patchy and very light in the overdried parts; (2) the dye-stuff must not be used in excess; and (3) the temperature of the dye-bath must be kept as low as is consistent with the fixation of the colour. If these last two points are neglected the unprinted parts of the cloth, which should remain a pure white when it is finished, will be soiled beyond repair unless indeed the "whites" are cleared at the expense of weakening the colour. Iron mordants especially are liable to unevenness due to the oxidation being too rapid; and as this defect is most noticeable in purples and lavenders, the pyrolignite of iron or "black-liquor" is frequently boiled for half an hour or more with 1 per cent. of its weight of arsenious acid, or "white arsenic," a substance which retards its oxidation. For this purpose the goods are printed with either aluminium or iron acetates, and hung or "aged" for 2 to 3 days in a brick chamber containing moist air at about 30° C. dry bulb, and 27° C. wet bulb thermometer. In this operation the "ageing" (which is really the volatilization of the acetic acid, leaving the hydrated oxide on the fibre) goes on slowly and evenly. After hanging, the last traces of acid are removed and the hydroxide thoroughly fixed by "dunging," a process in which the goods are passed through a mixture of cow-dung and chalk at a temperature of about 50° C. In this "dunging" bath they are worked altogether about $1\frac{1}{2}$ hours, at the end of which the mordants are thoroughly fixed, and all the thickening agents perfectly eliminated, thus leaving the cloth in the best condition to absorb the dye-stuff. The dyeing is carried out by working the goods at 60° C. in a mixture of alizarine, a little chalk, and glue size for 1 to $1\frac{1}{2}$ hours. They are then well washed, soaped, and the whites cleaned by a passage through weak bleaching powder solution, followed by a passage through steam. Further soaping and washing is then resorted to until the goods are quite clear and bright.

In the case of cloth dyed in red and pink alone the goods after dyeing are well washed, passed through a bath of alizarine oil containing oxalate of ammonia, and then steamed for one hour at 15 lb pressure. This brightens the colours by removing the brown appearance they possess after dyeing. When reds are associated with chocolates and purples, however, the oiling process must be carefully conducted, otherwise the two latter suffer; frequently it is omitted altogether, the brightening being effected by vigorous soaping.

By printing the following mordants a six-colour design may be produced with a single dye-stuff and in one dyeing:—

	Red.	Pink.	Chocolate.	Dark Purples.	Violet.	Black.
Aluminium acetate, 6° Tw.	12 gals.	3 gals.	$10\frac{1}{2}$ gals.	.	..	..
Black liquor, 24° Tw.	..	..	$1\frac{1}{2}$ "	1 gal.	$\frac{1}{2}$ gal.	8 gals.
Water	..	8 gals.	..	11 "	$11\frac{1}{2}$ "	4 "
British gum	..	36 lb	..	..	36 lb	..
Acetic acid	..	1 gal.	..	..	..	..
Tin crystals	$1\frac{1}{2}$ lb	$\frac{3}{4}$ lb	..	..	..	..
Cotton-seed oil	$\frac{1}{4}$ gal.	..	$\frac{1}{4}$ gal.	$\frac{1}{4}$ gal.	..	$\frac{1}{4}$ gal.
Starch	16 lb	..	16 lb	16 lb	..	16 lb

The above mordants are printed on white bleached cloth, dried, hung 2 to 3 days, "dunged," dyed, washed, well soaped and washed again; then "chemicked" through weak bleaching powder solution, and finished.

The "dunging" is performed in vats through which the cloth circulates continually during the operation. As a rule dunging is done twice, the second bath being weaker than the first. The vats or "becks" contain a mixture of:—

100 gals. water
10 lb chalk
50 lb cow-dung } 1st dunging.
at 60° C.

100 gals. water
5 lb chalk
25 lb cow-dung } 2nd dunging.

Wash well after "dunging" and dye in alizarine, &c.

The dyeing is carried out in large becks over which a roller or bowl revolves, equal in length to the beck. Over this roller the cloth is wound spirally in large loose loops so that one end of the loop is on the roller and the other dips into the dye liquor. When about 700 yds. of cloth have been entered in this way the two ends of it are knotted together, thus forming an endless rope which circulates continuously in and out of the dye-liquor. The vat or beck is then charged with alizarine, chalk and glue, the proportions varying according to the amount of space covered by the mordants on the cloth. If, for instance, half the surface is printed then the dye-liquor might be made up as follows, the quantities being calculated on the weight of the cloth:—

$4\frac{1}{2}$ per cent. alizarine (blue shade), 20 per cent.
$1\frac{1}{2}$ " acetate of lime, 28° Tw.
10 " glue solution, or size, 15 per cent. } in a sufficiency of water.

The goods are entered into this solution cold. The temperature is gradually raised to 60° C., and the dyeing continued at this for one hour or more. The goods are then washed in a similar machine, soaped well and finished off by drying.

Aniline black may be printed along with "red liquor" and iron liquor, and many other modifications also employed, but the principle of dyeing is always the same.

(*b*) *The Printing of other Mordants*.—Of these the most important are tannic acid, chrome mordants and β-naphthol.

For printing tannic acid the following is used:—

{ 5 lb tannic acid dissolved in
1 gal. acetic acid and added to
9 " starch and tragacanth paste.

The goods are simply dried after printing and the tannic acid immediately fixed by passing through a solution of—

- 2 oz. tartar emetic.
- 1 oz. chalk.
- 1 gal. water at 60° C.

After washing they may be dyed up in any of the basic aniline colours.

Various chrome mordants are employed in printing, amongst which may be mentioned chromium chromate, and chromium acetate. The former is thickened with starch or gum, printed, and fixed by being passed through boiling sodium carbonate. The latter is applied in the same way but, after printing, is steamed before the carbonate treatment. Both these mordants are suitable for dyeing with any of the dyes mentioned under the direct printing of mordant colours, such as alizarine, alizarine bordeaux, coeruleine and the natural dye-wood extracts. They are dyed similarly to the madder colours, with an addition of glue size to preserve the white of the unprinted parts of the cloth.

(3) *The Discharge Style.*—This style is now one of the most important produced. Its range is so extensive, and its modifications so numerous, that it is impossible to mention more than a few of its chief applications. It may be used for locally destroying either the colours dyed on cloth, or the mordants with which they have been previously prepared. In both cases the resulting pattern appears in white, or colours, on a full rich ground the beauty of which cannot be equalled by direct printing.

The discharging agents consist of organic acids, caustic alkalis, oxidizing agents and reducing agents, each used according to the kind of colour or mordant to be discharged.

(*a*) *Discharge of Iron and Aluminium Mordants.*—The cloth is padded with a solution of these mordants, dried in hot air, and then printed with thickened citric acid or acid citrate of soda mixed with china clay to prevent the pattern running. It is then passed through the rapid ager once or twice, "dunged," washed, and dyed in the usual way for madder colours. Wherever the discharge has been printed the mordant is dissolved out, leaving a white pattern on a dyed ground.

(*b*) Tannate of antimony mordant is similarly discharged by printing on caustic soda. The goods are passed in like manner through the ager, well washed in water, and dyed-up in any basic aniline dye.

(*c*) The chrome discharge is produced by padding the goods in chromium bisulphite; then drying them, and printing-on citric acid, or chlorate of soda and yellow prussiate of potash. They are then steamed, passed through chalk and water, well washed and dyed up in any mordant dye.

(*d*) Turkey red may be discharged in both white and coloured patterns by either oxidizing agents or caustic alkalis. (1) The dyed cloth is printed with strong citric acid, or arsenic acid, at 180° Tw., and then run through bleaching powder solution, whereby the printed parts are completely decolorized. If colours are required, the citric acid is mixed with lead salts and Prussian blue, and the fabric after passing through the bleaching powder solution, is further treated in a bath of bichromate of potash which forms with the lead salts the insoluble chrome yellow. Green is obtained by the combination of Prussian blue with the chrome yellow.

Examples:—

White. 6 lb citric acid or tartaric acid.
1 gal. water.
4 lb British gum or dextrine.
Boil together.

Yellow. 15 lb British gum.
1½ gals. dark British gum paste, 30 per cent.
2½ ,, water.
20 lb tartaric acid.
12 lb nitrate of lead.

Print, dry, discharge through bleaching powder solution, 18° Tw., and chrome.

(*e*) The dyed cloth is printed with strongly alkaline discharge pastes, passed through the "ager" two or three times, and then washed off in silicate of soda. If blue, yellow and green discharges are desired the dyed cloth must first be passed through glucose solution, well dried, printed with the colours, "aged," passed through silicate of soda, chromed in bichromate, well washed and dried. Examples:—

White. 10 lb stannous chloride dissolved cold in
8 gals. alkaline thickening.
2 ,, silicate of soda, 70° Tw.

Blue. 15 lb indigo pure 20 per cent. paste.
1/32 gal. turpentine.
1/16 ,, glycerin.
1½ ,, British gum paste.
7 ,, alkaline thickening.

Green. 8 parts of the yellow without silicate.
1 part of blue.

Yellow. 30 lb lead hydrated 50 per cent.
2 gals. water.
¾ ,, silicate soda.
5¼ ,, alk. thickening.

Alkaline Thickening.

15 lb yellow dextrine.
8 gals. caustic soda, 100° Tw.

(*f*) *Paranitraniline red* is discharged by means of the new hydrosulphite-formaldehyde compounds. The dyed cloth is printed with the following:—

25 lb hydrosulphite N.F. conc., or hydraldite conc.
1½ gals. British gum paste.
Heat till dissolved and add—
1/32 gal. glycerin.
4½ ,, starch-tragacanth thickening.

After printing, age twice for 4 minutes through dry steam at 220° F., then wash well and soap.

Coloured discharges are obtained by mixing hydrosulphite, tannic acid, aniline or phenol, and basic colouring matters together. Mordant dyes fixed with chromium acetate may also be used.

On α-naphthylamine maroon the above discharge white requires the addition of induline scarlet, patent blue or anthraquinone, before it becomes effective, otherwise the procedure is the same as for paranitraniline red.

(*g*) Indigo is usually discharged by oxidation. For this purpose the dyed cloth is printed in two different ways. Firstly, with chlorate of soda, and red or yellow prussiate of potash together with a little citric acid or citrate of soda; secondly, with chromate of potash. In the first instance, the cloth is "aged" through the rapid ager after printing, and, in the second, is passed through a vat containing hot sulphuric acid and oxalic acid. Coloured discharges may be obtained in both methods by adding albumen and pigment colours to the discharging agents.

(1) Discharge by steaming:—

12 lb citric acid, dissolve in:
7 lb caustic soda, 70° Tw., and add:
12 lb sodium chlorate.
5 gals. British gum paste.
Heat till dissolved, cool and add:—
1¾ gals. British gum paste.
2 lb yellow prussiate of potash.
Print, steam and wash.

Chlorate of aluminium is also used for this process, but it acts very energetically and is apt to tender the cloth.

(2) Chromate discharge:—

White. 8½ gals. British gum paste.
12 lb bichromate of soda.
½ gal. turpentine.

Yellow. 32 lb chrome yellow pigment.
3 gals. 50 per cent. albumen solution.
½ ,, thick tragacanth mucilage.
¼ ,, oil (vegetable).
12 lb bichromate of soda neutralized with
¾ gal. caustic soda, 70° Tw.
½ ,, water.

Print, dry, pass through a "beck" (*i.e.* a bath) containing:—
100 gals. water.
50 lb sulphuric acid (168° Tw.).
50 lb oxalic acid.
Then well wash and dry.

With these oxidation discharges it is impossible to prevent the fibre being attacked in the discharged portions, with the result that it is partially converted into oxycellulose. Recently a method has been brought out for the production of a white discharge on indigo which is said to do away with the formation of oxycellulose and which consists in printing on a thickened solution of sodium nitrate and, after drying, running through sulphuric acid of 50° Tw.

Another method of producing white discharges on indigo consists in printing the dyed cloth with hydrosulphite N.F., then steaming and running through a boiling solution of caustic soda. Good whites are thus obtained without the formation of oxycellulose, but the process is expensive.

(*h*) *Direct dyeing* or *substantive colours* can be easily discharged with the hydrosulphite discharge used for paranitraniline red (see above). It must be reduced in strength to about one-fourth for dark shades, and much weaker for lighter colours. Direct colours were formerly discharged by stannous chloride or acetate, but the hydrosulphite has almost entirely displaced these salts for white discharges.

(*i*) Discharges on manganese bronze are of little importance at the present time. They are effected by means of stannous chloride, colours being obtained by the addition of basic dyes and dyewood extracts.

(*j*) Sulphur-colours, dyed basic colours, and some alizarine colours, are discharged with chlorate and prussiate like indigo.

(4) *The Resist or Reserve Style.*—Reserves are substances which, when printed, prevent the fixation or development of mordants and colours subsequently applied, and are used to produce effects similar to those obtained by discharge printing.

The principal reserves are those used for madder dyed goods, steam alizarine reds and pinks, steam basic colours, vat indigo blue, insoluble azo colours, sulphur-colours and aniline black.

(*a*) *Reserves under Aluminium and Iron Mordants.*—For the production of this important class of goods, use is made of the fact that alkaline citrates prevent the fixation of the mordants. The cloth is first printed with citrate of soda (or sometimes citric and tartaric acids for iron mordants), then dried, and again printed over the previous impression, with either a fine "all over" pattern or flat uniform ground, in iron or aluminium mordants. The fabric is then aged, "dunged," washed and dyed as already described, with the result that wherever the "reserve" of citrate or acid was printed a white pattern is left on a figured or plain ground. The fine patterns printed over "reserves" are called "covers" and the plain grounds "pads," hence the name "cover and pad" style in cases where, as frequently happens, a dark "cover" and a light "pad" are both printed over a white "reserve." The "cover and pad" style is, for the most part, restricted to dyed alizarine purples under which red, black, dark purple and white can all be reserved at the same time, thus giving rise to very pleasing effects. For example: white cloth is first printed with four "colours," viz., citrate of soda and citric acid for the white; logwood and iron for the black; strong iron mordant for the purple; and aluminium acetate at 6° Tw. with 8 oz. per gallon of stannous chloride for the red. (The stannous chloride acts as a resist for iron mordants.) The whole is then "covered" in a fine pattern printed in a fairly strong iron mordant, dried, and again printed, in a very weak iron mordant, with a pad roller, that is, a roller which prints a uniform ground over the whole surface of the cloth. After this last printing, the cloth is "aged" for a day or two, by being hung as previously described, then "dunged," washed and dyed in a blue shade of alizarine. When finally washed, soaped and "cleared" in bleaching powder solution the first printed pattern in white, red, black and purple is seen to stand out, clearly and sharply, from a figured background in two lighter shades of purple. This "cover and pad" style of reserve printing constitutes one of the staple processes of nearly all print-works, and is produced in enormous quantities for both home and foreign markets. Red is not often introduced as in the above example, the usual colours being white, black and two purples. The same method of working can be adopted with aluminium mordants for red and pink covers and pads, but they are better produced with the steam alizarine colours as below.

(*b*) *Reserves under Steam Alizarine Red and Pink.*—In this case a reserve composed of citrate of chromium alone, or in conjunction with citrate of soda, gives the best results. The goods are first prepared in alizarine oil and then printed with the following:—

10 lb china clay.
½ gal. citrate of soda, 54° Tw.
½ ,, citrate of chromium, 42° Tw.
½ ,, water.
2½ ,, British gum paste.

After printing the above, the goods are dried and again printed either with "cover" or "pad" or both, in alizarine pink, dried, steamed for 1½ hrs., well washed and soaped. On leaving the steamer the parts printed with the resist are yellow, but become quite white on soaping. Like the purples, the alizarine pinks can be reserved in colours. For blue, green, yellow and violet the ordinary steam basic colours are used with additions of citric or tartaric acid.

Example:—

7 lb china clay.
½ gal. water.
6¼ ,, British gum paste.
2 lb methylene blue.
1 lb citric acid.
1 gal. acetic acid.

Boil, cool, and add:—

1¼ gals. 50 per cent. tannic acid solution in acetic acid.

Red with steam alizarine red; yellow with thioflavine in place of methylene blue in above; green a mixture of blue and yellow. These colours with the white reserve may all be printed at once. Then steam as usual, pass through a solution of tartar emetic and chalk, wash well and soap.

(*c*) *Reserves under Insoluble Azo-Colours.*—These are based upon the action of stannous chloride, which prevents the combination between the β-naphthol and the diazo bodies by reducing the latter to hydrazines. The β-naphthol prepared cloth is printed with the following colours, then dried and passed through diazotized solutions of paranitraniline for red grounds; a-naphthylamine for maroon; ortho-nitrotoluidine for orange, &c., &c. The cloth is then washed and soaped until the "whites" are clean.

White Resist. 5 gals. gum senegal solution.
30 lb tin crystals.
5 lb tartaric acid.

For heavy rollers this may be reduced with more gum.

	Blue.	Yellow.	Green.	Pink.
New methylene blue N.	2 ½lb	..	..	..
Auramine G. (B.A.S.F.)	..	..	2 lb	..
Brilliant green	..	..	1½ ,,	..
Thcoflavine T.	..	2 lb	..	..
Rhodamine 6 G. (extra)	..	..	..	1 lb
Acetic acid	2 gals.	2 gals.	2 gals.	2 gals.
Citric acid	2½ lb	2½ lb	2½ lb	2½ lb
Starch	10 ,,	10 ,,	10 ,,	10 ,,
Water	2 gals.	1½ gals.	2 gals.	2 gals.
Tragacanth mucilage	1 ,,	1 ,,	1 ,,	1 ,,
Tannic acid sol., 50 per cent.	1½ ,,	2 ,,	1½ ,,	2 ,,
Tin crystals	20 lb	20 lb	20 lb	20 lb
Make up to	10 gals.	10 gals.	10 gals.	10 gals.

Potassium sulphite is also used as a white reserve under insoluble azo-colours with good results.

(*d*) *Reserves under Steam Basic Colours.*—The white cloth is printed with:—

20 lb china clay.
2½ gals. water.
15 lb British gum.
20 lb sodium tartar emetic.
20 lb zinc sulphate.

All boiled well together,

and then covered, or over-printed, with any steam basic colour—steamed one hour, passed through tartar emetic, then washed and soaped, when the reserve white above comes away, bringing along with it the colour printed upon it and leaving a white pattern on a printed ground.

(*e*) *Reserves under Vat Indigo Blue.*—This was formerly a very important style, but at present is only used in special cases. Resist or reserve effects are obtained by printing the white cloth with oxidizing agents, &c., and subsequently dyeing it in the indigo vat. In addition to oxidizing agents the reserve pastes contain lead sulphate, barium sulphate, resins, fats and thickenings in various proportions. The following is a good white reserve:—

15 lb flour.
6 gals. water.

Boil, cool a little, and add—

18 lb copper sulphate powdered.
2½ lb copper nitrate, 90° Tw.
1 pint alizarine oil.

Yellow. 2¾ gals. British gum paste.
33 lb lead sulphate, 66 per cent. paste.
18 lb zinc sulphate.
22 lb lead nitrate.

Print the white and yellow, dry, dye in the indigo vat—sour slightly in sulphuric acid, wash, and pass into a hot solution of bichromate of soda, which develops the lead yellow. Reserve whites also contain lead salts when used for white alone, but obviously the white given is best suited to white and yellow reserves, as its soluble copper salts wash out before the "chroming" stage is reached.

(*f*) *Reserves under Sulphur Colours.*—These are obtained with zinc chloride. They are not much used, but are capable of yielding fine effects.

(*g*) *Reserves under Aniline Black.*—Reserves under aniline black are produced with caustic alkalis, alkaline carbonates, silicates and sulphites, sulphocyanides, oxide of zinc and the acetates of magnesia, zinc and soda. The white and coloured resists may be printed upon either the undeveloped black or upon the cloth before the black is applied.

In the former case the cloth is slop-padded through a mangle-box with the following black:—

7½ lb aniline hydrochloride.
3½ lb sodium chlorate.
4 lb potassium ferrocyanide.
10 gals. water.

It is then very carefully dried in hot air so that it becomes no darker than a pale yellow; if it is green before printing, the white is sure to be bad.

The dried padded cloth is then printed with the "resist" colours, dried and steamed 3 to 4 minutes in a rapid ager, chromed through warm bichromate of potash, and finally washed and soaped. During the steaming the black is developed all over the cloth except where the colours are printed. Here its development is prevented by the alkali or the reducing agent, whichever may be present, in the colour, and instead of a plain black dyed piece a coloured design on a black ground is produced. The following formulae may be employed for white and coloured resists:—

White. 8 lb starch.
8 lb British gum.
30 lb potassium sulphite, 90° Tw.
3 gals. water.
15 lb soda acetate.
10 lb bisulphite of soda, 66° Tw.
¼ lb ultramarine blue.

Boil together.

	Red.	Pink.	Blue.	Yellow.	Green.	Violet.
Rhodamine 6 G. (100 per cent.)	2¼ lb	1 lb	..	..	..	..
Auramine O	¼ ,,	..	..	..	..	..
Acridine yell. G.	..	..	..	2 lb	2¼ lb	..
Thionine blue O.	..	..	2 lb	..	..	..
New solid green 2 B.	..	..	..	..	1 lb	..
Methyl violet, B. x.	..	..	..	..	..	2 lb
Water	1¾ gals.	1¾ gals.	1½ gals.	1½ gals.	1½ gals.	1½ gals.
Tragacanth mucilage	1 ,,	1 ,,	1 ,,	1 ,,	1 ,,	1 ,,
Glycerin	..	..	¼ ,,	¼ ,,	¼ ,,	¼ ,,
Albumen, 40 per cent. solution	1 gal.	1 gal.	1 ,,	1 ,,	1 ,,	1 ,,
Resist paste	6 ,,	6 ,,	6 ,,	6 ,,	6 ,,	6 ,,

Print on the padded cloth, age, chrome and wash. The resist paste is as under:—

Resist Paste. 10 lb zinc oxide.
1½ gals. magnesium acetate, 40° Tw.
2½ ,, tragacanth mucilage (dragon).
1 ,, starch paste.

For reducing the colours take 6 parts resist paste.
4 ,, starch paste.
4 ,, white resist.

Very good results can be obtained by the alternative method, *i.e.* printing the resists on white cloth and applying the black afterwards. The basic colours are chiefly used, though chrome yellow and ultramarine are also employed for some styles. The following formulae will serve as types of the composition of white and colours:—

White. 20 lb precipitated chalk.
5 lb potassium sulphite, 90° Tw.
5 lb acetate of soda.
½ lb ultramarine blue for sightening.
1 gal. water.
6 ,, starch paste.

The whole ground together in a mill.

Colour. 2 lb basic dye-stuff.
1 gal. water.
2¼ ,, starch paste.

17 lb zinc oxide.
1 gal. water.
¼ ,, glycerin.
¼ ,, turpentine.
¼ ,, bisulphite of soda.
3 ,, starch paste.

Print on white cloth, allow to lie a day or two, then slop-pad in the Prud'homme black already given, dry, age, chrome and soap.

Pigment colours may be applied on black padded cloth as follows:—

Yellow. 40 lb chrome yellow, &c. &c.
2½ gals. 40 per cent. albumen.
2½ ,, tragacanth water, 6 oz. per gal.
6 lb soda ash.
1 gal. citrate of soda, 40° Tw.

Other methods, varying in detail, have been used from time to time, but the above two are at the present time generally employed—especially the former, by which many fine patterns have been produced in all sorts of delicate and artistic shades.

The Treatment of Cloth after Printing.

After printing, the various classes of goods undergo many different treatments according to the character of the colours printed. These treatments include steaming, hanging in the ageing chamber, passing through tartar emetic, the chalk bath, washing, soaping, "chemicking" or clearing and finishing.

(1) The operation of steaming is necessary for all styles except those with the insoluble azo-colours, vat dyes discharged, and some colours that are precipitated on the fibre. The short steaming necessary for most discharges, indigo blue prints, and aniline black is effected in the Mather and Platt ager, of which a sketch is here given (fig. 2) showing its principle.

It consists of an iron box A A A through which the goods (indicated by the dotted line) pass in the direction of the arrows. They enter at B, and traverse the whole chamber over a series of top and bottom rollers C C C, finally emerging at the same point B, whence they are drawn forward, by mechanical means, and plaited down on a waggon placed conveniently near. Steam enters the chamber A A A by the steam pipe D at the bottom, and escapes through the same slot (B) that the cloth enters and leaves by. An engine or electric motor drives the gearing, and the whole process is continuous.

This ager affords quite a sufficient steaming for aniline blacks, printed indigo, chlorate discharges, and for some mordants, but alizarine reds and pinks, mordant dyes generally, and basic colours require much more than the 2 to 3 minutes' exposure to steam which is all that can be given in the ordinary Mather-Platt ager, although they are frequently passed through it to eliminate the greater part of the volatile acids they contain. Paranitraniline red discharged with hydrosulphite also requires a modification of the ager for its success—for the steam must be very hot and very dry if any of the azo-colours are to be effectively discharged by the hydrosulphite method.

A longer exposure to the action of steam is obtained by means of the *cottage steamer* and the *continuous steamer*, in both of which goods may be steamed for any length of time. The cottage steamer consists (1) of a cylindrical iron box or chamber fitted with a false bottom on which rails are laid, and under which lie the pipes for the admission of steam, and for the drawing off of the condensed water; and (2) of a carriage or iron framework mounted on wheels and furnished with a series of removable rods capable of being revolved by means of spur-wheel gearing. Convenient lengths of the cloth to be steamed, together with a "back grey" (a piece of unbleached calico) are then wound in the open width, into a sort of broad hank on a folding frame. As each hank, so to speak, is completed it is removed from the winding frame and hung over one of the rods, which is then placed in position on the carriage.

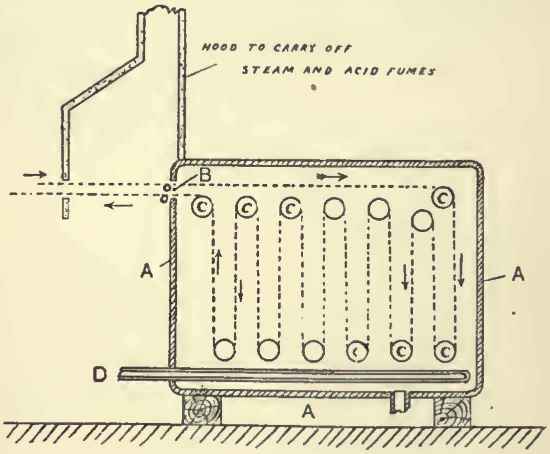


FIG. 2.

When the latter is fully loaded in this way it is run into the "cottage," the doors are closed, and steam turned in. The steaming is continued for various periods of time—from ¾ hour to 2 hours—according to the style of work in hand, and either with or without pressure, as may be required. The carriage is then withdrawn and the goods unwound in readiness for subsequent operations.

The object of enveloping the printed goods in a "back grey" is to prevent the colour from marking off from the face of one fold on to the back of the next, and also to minimize the risk of damage from drops of condensed water. This latter defect is further guarded against by heating up for an hour or so every morning before any goods are introduced.

In works where the modern continuous steaming apparatus is installed the cottage steamer is reserved for the treatment of dyed alizarine reds and for goods, such as heavy printed velvets, which are difficult to manipulate in the continuous steamer.

The continuous steamer was originally invented by Cordillot, but its present efficient form is due to Messrs Mather and Platt, who have continually improved it, so that now it bears but little resemblance to Cordillot's original machine. Its construction is too complex to be adequately described without the aid of detailed sketches. Generally speaking, it may be said to consist of a long, high, narrow chamber of brick, through which the cloth passes continuously in the form of long loops suspended from rods resting upon, and carried forward by travelling chains, situated at the top, and close to the sides, of the chamber. Steam is admitted to this chamber through a series of pipes at the bottom, and the cloth enters and emerges through slots at the top of its opposite ends. On entering, the cloth falls over one of the slowly travelling rods and continues to run downwards until a sufficient length to form the loop has run in. By this time the first rod has moved forward and a second taken its place, with the result that the cloth now falls over the second rod and commences to form the second loop. At this point—the commencement of a second loop—the second rod comes in contact with a brass bar carried by arms pivotted above. The object of this bar, which clips the continuously entering cloth firmly between itself and the rod until the second loop is complete, is twofold, namely (1) to prevent too much cloth being fed into the first loop, and (2) to prevent the weight of the first loop from pulling the cloth over the second rod during the formation of the second loop. By the time this latter is complete the second rod has moved sufficiently far forward to escape contact with the pivotted brass bar, which thereupon swings back and takes up a similar position on the third rod. In this way each rod is supplied with cloth, which it carries forward continuously until the other end of the steamer is reached, where both cloth and rods emerge—the former through the top of the chamber and the latter through a slotted opening at the top of the end wall. Through a similar slot, at the beginning end of the steamer, the rods are fed in automatically as long as any cloth remains to be steamed.

The usual time occupied in passing the goods through a "steamer" of this description is one hour, but it may be shortened or prolonged at will, and, if desirable, the goods may be allowed to remain in it for any length of time.

The room used for *ageing* is lofty and is furnished near the top with suspending rods of wood, and at the bottom with a series of steam inlet pipes through which thin streams of free steam may be introduced into the chamber, as required. Its temperature is generally kept about 36° C. on the dry-bulb thermometer and 32°–33° on the wet-bulb thermometer.

"*Dunging*" is carried out in a series of becks provided with rollers at the top and bottom, and heated by steam pipes. It may also be performed in becks through which the cloth passes in rope form. Many attempts have been made from time to time to replace cow-dung by sodium silicate, phosphate, arsenite and carbonate of ammonia, but none of them yield results quite so good as cow-dung.

The tartar emetic treatment is only used for the fixation of tannin mordants, and of basic aniline colours printed with tannic acid. It is performed by passing the cloth in the open width over and under a series of wooden rollers arranged in a water-tight box—a beck—containing the following solution:—

2 ℔ tartar emetic.
2 ℔ chalk.
16 gals. water at 60°–70° C.

The chalk is added simply to neutralize the acid salt produced in the bath—a salt which exerts a solvent action on the basic colour tannin lakes and utterly spoils any ultramarine blues that may have been printed in combination with them.

Chroming is only applied to a few styles, such as aniline black, catechu brown, and colours containing salts of lead which have to be converted into chrome yellow. "Chroming" is carried out in a beck similar to that used for tartar emetic. The cloth runs continuously through a 3 to 4 per cent. solution of bichromate of potash at 60° C.; the excess is squeezed out in a mangle, and the cloth then passes directly into a washing machine to clear it completely of the chrome. When alizarine reds, and other colours susceptible to chrome, are present, the chroming must be either omitted altogether or the operation conducted cold with a very weak solution.

Washing is a very important process, and upon its proper performance depends a good deal of the final success of the work. It may be carried out in several different ways according to the different styles of work to be treated. Alizarine reds and pink, both printed and dyed, dyed chocolates, purples, &c., aniline black, indigo blue, &c. &c., all very fast colours, are usually washed and soaped in the rope form in machines like that described for madder-dyeing. Other colours, especially pigments, must be washed, in the open width, through a series of wash-boxes furnished with rollers over which the cloth passes. In these boxes the water usually enters where the cloth leaves, thus ensuring that the cleanest cloth gets the cleanest water. Some of the boxes are occasionally fitted with heaters and others again with "spirt pipes" through which the water is forced at a high pressure for the purpose of causing it to pass straight through the cloth. Other types of machine are also used, for details of which some technical work must be consulted.

Soaping is also an important factor in the production of the best work. It clears the white parts of the goods, brightens the colours and generally improves the whole appearance of the cloth. The strength and temperature of the soap solution, the duration of the soaping and the type of machine used are all varied according to the fastness of the colours to be soaped. As in washing, the alizarine dyed colours, alizarine "steam" reds and pinks, aniline black and the ice-colours, will not only withstand a long, hot and strong soaping, but are greatly brightened and enhanced in beauty thereby. On the other hand, direct dyeing colours, basic colours, pigments and a few others require only a moderate soaping and that in the open width. Colours which will stand a drastic soaping are usually soaped, in spiral becks, in the rope state, and pass from one to another of these becks, going through as many as half a dozen times before being washed off in water. Goods requiring to be soaped in the open width are treated in a special soaping machine known as the "open soaper." In principle this is simply a range of watertight boxes each fitted with rollers at the top and bottom. The first two or three boxes contain hot soap solution and the rest hot or cold water or a series of "spirt pipes" to better wash out the soap. Very frequently open soapers are supplied with "tartar emetic" and "chroming" boxes, so that the goods can go through two or more processes directly and without any intermediate handling.

"*Chemicking.*"—In this process all traces of colour still remaining after soaping are removed from the white parts of the printed cloth, by a weak solution of bleaching powder. Two methods are used in applying the "chemick," or bleaching powder solution, to the cloth. In the first the cloth is passed between a pair of squeezing bowls the lower of which is of wood, and revolves partly immersed in a solution of bleaching powder or "chemick" varying in strength from ⅛° Tw. to ½° Tw. This lower bowl carries the chemick to the cloth, the excess is then squeezed by passing between the two, and the cloth goes forward over a set of steam-heated drying cylinders, during its passage over which the bleaching properties of the chemick effectually remove the last traces of colour on the white parts of the cloth and leave it perfectly clean and bright.

The second method of "chemicking" is employed when the cloth is too deeply stained to be successfully "cleared" by the first. All madder-dyed goods, and goods printed in strong heavy dark-coloured patterns, are liable to attract, to their white parts, a considerable amount of colour during the dyeing, washing and soaping operations. They therefore require a stronger "chemicking" to clear them, and this the second method supplies. The goods are passed successively through (1) a trough containing "chemick" at about ¼° Tw.; (2) a pair of squeezing rollers; (3) a small steam chest fitted with half a dozen guide rollers top and bottom, and a steam admission pipe; (4) a series of "spirt pipes" to wash out the bulk of the lime salts; and (5) through a washing-box and squeezing rollers, whence they go directly to a drying machine.

In both methods the strength of the "chemick" depends upon the power of the resistance to its action of the colours printed, and great care must therefore be taken to keep it weak enough.

Occasionally a little ultramarine blue is added to the chemick for the purpose of correcting the yellowish tinge usually possessed by bleached cotton.

From the fact that two or more styles can be combined in one pattern it is obviously impossible to formulate any general rule for the practical application of any of the foregoing after treatments.

For example, in aniline black resists the black ground will stand any amount of soaping, but the basic colours which constitute the pattern are only moderately fast to soaping, and, consequently, this process must be so regulated as to yield the best possible results. The same may be said of alizarine reds and pinks printed in combination with basic or pigment colours, and of paranitraniline red and other ice-colours associated with basic colours.

Finishing.—In this process the cloth undergoes various operations of softening, stiffening, embossing and polishing or smoothing, according to the requirements of the customer. The following substances are chiefly employed for the above purposes:—

Softening Agents.—Turkey red oil, tallow, paraffin, stearine, wax and certain soaps.

Stiffening Agents.—Starch of all sorts, dextrine, gum tragacanth, vegetable gelatine or Blandola, glue size, various preparations of soluble starch, lichens, &c. &c., all of which are applied on special finishing mangles, and either to one or both sides of the cloth.

Hygroscopic substances, such as zinc chloride, glycerin and glucose are added to the stiffening pastes for the purpose of softening the feel of the cloth without detracting from its "body."

The smoothing, polishing and embossing of the fabric are all performed on various types of calenders. Smoothing and polishing calenders have highly polished steel "bowls" which may be heated by steam or gas, embossing calenders have an engraved steel or brass bowl working against one of compressed paper, or one in which depressions are engraved to exactly correspond with the projections on its fellow. The cloth is run between these various kinds of bowls according to the effect desired. In the finishing process all creases are smoothed out of the cloth, and it is stretched to its proper width (and its weft straightened if awry) on special

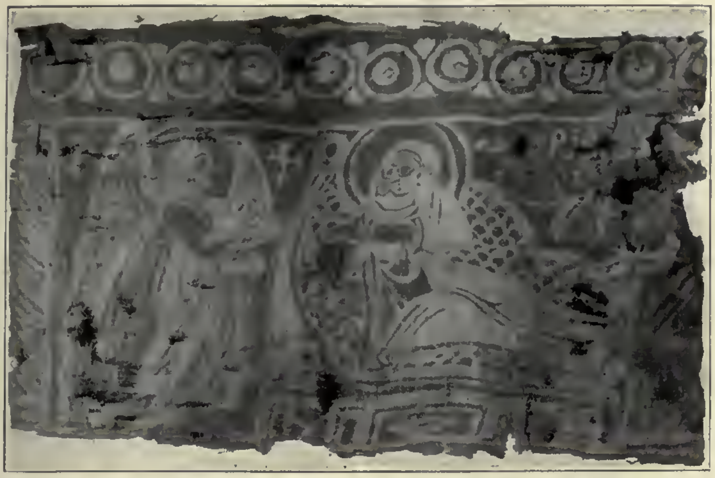


FIG. 1.—Linen, dyed blue, the "reserved" parts represent the Annunciation; above the reclining figure of the Virgin Mary is the word ΜΑΡΙΑ. Coptic, probably 5th or 6th century. 18 in. × 2 ft. 5 in.

FIG. 2.—Child's Tunic of linen dyed blue, the pattern being "reserved." Coptic, 4th century (?). 18¼ in. × 23½ in.

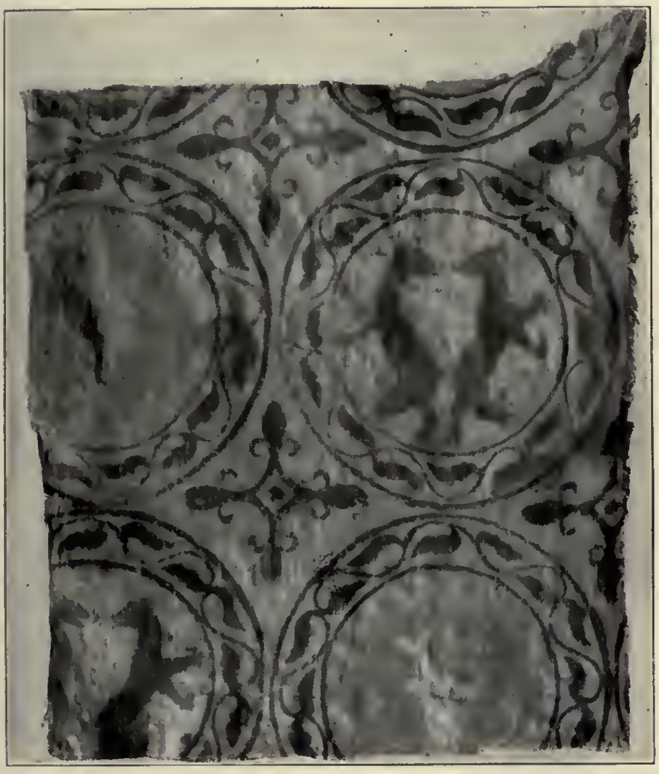


FIG. 3.—Piece of red silk, printed in red, green, and black from wood blocks, with a repeating pattern of black circles or roundels containing pairs of animals and dragons; floriated crosses in the interspaces. Rhenish, 12th or 13th century. 15⅞ in. × 12⅝ in.

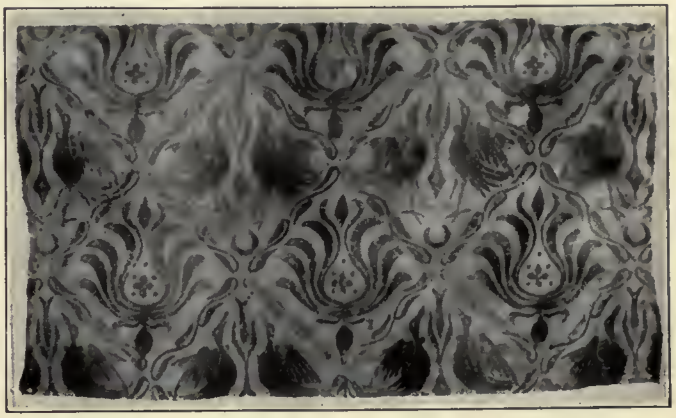


FIG. 4.—Piece of red silk, printed in black from wood blocks, with a trellis pattern enclosing pairs of birds and anthemions. Rhenish, 13th or 14th century. 8⅜ in. × 13¾ in.

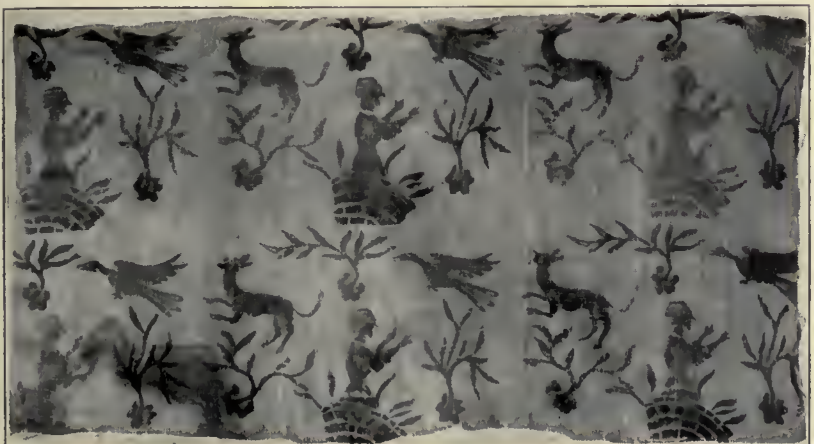


FIG. 5.—Piece of linen, printed in black from a wood block, with a pattern composed of repetitions of a lady on a turret, leafy sprays, a hound, and a bird on the wing. Rhenish, 14th century. 9½ in. × 19¾ in.

FIG. 6.—Strip of linen printed in deep purple from a wood block, with a repeating pattern of eagles and conventional leaf and fruit forms. Rhenish, 14th or early 15th century. 20¼ in. × 6½ in.

TEXTILE PRINTING

FIG. 7.—Portion of reddish linen lining for a chasuble printed in black from wood blocks, with a repeating pattern composed of five-lobed shapes enclosing conventional fruit device surrounded by small blossom and leaf forms. Rhenish, 15th century; from the neighbourhood of Düsseldorf. 3 ft. 8 in. × 24½ in.

FIG. 8.—Cotton print in colours. Dutch, 17th century. About 14 in. × 9 in.

FIG. 9.—Part of a coverlet of cotton, printed at Genoa, in colours, from metal plates engraved with trees, flowers, birds, and animals in the style of Indian palampores or printed calicoes. 19th century. About 6 ft. × 3 ft.

FIG. 10.—Part of a hanging of cotton, printed in red from metal plates engraved with repetitions of pictorial scenes. At the bottom is printed "D 5 T. P. Meillier & Ce de Beautiran près Bordeaux Bon Teint. MF. 3 X. Comm. 19." French, second half of 18th century. 4 ft. 6 in. × 3 ft. 4 in.

FIG. 11.—Part of a cotton chair back, printed in red from a metal plate engraved with a Chinese pagoda in a landscape; in front is a woman kneeling on the ground, while a priest stands to the left holding up an image. Marked "Collins Woolmers." English, dated 1766. 24 in. × 24¼ in.

FIG. 12.—Linen panel, with a stipple engraving printed in colours, for use as a small fire-screen. English, late 18th century. 2 ft. 4½ in. × 2 ft. 3½ in.

"stentering" machines. On these machines the damped cloth is carried forward, over steam-heated drying plates, by two travelling endless chains, each link of which is constructed to clip the selvedge of the cloth. The distance apart of these chains can be regulated to suit various widths of cloth and in travelling forward they diverge, so that as the cloth advances it gradually becomes stretched out to the required width and is dried at the same time to prevent it contracting when it is released from the pull of the chains, as it leaves the machine.

Finally the goods are cut into certain lengths, wound round flat boards, tied up, ticketed and packed.

Wool-Printing.

The printing of wool differs little from the printing of cotton in general. Most of the colours employed in the one industry are used in the other, and the operations of steaming, washing and soaping are almost identical.

Unlike cotton, however, wool requires to be specially prepared, after bleaching, if the full tinctorial value of the colours is to be obtained.

Two quite different methods of preparation are resorted to, namely (1) the chlorination of the wool; and (2) the precipitation of stannic acid on the fibre. In the first method the woollen fabric is first passed through a solution of bleaching powder, then well squeezed and passed, without washing, into dilute sulphuric or hydrochloric acid, squeezed again and well washed in water, after which it is dried. Great care and experience are demanded in this operation to prevent the wool from becoming hard and yellow.

In the second method the cloth is padded in stannate of soda, well squeezed, passed into dilute sulphuric acid, well washed and dried. For certain styles of work it is necessary to combine both preparations.

Although alizarine, mordant colours and dyewood extracts can be used on wool, the vast majority of patterns printed on wool are executed by means of acid dye-stuffs and basic colours, for both of which this fibre possesses a natural affinity. In most cases therefore these colours are simply dissolved in a little acetic and citric acids, thickened with gum and printed without any further addition. The addition of tannic acid, however, can be made to, and considerably increases the fastness of, the basic dyes. Mordant colours like logwood black are applied in the usual way.

The printing of wool is carried out exactly as for cotton, but if the best results are to be obtained, the engraving of the rollers must be deep, the blanket on the machine as soft as possible, and the drying of the printed cloth very gentle. After printing, the goods are steamed in moist steam or wrapped between moistened "greys" and steamed in a "cottage" steamer. If too little moisture is given, the colours lack both strength and brilliancy; if too much they run. The correct degree of dampness can only be determined by experience of the work, combined with a special knowledge of the particular apparatus employed.

After steaming, the printed goods are washed in plenty of water, then dried up and finished with a little glycerin or some waxy preparation.

Discharges may be very easily obtained on wool dyed in acid dye-stuffs, by means of stannous chloride and basic colours for the coloured effect, and hydrosulphite for the white.

Silk-Printing.

Silk-printing calls for no special mention. The colours and methods employed are the same as for wool, except that in the case of silk no preparation of the material is required before printing and the ordinary dry "steaming" is preferable to damp "steaming."

Both acid and basic dyes play an important rôle in silk-printing, which for the most part is confined to the production of articles for wearing apparel—dress goods, handkerchiefs, scarves, &c. &c.—articles for which bright colours are in demand. Alizarine and other mordant colours are mainly used, or ought to be, for any goods that have to resist repeated washings and prolonged exposure to light. In this case the silk frequently requires to be prepared in alizarine oil, after which it is treated in all respects like cotton—steamed, washed and soaped—the colours used being the same.

Silk is especially adapted to discharge and reserve effects. Most of the acid dyes can be discharged in the same way as when they are dyed on wool; and reserved effects are produced by printing mechanical resists, such as waxes and fats, on the cloth and then dyeing it up in *cold* dye-liquor. The great affinity of the silk fibre for basic and acid dye-stuffs enables it to extract colouring matter from cold solutions, and permanently combine with it to form an insoluble lake. After dyeing, the reserve prints are washed, first in cold water to get rid of any colour not fixed on the fibre, and then in hot water or benzene, &c., to dissolve out the resisting bodies.

As a rule, after steaming, silk goods are only washed in hot water, but, of course, those printed entirely in mordant dyes will stand soaping, and indeed require it to brighten the colours and soften the material. (E. K.)

II. Art and Archaeology

Printing patterns on textiles whether of flax, cotton or silk, by means of incised wooden blocks, is so closely related in its ornamental effects to other different methods of similar intention, such as by painting and by processes of dyeing and weaving, that it is almost impossible to determine from the picturesque indications afforded by ancient records and writings of pre-Christian, classical or even medieval times, how far, if at all, allusion is being made in them to this particular process. Hence its original invention must probably remain a matter of inference only. As a process, the employment of which has been immensely developed and modified in Europe during the last hundred years by machinery and the adoption of stereotypes and engraved metal plates, it is doubtless traceable to a primeval use of blocks of stone, wood, &c., so cut or carved as to make impressions on surfaces of any material; and where the existence of these can be traced in ancient civilizations, *e.g.* of the Chinese, Egyptians and Assyrians, there is a probability that printing ornament upon textiles may have been practised at a very early period.[1] Nevertheless, highly skilled as the Chinese are, and for ages have been, in ornamental weaving and other branches of textile art, there seem to be no direct evidences of their having resorted so extensively to printing for the decoration of textiles as peoples in the East Indies, those, for instance, of the Punjab and Bombay, from whose posterity 16th-century European and especially Dutch merchants bought goods for Occidental trade in "Indiennes" or printed and painted calicoes.

Whilst the earlier history of stamping patterns by hand on to textiles in the East has still to be written, a serious attempt has recently been made to account for the existence of this decorative process in Europe during several centuries prior to the introduction of the "Indiennes" above mentioned. As in the case of weaving and embroideries, specimens of printed stuffs have of recent years been obtained from disused cemeteries in Upper Egypt (Akhmîm and elsewhere) and tell us of Egypto-Roman use of such things. Some few of them are now lodged in European museums. For indications that earlier Egyptians, Greeks and Romans were likely to have been acquainted with the process, one has to rely upon less certain evidence. Of textiles painted by Egyptians there are many actual examples. Apart from these there are wall paintings, *e.g.*, those of Beni Hassan—about 2100 B.C.—in which are represented certain Asiatic people wearing costumes irregularly patterned with spots, stripes and zig-zags, which may have been more readily stamped than embroidered or woven. A rather more complicated and orderly pattern well suited to stamping occurs in a painting about 1320 B.C., of Hathor and King Meneptha I. Herodotus, referring to the garments of inhabitants of the Caucasus, says that representations of various animals were dyed into them so as to be irremovable by washing. Pliny describes "a very remarkable process employed in Egypt for the colouring of tissues. After pressing the material, which is white at first, they saturate it, not with colours, but with mordants that are calculated to absorb colour." He does not explain how this saturation is done. But as it is clearly for the purpose of obtaining a decorative effect, stamping or brushing the mordants into the material may be inferred. When this was finished the cloth was "plunged into a cauldron of boiling dye" and "removed the next moment fully coloured." "It is a singular fact, too, that although the dye in the pan is of one uniform colour, the material when taken out of it is of various colours according to the nature of the mordants that have been respectively applied to it." Egypto-Roman bits of printed stuffs from Akhmîm exhibit the use, some three hundred years later than the time of Pliny, of boldly cut blocks for stamping figure-subjects and patterns on to textiles. Almost concurrent

[1] When Cortes conquered Mexico he sent to Charles V. cotton garments with black, red, yellow, green and blue figures. The North American Indians have a mode of applying patterns in different colours to cloth (see Parnell's *Dyeing and Calico Printing*, p. 12).

with their discovery was that of a fragment of printed cotton at Arles in the grave of St Caesarius, who was bishop there about A.D. 542. Equal in archaeological value are similar fragments found in an ancient tomb at Quedlinburg. These, however, are of comparatively simple patterns. Other later specimens establish the fact that more important pattern-printing on textiles had become a developed industry in parts of Europe towards the end of the 12th and the beginning of the 13th century.

According to Forrer (*Die Kunst des Zeugdrucks*, 1898) medieval Rhenish monasteries were the cradles of the artistic craft of ornamental stamp or block cutting. In rare monastic MSS. earlier in date than the 13th century, initial letters (especially those that recurred frequently) were sometimes stamped from hand-cut blocks; and German deeds of the 14th century bear names of block cutters and textile stampers as those of witnesses. Between the 11th and 14th centuries there was apparently in Germany no such weaving of rich ornamental stuffs as that carried on in Spain and Italy, but her competitive and commercial instincts led her to adapt her art of stamping to the decoration of coarse textiles, and thus to produce rather rough imitations of patterns woven in the Saracenic, Byzantine and Italian silks and brocades. Amongst the more ancient relics of Rhenish printed textiles are some of thin silken stuff, impressed with rude and simplified versions of such patterns in gold and silver foil. Of these, and of a considerable number of later variously dyed stout linens with patterns printed in dark tones or in black, specimens have been collected from reliquaries, tombs and old churches. From these several bits of evidence Dr Forrer propounds an opinion that the printing of patterns on textiles as carried on in several Rhenish towns preceded that of printing on paper. He proceeds to show that from after the 14th century increasing luxury and prosperity promoted a freer use of woven and embroidered stuffs, in consequence of which textile-printing fell into neglect, and it was not until three centuries later that it revived, very largely under the influence of trade importing into Europe quantities of Indian printed and painted calicoes.

Augsburg, famous in the 17th century for its printing on linens, &c., supplied Alsace and Switzerland with many craftsmen in this process. After the revocation of the edict of Nantes, French refugees took part in starting manufactories of both painted and printed cloths in Holland, England and Switzerland; some few of the refugees were allowed back into France to do the same in Normandy: manufactories were also set up in Paris, Marseilles, Nantes and Angers; but there was still greater activity at Geneva, Neuchâtel, Zürich, St Gall and Basel. The first textile-printing works in Great Britain are said to have been begun towards the end of the 17th century by a Frenchman on the banks of the Thames near Richmond, and soon afterwards a more considerable factory was established at Bromley Hall in Essex; many others were opened in Surrey early in the 18th century. At Mulhouse the enterprise of Koechlin, Schmatzer and Dollfus in 1746, as well as that of Oberkampf at Jouy, led to a still wider spread of the industry in Alsace. In almost every place in Europe where it was taken up and followed, it was met by local and national prohibitions or trade protective regulations and acts, which, however, were gradually overcome.

Towards the end of the 18th century a revolution in the British manufacture of printed textiles was brought about through the invention of cylinder or roller printing from metal plates. This is usually credited to Oberkampf of Jouy, but it seems to have also occurred to a Scotsman named Bell, and was successfully applied in a large way about 1785 at Monsey near Preston. From this and the calico-printing works at Manchester in 1763, and in Scotland in 1768, the present huge proportions of the industry in the United Kingdom have grown.

Illustrations accompanying this brief account merely indicate a few types of patterns used in various European countries up to the beginning of the 19th century. Typical specimens of East Indian painted and printed calicoes for coverlets and other draperies are shown in the Indian division of the Victoria and Albert Museum. These are *sui generis*, and therefore differ from the bulk of Western prints on chintz, cretonne, &c., which together with a less quantity of printing on satin, silk, velvet, crêpe and the like are principally from adaptations of weaving patterns. An interesting series of over 2500 patterns, chiefly of this character, was made by M. Corimand between 1846 and 1860, and is preserved in the National Art Library at South Kensington. For many years of the latter part of the 19th century, William Morris designed and produced attractively ingenious floral and bird patterns, admirable in contrasts of bright colours, frequently basing his arrangement of crisply defined forms in them upon that of Persian surface ornament. His style, which on its appearance struck a distinctive note, has very considerably affected numbers of British and foreign designers of printed patterns whether for textiles or wall papers.

The portion of linen hanging or valance given in fig. 1 (Plate I.) comes from an ancient cemetery at Akhmîm in Upper Egypt. The linen dyed blue bears ornamentation with figures undyed or "reserved," through the previous application to it, by means of an engraved block, of some such saturating fluid as that mentioned by Pliny. The design and cutting of the block were no doubt the work of Coptic artificers, the style of the composition being Egypto-Roman of the 5th century A.D. On the child's tunic dyed blue (fig. 2) the simple trellis and blossom pattern is similarly produced by the "reserve" process, and the specimen is of the same *provenance* as that of fig. 1. It is perhaps rather earlier in date, *i.e.* 4th century A.D. Fig. 3 is from a fragment of red silk printed in red, green and black from wood-blocks, thus illustrating another method of applying colours to textiles. It is probably of Rhenish work in the 12th or 13th century, and came from the Eifel district. The ornament, however, is a survival of a scheme of pattern which was in use in Perso-Roman weavings as early as the 7th century A.D. Fig. 4 shows a piece of red silk printed with a Rhenish adaptation of a 13th-century North Italian weaving pattern possessing earlier Byzantine features. The design in fig. 5 is another Rhenish version of a richer style of 14th-century North Italian weaving. An advance in refinement of block-cutting is seen in fig. 6, a Rhenish adaptation of a 14th-century North Italian pattern often employed in brocade weaving of that period. The pattern in fig. 7 (Plate II.) is typical of a style introduced during the 15th century in sumptuous damask satins, and velvets woven at Florence, Genoa and Venice. Very different is the style exemplified in fig. 8, taken from a Dutch 17th-century "Indienne," the trade name for such prints. The repeated wide and narrow stripes recall a scheme of design which the Siculo-Saracens of the 11th century employed for brocades; the intertwining floral ornament closely resembles such as occurs in 16th-century Indian painted and printed cottons. Fig. 9 is a 19th-century Italian reproduction of the Persianesque spreading tree device often used in Indian palampores from the 16th century onwards to the present day. These, however, were either painted or printed from wood-blocks, whereas for this Italian copy engraved metal plates were used, after the manner of the process which was started, as already mentioned, by Oberkampf and Bell in the 18th century. The remaining figures 10, 11 and 12 are from stuffs metal-printed with subjects of a pictorial character which had a vogue for some time. In fig. 10—a French print—are family groups: shepherds and shepherdesses with their flocks; children at play; buildings, rocks, trees, &c.; the decorative effect of which, for the purposes of curtains and furniture covers, resulted mainly from the ordered repetition of these somewhat unrelated details. A landscape with a Chinese pagoda was repeated in lengths of the English cotton print, a piece of which was cut to fit the back of a chair as in fig. 11. Fig. 12 is from a linen panel printed in colours with a stipple engraving to be used as a small fire screen. The style reflects the pseudo-classical taste of the end of the 18th century in England. Beneath the group of figures in the original is an inscription, "London, engraved and published, August 1, 1799, by M—Bost No. 207 Piccadilly." This sort of printing has practically disappeared: it was unsuitable for manufacture on a large scale.

AUTHORITIES.—J. Persoz, *L'Impression des Tissus* (Paris, 1846, see vol. i. Preface); E. A. Parnell, *Dyeing and Calico Printing* (London, 1849); W. Crookes, F.R.S., *Dyeing and Calico Printing* (London, 1864, see Introduction); Dr R. Forrer, *Die Kunst des Zeugdrucks* (Strassburg, 1894). (A. S. C.)

TEXTUAL CRITICISM, a general term given to the skilled and methodical application of human judgment to the settlement of *texts*. By a "text" is to be understood a document written in a language known, more or less, to the inquirer, and assumed to have a meaning which has been or can be ascertained.

The aim of the "textual critic" may then be defined as the restoration of the text, as far as possible, to its original form, if by "original form" we understand the form intended by its author.

Texts may be either *autographs* or they may be *transmitted* texts; the latter, again, being *immediate copies* of autographs or *copies of copies* in any degree.

Autographs (which may be taken to include whatever, though not actually in the writing of its author, has been revised and attested by him) are not exempt from the operations of textual criticism. Editors of journals remove the slips of the pens of their contributors; editors of books, nowadays usually in footnotes, the similar lapses of their authors. With this branch of textual criticism, however, modern scholarship is not largely concerned. Not so with *immediate copies*. Textual criticism is called upon to repair the mischief done to *inscriptions* (texts inscribed upon stones) by weathering, maltreatment or the errors of the stone-cutter. Any great collection, such as the *Corpus* of Latin inscriptions or the similar *Corpus* of Greek, will show at once its activity and ability in this direction.

The chief field of textual criticism is elsewhere. The texts of the older authors which have come down to us were written for the most part not on stone but on papyrus, parchment or other perishable material. Of these several copies had to be made, both by way of prevention against the wear and tear of use and as a means of satisfying the desire of other persons than the original possessor to be acquainted with their contents. Had the copies made of ancient writings been mechanical reproductions of the originals, such as the photographic facsimiles of modern times, there would have been little here for textual criticism to do. The ancient texts have not come to us in this way, but through copies made by the human hand directed more or less by the human intelligence. Now a copy made thus can in no circumstances be a quite exact rendering of that from which it is copied or its *exemplar*. A copy, *qua* copy, can never be the equal of the exemplar, and it may be much its inferior. This deterioration increases with the number of successive copyings. Let us suppose that from a text which we will call A a copy has been made which we will call B, and from this again a copy which we will call C. If the copyist of B goes wrong once and the copyist of C twice in a hundred times, then, assuming that there is no coincidence or cancelling of errors, the relative correctness of the three texts A, B, C will be 100 (absolute correctness), 99 and 97·02. If C had made his copy direct from A, his percentage would have been 98. The importance of this must be borne in mind when we are dealing with *transmitted texts*, which have passed through many stages of copying.

In the *Epidicus* of Plautus, I. I. 10, the right reading *habitior*, "more portly," has been preserved to us by Donatus, an ancient commentator on Terence (*Eunuchus*, 2. 2. 11). It was corrupted to *abilior* by omission of the *h* and confusion of *t* and *l*, and this corruption, which is attested by the oldest extant copy, the Ambrosian palimpsest, was still further corrupted in the other copies to *agilior*.

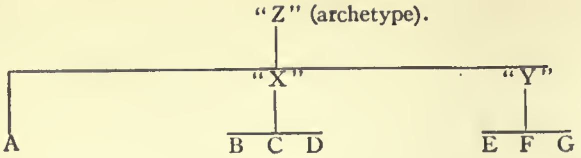
The first step towards the restoration of a text is the examination of the evidence upon which it is or is to be based. This begins with the investigation of its traditional or transmitted form. For this we have usually to rely upon *manuscripts* (MSS.). By manuscripts (*q.v.*) we understand copies of the text made before the art of printing came into general use. These may be either *extant* or *non-extant*. The evidence of extant manuscripts must be ascertained by *collation*. To collate a manuscript is to observe and record everything in it which may be of use towards determining what stood in the source or the sources from which it is derived. A manuscript is not usually a clean or single piece of writing; it is commonly found to contain alterations by erasure, addition or substitution. Such alterations may be due to the writer or writers of the MS., called the *scribe* or *scribes*, or to some other person or persons (for there may be several) called *correctors*. The relative importance of these corrections, it is obvious, may be very different. It is therefore necessary to distinguish the different *hands* which have been at work on the manuscript. Account must also be taken of the number of lines in each page, the number of pages in each quire, of gaps or lacunae in the manuscript, and so forth. The work cannot be considered complete till all the extant manuscripts have been collated or at least examined.

When this is done we shall have the materials for pronouncing a judgment upon the text as *directly transmitted*. Perhaps there is only one extant MS. of the text, as in the case of the *Mimes* of Herodas and the *Annals* and *Histories* of Tacitus. Then this part of our work is done.

But often we have to take account of a number, and it may be a large number, of manuscripts, whose respective claims to attention we must determine. In the first place we shall discard all manuscripts which are *derived* by copying *from other extant manuscripts*. If a MS. is immediately or ultimately derived by copying from another MS., it cannot, *qua* copy, tell us anything that we do not know already if the latter MS. is known to us. But how can we tell that a MS. is so derived? It must be later than the other MS., *and* the similarity between them must be such as to permit of no other explanation. In the absence of explicit dates the relative age of MSS. is often hard to determine, and hence the criterion of unmistakable resemblance is one of special importance. If the MSS. agree in singular though trivial mistakes, if they omit, apparently without motive, words and passages which other MSS. preserve, we shall be safe in pronouncing that there exists a close bond of connexion between them, and if one of them shows errors which, though strange in themselves, are quite intelligible when we see what stands in the other, then we shall be justified in concluding that the second is that from which the first is derived. For the proper consideration of such points a personal examination, *autopsy*, of the MSS. or of facsimiles of them, is very often indispensable. It was thought at one time that a MS. of the Latin poet Propertius at Naples (*Neap.* 268) might have independent value as an authority for the text. But its claims were disposed of when (amongst other facts) it was observed that at book iv. 8, 3, the MS. with which it most closely agreed (F, No. 36, 49 in the Laurentian library) had a gap at the beginning of the line and only the end words "uetus est tutela draconis," with the marginal note "*non potuit legi* in exemplari hoc quod deficit," and that *Neap.* 268 gives the line as follows, "*non potuit legi* uetus est tutela draconis."

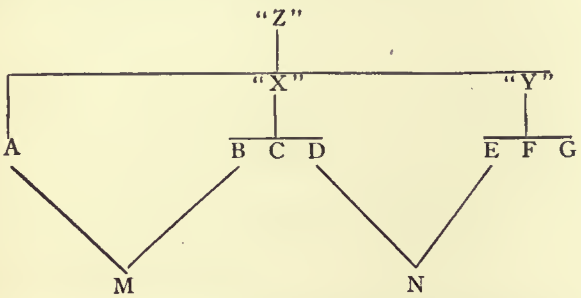
Accident apart, *identity of reading implies identity of sources*. The source of a transmitted reading may undoubtedly be the author's autograph: but if not, then it is some MS. in the line of transmission.

The peculiar resemblances of two MSS., though not sufficient to warrant the derivation of either from the other, may be sufficient to establish some connexion between them. From the axiom which has just been cited it follows that this connexion can be due only to community of source, and we thus arrive at the idea of *families of MSS*. Suppose that a text is preserved in seven MSS., A, B, C, D, E, F, G. If we find that of these A stands apart, showing no great similarity to any of the other six, while B, C, D on the one side, and E, F, G on the other, much resemble each other though differing considerably from the rest, we may express this by saying that B, C, D form a "family" descended from a hypothetical common "ancestor" which we may call X, and E, F, G another "family" descended from a hypothetical "ancestor" which we may call Y. The readings of X which can be deduced from considering the agreements in B, C, D will be of higher antiquity and of greater external authority than any of the readings in B, C, D taken singly. And similarly for the readings of Y and those of E, F, G. Nor shall we stop here: but we shall further compare the readings of X and Y with each other and with those of A, and thus deduce the readings of a still more remote ancestor which we may call Z. Z will be the *archetype* of all our existing MSS., and we may embody our results in a *pedigree* of manuscripts or *stemma codicum* as follows:—



If we have done our work properly, the texts that we arrive at for X and for Y will be freer from error than the texts of the separate members of the families B, C and D, and E, F, G respectively, and that of Z freer from error than that authenticated by any existing MS.

The procedure, however, is by no means always so simple. That a text may be improved by the comparison of different MSS. is not a modern discovery. It has long been known, and the knowledge has led to the production of what are known as *conflated manuscripts* or *Misch-codices*. These are MSS. produced by "crossing" or "intermixture." In the following stemma M and N are "mixed" or "conflated" MSS., being formed by the blending of readings from the "pure" or "unmixed" codices A, B and D, E respectively.



Intermixture may take place to any extent, and the more of it there has been the more difficult does it become to trace the transmission of a text.

Whether crossing improves a given text or not depends ultimately on the knowledge and the judgment of the crosser, and these will vary indefinitely. On the whole it is probable that it does, provided it is not accompanied by other attempts at improvement. If it be, as may very well be the case, the text will probably suffer. For but a small proportion of scholars' corrections are really amendments, and a far smaller proportion of scribes'.

The "genealogical" method, as we may call it, cannot in strictness be applied to conflated MSS., as their mutual relations can rarely be with certainty disentangled. But it is often possible to detect in such MSS. a common strain, shown by their agreement in peculiar corruptions or in probable readings when these latter would have been hard to discover by conjecture. This is practically an application of the method to a portion of such manuscripts.

A special value attaches to a conflated codex when one of the MSS. from which it has been compounded has perished and its readings are thus otherwise irrecoverable. This is exemplified in the *Neapolitanus* of Propertius, a manuscript now at Wolfenbüttel.

It not unfrequently happens that good or instructive readings are found in manuscripts which are in general of small trustworthiness (see below), and whose relations to the general tradition it is not worth while to investigate. These readings may be cited by the name of the MS., or if still greater brevity is required as the readings of inferior MSS. (*deteriores*), or, as is frequently done, by the symbol $\mathcal{S}$.

Non-extant Manuscripts.—Some of the most valuable of ancient MSS. have disappeared since their discovery in modern times. When this has happened we have to rely upon mere copies, many times of inferior quality, or upon the information which old scholars have given us respecting them. In the latter case what we have are not "collations," for the art of collation was not understood till the 19th century, but selections or "excerpts" of readings which we have reason to fear are often imperfect and erroneous. Further, it must not be assumed that all readings which are cited as being "*ex uetustis codicibus*" are necessarily from older or better MSS. than we now possess or indeed from MSS. at all. Scholars since the Renaissance have not always been above inventing codices to obtain currency for their own conjectures. The codices of Bosius (1535–1580) are just as imaginary as the "old plays" which appear as the source of so many of the quotations that head the chapters of the Waverley novels, and suspicion rests on Barth, Lambinus and others.

Some texts and portions of texts of ancient writers are now only known from printed books. The metrical treatise of Terentianus is now preserved in the *editio princeps* (1497) alone. All known MSS. of Silius Italicus have a considerable gap in the 8th book, first filled up on the authority of Jac. Constantius (1503), and not printed with the rest of the poem till the edition of Aldus (1523). The early printed books are often called by old scholars *codices impressi* (*typis*), "printed manuscripts," a phrase which at first seems curious to us but becomes perfectly intelligible when we examine these *codices impressi* and observe how closely they follow the *codices scripti*.

By the methodical employment of these means we shall arrive at a text different from any existing one. It will not be the best one, possible or existing, nor necessarily even a good one. But it will be *the most ancient one* according to the *direct line of transmission*, and the purest in the sense of being the freest from traceable errors of copying and unauthorized improvements.

The textual critic has occasionally to deal with the effects of *oral* transmission. A text so transmitted must in the lapse of time be profoundly though insensibly modified, its forms and expressions modernized, and, if widely disseminated, local variations introduced into it. This is the case with the Homeric poems, the ascertainment of the original form of which is a task beyond the powers of criticism. Even where, as in the Vedas, the sacred books of India, there is proof that the work has been transmitted without change through many centuries, the existence of unintelligible passages and unmetrical verses shows that here too there is work for textual criticism to perform, though in the opinion of most scholars it should be confined to the restoration of such forms as would be unconsciously and inevitably corrupted through changes of pronunciation and the like.

The invention of *printing* has naturally limited the province of textual criticism, and modified its operations. The writer's autograph, if it is preserved after it has been through the hands of the printer, has seldom more than an antiquarian value. As a source for the text it is superseded by the printed edition, and if there is more than one, then by the latest printed edition, which has been revised in proof by the author, or, in certain cases, by his representative; and the task of the textual critic is restricted to the detection of "misprints," in other words, of errors which the compositor (the modern analogue to the scribe) has made in "setting up" the manuscript, and which have escaped the notice of the proof-reader and the author or his representative. If, however, this revision has been neglected or incompetently performed, the number of such mistakes may be considerable.

Another question with which the textual critic of modern authors must be prepared to deal is the relative importance of different editions, each of which may have a prima facie claim to be considered authentic. Thus Shakespearean criticism must decide between the evidence of the first folio and the quartos: the critic of Shelley's poems must consider what weight is to be attached to the readings in the posthumous edition by Mrs Shelley, and in unpublished transcripts of various poems. Where there is great or complicated divergence between the editions, as in the case of Marlowe's *Faustus*, the production of a resultant text which may be relied upon to represent the ultimate intention of the author is well-nigh impossible.

For the bettering of the *transmitted text* we can call in aids of a partial or subsidiary character which are known in general as *testimonia*. Such are *Anthologies* or collections of extracts. The oldest authority for an epithalamium of Catullus (62) is an anthology at Paris written in the 9th century.

Translations from one language into another may help to fix the reading of the original, or this again that of the translation.

In Shelley's *Prometheus Unbound*, ii. 5, 54,—"Child of Light! thy limbs are burning | Through the vest which seems to hide them"—"limbs" is supported against "lips" (ed. 1) by "*membre*" in the Italian prose version made by Shelley himself: and similarly in l. 52 "looks" (not "locks") by the rendering "sguardi." In his translations of Euripides' *Cyclops*, 381, "a bowl | Three cubits wide and four in depth, as much | As would contain four amphorae" the Greek original clearly points to "*ten* amphorae" and *four* may have come from the previous line.

In *direct quotations*, either of passages or single words, and either with or without the author's name, we must be sure that the writer is quoting exactly.

A couplet of Propertius is written upon the walls of Pompeii in the following form: "Quisquis amator erit, *Scythiae* licet ambulet oris, | Nemo *adeo ut feriat*, barbarus esse uolet." Here the manuscripts have "*Scythicis*"—"*deo ut noceat*," of which *deo* is rejected by every one in favour of the Pompeian reading, but *Scythicis* and *noceat* are retained on the ground that they are in themselves better than the Pompeian readings, which may be simply due to lapse of memory. In Shelley's *Julian and Maddalo*, 40, —"(talk) such as once, so poets tell, | The devils held within the *dales* of Hell | Concerning God, freewill and destiny,"—*vales* has been suggested to make it harmonize with the passage of Milton to which reference is made: but the argument is not conclusive.

Parodies may prove of service in restoring the form of what is parodied or this in restoring the parody. So also *obvious imitations*, especially in a highly imitative literature such as Latin poetry. The connexion of the passages must in all these cases be unmistakable.

In Homer, *Iliad*, i. 4 seq., Aristarchus had the common reading αὐτοὺς δὲ ἑλώρια τεῦχε κύνεσσι | οἰωνοῖσί τε πᾶσι, but another Homeric critic of note, Zenodotus, read δαῖτα for πᾶσι, and this is supported by the obvious imitation in Aeschylus, *Supplices*, 800, who has ὄρνισι δεῖπνον.

The support which a reading gains from the evidence of the directly transmitted text *and* from the auxiliary testimonia may be called its *documental probability*. To restore a text from the documental evidence available we must know and weigh the causes which tend to vitiate this evidence in its various kinds. We shall speak first of those which affect the *direct* transmission of texts. These are either external or internal.

External.—A text may become illegible through damp or constant thumbing; portions of it may be torn away; if it is in book form, leaves or whole quires may be detached and either lost or misplaced. When this has taken place on a considerable scale, the critic is helpless; but minor injuries may sometimes be traced and remedied. The weakest parts of a MS. book were the outer margins; and hence the beginnings and the ends of lines, whether of verse or prose, were specially liable to injury. It obviously makes a difference upon which side of a leaf, whether on the verso or the recto, a line was written. Hence the determination of the paging of the archetype (as was done for the archetype of Lucretius by Lachmann) has more than a merely antiquarian value. In ancient classical MSS. the first letters of poems in verse and of paragraphs in prose usually, and the initial letters of lines in verse occasionally, were written separate and by another person than the scribe (who was called the *rubricator*), and hence were apt to be omitted. Other external circumstances may prejudicially affect a text. The copy from which Shelley's *Julian and Maddalo* was printed was written on very narrow paper, and the punctuation marks at the ends of the lines were frequently omitted.

Internal.—These errors arise from the default of the scribe or copyist, and, in the case of printed books, the compositor.[1] They are very numerous. They may be roughly arranged according to the degree in which the volition of the copyist is absent or present, as involuntary or mechanical, semi-voluntary and voluntary; or again as they affect single signs (letters, figures or symbols), words, lines or even larger units such as sentences or paragraphs.

[1] For the convenience of the general reader these errors have been illustrated as far as possible from English authors and especially from the poems of Shelley (ed. Hutchinson).

Simple Errors of the Eye.—(*a*) Confusions of letters. These are very numerous, and different in different scripts or styles of writing (see PALAEOGRAPHY). Thus the Roman letters *E* and *F* are liable to be confused in capital script, but not in cursive (*e*, *f*), *C*, *G*, in capitals, *c*, *e* in the cursive writing called Caroline minuscule, *c*, *t*, in the angular cursive of the 13th century and later. Texts which have had a long history will often show by the letter-confusions which they exhibit that they have passed through several distinct stages of copying. It is to be observed that two different styles of writing are often found in the same manuscript, the difference being utilized for the purposes of distinction. Thus in Greek cursive MSS. notes were often written in uncials; the use of majuscules or capitals for headings and for the initial letters of lines is well known. (*b*) Omissions of letters. (*c*) Shiftings of letters, sometimes by syllables. This is very common in half intelligent or half mechanical copying. In printing we get the disarrangement of type which is known as "pie." (*d*) Confusions of symbols and abbreviations.

(*a*) Examples of confusion of capital letters from Shelley's poems are: *Prometheus*, i. 553, "*M*ark that outcry of despair" for "*H*ark"; *Hellas*, 472, "*H*old each to the other in loud mockery" for "*T*old." Of *cursive letters: Marenghi*, 130, "the d*im* ocean" for "the d*un* ocean"; *Letter to Maria Gisborne* 126, sqq., "above | One chasm of Heaven smiles like the *age* of Love | On the unquiet world" for "*eye*." (*b*) *Translations from Goethe's Faust*, sc. i. 46, "To live more beas*t*ily than any beast," for "beas*tl*ily"; ii. 165, "eye" for "ey*ne*" (in spite of the rhyme with 163). (*c*) *Prometh.*, iv. 575, "Neither to change, nor f*la*tter, nor repent," for "falter." In Latin MSS. we often find a mere jumble of letters. (*d*) Confusion of words through abbreviations is very common in ancient MSS., where they were much employed. At a famous place in the doxology of 1 Timothy iii. 16, the MSS. vary between ὃς (or ὃ) and Θεός. In uncial writing OC (ὃς) might easily be miswritten or altered to ΘC (Θεός) or vice versa.

Loss of Letters, Syllables, Words or Lines, through Similarity of Writing: Homoeographon.—When similar letters or groups of letters stand next to each other, one of these is liable to be omitted. This is the simplest case and is called *haplography*.

Similarity operates differently if the similar groups stand in different lines of the exemplar. Then the copyist's eye is apt to slip from the first of two similarly written groups to the second; and he will thus omit all that is between. The term *homoeoteleuton* ("similarity of ending") is often used of these omissions, but it is not adequate, as similarity anywhere may produce the same result.

Examples of *homoeographon* and *haplography*. Shelley's *Cenci*, v. 4, 136, "whose love *was* [*as*] a bond to all our loves": a similar omission in *Witch of Atlas*, 599. In *Stanzas written in Dejection near Naples* the two lines 4, 5, "The purple noon's transparent *might*, | The breath of the moist earth is *light*," were printed in the 1st edition, "The purple noon's transparent *light*," owing to the *homoeographon* "might" "light."

Omissions through Simple Negligence.—Groups of letters, words, syllables and lines are often omitted without any contributory cause. Short words or such as are not necessary to the sense are especially prone thus to disappear.

Examples of *omission*. Shelley's *Prometheus*, iii. i, 70, "No refuge! No appeal! Sink with me [then];" *Cenci*, i. i, 26, "Respited [me] from Hell! So may the Devil | Respite their souls from Heaven!"; *Hellas*, 657, "Bask in the [deep] blue noon divine"; *Julian and Maddalo*, 218, where "Moans, shrieks, and curses, and blaspheming prayers" is absent in the earlier editions though required for the rhyme; so lines 299–301 of the *Letter to Maria Gisborne*.

Repetitions: Dittography.—Letters, groups of letters, words and lines may be written twice (or even oftener) instead of once.

Other repetitions of words already written and anticipations of words yet to be written are also found, through the scribe's eye wandering into the preceding or the following context. Wherever the word or group of words repeated is not the one that he has just copied loss is liable to occur.

Dittography is common enough in manuscripts but is usually detected in reading proofs. In the unique MS. of Cicero's treatise *De Republica*, 2, 33, 57, *secutus* appears as "*secututus secutus.*" Other kinds of repetition are Shelley's *Witch of Atlas*, 611 seq., "Like one asleep in a green hermitage, | With gentle *sleep* about its eyelids playing" (*sleep* for *smiles* has come from the previous line); *Revolt of Islam*, 4749, "Where" for "When" appears to have come from "*Where*" in 4750 or 4751. Often the word thus extruded is irrecoverable; *Ginevra*, 125 sqq., "The matin *winds* from the expanded flowers | Scatter their hoarded incense and awaken | The earth, until the dewy sleep is shaken | From every living heart which it possesses | Through seas and *winds*, cities and wildernesses"; the second "winds" is a repetition of the first, but what should stand in its place,—"lands" or "strands" or "waves" or something else—no one can say.

Confusions of Words.—Words are not only changed through confusion of single letters or abbreviations, but also through general resemblance or (a semi-voluntary change) through similarity of meaning.

Shelley, *Prometheus*, ii. 2, 53: "There streams a plume-uplifting wind" for "steams." In Shelley's lines, *When the lamp is shattered*, vv. 5–6, "When the lute is broken, | Sweet *tones* are remembered not," the printed edition had "notes" for "tones." In Mrs Gaskell's *Cranford*, ch. xiv. (near the end), "The lunch—a hot savoury mutton-chop, and a little of the cold *loin* sliced and fried —was now brought in" is the reading of most if not all the editions; but "*loin*" should be "lion," the reference being to the pudding, "a lion with currant eyes," described earlier in the chapter. In Shelley's "Evening: Ponte al Mare, Pisa," 20, "By darkest barriers of *enormous* cloud" for "*cinereous*"; "Hymn to Mercury" (trans.), 57, "And through the tortoise's hard *strong* skin" for "*stony*." Shelley's "The Boat on the Serchio," 117, "woods of stunted *fir*" for "*pine*" which the rhyme requires; *Prince Athanase*, 250, "And sea buds burst *beneath* the waves serene" for "*under*."

The same character frequently attaches to *transpositions of words and parts of words.* The copyist does not as a general rule consciously intend a change, but he falls into one through the influence of dominant associations. He substitutes an order of words which, in respect of syntax, metre or rhythm is more familiar to him.

Transpositions of words, if not purely accidental, as in Chaucer, "Parson's Tale," p. 689 (ed. Skeat), "God yaf (gave) his benison to *Laban* by the service of Jacob and to *Pharao* by the service of Joseph," where the MSS. transpose *Laban* and *Pharao*, are generally to a more usual order, as in Shelley's *Witch of Atlas*, 65, "She first was changed" to "she was first changed." An instance of transposition of words *in part* is in Shelley's "Invocation to Misery," l. 27, "And *mine* arm shall be *thy* pillow," where the 1st ed. had "*thine* arm" and "*my* pillow."

Faulty Divisions of Words.—These will generally imply an exemplar in which the words were without any division or without a sufficient one. Under this head we may class errors which arise from the omission or the insertion of such marks as the apostrophe and the hyphen.

Examples of *wrong division* of words. Chaucer's *House of Fame*, iii., 1975, "Of good or misgovernement" which should be "mis (*i.e.*, bad) governement"; Shelley's *Prometheus*, iii. 2, 22, "Round many peopled continents" for "many-peopled," *ib.* 26, "the light laden moon" for "light-laden"; *Revolt of Islam*, 4805, "Our bark hung there, as *one* line suspended | Between two heavens," for "*on a* line."

With this we may class *faulty division of sentences*. Wrong punctuation is a common error and usually easy to correct.

As an example of mispunctuation we may take Shelley's *Triumph of Life*, 188 sqq., "'If thou can'st, forbear | To join the dance, which I had well forborne' | Said the grim Feature of my thought 'Aware | I will unfold,'" &c., for "said the grim Feature (of my thought aware) 'I will unfold.'"

Grammatical Assimilations.—These are often purely mechanical errors: but they may be semi-voluntary or even voluntary, the copyist desiring to set the syntax right.

Examples: Shelley's *Rosalind and Helen*, 63, "A sound from *thee*, Rosalind dear" instead of *there; Mask of Anarchy*, 280 seq., "the daily strife | With common wants and common cares | Which *sow* the human heart with tares," for "*sows*."

Insertions (or Omissions) of Seemingly Unimportant Words.—These, inasmuch as they must often import some judgment on the sense of the passage copied, will be frequently semi-voluntary if not voluntary.

Examples: Shelley, *Prometheus*, iii. i, 5, "The soul of man like [*an*] unextinguished fire." So in *Triumph of Life*, 265, "Whom from the flock of conquerors | Fame singled *out* for her thunder-bearing minion," *out* seems to be due to the compositor.

False Recollections.—The passage which a copyist is reproducing may suggest to him something else and he will write down what is thus in his mind instead of what is before his eyes.

There is a noteworthy instance in Horace, *Odes*, iii. 18, 11 seq., "*festus in pratis uacat otioso* | *cum boue pagus*" where some MSS. give *pardus*, a reminiscence of Isaiah xi. 6, "The *leopard* (*pardus*) shall lie down with the kid." In iv. i. 20, for "*trabe citrea*" many MSS. have "*trabe Cypria*," which occurs in i. 1, 13.

Incorporation of Marginalia.—The copyist may erroneously suppose that something written in the margin, between the lines or at the top or the foot of the page which he is copying, is intended to be placed in the text. The words so incorporated may appear side by side with the genuine reading or they may expel it.

In Horace, *Odes*, iii. 27, 47, "amati | cornua *monstri*" (of the bull which carried off Europa), more than one MS. has "cornua *tauri*," an explanation of *monstri*. The celebrated passage about the three heavenly witnesses inserted in the Epistle of St John (v. 2) seems to have been originally a comment explanatory of the text.

Transpositions of Lines and Passages.—This kind of transposition is really arrested loss. An accidental omission is discovered, and the person responsible, or another, places what is omitted in the margin at the foot of the page or in some other part of the text, usually adding a mark to show where it ought to have been. The next copyist may easily overlook this sign and thus the passage may be permanently displaced.

In Chaucer's *Canterbury Tales*, most MSS. place the couplet, "And eek of many another maner cryme | Which nedeth nat rehercen at this tyme," which should stand after v. 8 of the "Friar's Tale," in the Prologue to the Tale before the fourth line from the end. In the "Monk's Tale" a block of 88 lines (3565–3652) is transposed in most MSS. to follow 3956.

Interpolation.—This is the deliberate alteration of an exemplar by way of substitution, addition or omission, but when it takes the particular form of omission it is naturally very hard to detect. Interpolation then always has a motive. The most frequent motive is the removal of some difficulty in the sense, expression or metre of the text, and especially obvious gaps or corruptions which the interpolator endeavours to fill or to heal. Fraudulent interpolation, whether the fraud be pious or otherwise, does occur, but is comparatively rare. The removal or the mitigation of objectionable matter is also occasionally found. Interpolation is then a voluntary alteration, but in practice it is often hard to distinguish from other changes in which its motive is absent.

The usual character of scribes' alterations is well illustrated by a passage in Bacon's *Advancement of Learning*, II. xix., "For these critics have often presumed that that which they understand not is false set down: as the Priest that where he found it written of St Paul *Demissus est per sportam*" [Acts ix. 25] "mended his book, and made it *Demissus est per portam*, because *sporta* was an hard word, and out of his reading." Shelley in *Triumph of Life*, 201 seq., wrote, "And if the spark with which Heaven lit my spirit | Had been with proper *nutriment* supplied," but the printed editions made it "*sentiment*." The transcript used for the printed edition of *Marenghi* apparently often corrupted what was rare and strange to what was commonplace; *e.g.*, l. 119, "dewglobes" to "dewdrops." Interpolation is sometimes due to an inopportune use of knowledge, as when a quotation or a narrative is made to agree with what the interpolator has read elsewhere. The text of the Septuagint, a translation of the Old Testament made from MSS. older than those accessible to Origen, was much altered by him in order to make it conform more closely to the Hebrew text with which he was familiar, and in the Synoptic Gospels changes are found, the aim of which is to "harmonize" the accounts given by the different evangelists. Deliberate alteration is occasionally due to disapproval of what stands in the text or even to less creditable reasons. There is an old and seemingly trustworthy tradition that some lines in Homer's "Catalogue of the Ships," *Iliad*, ii. 553–555 and 558, were introduced there to gratify the vanity or ambition of the Athenians. Insertions of this or of a similar character may be of almost any length, from a few words to a whole chapter or a complete poem. Literary forgery has never set any bounds to itself, and the history of every literature will supply examples of entire works being foisted upon authors and personages of repute. A notable one was the *Epistles* of *Phalaris*, a late Greek forgery, demonstrated to be such by Bentley in a treatise which is a model of what such a demonstration should be.

Special Conditions conducing to Corruption.—The chief of these is strangeness or difficulty in the matter to be copied. Proper names, technical expressions, quotations from foreign languages, and frequent change of subject, are all likely to cause difficulty to a scribe and error in his work.

Careful and continuous regard to the various kinds of errors and defaults that are found in transcription will enable us to judge whether a reading which it is suggested stood in the archetype of our text is likely to have been corrupted to the reading, or readings, which stand in the extant manuscripts or editions. If it is, we say of this reading that it is *transcriptionally probable.*

Some precautions must be observed. First we must rule out any proposal which assumes confusions of letters and abbreviations which are not attested for the particular tradition. Secondly, since different scribes are prone to different kinds of error, we must ever bear in mind the particular failings of the scribes responsible for the transmission of our text as these failings are revealed in the *apparatus criticus.*

Maxims of criticism to which we may here refer are that "harder readings are better than easier" and that "the shorter reading is generally the truer." The first maxim is indisputable, provided we understand by "harder" *harder to the scribe*, and by "easier" *easier to the scribe.* The characteristic of scribes' emendations or interpolations is that they are superficial. Their mark is that at the time of their making they "combine the appearance of improvement with the absence of its reality" (Westcott and Hort, *New Testament*, i. p. 27). The second maxim refers to the well-known fact that accretions from marginalia, &c., lengthen and at the same time weaken a text.

The virtues of a scribe are *honesty* and *care* (or in a single word *fidelity*) and *intelligence.* But it is rare to find these combined in a very high degree, and out of them we can least easily dispense with fidelity. Paradoxical as it may seem, the mechanical corruptions of a stupid but faithful copyist may tell us more than the intelligent copyings of a less faithful one.

A nice question is how far *any* alteration of the text of the exemplar is compatible with fidelity. Is a scribe, who recognizes under a corruption the word certainly intended, to perpetuate the error of the exemplar? Considering the liability of corruption to breed corruption we can hardly blame him if he does not, and we may say that it is no derogation to his *fides* if he makes self-evident corrections. But with these he must stop.

At certain epochs in the transmission of literature systematic efforts have been made to improve the transmitted texts, and these efforts have naturally been accompanied by a good deal of emendation both successful and unsuccessful. Such an epoch was the revival of Latin and Greek learning in the 15th century, and a modern scholar would for that reason naturally prefer to have a manuscript to work on, which was written immediately before this epoch to one which was written immediately after it.

The fidelity of a scribe has to be judged chiefly by *internal* tests, and these are best applied to his work in passages where there is no reasonable doubt of the correctness of the transmitted text. But there are two tests of a more objective character that may be used—orthography, and indication of lacunae or other faults in his exemplar. A scribe who preserves in his spelling the traces of a bygone age is probably trustworthy. If faithful in small things, he is likely to be faithful in great. A scribe again who scrupulously records the presence of a lacuna or illegibility in what he is copying, inspires us with confidence in the rest of his work.

As regards the use of *testimonia*, it may be observed to begin with that their value must depend on the trustworthiness of the texts of the writers from whom they are taken, and further upon that of the text used by the translator, the excerptor or the quoter, about which we can know nothing for certain, though we may sometimes make probable inferences. In the case of quotations we must allow for failures of memory.

Many times in the course of his investigations the critic will be confronted with problems which cannot be resolved by considerations of transcriptional or documental probability. To take an instance already referred to, it is not clear at first sight whether in the couplet from Propertius *Scythiae* is more likely to be a misrecollection of some text of the 1st century A.D., or *Scythicis* some scribe's assimilation which made its way into the transmitted text in the course of the next thousand years.

This leads us to consider *Intrinsic Probability.* By this is meant the likelihood that the writer of our text would at the time of writing have written, or not have written, a particular thing. Two questions which may be separated, though they are not entirely distinct, are here involved. What was the meaning of the writer? And how did he express it? The sense may be clear though the words may no longer be determinable.

A reading may be impugned on a number of grounds: that it gives no sense or an inappropriate sense, that it involves a usage or an idiom not current at the assumed time of writing, or foreign to the reputed author, or to the style in which he then was writing, that it involves some metrical or rhythmical anomaly, or that the connexion of thought which it produces is incoherent or disorderly. These charges cannot be played off against each other. It is no answer to the objection that a reading in some Roman poet makes nonsense to say that its Latinity is perfect or its metre excellent. But they may reinforce each other, and to such corroboration great weight must be assigned.

To set the meaning of a passage in a foreign language before us we must frequently have recourse to *translation.* But this method of representation is a very imperfect one; we may easily impose on ourselves and others by strained and ambiguous renderings. A more subtle danger to which we are especially liable in the case of a dead language is that of our acquiescing in a sense which satisfies us but which would not have satisfied the ancient writer. Above all we must avoid applying our own standards of taste, style and morality to the judgment of the text before us. The textual critic has no concern with what the writer ought to have thought or said; his business is solely with what he did say or think or might have said or thought. Amongst the legitimate reasons for suspecting the correctness of a text are patent contradictions in a passage or its immediate neighbourhood, proved and inexplicable deviations from the standards for forms, constructions and usages (mere rarity or singularity is not enough), weak and purposeless repetitions of a word (if there is no reason for attributing these to the writer), violations of the laws of metre and rhythm as observed by the author, obvious breaks in the thought (incoherence) or disorderly sequence in the same (double or multiple incoherence).

Where the critic has ascertained the earliest form of a reading in his text, he will apply to it the tests of intrinsic probability. No part of a text can be considered exempt from this scrutiny, though for a very large part of it it may be dispensed with. It should, however, be here observed, that whoever takes a reading without investigation, on the authority either of a manuscript or of a great scholar, or of a number of scholars, ceases for the time being to be a textual critic.

After every such critical examination four conclusions are possible—acceptance, doubt, rejection and alteration. In other words, a critic may deliberately pronounce that what stands in the text represents what the author wrote or might well have written, that it is doubtful whether it does, that it certainly does not, or, in the last event, that it may be replaced with certainty by something that does. In the three first cases his judgment will be governed by considerations of intrinsic probability alone: but in the last it must regard transcriptional probability as well. No alteration of a text, or *emendation,* is entitled to approval, unless in addition to providing the sense and diction required, it also presents a reading which the evidence furnished by the tradition shows might not improbably have been corrupted to what stands in the text. These tests, and these alone, are emendations bound to satisfy; but others are often tacitly imposed upon them. Of this the transposition of lines is the most notable example. This kind of change is troublesome to estimate and inconvenient to adopt, as it involves placing passages where we are not accustomed to look for them; but to the question, did the author write the passage here or there? the matter of *our* trouble or inconvenience is wholly irrelevant. There is, however, one class of cases in which no conclusion may be drawn, documental and intrinsic probability both failing us. This is where two alternative readings, neither of which can have come from the other, have equal external support and equal intrinsic merit. Isolated discrepancies of this kind may be due to some accident to our text at a period now beyond our power to trace. Numerous and striking discrepancies may be due to the fact that there was more than one edition or recension of it in early times, or to the author leaving his work in such a condition that such discrepancies must inevitably gain currency. In the case of dramas, different acting editions will give rise to them.

Up to this point all schools of textual criticism are theoretically at least in accord. But here begins a divergence which has done more than anything else to discredit the study with the outside world. It emerges because in all judgments on textual matters it is presupposed that they will be acted on, that a reading accepted will remain in the text, a rejected one obelized, enclosed between brackets or removed, and, in this last case, something else substituted in its place.

The "conservative" critic's chief concern is for the safety of the traditional and by preference the transmitted text. He urges very rightly that if alteration is carried beyond a certain point it cuts away its own foundation, and so all certainty is destroyed. His objective is the minimum of change. And as the need of making a text compels some sort of decision in every case, the "doubtful" readings of the tradition, some of which on the evidence would be doubtfully accepted and others doubtfully rejected, will all appear with the accepteds in the text. As to alterations (emendations) that are less than certain, his attitude is clearly if somewhat crudely expressed in the dictum that it is better to leave in the text "what if not the original reading is at least the remains of it." The corresponding thesis of the opposite school would be that it is better to present to the reader something which the author might have written than something which he could not: or, in other words, that "stopgaps" should be preferred to débris.

An editor of a corrupt and disputed text may reasonably adopt either of two methods of procedure. He may present the text in the purest form which the external evidence warrants, and place all plausible suggestions for its improvement in notes or appendices. The text will be faithful but unreadable, and his work will be that of an honest man but of a textual antiquarian, not a textual critic, since he declines the duty of "the restoration of the text, as far as possible, to its original form." On the other method the editor will provide all necessary information about the evidence for the text in the notes of his critical apparatus; but in the text itself he will give whatever in each case is supported by the balance of the probabilities. Each and every case he will decide on its own merits and without reference to decisions upon the other cases not now before him. Special consideration will be paid to "doubtful" readings, which will be distinguished in his work as "doubtfully accepted" or "doubtfully rejected." Legitimate doubt arises when the evidence *pro et contra* of documental and intrinsic probability is equal, or nearly equal, or when documental probability points strongly to one side and intrinsic probability to another. Illegitimate doubt is the uncertainty of the doubter as to whether he has examined the whole of the evidence. Such doubt is much more frequently felt than acknowledged, and its effect upon critical work is highly injurious. On the one hand, it is apt to take refuge in an uncritical acceptance of the traditional readings, and, on the other hand, to produce a crop of hesitant and mutually destructive conjectures which a reader naturally resents as a needless waste of his time.

The so-called "conservative text" is neither an antiquarian's text nor a critic's text, but a compromise between the two. When it is conscientiously obtained, it is arrived at by handicapping, more or less heavily, intrinsic probability as compared with documental probability, or by raising the minimum of probability which shall qualify a reading for admission into the text until it is in agreement with the notions of the editor. Both of these procedures are arbitrary in their principle, and liable to be erratic in their application. The text will suffer whichever course is adopted, and it will suffer the more the more conservative is the editor, as may easily be shown. Thus, to take the latter one, if we suppose that of two editors of equal competence A requires a probability of four-fifths to admit a reading into his text and B a probability of three-fifths only, then in all the cases in which the probability lies between these two fractions B will be right seven times to A's three, while outside these limits there will be no difference between them.

Many persons appear to suppose that decisions upon doubtful points can be avoided by the expedient of leaving the traditional reading in possession of the text. The rule is a simple one and easy to apply. But owing to the constitution of the human mind it has consequences which possibly they have not contemplated. The great works of classical literature are not studied as pathological specimens, and they will be studied the less the more they contain to repel and disquiet the reader. If a corruption is left in a text when something might be substituted which would at least, as a "stopgap," give the sort of sense required, then one of two things must happen. Either the sense of the passage is blotted out for the reader and the conservation of the corruption is tantamount to the expunging of the rest of the sentence, or else he will obtain the required sense by wresting the meaning of the other constituents of the context until they furnish it. So far so good: the requisite sense has been obtained, but the price has now to be paid. And the price is that the reader's perception of the signification of the word or words so wrested is dimmed and impaired, and his power of discriminating and understanding them when he meets them again is shot with doubt and error. In dealing with writings in dead languages this is particularly mischievous.

There are two reasons in particular why the part which emendation plays in the shaping of Greek and Latin texts is apt to be overlooked. Most people take their notions of a classical book not from its traditional form but from a "received" or *vulgate* text. This in the case of most writings is fairly readable, because it has been purged by the continuous emendation of scholars during several centuries. But the received conjectures which make this text acceptable have no more authority in themselves than equally good conjectures which have not yet won their way into the text, and it is clearly illogical to treat a text largely built upon conjectures as if it were now beyond the reach of conjecture. Again, it has often happened that readings which have been discovered by conjecture, and as such received into a text, have afterwards been found to have the support of MSS. Thus in one speech of Cicero, *pro Caelio*, some thirty conjectures of critics were found to be attested by a single recently discovered MS. Such readings it is now commonly the practice to transfer to the credit of the MS. and to suppress the fact that they were originally discovered by emendation. These *confirmations*, as they are called, should be carefully recorded in all critical texts, inasmuch as they constitute the most striking justification of the critical method.

Some examples from Shelley's poems are *Prometheus*, ii. 3, 50, "*See'st thou* shapes within the mist" (Zupitza for "*I see thin* shapes"); *ib.* iv. 4, 242, "Purple and azure, white *and* green, and golden" (*and* inserted by Rossetti); *Prince Athanase*, 150 sqq. "the rugged path | Where she once saw that horseman toil, with brief | And *blighting* hope, who with the news of death | Struck body and soul as with a mortal blight" (*blighting*, condemned by Rossetti, is cancelled in the Bodleian MS.).

It is a weakness of conservative critics to extol interpretation (or exegesis) at the expense of emendation. Some have even ventured to say that the successful defence of a passage in a text is a greater service than its successful correction. This is not true. The service to the text is the same, what was previously dark being now made clear. But the emendation deserves the higher praise as being in most instances the more difficult achievement. The fault of the opposite school, on the other hand, is to disparage interpretation and to regard correction as the proper field of a scholar and gentleman. This bias is reflected in the maxim that "correction should precede interpretation," which is no more than a half-truth. For emendation must inevitably fail unless it express the meaning which the proper interpretation of the passage has shown to be required. Further, a corrector may propose the right word with the wrong meaning. Yet the custom is to give the credit of the emendation to him, and not to a successor who has seen what the right sense was and that this was the only word to express it, whereas the first scholar blundered once if not twice, first assigning the wrong sense to the passage and then selecting what (in most cases) would be the wrong word to express it. The proper course would be not to mention the first conjecturer or to mention him only for his error.

One of the most vexed questions of textual criticism, and one which divides scholars more perhaps than any other, is the question to what extent admitted imperfections and inconsistencies may properly be left in a text as due to the default of an author rather than of a scribe or compositor. No universal rule is here attainable. Each case must be considered on its merits; and the critic's procedure must of necessity be "eclectic"—an epithet often used with a tinge of reproach, the ground for which it is not easy to discover. Two general considerations may be indicated. If the autograph of a work is not accessible, there is no means of distinguishing between the involuntary errors of a scribe and the involuntary errors—"slips of pen"—of an author. For the latter are in fact only scribe's mistakes, the author being his own amanuensis. To take the example given under *Confusions of Words* above, *loin* for *lion* in *Cranford* is probably a printer's error, but it is conceivable that it is due to a deflexion of the authoress's mind or pen through the accidental proximity of the "mutton chop."

Passing over this class we come to one about which there may frequently be serious doubt. What is clearly erroneous or faulty may as clearly be intended, and therefore *not* to be removed by the critic. In Chaucer's "Miller's Tale" (3451, 3457) *astromie* is used for *astronomie*, and *Noë* and *Noël* (Christmas) confused, "Nowélis flood" (3451, 3457), because the speaker is an illiterate carpenter. In the Prologue to the "Parson's Tale" (10) there is, on the other hand, a mistake of Chaucer's own, which no judicious critic would think of removing, the constellation Libra being said to be "*the moon's* exaltation" when it should be *Saturn's*. But this error in an astrological detail would not warrant us in assigning to the poet the blunder about Jacob and Laban in the same tale (see above). Much depends on the precision with which an error can be corrected: wherever there are more plausible ways than one of doing this, the faulty reading must be allowed to remain. Collateral as well as direct evidence must be obtained. If there are a number of instances where there is faultiness which is hard to remove, it is probable that the evil lies too deep for emendation. The author's own carelessness may be to blame, or, as in the case of Virgil and Lucan, he may not have been allowed to put the finishing touches to his work.

Certain lapses from grammatical correctness and metrical regularity that we find in the poems of Shelley are undoubtedly due to the author, though the number of these has been reduced (as Mr Buxton Forman has pointed out) with our improved knowledge of the sources of the text. Amongst such lapses we may instance *Prince Athanase* (287), "The shadow of thy moving wings *imbue* | Its deserts and its mountains"; "To a Skylark" (80), "Thou lovest—but ne'er *knew* love's sad satiety." The solecism in the Preface to the *Adonais*, "My known repugnance to the narrow principles of taste on which several of his earlier compositions were modelled *prove* at least that I am an impartial judge," would probably have been corrected by the poet if his attention had been called to it; but the two first ones, with others, cannot be thus regarded. We may detect occasional laxity also in his handling of his verse. Lines are left unrhymed: *e.g., Julian and Maddalo* (211); *Rosalind and Helen* (366). Or the same word is used in place of another rhyming word: *Revolt of Islam* (3573 and 3576, 3829 and 3831). In the *Daemon of the World* (341–2), Shelley himself cancelled a metrical reading for one that makes the verse a syllable too short. It is in this department of criticism that the personal equation has the freest play, and hence the natural adherents of either school of critics should be specially on their guard against their school's peculiar bias.

The part which conjectural emendation should play must obviously be very different in different texts. In the New Testament, for example, this part is very small indeed, though it cannot be altogether excluded. Colossians ii. 18 is corrupt as it appears; but the adoption of a correction recommended by Bishop Lightfoot and Dr C. Taylor will restore it to sense.

It has been maintained that emendation (being guessing) is no part of textual criticism at all, though judgment upon emendation is. The position approaches to paradox and is not likely to be generally accepted. But it does contain an element of truth and indicates a well-founded reproach against the majority of those who practise conjecture. Nothing has discredited emendation as a means of improving texts more than the want of method, common care and research, which those addicted to it show. Some of the most distinguished scholars have offended worst. The *Milton* of Bentley, England's greatest critic, is a by-word. To examine all the causes which may vitiate emendations would mean writing a treatise upon human frailty. But the reason why the vast majority of them fail is that the vast majority of them should never have been made at all. Their proposers do not take even elementary precautions to be right. An inquirer who examines the stars with a shilling telescope is not likely to make observations of value, and even a trained astronomer has to allow for his "personal equation"—a point to which even a finished critic rarely attends. Successful emendation requires a rare union of qualifications—insight, prudence, patience and familiarity with the author emended and the conditions of his text. If any of these is absent, the work is apt to be wasted.

Authority, as already hinted, has properly no place in textual criticism. For his facts a textual critic may, and often must, be beholden to others: but never for his opinions. It adds nothing to the evidence for a reading that it has been approved by a Lachmann or a Madvig or rejected by a Stoeber or a Carutti: and an appeal to names on any such question confuses issues and deters inquiry. But inasmuch as there are many persons, including most makers of school editions, who prudently and modestly desire a better road to truth than their own investigations can discover and think thus to find it, it will not be amiss to observe on the one hand that the concurrence of a succession of editors in a reading is no proof and often no presumption either that their agreement is independent or that their reading is right; and on the other that, though independence may generally be granted to coinciding emendations of different scholars, yet from the general constitution of the human mind it is likely that not a few of these will be coincidences in error rather than in truth.

One of the marks of a great textual critic is his attention to details. He will not consider his work upon the text complete until he has made it, as far as he can, such as the author would approve in every particular. Accordingly he will restore the spelling of the author if that can be ascertained: he will not accept the corruptions which have been introduced into it by copyists or printers, even though these may not affect its sense, nor will he modernize it so as to bring it into harmony with that of a later and to him a more familiar age. Thus, to take an example, he will not print a critical text of Plautus with two letters (Y and Z) which were no part of the Latin alphabet in the age of that comedian; still less will he introduce into Latin texts distinctions, such as *i*, *j* and *u*, *v*, which were not used till long after the middle ages.

As time goes on, textual criticism will have less and less to do. In the old texts its work will have been performed so far as it is performable. What is left will be an obstinate remainder of difficulties, for which there is no solution or only too many. In the newer texts, on the other hand, as experience has already shown, it will have from the outset but a very contracted field.

(J. P. P.)

TEZPUR, or TEJPUR, a town of British India, the administrative headquarters of Darrang district, Eastern Bengal and Assam, on the right bank of the Brahmaputra. Pop. (1901) 5047. It is the centre of a flourishing tea industry, and contains many houses of English residents. Communications are maintained by river steamer, while a light railway runs northward through the tea-growing tract.

THAʽĀLIBĪ [Abu Manṣūr ʽAbd ul-Malik ibn Mahommed ibn Isma'īl uth-Thaʽālibī] (961–1038), Arabian philologist, was born in Nīshāpūr, and is said to have been at one time a furrier. Although he wrote prose and verse of his own, he was most famous for his anthologies and collections of epigrams. Like many other Arabian writers, he does not always distinguish between his own and other people's work. Of the twenty-nine works known to have been written by him, the most famous is his *Kitāb Yatīmat ud-Dahr*, on the poets of his own and earlier times, arranged according to the countries of the poets, and containing valuable extracts (published at Damascus, 4 vols., 1887). Another of his works, the *Kitāb Fiqh ul-Lugha*, is lexicographical, the words being arranged in classes. It has been published at Paris (1861), Cairo (1867), and Beirūt (1885, incomplete).

For his other works see C. Brockelmann's *Geschichte der Arabischen Litteratur*, vol. i. (Weimar, 1898), pp. 284–86. (G. W. T.)

THACKERAY, WILLIAM MAKEPEACE (1811–1863), English novelist, only son of Richmond and Anne Thackeray (whose maiden name was Becher), was born at Calcutta on the 18th of July 1811. Both his father and his grandfather (W. R. Thackeray) had been Indian civil servants. His mother was only nineteen at the date of his birth, was left a widow in 1816, and afterwards married Major Henry Carmichael Smyth. Young Thackeray was brought home to England from India as a child, and was sent to private schools, first in Hampshire and then at Chiswick. In 1822 he was transferred to Charterhouse, at that time still on its ancient site near Smithfield. Anthony Trollope, in his book on Thackeray in the "English Men of Letters" series, quotes a letter written to him about Thackeray's schooldays by George Stovin Venables. "He came to school young," Venables wrote, "a pretty, gentle, and rather timid boy." This accords with the fact that all through Thackeray's writings the student may find traces of the sensitiveness which often belongs to the creative mind, and which, in the boy who does not understand its meaning and its possible power, is apt to assume the guise of a shrinking disposition. To this very matter Venables tersely referred in a later passage of the letter quoted by Trollope: "When I knew him better, in later years, I thought I could recognize the sensitive nature which he had as a boy." Another illustration of this idiosyncrasy is found in the statement, which will be recognized as exact by all readers of Thackeray, that "his change of retrospective feeling about his schooldays was very characteristic. In his earlier books he always spoke of the Charterhouse as Slaughter House and Smithfield. As he became famous and prosperous his memory softened, and Slaughter House was changed into Grey Friars, where Colonel Newcome ended his life." Even in the earlier references the bitterness which has often been so falsely read into Thackeray is not to be found. In "Mr and Mrs Frank Berry" (*Men's Wives*) there is a description of a fight at Slaughter House following on an incident almost identical with that used in *Vanity Fair* for the fight between Dobbin and Cuff. In both cases the brutality of school life, as it then was, is very fully recognized and described, but not to the exclusion of the chivalry which may go alongside with it. In the first chapter of "Mr and Mrs Frank Berry," Berry himself and old Hawkins both have a touch of the heroic, and in this story the bully whom Berry gallantly challenges is completely defeated, and one hears no more of him. In *Vanity Fair* Cuff the swaggerer is defeated as completely as is Berry's opponent, but regains his popularity by one well-timed stroke of magnanimity, and afterwards shows the truest kindness to his conqueror. Thackeray left Charterhouse in 1828 to join his mother and her husband at Larkbeare in Devonshire, near Ottery St Mary. Ottery St Mary is the "Clavering St Mary," as Exeter and Sidmouth are respectively the "Chatteris" and "Baymouth" of *Pendennis*.

In February 1829 Thackeray went to Trinity College, Cambridge, and in that year contributed some engaging lines on "Timbuctoo," the subject for the Prize Poem (the prize for which was won in that year by Tennyson), to a little paper called *The Snob*, a title which Thackeray afterwards utilized in the famous *Book of Snobs*. The first stanza has become tolerably well known, but is worth quoting as an early instance of the direct comic force afterwards employed by the author in verse and prose burlesques:—

> "In Africa—a quarter of the world—
> Men's skins are black; their hair is crisp and curled;
> And somewhere there, unknown to public view,
> A mighty city lies, called Timbuctoo."

One other passage at least in *The Snob*, in the form of a skit on a paragraph of fashionable intelligence, seems to bear traces of Thackeray's handiwork. At Cambridge, James Spedding, Monckton Milnes (Lord Houghton), Edward FitzGerald, W. H. Thompson (afterwards Master of Trinity), and others who made their mark in later life, were among his friends. In 1830 he left Cambridge without taking a degree, and went to Weimar and to Paris. His visit to Weimar bore fruit in the keen sketches of life at a small German court which appear in *Fitz-Boodle's Confessions* and in *Vanity Fair*. In G. H. Lewes's *Life of Goethe* is a letter containing Thackeray's impressions of the German poet. On his return to England in 1831 he entered the Middle Temple. He did not care to pursue the study of the law, but he found in his experience of the Temple the material for some capital scenes in *Pendennis*. In 1832 he came of age, and inherited a sum which, according to Trollope, "seems to have amounted to about five hundred a year." The money was soon lost—some in an Indian bank, some at play and some in two newspapers, *The National Standard* (with a long sub-title) and *The Constitutional*. In *Lovel the Widower* these two papers are indicated under one name as *The Museum*, in connexion with which our friends Honeyman and Sherrick of *The Newcomes* are briefly brought in. Thackeray's adventures and losses at play were utilized in his literary work on three occasions, in "A Caution to Travellers" (*The Paris Sketch-Book*), in the first of the Deuceace narrations (*The Memoirs of Mr C. J. Yellowplush*), and in *Pendennis*, vol. ii. chap. v., in a story (wherein Deuceace reappears) told to Captain Strong by "Colonel Altamont." As to Deuceace, Sir Theodore Martin has related how once in the playrooms at Spa Thackeray called his attention to a certain man and said presently, "That was the original of my Deuceace."

In 1834 or at the end of 1833 Thackeray established himself in Paris in order to study art seriously. He had, like Clive in *The Newcomes*, shown talent as a caricaturist from his early boyhood. His gift proved of great value to him in illustrating much of his own literary work in a fashion which, despite all incorrectness of draughtsmanship, conveyed vivid suggestions that could not have been so well given by anyone but himself. Perhaps his pencil was at its best technically in such fantastic work as is found constantly in the initial letters which he frequently used for chapters in his various kinds of work, and in those drawings made for the amusement of some child friends which were the origin of *The Rose and the Ring*.

In 1836 Thackeray married Isabella, daughter of Colonel Matthew Shawe. There were three daughters born of the marriage, one dying in infancy. The eldest daughter, Anne Isabella (b. 1837), married in 1877 Mr Richmond Ritchie, of the India Office, who in 1907 was created a K.C.B. She inherited literary talent from her father and wrote several charming works of fiction, notably *Miss Angel* (1875), and subsequently edited Thackeray's works and published some volumes of criticism and reminiscences. The younger daughter, Harriet Marian (b. 1840), married (Sir) Leslie Stephen in 1867 and died in 1875. Thackeray's own family life was early broken, for Mrs Thackeray, to quote Trollope, "became ill and her mind failed her," in 1840, and he "became as it were a widower to the end of his days"; Mrs Thackeray did not die till 1892.

In 1837 Thackeray came to London, worked at various kinds of journalism, and became a regular contributor to *Fraser's Magazine*. In this in 1841 appeared *The History of Mr Samuel Titmarsh and the Great Hoggarty Diamond*, a work filled with instances of the wit, humour, satire, pathos, which found a more ordered if not a fresher expression in his later and longer works. For freshness, indeed, and for a fine perception which enables the author to perform among other feats that of keeping up throughout the story the curious simplicity of its supposed narrator's character, *The Great Hoggarty Diamond* can scarcely be surpassed. The characters, from Lady Drum, Lady Fanny Rakes, Lady Jane and Edmund Preston, to Brough, Mrs and Miss Brough, Mrs Roundhand, Gus Hoskins, and, by no means least, Samuel Titmarsh's aunt, Mrs Hoggarty, with her store of "Rosolio," are full of life; the book is crammed with honest fun; and for pure pathos, the death of the child, and the meeting of the husband and wife over the empty cradle, stands, if not alone in its own line, at least in the company of very few such scenes in English fiction. *The Great Hoggarty Diamond*, oddly enough, met with the fate that afterwards befell one of Lever's best stories which appeared in a periodical week by week—it had to be cut short at the bidding of the editor. In 1840 came out *The Paris Sketch-Book*, much of which had been written and published at an earlier date. The book contains among other things some curious divagations in criticism, along with some really fine critical work, and a very powerful sketch called "A Gambler's Death." In 1838 Thackeray had begun, in *Fraser*, *The Yellowplush Papers*, with their strange touches of humour, satire, tragedy (in one scene, the closing one of the history of Mr Deuceace), and their sublimation of fantastic bad spelling (M'Arony for macaroni is one of the typical touches of this); and this was followed by *Catherine*, a strong story, and too disagreeable perhaps for its purpose, founded closely on the actual career of a criminal named Catherine Hayes, and intended to counteract the then growing practice of making ruffians and harlots prominent characters in fiction. Now, when *Pendennis* was coming out in serial form (1850), Miss Catherine Hayes, a singer of Irish birth and a famous *prima donna* (Sims Reeves described her as "the sweetest Lucia [di Lammermoor] he had ever sung with") was much before the public. A reflective passage in a number of *Pendennis* referred indignantly and scornfully to Catherine Hayes, the criminal of old time, coupling her name with that of a then recently notorious murderer. It would appear that Thackeray had for the moment, oddly enough, omitted to think of Miss Catherine Hayes, the justly famed soprano, while certain Irish folk were obviously ignorant or oblivious of the history of Catherine Hayes the murderess. Anyhow, there was a great outcry in the Irish press, and Thackeray was beset by private letters of indignation from enthusiastic compatriots of the *prima donna*. In deference to susceptibilities innocently outraged Thackeray afterwards suppressed the passage which had given offence. The thing is worth mention if only because it explains the initial letter drawn by Thackeray for chap. xv., vol. ii., of *Pendennis*. The drawing is in itself highly comic, but must seem quite meaningless without the key.

There soon followed *Fitz-Boodle's Confessions and Professions*, including the series *Men's Wives*, already mentioned; and slightly before these, the *Shabby Genteel Story*, a work interrupted by Thackeray's domestic affliction and afterwards republished as an introduction to *The Adventures of Philip*, which took up the course of the original story many years after the supposed date of its catastrophe. In 1843 also came out the *Irish Sketch-Book*, and in 1844 appeared the account of the journey *From Cornhill to Grand Cairo*, in which was included the excellent poem of "The White Squall." In 1844 there began in *Fraser* the *Memoirs of Barry Lyndon*, called in the magazine "The Luck of Barry Lyndon, a Romance of the Last Century." "Barry Lyndon" has, with a very great difference in treatment, some resemblance to Smollett's "Ferdinand, Count Fathom"—the hero, that is to say, is or becomes a most intolerable scoundrel, who is magnificently unconscious of his own iniquity. The form and pressure of the time depicted are caught with striking verisimilitude, and in the boyish career of Barry Lyndon there are fine touches of a wild chivalry, simplicity, generosity, which mingle naturally with those worse qualities that, under the influence of abominable training, afterwards corrupt his whole mind and career. The man is so infatuated with and so blind to his own roguery, he has so much dash and daring, and is on occasions so infamously treated, that it is not easy to look upon him as an entirely detestable villain until, towards the end of his course, he becomes wholly lost in brutish debauchery and cruelty. His latter career is founded on that of Andrew Robinson Stoney Bowes, who married the widow of John, 9th earl of Strathmore. There is also no doubt a touch of Casanova in Barry Lyndon's character. Thackeray became a contributor to *Punch* within the first year of its existence. John Leech, who was one of the earliest contributors, had been at Charterhouse with Thackeray and the two men were friends through life. Thackeray's first series contributed to *Punch* did not attain or indeed deserve signal success. He made his first hit with *Jeames's Diary*, begun in November 1845, and may be said to have established his reputation by the *Snob Papers* (1846), now better known as *The Book of Snobs*. These, besides greatly improving Thackeray's position, provoked much discussion of various kinds. Thackeray himself was naturally accused of being a snob. To this charge he had partly given an anticipatory answer (in the third chapter) in the statement that "it is impossible, in our condition of society, *not* to be sometimes a Snob," and in giving the name of "Mr Snob" to the supposed historian of snobs throughout the series. Thackeray's connexion with *Punch* came practically to an end in 1851. The severance was due partly to differences in political opinion. His personal relations with the staff of *Punch* always remained cordial. Special mention may be made of one other contribution of his to the paper, "*Punch's Prize Novelists*," containing some brilliant parodies of Edward Lytton Bulwer, Lever, Benjamin Disraeli (in "Codlingsby," perhaps the most perfect of the series), and others. Among minor but admirable works of the same period are found *A Legend of the Rhine* (a burlesque of the great Dumas's *Othon l'Archer*), brought out in George Cruikshank's *Table Book*, edited by Gilbert Abbott À Beckett, *Cox's Diary* (on which has been founded a well-known Dutch comedy, *Janus Tulp*), and *The Fatal Boots*. This is the most fitting moment for naming also *Rebecca and Rowena*, which towers, not only over Thackeray's other burlesques, excellent as they are, but over every other burlesque of the kind ever written. Its taste, its wit, its pathos, its humour, are unmatchable; and it contains some of the best songs of a particular kind ever written—songs rivalled only by Peacock's best of the same sort. In 1846 was published, by Messrs Bradbury and Evans, the first of twenty-four numbers of *Vanity Fair*, the work which first placed Thackeray in his proper position before the public as a novelist and writer of the first rank. It was completed in 1848, when Thackeray was thirty-seven years old; and in the same year Abraham Hayward paid a tribute to the author's powers in the *Edinburgh Review*. It is probable that on *Vanity Fair* has been largely based the foolish cry, now heard less and less frequently, about Thackeray's cynicism, a cry which he himself, with his keen knowledge of men, foresaw and provided against, amply enough as one might have thought, at the end of the eighth chapter, in a passage which is perhaps the best commentary ever written on the author's method. He has explained how he wishes to describe men and women as they actually are, good, bad and indifferent, and to claim a privilege.

"Occasionally to step down from the platform, and talk about them; if they are good and kindly, to love and shake them by the hand; if they are silly, to laugh at them confidentially in the reader's sleeve; if they are wicked and heartless, to abuse them in the strongest terms politeness admits of. Otherwise you might fancy it was I who was sneering at the practice of devotion, which

Miss Sharp finds so ridiculous; that it was I who laughed good-humouredly at the railing old Silenus of a baronet—whereas the laughter comes from one who has no reverence except for prosperity, and no eye for anything beyond success. Such people there are living and flourishing in the world—Faithless, Hopeless, Charityless: let us have at them, dear friends, with might and main. Some there are, and very successful too, mere quacks and fools; and it was to combat and expose such as those, no doubt, that laughter was made."

As to another accusation which was brought against the book when it first came out, that the colours were laid on too thick, in the sense that the villains were too villainous, the good people too goody-goody, the best and completest answer to that can be found by anyone who chooses to read the work with care. Osborne is, and is meant to be, a poor enough creature, but he is an eminently human being, and one whose poorness of character is developed as he allows bad influences to tell upon his vanity and folly. The good in him is fully recognized, and comes out in the beautiful passage describing his farewell to Amelia on the eve of Waterloo, in which passage may be also found a sufficient enough answer to the statement that Amelia is absolutely insipid and uninteresting. So with the companion picture of Rawdon Crawley's farewell to Becky Sharp: who that reads it can resist sympathy, in spite of Rawdon's vices and shady shifts for a living, with his simple bravery and devotion to his wife? As for Becky, a character that has since been imitated a host of times, there is certainly not much to be said in her defence. We know of her, to be sure, that she thought she would have found it easy to be good if she had been rich, and we know also what happened when Rawdon, released without her knowledge from a spunging-house, surprised her alone with and singing to Lord Steyne in the house in Mayfair. After a gross insult from Steyne, "Rawdon Crawley, springing out, seized him by the neckcloth, until Steyne, almost strangled, writhed and bent under his arm. 'You lie, you dog,' said Rawdon; 'you lie, you coward and villain!' And he struck the peer twice over the face with his open hand, and flung him bleeding to the ground. It was all done before Rebecca could interpose. She stood there trembling before him. She admired her husband, strong, brave, and victorious." This admiration is, as Thackeray himself thought it, the capital touch in a scene which is as powerful as any Thackeray ever wrote—as powerful, indeed, as any in English fiction. Its full merit, it may be noted in passing, has been curiously accented by an imitation of it in Alphonse Daudet's *Fromont Jeune et Risler Aîné*. As to the extent of the miserable Becky's guilt in the Steyne matter, Thackeray leaves it practically open to the reader to form what conclusion he will. There is, it should be added, a distinct touch of good in Becky's conduct to Amelia at Ostend in the last chapter of the book, and those who think that too little punishment is meted out to the brilliant adventuress in the end may remember this to her credit. It is supreme art in the treatment of her character that makes the reader understand and feel her attractiveness, though he knows her extraordinarily evil qualities; and in this no writer subsequent to Thackeray who has tried to depict one of the genus Becky Sharp has even faintly succeeded. Among the minor characters there is not one—and this is not always the case even with Thackeray's chief figures—who is incompletely or inconsistently depicted; and no one who wishes fully to understand and appreciate the book can afford to miss a word of it.

Vanity Fair was followed by *Pendennis*, *Esmond* and *The Newcomes*, which appeared respectively in 1850, 1852 and 1854. It might be more easy to pick holes critically in *Pendennis* than in *Vanity Fair*. Pendennis himself, after his boyish passion and university escapades, has disagreeable touches of flabbiness and worldliness; and the important episode of his relations with Fanny Bolton, which Thackeray could never have treated otherwise than delicately, is so lightly and tersely handled that it is a little vague even to those who read between the lines. It can hardly be said that there is adequate preparation for the final announcement that those relations have been innocent, and one can hardly see why it should have been so long delayed. This does not, of course, affect the value of the book as a picture of middle- and upper-class life of the time, the time when Vauxhall still existed, and the haunt for suppers and songs which Thackeray in this book called the Back Kitchen, and it is a picture filled with striking figures. In some of these, notably in that of Foker, Thackeray went, it is supposed, very close to actual life for his material, and in that particular case with a most agreeable result. As for the two "umbrae" of Lord Steyne, it is difficult to believe that they were intended as caricatures of two well-known persons. If they were, for once Thackeray's hand forgot its cunning. Here, as in the case of Amelia Sedley (*Vanity Fair*), the heroine has been thought a little insipid; and there may be good ground for finding Laura Pendennis dull, though she has a spirit of her own. In later books she becomes, what Thackeray's people very seldom are, a tiresome as well as an uninviting person. Costigan is unique, and so is Major Pendennis, a type which, allowing for differences of periods and manners, will exist as long as society exists, and which has been seized and depicted by Thackeray as by no other novelist. The Major's two encounters, from both of which he comes out victorious, one with Costigan in the first, the other with Morgan in the second volume, are true touches of genius. In opposition to the worldliness of the Major, with which Pendennis does not escape being tainted, we have Warrington, whose nobility of nature has come unscathed through a severe trial, and who, a thorough gentleman if a rough one, is really the guardian of Pendennis's career. There is, it should be noted, a characteristic and acknowledged confusion in the plot of *Pendennis*, which will not spoil any intelligent reader's pleasure.

Probably most readers of *The Newcomes* (1854) to whom the book is mentioned think first of the fine, chivalrous and simple figure of Colonel Newcome, who stands out in the relief of almost ideal beauty of character against the crowd of more or less imperfect and more or less base personages who move through the novel. At the same time, to say, as has been said, that this book "is full of satire from the first to the last page" is to convey an impression which is by no means just. There is plenty of kindliness in the treatment of the young men who, like Clive Newcome himself and Lord Kew, possess no very shining virtue beyond that of being honourable gentlemen; in the character of J. J. Ridley there is much tenderness and pathos, and no one can help liking the Bohemian "F. B.," and looking tolerantly on his failings. It may be that there is too close an insistence on the fiendish temper of Mrs Mackenzie and on the sufferings she inflicts on the colonel; but it must be remembered that this heightens the singular pathos of the closing scenes of the colonel's life. It has seemed convenient to take *The Newcomes* after *Pendennis*, because Pendennis and his wife reappear in this book as in *The Adventures of Philip*; but *Esmond* (1852) was written and published before *The Newcomes*. To some students *Esmond* seems and will seem Thackeray's capital work. It has not been rivalled as a romance reproducing with unfailing interest and accuracy the figures, manners and phrases of a past time, and it is full of beautiful touches of character. But Beatrix, upon whom so much hinges, is an unpleasing character, although one understands fully why men were captivated by her insolent beauty and brilliancy; and there is some truth in Thackeray's own saying, that "Esmond was a prig." Apart from this, the story is, like the illusion of a past time in the narrative, so complete in all its details, so harmoniously worked out, that there is little room for criticism. As to Esmond's marriage with the lady whom he has served and loved as a boy, that is a matter for individual judgment. Beatrix, it has been indicated above, is wonderfully drawn: and not the least wonderful thing about her is her reappearance as the jaded, battered, worldly, not altogether unkindly, Baroness in *The Virginians*. It was just what Beatrix must have come to, and her decline is handled with the lightest and finest touch.

In 1851 Thackeray had written *The English Humourists of the Eighteenth Century*, delivered as a series of lectures at Willis's

Rooms in the same year, and re-delivered in the United States in 1852 and 1853, as was afterwards the series called *The Four Georges*. Both sets were written for the purpose of lecturing. In 1854 was published a most delightful burlesque, *The Rose and the Ring*, whereof the origin has already been mentioned. In 1857 Thackeray stood unsuccessfully as a parliamentary candidate for Oxford against Mr Cardwell, and in the same year appeared the first number of *The Virginians*, a sequel to *Esmond*. This is a most unequal work—inferior, as sequels are apt to be, to *Esmond* as an historical romance, less compact and coherent, prone to divagation and desultoriness, yet charming enough in its lifelikeness, in the wit and wisdom of its reflexions, and, as has been said, in its portrait of Beatrix grown old. The last number of *The Virginians* came out in 1859, and in the same year Thackeray undertook the editorship of the *Cornhill Magazine*. This was a task which, as readers of his *Roundabout Paper* "Thorns in the Cushion" will remember, the kindliness and sensitiveness of his disposition made irksome to him, and he resigned the editorship in April 1862, though he continued to write for the magazine until he died. In the *Cornhill* appeared from his pen *Lovel the Widower*, previously written, with different names for some of the personages, in dramatic form; *The Adventures of Philip* (1861–62); the *Roundabout Papers;* and (1860–63) the story, unhappily never finished, called *Denis Duval*. *Lovel the Widower*, changed from the dramatic to the narrative form, remains a piece of high comedy in which the characters are indicated rather than fully worked out, with a bold and practised touch. The *Roundabout Papers*, a small storehouse of some of Thackeray's best qualities as an essayist, came out in the *Cornhill Magazine* simultaneously with *Lovel the Widower* and with *The Adventures of Philip*. Among these papers is one differing in form from the rest, called "The Notch on the Axe—a Story à la Mode." It is an almost perfect specimen of the author's genius for burlesque story-telling; but it contains an odd instance, which a careful reader will not fail to discover, of that odd habit of inaccuracy of which Thackeray himself was conscious. *The Adventures of Philip* is, as has been before said, in the nature of a sequel to or a completion of *A Shabby Genteel Story*. As with the other direct sequel, it is a work of great inequality. It contains scenes of humour, pathos, satire, which rank with Thackeray's best work; some old friends from others of the novels make brief but pleasant reappearances in its pages; there are fine sketches of journalistic, artistic and diplomatic life, and the scene from the last-named in Paris is inimitable. The Little Sister is altogether delightful; the Twysden family are terribly true and vastly diverting; the minor characters, among whom old Ridley, "J. J.'s" father, should be mentioned, are wonderfully hit off; nor did Thackeray ever write a better scene than that of the quarrel between Bunch, Baynes and M'Whirter in the Paris pension. Philip himself is impossible; one cannot say that the character is ill-drawn—it is not drawn at all. It is an entirely different personage in different chapters; and it has here and there a very unpleasant touch which may perhaps have come of rapid writing. Yet so admirable are many parts of the book that *Philip* cannot be left out of the list of Thackeray's most considerable works. *Denis Duval*, which reached only three numbers, promised to be a first-rate work, more or less in the *Esmond* manner. The author died while it was in progress, on the day before Christmas day 1863. He was buried in Kensal Green, and a bust by Marochetti was put up to his memory in Westminster Abbey.

Little has yet been said of Thackeray's performances in poetry. They formed a small but not the least significant part of his life's work. The grace and the apparent spontaneity of his versification are beyond question. Some of the more serious efforts, such as "The Chronicle of the Drum" (1841), are full of power, and instinct with true poetic feeling. Both the half-humorous, half-pathetic ballads and the wholly extravagant ones must be classed with the best work in that kind; and the translations from Béranger are as good as verse translations can be. Thackeray had the true poetic instinct, and proved it by writing poetry which equalled his prose in grace and feeling.

There can be little doubt that Thackeray will always be ranked among the foremost English writers of fiction, or that his more infrequent work as essayist and poet will go hand in hand with his wider achievements as a novelist. Many attempts have been made at many times to institute a comparison between Thackeray and Dickens as novelists. In truth it would be as much to the purpose, to borrow a homely metaphor, to compare chalk with cheese. The two authors were so radically different in their purviews, in their modes of thought, in their methods of expression, that critical comparison between them is of its nature absolutely unprofitable. It is better to recognize simply that the two novelists stood, each in his own way, distinctly above even their most distinguished contemporaries. As to preference, that is a matter with which criticism has nothing, and individual inclination has everything, to do.

The books of reference that can be best commended to the student of Thackeray's life and works are Merivale and Marzials' *Life of Thackeray* (1891); R. H. Shepherd, *Bibliography of Thackeray* (1880); C. P. Johnson, *The Early Writings of Thackeray* (1888); Charles Whibley's *Thackeray* (1905), a critical commentary; the edition of Thackeray's Works with biographical introductions (1897–1900), by his daughter, Lady Ritchie; the *Life of Thackeray* ("English Men of Letters Series," 1899) by Anthony Trollope. It is curious that Trollope showed in his own Autobiography far more appreciation of Thackeray's great qualities than is apparent in the formal Life. (W. H. P.)

THAÏS, a Greek courtesan, who lived during the time of Alexander the Great. She accompanied him on his Asiatic campaign, and is chiefly known from the story which represents her as having persuaded the conqueror to set fire to the city of Persepolis. This anecdote forms the subject of Dryden's *Ode to Saint Cecilia's Day*. But its authenticity is doubtful, since it is based upon the authority of Cleitarchus, one of the least trustworthy of the historians of Alexander. Thaïs subsequently became the wife of Ptolemy Lagus, king of Egypt. Numerous anecdotes and witticisms attributed to her will be found in Athenaeus.

See Diod. Sic. xvii. 72; Plutarch, *Alexander*, 38; Athenaeus xiii. 576, 585; Quintus Curtius v. 7.

THALBERG, SIGISMOND (1812–1871), German pianist and composer, was born at Geneva in 1812 (May the 5th or January the 7th). In 1822 he was taken to Vienna, where, under the watchful care of Count Dietrichstein, his education was completed. He made his first appearance as a pianist at Prince Metternich's in 1826, and published his first composition—a *Fantasia on Airs from "Euryanthe"*—in 1828, but it was not until 1830 that he was first fairly introduced to the public, with such brilliant success that from that time forward his only rival was Liszt (*q.v.*). In 1834 he was appointed "kammervirtuos" to the emperor of Austria. He first appeared in Paris in 1837; and in 1838 he went to England, astonishing his hearers with the novel effects produced in his *Variations on God Save the Queen*, while he charmed them with his delicate touch and the purity of his expression. Thenceforward his career was a succession of triumphs. In order to disprove the popular idea that he could execute no music but his own, he played Beethoven's *Concerto in C minor* (Op. 37) at the London Wednesday Concerts, held in 1846–47 at Exeter Hall, with a keen intelligence which proved his power of interpreting the works of the great masters to be at least on a level with his wonderful *technique*. Besides his pianoforte compositions, which are almost innumerable, Thalberg produced two operas—*Cristina*, which proved a complete failure, and *Florinda*, which fared but little better at Her Majesty's Theatre in 1851. He played in London for the last time in 1863, and afterwards retired to his estate near Naples. He died at Naples on the 27th of April 1871.

THALE, a town of Germany, in the Prussian province of Saxony, charmingly situated under the northern declivity of the Harz Mountains, 8 m. by rail S.W. of Quedlinburg, at the entrance to the romantic gorge of the Bode, and in the immediate vicinity of the Rosstrappe, the Hexentanzplatz and other notable points in the Harz. Pop. (1905) 13,194. It is largely frequented as a summer resort and for its saline springs. It is also a brisk manufacturing centre, its chief products being enamelled goods, iron-ware and machinery.

THALES OF MILETUS (640–546 B.C.), Greek physical philosopher, son of Examyus and Cleobuline, is universally recognized as the founder of Greek geometry, astronomy and philosophy. He is said by Herodotus and others to have been of Phoenician extraction, but the more common account (see DIOGENES LAËRTIUS) is that he was a native Milesian of noble birth. Zeller thinks that his ancestors belonged to the Cadmean tribe in Boeotia, who were intermingled with the Ionians of Asia Minor, and thus reconciles the conflicting statements. The nationality of Thales is certainly Greek and not Phoenician. The high estimation in which he was held by his contemporaries is shown by the place he occupied as chief of the seven "wise men" of Greece; and in later times amongst the ancients his fame was quite remarkable. It is well known that this name (σοφός) was given on account of practical ability; and in accordance with this we find that Thales had been occupied with civil affairs, and indeed several instances of his political sagacity have been handed down. Of these the most remarkable is the advice, praised by Herodotus, which he gave to his fellow-countrymen "before Ionia was ruined"—"that the Ionians should constitute one general council in Teos, as the most central of the twelve cities, and that the remaining cities should nevertheless be governed as independent states" (Herod. i. 170). It is probable, however, that in the case of Thales the appellation "wise man," which was given to him and to the other six in the archonship of Damasius (586 B.C.),[1] was conferred on him not only on account of his political sagacity, but also for his scientific eminence (Plut. *Solon*, c. 3). To about the same time must be referred his celebrated prediction of the eclipse of the sun, which took place on the 28th of May 585 B.C. This event, which was of the highest importance, has given rise to much discussion. The account of it as given by Herodotus (i. 74) contains two statements:—(1) the fact that the eclipse did actually take place during a battle between the Medes and the Lydians, that it was a total eclipse (Herodotus calls it a "night battle"), that it caused a cessation of hostilities and led to a lasting peace between the contending nations; (2) that Thales had foretold the eclipse to the Ionians, and fixed the year in which it actually did take place. Various dates—ranging from 625 B.C. to 583 B.C.—have been assigned by different chronologists to this eclipse; but, since the investigations of Airy,[2] Hind,[3] and Zech,[4] the date determined by them (May 28, 585 B.C.) has been generally accepted (for later authorities see ECLIPSE and ASTRONOMY). This date agrees nearly with that given by Pliny (*H. N.* ii. 12). The second part of the statement of Herodotus—the reality of the prediction by Thales—has been frequently called in question, chiefly on the ground that, in order to predict a solar eclipse with any chance of success, one should have the command of certain astronomical facts which were not known until the 3rd century B.C., and then merely approximately, and only employed with that object in the following century by Hipparchus. The question, however, is not whether Thales could predict the eclipse of the sun with any chance of success—much less whether he could state beforehand at what places the eclipse would be visible, as some have erroneously supposed, and which of course would have been quite impossible for him to do, but simply whether he foretold that there would be a solar eclipse in that year, as stated by Herodotus. Now as to this there is quite a remarkable unanimity in the testimony of the ancients, and the evidence is of the strongest kind, ascending to Herodotus, and, according to the account of Diogenes Laërtius, even to Xenophanes, who was an Ionian, and not much later than Thales. Further, we know that in the 8th century B.C., there were observatories in most of the large cities in the valley of the Euphrates, and that professional astronomers regularly took observations of the heavens, copies of which were sent to the king of Assyria; and from a cuneiform inscription found in the palace of Sennacherib at Nineveh, the text of which is given by George Smith,[5] we learn that at that time the epochs of eclipses of both sun and moon were predicted as possible—probably by means of the cycle of 223 lunations or Chaldaean Saros—and that observations were made accordingly.

The wonderful fame of Thales amongst the ancients must have been in great part due to this achievement, which seems, moreover, to have been one of the chief causes that excited amongst the Hellenes the love of science which ever afterwards characterized them. Thales seems not to have left any writings behind him, though as to this there appears to be some doubt (see Diog. Laër. i. 23). Many anecdotes, amusing rather than instructive, are related of him, which have been handed down by Diogenes Laërtius and other writers. From some of them it would appear that he was engaged in trade, which is indeed expressly stated by Plutarch (*Solon*, c. 2). It is probable that in the pursuit of commerce he was led to visit Egypt. Of the fact that Thales visited Egypt, and there became acquainted with geometry, there is abundant evidence. Hieronymus of Rhodes (ap. Diog. Laër. i. 27) says, "he never had any teacher except during the time when he went to Egypt and associated with the priests."[6]

But the characteristic feature of the work of Thales was that to the knowledge thus acquired he added the capital creation of the geometry of lines, which was essentially abstract in its character. The only geometry known to the Egyptian priests was that of surfaces, together with a sketch of that of solids, a geometry consisting of some simple quadratures and elementary cubatures, which they had obtained empirically. Thales, on the other hand, introduced *abstract* geometry, the object of which is to establish precise relations between the different parts of a figure, so that some of them could be found by means of others in a manner strictly rigorous. This was a phenomenon quite new in the world, and due, in fact, to the abstract spirit of the Greeks.

The following discoveries in geometry are attributed to Thales:—(1) the circle is bisected by its diameter (Procl. *op. cit.* p. 157); (2) the angles at the base of an isosceles triangle are equal (*Id.* p. 250); (3) when two straight lines cut each other the vertically opposite angles are equal (*Id.* p. 299); (4) the angle in a semicircle is a right angle;[7] (5) the theorem Euclid i. 26 is referred to Thales by Eudemus (Procl. *op. cit.* p. 352). Two applications of geometry to the solution of practical problems are also attributed to him:—(1) the determination of the distance of a ship at sea, for which he made use of the last theorem; (2) the determination of the height of a pyramid by means of the length of its shadow: according to Hieronymus of Rhodes (Diog. Laër. i. 27) and Pliny (*N. H.* xxxvi. 12), the shadow was measured at the hour of the day when a man's shadow is the same length as himself. Plutarch, however, states the method in a form requiring the knowledge of Euclid vi. 4, but without the restriction as to the hour of the day (*Sept. Sap. Conviv.* 2). Further, we learn from Diogenes Laërtius (i. 25) that he perfected the things relating to the scalene triangle and the theory of lines. Proclus, too, in his summary of the history of geometry before Euclid, which he probably derived from Eudemus of Rhodes, says that Thales, having visited Egypt, first brought the knowledge of geometry into Greece,

[1] Bretschneider (*Die Geom. vor Euklides*, p. 40), without stating his authority, gives "between 585 and 583 B.C." as the date of the archonship of Damasius. In this he is followed by some other recent writers, who infer thence that the name "wise" was conferred on Thales on account of the success of his prediction. The date 586 B.C., given above, which is taken from Clinton, is adopted by Zeller.

[2] "On the Eclipses of Agathocles, Thales, and Xerxes," *Phil. Trans.* vol. cxliii. p. 179 seq., 1853.

[3] *Athenaeum*, p. 919, 1852.

[4] *Astronomische Untersuchungen der wichtigeren Finsternisse*, &c., p. 57, 1853.

[5] *Assyrian Discoveries*, p. 409.

[6] Cf. Pamphila and the spurious letter from Thales to Pherecydes, ap. Diog. Laër.; Proclus, *In primum Euclidis Elementorum Librum Commentarii*, ed. Friedlein, p. 65; Pliny, *H. N.* xxxvi. 12; Iamblichus, *In Vit. Pythag.* 12; Plutarch, *Sept. Sap. Conviv.* 2, *De Iside*, 10, and *Plac.* i. 3, 1.

[7] This is unquestionably the meaning of the statement of Pamphila (temp. Nero), ap. Diog. Laër. i. 24, that he was the first person to describe a right-angled triangle in a circle.

that he discovered many things himself, and communicated the beginnings of many to his successors, some of which he attempted in a more abstract manner (καθολικώτερον) and some in a more intuitional or sensible manner (αἰσθητικώτερον) (*op. cit.* p. 65).

From these indications it is no doubt difficult to determine what Thales brought from Egypt and what was due to his own invention. This difficulty has, however, been lessened since the translation and publication of the papyrus Rhind by Eisenlohr;[1] and it is now generally admitted that, in the distinction made in the last passage quoted above from Proclus, reference is made to the two forms of his work—αἰσθητικώτερον pointing to what he derived from Egypt or arrived at in an Egyptian manner, while καθολικώτερον indicates the discoveries which he made in accordance with the Greek spirit. To the former belong the theorems (1), (2), and (3), and to the latter especially the theorem (4), and also, probably, his solution of the two practical problems. We infer, then, [1] that Thales must have known the theorem that the sum of the three angles of a triangle are equal to two right angles. This inference is made from (4) taken along with (2). No doubt we are informed by Proclus, on the authority of Eudemus, that the theorem Euclid i. 32 was first proved in a general way by the Pythagoreans; but, on the other hand, we learn from Geminus that the ancient geometers observed the equality to two right angles in each kind of triangle—in the equilateral first, then in the isosceles, and lastly in the scalene (Apoll. *Conica*, ed. Halleius, p. 9), and it is plain that the geometers older than the Pythagoreans can be no other than Thales and his school. The theorem, then, seems to have been arrived at by induction, and may have been suggested by the contemplation of floors or walls covered with tiles of the form of equilateral triangles, or squares, or hexagons. [2] We see also in the theorem (4) the first trace of the important conception of geometrical loci, which we, therefore, attribute to Thales. It is worth noticing that it was in this manner that this remarkable property of the circle, with which, in fact, abstract geometry was inaugurated, presented itself to the imagination of Dante:—

> "O se del mezzo cerchio far si puote
> Triangol sì, ch'un retto non avesse."—*Par.* c. xiii. 101.

[3] Thales discovered the theorem that the sides of equiangular triangles are proportional. The knowledge of this theorem is distinctly attributed to Thales by Plutarch, and it was probably made use of also in his determination of the distance of a ship at sea.

Let us now consider the importance of the work of Thales. I. In a scientific point of view: (*a*) we see, in the first place, that by his two theorems he founded the geometry of lines, which has ever since remained the principal part of geometry; (*b*) he may, in the second place, be fairly considered to have laid the foundation of algebra, for his first theorem establishes an equation in the true sense of the word, while the second institutes a proportion.[2] II. In a philosophic point of view: we see that in these two theorems of Thales the first type of a natural law, *i.e.* the expression of a fixed dependence between different quantities, or, in another form, the disentanglement of constancy in the midst of variety—has decisively arisen.[3] III. Lastly, in a practical point of view: Thales furnished the first example of an application of theoretical geometry to practice,[4] and laid the foundation of an important branch of the same—the measurement of heights and distances. For the further progress of geometry see PYTHAGORAS.

As to the astronomical knowledge of Thales we have the following notices:—(1) besides the prediction of the solar eclipse, Eudemus attributes to him the discovery that the circuit of the sun between the solstices is not always uniform;[5] (2) he called the last day of the month the thirtieth (Diog. Laër. i. 24); (3) he divided the year into 365 days (*Id.* i. 27); (4) he determined the diameter of the sun to be the 720th part of the zodiac;[6] (5) he appears to have pointed out the constellation of the Lesser Bear to his countrymen, and instructed them to steer by it [as nearer the pole] instead of the Great Bear (Callimachus ap. Diog. Laër. i 23; cf. Aratus, *Phaenomena*, v. 36 seq.). Other discoveries in astronomy are attributed to Thales, but on authorities which are not trustworthy. He did not know, for example, that "the earth is spherical," as is erroneously stated by Plutarch (*Placita*, iii. 10); on the contrary, he conceived it to be a flat disk, and in this supposition he was followed by most of his successors in the Ionian schools, including Anaxagoras. The doctrine of the sphericity of the earth, for which the researches of Anaximander had prepared the way,[7] was in fact one of the great discoveries of Pythagoras, was taught by Parmenides, who was connected with the Pythagoreans, and remained for a long time the exclusive property of the Italian schools.[8] (G. J. A.)

Philosophy.—Whilst in virtue of his political sagacity and intellectual eminence Thales held a place in the traditional list of the wise men, on the strength of the disinterested love of knowledge which appeared in his physical speculations he was accounted a "philosopher" (φιλόσοφος). His "philosophy" is usually summed up in the dogma "water is the principle, or the element, of things"; but, as the technical terms "principle" (ἀρχή) and "element" (στοιχεῖον) had not yet come into use, it may be conjectured that the phrase "all things are water" (πάντα ὕδωρ ἐστί) more exactly represents his teaching. Writings which bore his name were extant in antiquity; but as Aristotle, when he speaks of Thales's doctrine, always depends upon tradition, there can be little doubt that they were forgeries.

From Aristotle we learn (1) that Thales found in water the origin of things; (2) that he conceived the earth to float upon a sea of the elemental fluid; (3) that he supposed all things to be full of gods; (4) that in virtue of the attraction exercised by the magnet he attributed to it a soul. Here our information ends. Aristotle's suggestion that Thales was led to his fundamental dogma by observation of the part which moisture plays in the production and the maintenance of life, and Simplicius's, that the impressibility and the binding power of water were perhaps also in his thoughts, are by admission purely conjectural. Simplicius's further suggestion that Thales conceived the element to be modified by thinning and thickening is plainly inconsistent with the statement of Theophrastus that the hypothesis in question was peculiar to Anaximenes. The assertion preserved by Stobaeus that Thales recognized, together with the material element "water," "mind," which penetrates it and sets it in motion, is refuted by the precise testimony of Aristotle, who declares that the early physicists did not distinguish the moving cause from the material cause, and that before Hermotimus and Anaxagoras no one postulated a creative intelligence.

It would seem, then, that Thales sought amid the variety of things a single material cause; that he found such a cause in one of the forms of matter most familiar to him, namely, water, and accordingly regarded the world and all that it contains as water variously metamorphosed; and that he asked himself no questions about the manner of its transformation.

The doctrine of Thales was interpreted and developed in the course of three succeeding generations. First, Anaximander chose for what he called his "principle" (ἀρχή), not water, but a corporeal element intermediate between fire and air on the one hand and water and earth on the other. Next, Anaximenes, preferring air, resolved its transformations into processes of thinning and thickening. Lastly, Heraclitus asserted the claims of fire, which he conceived to modify itself, not occasionally, but perpetually. Thus Thales recognized change, but was not careful to explain it; Anaximander attributed to change two directions; Anaximenes conceived the two sorts of change as rarefaction and condensation; Heraclitus, perceiving that, if, as his predecessors had tacitly assumed, change was occasional, the interference of a moving cause was necessary, made change perpetual. But all four agreed in tracing the variety of things to a single material cause, corporeal, endowed with qualities, and capable of self-transformation. A new departure was taken by the Eleatic Parmenides (*q.v.*), who, expressly noting that, when Thales and his successors attributed to the supposed element changing qualities, they became pluralists, required that the superficial variety of nature should be strictly distinguished from its fundamental unity. Hence, whereas Thales and his successors had confounded the One, the element, and the Many, its modifications, the One and the Not-One or Many became with Parmenides matters for separate investigation. In this way two lines of inquiry originated. On the one hand Empedocles and Anaxagoras, abandoning the pursuit of the One, gave themselves to the scientific study of the Many; on the other Zeno, abandoning the pursuit of the Many, gave himself to the dialectical study of the One. Both successions were doomed to failure; and the result

[1] *Ein mathematisches Handbuch der alten Aegypter* (Leipzig, 1877).
[2] Auguste Comte, *Système de Politique Positive*, iii. pp. 297, 300.
[3] P. Laffitte, *Les Grands Types de l'Humanité*, vol. ii. p. 292.
[4] *Ibid.*, p. 294.
[5] Theonis Smyrnaei Platonici *Liber de Astronomia*, ed. Th. H. Martin, p. 324 (Paris, 1849). Cf. Diog. Laër. i. 24.
[6] This is the received interpretation of the passage in Diogenes Laërtius, i. 24 (see Wolf, *Gesch. der Astron.*, p. 169), where σεληναίου is probably a scribe's error for ζῳδιακοῦ. Cf. Apuleius, *Florida*, iv. 18, who attributes to Thales, then old, the discovery: "quotiens sol magnitudine sua circulum quem permeat metiatur."
[7] In likening the earth to a cylinder Anaximander recognized its circular figure in one direction.
[8] See G. V. Schiaparelli, *I Precursori di Copernico nell' Antichità*, p. 2 (Milan, 1873).

was a scepticism from which the thought of Greece did not emerge until Plato, returning to Parmenides, declared the study of the One and the Many, jointly regarded, to be the true office of philosophy. Thus, meagre and futile as the doctrine of Thales was, all the Greek schools, with the solitary exception of that of Pythagoras, took their origin from it. Not in name only, but also in fact, Thales, the first of the Ionian physicists, was the founder of the philosophy of Greece.

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THALLIUM [symbol Tl, atomic weight 204·0 (O=16)], a metallic chemical element. It was discovered in 1861 by Sir William Crookes, who, during a spectroscopic examination of the flue-dust produced in the roasting of seleniferous pyrites occurring at Tilkerode in the Harz, observed a green line foreign to all then known spectra. He concluded that the mineral contained a new element, to which he gave the name of thallium, from θαλλός, a green twig. Crookes presumed that his thallium was something of the order of sulphur, selenium or tellurium; but Lamy, who anticipated him in isolating the new element, found it to be a metal. Our knowledge of the chemistry of thallium is based chiefly upon the labours of Crookes.

The chemical character of thallium presents striking peculiarities. Dumas once called it the "*ornithorhynchus paradoxus* of metals." As an elementary substance, it is very similar in its physical properties to lead; it resembles lead chemically inasmuch as it forms an almost insoluble chloride and an insoluble iodide. But the hydroxide of thallium, in most of its properties, comes very close to the alkali metals; it is strongly basic, forms an insoluble chloroplatinate, and an alum strikingly similar to the corresponding potassium compounds. Yet, unlike potassium or lead, it forms a feebly basic sesquioxide similar to manganic oxide, Mn_2O_3.

Traces of thallium exist in many kinds of pyrites, as used for vitriol-making. The only known mineral of which it forms an essential component is the rare mineral crookesite of Skrikerum, Småland, Sweden, which, according to Nordenskiöld, contains 33·3 per cent. of selenium, 45·8 per cent. of copper, 3·7 per cent. of silver, and 17·2 per cent. of thallium. The best raw materials for the preparation of thallium are the flue-dusts produced industrially in the roasting of thalliferous pyrites and the "chamber muds" accumulating in vitriol-chambers wrought with such pyrites; in both it is frequently associated with selenium. The flue-dust from the pyrites of Theux, near Spa (Belgium), according to Böttcher, contains 0·5 to 0·75 per cent. of thallium; that of the pyrites of Meggen, according to Carstanjen, as much as 3·5 per cent.; while that of the pyrites of Ruhrort yielded 1 per cent. of the pure chloride to Gunning.

For the extraction of the metal from chamber mud, the latter is boiled with water, which extracts the thallium as the sulphate. From the filtered solution the thallium is precipitated as the chloride by addition of hydrochloric acid, along, in general, with more or less of lead chloride. The mixed chlorides are boiled down to dryness with sulphuric acid to convert them into sulphates, which are then separated by boiling water, which dissolves only the thallium salt. From the filtered solution the thallium is recovered, as such, by means of pure metallic zinc, or by electrolysis. The (approximately pure) metallic sponge obtained is washed, made compact by compression, fused in a porcelain crucible in an atmosphere of hydrogen, and cast into sticks.

Metallic thallium is bluish white; it is extremely soft and almost devoid of tenacity and elasticity. Its specific gravity is 11·86. It fuses at 290° C.; at a white heat it boils and can be distilled in hydrogen gas. Its vapour density at 1728° corresponds to the molecule Tl_2. Its salts colour the Bunsen flame a bright green. When heated in air it is readily oxidized, with the formation of a reddish or violet vapour. When exposed to the air it becomes quickly covered with a film of oxide; the tarnished metal when plunged into water reassumes its metallic lustre, the oxide film being quickly dissolved. When kept in contact with water and air it is gradually converted into hydroxide, TlOH. It decomposes water at a red heat, liberating hydrogen and being itself converted into the hydrate. It is readily soluble in nitric and sulphuric acids, but less so in hydrochloric.

Thallium forms two series of salts: thallous, in which the metal is monovalent; and thallic, in which it is trivalent. In the thallous series many analogies with lead compounds are observed; in the thallic some resemblance to aluminium and gold.

Thallous hydroxide, TlOH, is most conveniently prepared by decomposing the solution of the sulphate with baryta water. It crystallizes from its solution in long yellow needles, TlOH or $TlOH+H_2O$, which dissolve readily in water, forming an intensely alkaline solution, which acts as a caustic, and like it greedily absorbs carbonic acid from the atmosphere. Unlike the alkalis, it readily loses its water at 100° C. and even at the ordinary temperature, to form the oxide Tl_2O, which is black or black-violet. *Thallic oxide*, TlO or Tl_2O_2, was obtained by O. Rabe (*Abst. J.C.S.*, 1907, ii. 769) by acting with hydrogen peroxide on an alkaline solution of thallous sulphate at low temperatures, an initial red precipitate rapidly changing into a bluish-black compound. It melts at 720° and decomposes rapidly above 800°, giving oxygen and thallous oxide. *Thallous chloride*, TlCl, is readily obtained from the solution of any thallous salt, by the addition of hydrochloric acid, as a white precipitate similar in appearance to silver chloride, like which it turns violet in the light and fuses below redness into a (yellow) liquid which freezes into a horn-like flexible mass. It is also formed when the metal is burnt in chlorine. The specific gravity of this "horn" thallium is 7·02. One part of the precipitated chloride dissolves at 0° C. in 500 parts of water, and in 70 parts at 100° C. It is less soluble in dilute hydrochloric acid. Carbonate of soda solution dissolves it pretty freely. *Thallous iodide*, TlI, is obtained as a yellow precipitate, which requires 16,000 parts of cold water for its solution, by the addition of potassium iodide to a solution of a thallous salt, or by the direct union of its components. The yellow crystals melt at 190°, and when cooled down assume a red colour, which changes to the original yellow on standing. *Thallous bromide*, TlBr, is a light yellow crystalline powder; it is formed analogously to the chloride. *Thallous fluoride*, TlF, forms white glistening octahedra; it is obtained by crystallizing a solution of the carbonate in hydrofluoric acid. It resembles potassium fluoride in forming an acid salt, $TlHF_2$. *Thallous chloroplatinate*, Tl_2PtCl_6, readily obtainable from thallous salt solutions by addition of platinum chloride, is a yellow precipitate soluble in no less than 15,600 parts of cold water. *Thallous perchlorate*, $TlClO_4$, and *periodate*, $TlIO_4$, are interesting inasmuch as they are isomorphous with the corresponding potassium salts. Other instances of the isomorphism of thallous with potassium salts are the nitrates, phosphates, hydrazoates, sulphates, chromates, selenates, and the analogously constituted double salts, and also the oxalates, racemates and picrates. *Thallous carbonate*, Tl_2CO_3, more nearly resembles the lithium compound than any other ordinary carbonate. It is produced by the exposure of thallous hydrate to carbon dioxide, and therefore is obtained when the moist metal is exposed to the air. It forms resplendent monoclinic prisms, soluble in water. *Thallous sulphate*, Tl_2SO_4, forms rhombic prisms, soluble in water, which melt at a red heat with decomposition, sulphur dioxide being evolved. It unites with sulphuric acid giving an acid salt, $TlHSO_4 \cdot 3H_2O$, and with aluminium, chromium and iron sulphates to form an "alum." It also forms double salts of the type $Tl_2SO_4(Mg,Fe,ZnSO_4) \cdot 6H_2O$. *Thallous sulphide*, Tl_2S, is obtained as a black precipitate by passing sulphuretted hydrogen into a thallous solution. It is insoluble in water and in the alkalis, but readily dissolves in the mineral acids. On thallium sulphides see H. Pélabon, *Abst. J.C.S.*, 1907, ii. 770. *Thallous nitrate*, $TlNO_3$, is obtained as white, rhombic prisms by crystallizing a solution of the metal, oxide, carbonate, &c., in nitric acid. Various thallous phosphates are known. The normal salt, Tl_3PO_4, is soluble in 200 parts of water, and may be obtained by precipitation. On thallous salts see W. Stortenbeker, *Abst. J.C.S.*, 1907, ii. 770. *Thallic oxide*, Tl_2O_3, is obtained as a dark reddish powder, insoluble in water and alkalis, by plunging molten thallium into oxygen, or by electrolysing water, using a thallium anode. *Thallic hydroxide*, $Tl(OH)_3$, is obtained as a brown precipitate by adding a hot solution of thallous chloride in sodium carbonate to a solution of sodium hypochlorite. On drying it has the composition TlO(OH). Hydrochloric acid gives thallous chloride and chlorine; sulphuric acid gives off oxygen; and on heating it first gives the trioxide and afterwards the monoxide. The hydroxide is obtained as brown hexagonal plates by fusing thallic oxide with potash to which a little water has been added. *Thallic chloride*, $TlCl_3$, is obtained by treating the monochloride with chlorine under water; evaporation in a vacuum gives colourless deliquescent crystals of $TlCl_3 \cdot H_2O$. By heating the metal or thallous chloride in chlorine, $TlCl \cdot TlCl_2$ is obtained, which on further heating gives $3TlCl \cdot TlCl_3$ as a yellowish brown mass. The chloride when anhydrous is a crystalline mass which melts at 24°. It forms several double salts, *e.g.* with hydrochloric acid and the alkaline chlorides, and also with nitrosyl chloride. The chlorine is not completely precipitated by silver nitrate in nitric acid solution, the ionization apparently not proceeding to all the chlorine atoms. *Thallic iodide*, TlI_3, is interesting on account of its isomorphism with rubidium and caesium tri-iodides, a resemblance which suggests the formula $TlI(I_2)$ for the salt, in which the metal is obviously monovalent. On the halogen compounds see V. Thomas, *Abst. J.C.S.* (1907), ii. 547. *Thallic sulphate*, $Tl_2(SO_4)_3 \cdot 7H_2O$, and *thallic nitrate*, $Tl(NO_3)_3 \cdot 8H_2O$, are obtained as colourless crystals on the evaporation of a solution of the oxide in the corresponding acid. The sulphate decomposes into sulphuric acid and the trioxide on warming with water, and differs from aluminium sulphate in not forming alums.

Analysis.—All thallium compounds volatile or liable to dissociation at the temperature of the flame of a Bunsen lamp impart to such flame an intense green colour. The spectrum contains a bright green of wave-length 5351. From solutions containing it as thallous salt the metal is easily precipitated as chloride, iodide, or chloroplatinate by the corresponding reagents. Sulphuretted hydrogen, in the presence of free mineral acid, gives no precipitate; sulphide of ammonium, from neutral solutions, precipitates Tl_2S as a dark brown or black precipitate, insoluble in excess of reagent. Thallic salts are easily reduced to thallous by means of solution of sulphurous acid, and thus rendered amenable to the above reactions. The chloroplatinate serves for the quantitative estimation. L. F. Hawley employs sodium thiostannate which precipitates thallium as Tl_2SnS_4, insoluble in water, and which may be dried on a Gooch filter at 105°. It may be noted that all thallium compounds are poisonous.

The atomic weight of thallium was determined very carefully by Crookes, who found $Tl = 204 \cdot 2$ $(O = 16)$; this figure was confirmed by Lepierre in 1893.

THALWEG (a German word compounded from *Thal*, valley, and *Weg*, way) in physical geography, a term adopted into English usage signifying the line of greatest slope along the bottom of a valley, *i.e.* a line drawn through the lowest points of a valley in its downward slope. It thus marks the natural direction of a watercourse.

THAMES, the chief river of England, rising in several small streams among the Cotteswold Hills in Gloucestershire. Its source is generally held to be at a place known as Thames Head, in the parish of Coates, 3 m. W. by S. of Cirencester; but claims have also been advanced on behalf of the Seven Springs, the head waters of the river Churn, 5 m. S. of Cheltenham. The length of the river from Thames Head Bridge to London Bridge is 161¼ m. and from London Bridge to the Nore, 47¾ m., a total of 209 m. The width at Oxford is about 150 ft., at Teddington 250 ft., at London Bridge 750 ft., at Gravesend 2100 ft., and between Sheerness and Shoeburyness, immediately above the Nore, 5½ m. The height of Thames Head above sea-level is 356 ft., but that of Seven Springs, the adoption of which as the source would extend the length of the river by several miles, is 700 ft. The height of the river at Lechlade is 237 ft., the average fall between Lechlade and London, 143¼ m., being rather less than 20 in. per mile. The drainage area of the Thames is 5924 sq. m., including that of the Medway, which, as it joins the estuary immediately above Sheerness, may be considered a tributary of the Thames. The Thames forms part of the Gloucestershire-Wiltshire boundary to a point below Lechlade; thence for a short distance it separates Gloucestershire from Berkshire; after which it separates successively Oxfordshire and Berkshire, Buckinghamshire and Berkshire, Middlesex and Surrey, and finally, at its estuary, Essex and Kent. In the succeeding paragraph the bracketed figures indicate the distance in miles above London Bridge.

The upper course lies through a broad valley, between the foot-hills of the Cotteswolds on the north, and the slight elevations dividing it from the Vale of White Horse on the south. The scenery is rural and pleasant; the course of the river winding. Before reaching Oxford the stream swings north, east and south to encircle the wooded hills of Wytham and Cumnor, which overlook the city from the west. The Windrush joins from the north (left) at New Bridge (126¾), the Evenlode near Eynsham (119), and the Cherwell at Oxford (112). Between Lechlade and Oxford the main channel sends off many narrow branches; the waters of the Windrush are similarly distributed, and the branches in the neighbourhood of Oxford form the picturesque "backwaters" which only light pleasure boats can penetrate. The river then follows a valley confined between the hills on either side of Oxford, passes the pleasant woods of Nuneham, and at Abingdon (103½) receives the Ock from the Vale of White Horse. At Dorchester (95¼) the Thame enters on the left, and the river then passes Wallingford (90¾) and Goring (85). Hitherto from Oxford its course, though greatly winding, has lain generally in a southerly direction, but it now bends eastward, and breaches the chalk hills in a narrow gap, dividing the Chilterns from the downs of Berkshire or White Horse Hills. From this point as far as Taplow the southern slopes of the Chilterns descend more or less closely upon the river; they are finely wooded, and the scenery is peculiarly beautiful, especially in early summer. The charm of the Thames is indeed maintained throughout its course; the view of the rich valley from Richmond Hill, of the outskirts of London, is celebrated; the river is practically the only physical attribute to the beauty of the metropolis itself, and the estuary, with its burden of shipping and its industrial activity, is no less admirable. At Pangbourne (80¾) the Thames receives the Pang on the right, and at Reading (74½) the Kennet on the same side. After passing Reading it bends northward to Henley (65), eastward past Great Marlow (57) to Bourne End (54), and southward to Taplow and Maidenhead (49¾), receiving the Loddon on the right near Shiplake above Henley. Winding in a south-easterly direction, it passes Eton and Windsor (43¼), Datchet (41½), Staines (36), Chertsey (32), Shepperton (30) and Sunbury (26½), receiving the Coln from the left at Staines, and the Wey from the right near Shepperton. Flowing past Hampton Court, opposite to which it receives the Mole on the right, and past Kingston (20½), it reaches Teddington (18¾). Passing Richmond (16) and Kew the river flows through London and its suburbs for a distance of about 25 m., till it has passed Woolwich. Gravesend, the principal town below Woolwich, is 26½ m. from London Bridge. The estuary may be taken to extend to the North Foreland of Kent. In the tideway the principal affluents of the Thames are the Brent at Brentford, the Wandle at Wandsworth, the Ravensbourne at Deptford, the Lea at Blackwall, the Darent just below Erith, and the Ingrebourne at Rainham, besides the Medway.

The basin of the Thames is of curiously composite character. Thus, the upper portion of the system, above the gap at Goring, is a basin in itself, defined on the west and south by the Cotteswold and White Horse Hills and on the east and north by the Chilterns and the uplands of Northamptonshire. But there are several points at which its division from other river basins is only marked by a very low parting. Thus a well-marked depression in the Cotteswolds brings the head of the (Gloucestershire) Coln, one of the head-streams of the Thames, very close to that of the Isborne, a tributary of the upper Avon; the parting between the head-streams of the Thames and the Bristol Avon sinks at one point, near Malmesbury, below 300 ft.; and head-streams of the Great Ouse rise little more than two miles from, and only some 300 ft. above, the middle valley of the Cherwell. The White Horse Hills and the Chilterns strike right across the Thames basin, but almost their entire drainage from either flank lies within it, and similarly a great part of the low-lying Weald, though marked off from the rest of the basin by the North Downs, drains into it through these hills. It may be noted further that the Kennet continues upward the line of the main valley below the Goring gap, and the Cherwell that of the main valley above it. The basin thus presents interesting problems. The existence of wide valleys where the small upper waters of the Cherwell, Evenlode and Coln now flow, the occurrence of waterborne deposits in their beds from the north-west of England and from Wales, and the fact that the Thames, like its lower southern tributaries which pierce the North Downs, has been able to maintain a deep valley through the chalk elevation at Goring, are considered to point to the former existence of a much larger river, in the system of which were included the upper waters of the present Severn, Dee and other rivers of the west. The question, in fact, involves that of the development of a large part of the hydrography of England.

The Thames about Oxford is often called the Isis. Camden gave currency to the derivation of the word from the combination of the names Thame and Isis. But it can be shown conclusively that the river has borne its present designation from the earliest times. Caesar (*De Bell. Gall.* v. 11) says that at the time of his invasion of Britain it was called Tamesis. Dion Cassius (xl. 3) and Tacitus (*Ann.* xiv. 32) both call it Tamesa, and in no early authority is the name Isis used. In early Saxon times the river was called Thamis, as may be seen in a grant before A.D. 675 to Chertsey Abbey by the sub-king Frithwald. In the first statute passed for improving the navigation of the river near Oxford (21 Jac. I.) it is called the river of Thames, and it was only in a statute of George II. (1751) that the word Isis appears. The name Isis has indeed the authority of Spenser as applied to the Thames in its course above Dorchester (*Faerie Queen*, Bk. iv. canto xi. stanza 24), but there is ample evidence to show that long before his time the name of the river throughout its course was not Isis but Thames. The word Isis is probably an academic rendering of Ouse or Isca, a common British river name, but there is no reason to suppose that it ever had much vogue except in poetry or in the immediate neighbourhood of Oxford.

The flow of the Thames varies greatly, according to the season of the year. The average gaugings at Teddington for the summer months of the years 1883 to 1900 were in July 413,000,000 gallons a day, in August 395,000,000 gallons, and in September 375,000,000 gallons. The normal natural flow in ordinary summer weather is about 350,000,000 gallons a day, and of this, after the companies have taken 130,000,000, only 220,000,000 gallons are left to pass over Teddington Weir. After a long period of dry weather the natural flow has been known to fall considerably below 200,000,000 gallons, whilst, on the other hand, in the rainy winter season, the flow in 1894 rose for a short time to as high a figure as 20,000,000,000 gallons, and the ordinary flow in winter months may be put down as 3,000,000,000 gallons. The importance of storage reservoirs is manifest under such conditions of flow, especially bearing in mind the growth of population in the London district and of its increasing needs. The water-supply of London is considered under that heading; it may be noted here that the Thames forms the chief source of supply for the metropolis, but apart from this the corporation of Oxford and two companies in the Staines district have powers to draw water from the river, though not in any large quantities.

Throughout the whole of the Thames watershed, and especially in the 3800 sq. m. above the intakes of the water companies (at Hampton or in the vicinity), the Thames Conservancy has enforced the requirements of parliament that no sewage or other pollution shall be allowed to pass into the Thames, into its tributary streams, or even into any water communicating with them. There is a large staff of inspectors constantly visiting the various parts of the watershed, and in spite of many difficulties arising from vested interests, the work of purification is attaining completion, with a correspondingly great improvement in the quality of the river water. So recently as 1890 the state of the river below London was such as to be dangerous to the public health. The metropolitan sewage was discharged untreated into the river, and the heavier solids deposited over the river-bed, while the lighter parts flowed backwards and forwards on the tide. The London County Council, directly after its establishment, took means to remedy this evil (see LONDON).

The Thames is navigable for rowing-boats as far upwards as Cricklade, except in dry seasons, and for barges at all times as far as Lechlade, 18 m. below Thames Head. At Inglesham, three-quarters of a mile above Lechlade, the Thames and Severn canal has its junction with the Thames. This canal is the link between the two great rivers from which it takes its name, or, in other words, between the east and west of England. It surmounts the watershed by means of Sapperton tunnel, 2 m. long, opened in 1789, and joins the Stroudwater canal, which completes the connexion, at Wallbridge near Stroud. It was long abandoned, but owing to the exertions of a joint committee of the counties and other interests concerned in 1895, powers were obtained from parliament for its restoration, and the works needful for its re-opening were carried out. Concurrently with the repair of the canal, the navigation works on the Thames were remodelled at a large cost, and barges drawing 3 ft. 6 in. can now, even in the summer season, navigate from London to Inglesham. Although the Thames, as one of the "great rivers of England," was always a navigable river, that is to say, one over which the public had the right of navigation, it was not until the last quarter of the 18th century that any systematic regulation of its flow in the upper reaches was attempted. Complaints of the obstructions in it are not uncommon, and John Taylor, the Water Poet (1580–1653), in a poem commemorating a voyage from Oxford to London, bewails the difficulties he found on the passage. No substantial measures to remedy this state of things were adopted till 1771, when an act of parliament was passed authorizing the construction of pound locks on the Thames above Maindenhead Bridge. In pursuance of the powers thus granted, the Thames Commissioners of that day caused locks to be built at various points above Maidenhead, and between 1810 and 1815 the Corporation of London carried out river works on the same lines as far down the river as Teddington. The works as subsequently maintained by the Thames Conservancy ensure an efficient head of water during the drier seasons of the year, and facilitate the escape of winter floods. The number of locks is 47, including four navigation weirs above Oxford. The uppermost lock is St John's, below Lechlade; the lowest is Richmond, but this is a half-tide lock, keeping the water above at a level corresponding to half that of flood tide. Under ordinary conditions the sluices are raised to admit boats to pass from the half flood to half ebb, so that the river remains tidal up to Teddington, the next lock.

The canals in use communicating with the Thames, in addition to the Thames and Severn canal, are the Oxford canal, giving communication from that city with the north, the Kennet and Avon canal from Reading to the Bristol Avon, the Grand Junction at Brentford, the Regent's canal at Limehouse, and the Grand Surrey canal at Rotherhithe. A short canal connects Gravesend with Higham. Navigation is also carried on by the Medway to Tonbridge, on the lower parts of the Darent and Cray, from Dartford and Crayford, and on the Wey up to Guildford and Godalming. The Woking, Aldershot and Basingstoke canal joins the Wey, but is little used. The Wilts and Berks canal, joining the Thames at Abingdon, is disused. By means of the Grand Junction and Oxford canals especially, constant communication is maintained between the Thames and the great industrial centres of England. The trade on the upper Thames is steady, though not extensive. The vast trade on the estuary, which lies within the bounds of the port of London, is considered under LONDON.

The utility of the river is great in the opportunities for exercise and recreation which it affords to the public, especially to Londoners. The scene on any part of the river from Oxford down on public holidays, and on Saturdays and Sundays during the summer, would be sufficient to show how it contributes to the public enjoyment. It is only since about 1870 that this popularity has grown up. Ten years earlier even rowing-boats were few excepting at Oxford, at Henley in regatta time, and at Putney on the tideway. Steam launches did not exist on the river before 1866 or 1867, and house-boats only in the form of college barges at Oxford. But by 1900 there were 541 launches, 162 house-boats, and 11,284 rowing-boats. Each boat is registered, a small tax being charged; while there are fixed prices for the passage of locks. During the season regattas take place at many of the towns and larger villages. Of these Henley Royal Regatta is pre-eminent by the number and importance of the entries, and by its comparative antiquity. The regattas at Molesey, Kingston, Reading, Marlow and Oxford, as well as many others, attract numerous competitors and spectators. The Oxford and Cambridge boat-race from Putney to Mortlake on the tideway, the summer eights and the "torpids" at Oxford University, and the school races at Eton and Radley should also be mentioned.

A statute of 1393 was granted to the citizens of London to remove weirs on the Thames, and empowered the Lord Mayor to enforce its provisions. For the next four centuries he acted through water-bailiffs, till in 1771 a committee of the Corporation of London took over the work. In 1857 the Thames Conservancy Board was established. Its powers were increased and its constitution varied in 1864, 1866 (till which year the jurisdiction of the river above Staines was under a large body of commissioners), and 1894, but the creation of the Port of London Authority (see LONDON) limited its jurisdiction.

Fish are abundant, especially coarse fish such as pike, perch, roach, dace and barbel. Of trout there are many fine specimens, especially at the weirs. Salmon are known to have existed at Maidenhead so recently as 1812, but they disappeared soon after that date. An association was formed under the presidency of Mr W. H. Grenfell, M.P., with the object of reintroducing this fish into the river, and in April 1901 and on subsequent occasions a number of young salmon were placed at Teddington by way of experiment. The right of the public to take fish has been frequently in dispute, but a committee of the House of Commons, which took much evidence on the question in the year 1884, came to the conclusion that "it is impossible to recognize anything like a general public right to take fish as now existing." They added "that the public at large have only to know that their rights are imaginary to induce them also to be content with the extant system under which permission is very freely granted by owners of fisheries to the public for angling on the more frequented parts of the Thames." These conclusions are interesting in face of the fact that the question has arisen from time to time since 1884.

The fisheries are under the regulation of by-laws made by the Thames Conservancy, which apply to the riparian owners as well as to the public generally. These by-laws are carried into effect by officers of the conservators, assisted by the river-keepers of the various fishing associations. The principal associations are those at Oxford, Reading, Henley, Maidenhead and Windsor, and the Thames Angling Preservation Society, whose district is from Staines to Brentford.

THAMES, a seaport and gold-mining centre in North Island, New Zealand, in the county and at the mouth of the river of its name, on the Firth of Thames, a deep inlet of the Hauraki Gulf of the east coast. Pop. (1906) 3750. It comprises under one municipality the settlement formerly called Grahamstown, with its suburbs Shortland and Tararu. It lies 42 m. S.E. of Auckland by the steamer-route, a pleasant journey among the islands of the Gulf. There is also railway communication with Auckland (but by a circuitous route of 120 m.), and with the neighbouring districts by branch lines. The harbour is good; the industries include foundries, shipbuilding yards and saw-mills. The sea fisheries are valuable, a large part of the yield being exported to Auckland. The inland district watered by the Thames river is auriferous; Waitekuri (40 m.) and Karangahake (28 m. S. of Thames) are centres of operations. The small town of Te Aroha (32 m. by rail), on the river, besides being the centre of mining and agricultural industries, is a favourite health resort on account of its hot medicinal springs. The river is navigable for steamers of light draught. The scenery along its course is pleasant, and at Ohinemuri (20 m. from Thames) it flows through a fine gorge.

THANA, or TANNA (=a fort, or police-station), a town and district of British India, in the Northern division of Bombay. The town is on the west of the Salsette creek or Thana river, just where the Great Indian Peninsula railway crosses to the mainland, 21 m. from Bombay city. Pop. (1901) 16,011.

The DISTRICT OF THANA has an area of 3573 sq. m. It extends along the coast for 105 m., with a breadth of 50 m., and is confined between the Western Ghats on the E. and the sea on the W., while on the N. it is bounded by the Portuguese territory of Damaun and by Surat district, and on the S. by Kolaba district. The district is well watered and wooded, and, except in the nort-east, is a low-lying rice tract broken by hills. Most of the hills were once fortified, but the forts built on them are now dilapidated and useless. Matheran (*q.v.*) is a favourite summer resort for the citizens of Bombay. The only rivers of any importance are the Vaitarna and the Ulhas, the former being navigable for a distance of about 20 m. from its mouth; the latter is also navigable in parts for small craft. There are no lakes; but the Vehar and the Tulsi, formed artificially, supply Bombay city with water. In 1901 the population was 811,433, showing a decrease of 1 per cent. in the decade. The staple crop is rice. Fishing supports many of the people, and the forests yield timber and other produce. Salt is largely manufactured by evaporation along the coast. At Kurla, in Salsette island, there are cotton mills and rice mills. The district is traversed throughout its length by the Bombay and Baroda railway, and also crossed by the two branches of the Great Indian Peninsula line.

The territory comprised in the district of Thana (apart from Salsette island, which was acquired in 1782) formed part of the dominions of the peshwa, and was annexed by the British in 1818 on the overthrow of Baji Rao. Since then the operations to put down the Koli robbers, which extended over several years, have been the only cause of serious trouble.

THANESAR (="place of the god"), an ancient town of British India, in Karnal district of the Punjab, on the river Saraswati, 100 m. by rail N. of Delhi: pop. (1901) 5066. As the centre of the tract called Kurukshetra in the Mahabharata, it has always been a holy place, and was in the seventh century the capital of King Harshavardhana, who ruled over all northern India. The bathing-fair held here on the occasion of a solar eclipse is said to be attended by half a million pilgrims.

THANET, ISLE OF, the extreme north-eastern corner of Kent, England, insulated by the two branches of the river Stour, and forming one of the eight parliamentary divisions of the county. Its name is said to be derived from Saxon *tene*, a beacon or fire (probably from the number of watch-fires existing on this easily ravaged coast), and numerous remains of Saxon occupation have been found, as at Osengal near Ramsgate. Thanet is roughly oblong in form, its extreme measurements being about 8 m. from E. to W., and 5 m. from N. to S. The branches of the Stour dividing near Sarre take the place of the former Wantsume, a sea-passage which had diminished in breadth to half a mile in the time of Augustine. The Wantsume was guarded by the Roman strongholds of *Regulbium* (Reculver) in the north and *Rutupiae* (Richborough) in the south, and was crossed by ferries at Sarre and Wade. With the drying up of this channel and the closing of Sandwich harbour in the 16th century, the present marshlands or level to the south and west of the isle were left. The sea-face of Thanet consists mainly of bold slopes or sheer cliffs, and the eastern extremity is the fine headland of the North Foreland. Containing the popular seaside resorts of Ramsgate, Broadstairs, Margate and Westgate, Thanet is served by the South-Eastern & Chatham railway, and Minster is a junction station of the lines to Ramsgate and Sandwich respectively.

THANKSGIVING DAY, in the United States, the fourth Thursday in November, annually set apart for thanksgiving by proclamation of the president and of the governors of the various states. The day is observed with religious services in the churches, and, especially in New England, as an occasion for family reunion. The Pilgrims set apart a day for thanksgiving at Plymouth immediately after their first harvest, in 1621; the Massachusetts Bay Colony for the first time in 1630, and frequently thereafter until about 1680, when it became an annual festival in that colony; and Connecticut as early as 1639 and annually after 1647, except in 1675. The Dutch in New Netherland appointed a day for giving thanks in 1644 and occasionally thereafter. During the War of Independence the Continental Congress appointed one or more thanksgiving days each year, except in 1777, each time recommending to the executives of the various states the observance of these days in their states. President Washington appointed a day of thanksgiving (Thursday, the 26th of November) in 1789, and appointed another in 1795. President Madison, in response to resolutions of Congress, set apart a day for thanksgiving at the close of the War of 1812. One was annually appointed by the governor of New York from 1817. In some of the Southern States there was opposition to the observance of such a day on the ground that it was a relic of Puritanic bigotry, but by 1858 proclamations appointing a day of thanksgiving were issued by the governors of twenty-five states and two Territories. President Lincoln appointed the fourth Thursday of November 1864, and since that time each president has annually followed his example.

See F. B. Hough, *Proclamations for Thanksgiving* (Albany, 1858); W. D. Love, *The Fast and Thanksgiving Days of New England* (Boston, 1895); May Lowe, "Thanksgiving Day" in *New England Magazine* (Nov. 1904); C. L. Norton, "Thanksgiving Day, Past and Present," in the *Magazine of American History* (Dec. 1885); R. M. Schauffler (ed.), *Thanksgiving* (New York, 1907).

THANN, a town of Germany, in Upper Alsace, 16 m. by rail N.W. of Mülhausen. Pop. (1905) 7901. It is the seat of cotton, calico, silk, machinery and other industries, and excellent wine is grown there. The (Roman Catholic) church of St Theobald (1351) is an elegant specimen of Gothic, and has a remarkably fine tower (1450–1516), 266 ft. high. Above the town are the ruins of the castle of Engelburg, destroyed by Turenne in 1675.

THAPSACUS, the "large and prosperous city" on the Arabian side of the Euphrates where Cyrus the Younger revealed to the Greeks the object of his expedition (Xen. *Anab.* i. 4, 11). No such place has yet been found mentioned in cuneiform texts. We may have a Semitic form of the name in the Hebrew Tiphsah; but it is impossible to determine whether the one phrase[1] "from Tiphsah to Gaza" (1 Kings v. 4—iv. 24 in the English version), where the name seems to occur, is as early

[1] 2 Kings xv. 16 cannot possibly refer to any place on the Euphrates.

as the Persian period: the Greek text is quite discrepant. Thapsacus was the crossing-place of Darius Codomannus, before and after his defeat (Arrian ii. 13), and of Alexander (iii. 7), and in Strabo's time it was the usual crossing-place (xvi. 1, 21); but Tiglath-pileser I. and Assur-nasir-pal crossed considerably farther north, and we have no reason to suppose that they were not simply following the practice of those early times; and we do not know when the custom of crossing at Thapsacus which the Hebrew text of the passage in 1 Kings may presuppose sprang up. Xenophon's army had to be content with fording the stream. Alexander, however, effected his crossing (Arrian, iii. 7) by two connected bridges (of boats?), and it was from this place that later he had the material for his fleet sent down (Arrian vii. 19; Strabo xvi. 741) to Babylonia. His successors must also have valued the place, for according to Pliny (v. 87) it bore later the name of Amphipolis, perhaps bestowed on it (Steph. Byz., Appian *Syr.* 57) by Seleucus I., although the name, like so many others, probably failed to win acceptance; and in the time of Eratosthenes the position of Thapsacus had become so central that he chose it as the point from which to make his measurements for all Asia (Strabo ii. 79, 80), and in the time of Strabo himself it was there that goods were embarked for transport down the Euphrates (Q. Curt. x. 1), and landed after having come by stream from lower districts (Strabo xvi. 1, 23). After Pliny the city is not again mentioned.[1]

After various attempts at identification (see Ritter, *Erdkunde*) it has apparently been correctly identified by J. P. Peters (*Nation*, May 23, 1889) and B. Moritz (*Sitz.-Ber. d. Berl. Akad.*, July 25, 1889). The name may survive in *Kal'at Dibse*, "a small ruin 8 m. below Meskene, and 6 m. below the ancient Barbalissus." See J. P. Peters, *Nippur*, 196 ff. (H. W. H.)

THAPSUS, a low peninsula, now known as Magnisi, joined by a narrow isthmus to the mainland of Sicily, about 7 m. N.N.W. of Syracuse. The founders of Megara Hyblaea settled here temporarily, according to Thucydides, in the winter of 729–728 B.C., but it seems to have remained almost if not entirely uninhabited until the Athenians used it as a naval station in their attack on Syracuse early in 414 B.C. A number of tombs were excavated in 1894, containing objects belonging to a transitional stage between the second and third Sicel period, attributable roughly to 1000–900 B.C., and with a certain proportion of Mycenean importations.

See Orsi in *Monumenti dei Lincei* (1897), vi. 89–150.

THAR AND PARKAR, or THUR AND PARKER, a district of British India in the Sind province of Bombay. Area, 13,941 sq. m. The district is divided into two portions. The western part, called the "Pat," is watered by the Eastern Nara and the Mithrau canals, which constitute the sole water-system of the district, and the presence of water has created a quantity of jungle and marsh; the other part, called the "Thar," is a desert tract of rolling sand-hills, running north-east and south-west, composed of a fine but slightly coherent sand. To the south-east of Thar is Parkar, where there are ranges of rocky hills, rising to 350 ft. above the surrounding level, and open plains of stiff clay. This portion contains the ruins of several old temples. The climate is subject to considerable extremes in temperature, being excessively hot in the summer and very cold in winter, the cold increasing as the sand-hills are approached. In 1901 the population was 389,714, showing an increase of 22 per cent. in the decade. The principal crops are millets, rice, wheat, oil-seeds and cotton. Cultivation largely depends upon the control of the water which comes down the canals and occasionally causes flood. Salt is found in two or three places. The western border of the district is entered by the narrow-gauge railway from Hyderabad to Shadipalli, connected with the North-Western main line by a bridge across the Indus at Kotri, and with the Rajputana system at Jodhpur. Umarkot, the administrative headquarters of the district, is on the edge of the desert. Pop. (1901) 4924. It is historically interesting as the birthplace of the emperor Akbar in 1542.

Very little is known of the early history of the district. The Soda Rajputs, said to be descendants of Parmar Soda, are supposed to have come into this part of Sind about 1226. when they quickly displaced the rulers of the country, though, according to other authorities, they did not conquer the country from the Sumras, the dominant race, before the beginning of the 16th century. The local dynasty of the Sodas succumbed to the Kalhoras about 1750, since which period the district has been subject more or less to Sind. The Talpur mirs succeeded the Kalhoras, and built a number of forts to overawe the people, who were lawless and addicted to robbery. On the British conquest of Sind in 1843 the greater part of the district was made over to Cutch, but in 1856 it was incorporated in the province of Sind. In 1859 a rebellion broke out, which was quickly suppressed.

THARANDT, a town of Germany, in the kingdom of Saxony, romantically situated on the Wilde Weisseritz, 9 m. S.W. of Dresden, on the Dresden-Reichenbach railway. Pop. (1905) 2967. It has a Protestant church, a hydropathic establishment, and the oldest academy of forestry in Germany (founded by Heinrich Cotta in 1811) with about sixty students. Tharandt is a favourite summer resort of the people of Dresden, one of its principal charms being the magnificent beech woods which surround it.

See Donner, *Tharandt* (Tharandt, 1890).

THARGELIA, one of the chief Athenian festivals in honour of the Delian Apollo and Artemis, held on their birthdays, the 6th and 7th of the month Thargelion (about the 24th and 25th of May). The name, which was derived by the ancients from *θέρειν τὴν γῆν* ("to reap the land"), is more probably connected with *τερσ-ῆναι* (cf. Lat. *torreo*, *tostus*), signifying the produce of the earth "baked" by the sun. Essentially an agricultural festival, the Thargelia included a purifying and expiatory ceremony. While the people offered the first-fruits of the earth to the god in token of thankfulness, it was at the same time necessary to propitiate him, lest he might ruin the harvest by excessive heat, possibly accompanied by pestilence. The purificatory preceded the thanksgiving service. On the 6th a sheep was sacrificed to Demeter Chloë on the Acropolis, and perhaps a swine to the Fates, but the most important ritual was the following. Two men, who were called *φαρμακοί* or *σύβακχοι*, the ugliest that could be found, were chosen to die, one for the men, the other (according to some, a woman) for the women. On the day of the sacrifice they were led round with strings of figs on their necks, and whipped on the genitals with rods of figwood and squills. When they reached the place of sacrifice on the shore, they were stoned to death, their bodies burnt, and the ashes thrown into the sea (or over the land, to act as a fertilizing influence). The whipping with squills and figwood was intended to stimulate the reproductive energies of the *φαρμακός*, who represented the god of vegetation, annually slain to be born again. It is agreed that an actual human sacrifice took place on this occasion, replaced in later times by a milder form of expiation. Thus at Leucas a criminal was annually thrown from a rock into the sea as a scapegoat: but his fall was checked by live birds and feathers attached to his person, and men watched below in small boats, who caught him and escorted him beyond the boundary of the city. Similarly, at Massilia, on the occasion of some heavy calamity (plague or famine), one of the poorest inhabitants volunteered as a scapegoat. For a year he was fed up at the public expense, then clothed in sacred garments, led through the city amidst execrations, and cast out beyond the boundaries. The ceremony on the 7th was of a cheerful character. All kinds of first-fruits were carried in procession and offered to the god, and, as at the Pyanepsia (or Pyanopsia), *εἰρεσιῶναι* (branches of olive bound with wool), borne by children, were affixed by them to the doors of the houses. These branches, originally intended as a charm to avert failure of the crops, were afterwards regarded as forming

[1] Stephanus of Byzantium gives it in a list of cities as a "Syrian town on the Euphrates," quoting from Theopompus, without noting that he has already referred to it under the name Amphipolis.

part of a supplicatory service. On the second day choruses of men and boys took part in musical contests, the prize for which was a tripod. Further, on this day adopted persons were solemnly received into the *genos* and *phratria* of their adoptive parents (see APATURIA).

See Preller-Robert, *Griechische Mythologie*, i. (1894); G. F. Schömann, *Griechische Alterthümer* (4th ed. by J. H. Lipsius, 1897–1902); P. Stengel, *Die griechischen Kultusalterthümer* (1890); article in Smith's *Dictionary of Greek and Roman Antiquities*, revised by L. C. Purser (3rd ed., 1891); A. Mommsen, *Feste der Stadt Athen* (1898); L. R. Farnell, *Cults of the Greek States*, iv. (1906), pp. 268–283; J. G. Frazer, *Golden Bough* (2nd ed., 1900), ii. appendix C, "Offerings of First-Fruits," and iii. p. 93, § 15, "On Scapegoats"; W. Mannhardt, *Antike Wald- und Feldkulte* (2nd ed. by W. Heuschkel, 1904–5).

THARRAWADDY, a town and district in the Pegu division of Lower Burma. The town has a station on the railway, 68 m. N.W. from Rangoon. Pop. (1901) 1643. The district has an area of 2851 sq. m. The Pegu Yoma range separates it from Toungoo district, and forms the water-parting between the rivers Irrawaddy and Sittang; there are also many small elevations. The Irrawaddy is the principal navigable river. Another important river is the Hlaing, which runs through the district from north to south, receiving from the east, through numerous channels, the drainage of the Pegu Yoma Mountains, which fertilizes the plain on its eastern bank. There are teak forests and fuel reserves, covering an area of 732 sq. m. Among the wild animals found in the mountains are elephant, rhinoceros, bison and various kinds of feathered game. The rainfall in 1905 was 91·65 in. Pop. (1901) 395,570, showing an increase of 17 per cent. in the decade. The railway runs through the centre of the district, with ten stations. The chief towns are Gyobingauk (6030) and Thonzè (6578). The staple crop is rice, but orchards and gardens are also common. The history of the district is identical with that of Henzada (*q.v.*). Tharrawaddy was formed in 1878 out of that portion of Henzada lying east of the Irrawaddy.

THARROS, an ancient town of Sardinia, situated on the west coast, on the narrow sandy isthmus of a peninsula at the north extremity of the Gulf of Oristano, now marked by the tower of S. Giovanni di Sinis. It was 12 m. W. of Othoca (Oristano) by the coast road, which went on northward to Cornus (a milestone of it is given in *Corp. Inscr. Lat.* x. 8009), and thence to Turris Libisonis. It was of Phoenician origin, but continued to exist in Roman times, as the inscriptions show, though they give but little information (Mommsen in *Corp. Inscr. Lat.* x. 822). It was destroyed by the Saracens in the 11th century. Scanty traces of Roman buildings may be seen, and an ancient road paved with large blocks of stone. A part of the site of the town is now invaded by the sea. The church of S. Giovanni di Sinis is a heavy building of the 8th (?) century A.D. originally cruciform, with a dome over the crossing; the transepts and dome are still preserved, but the nave with its two aisles is later. It is naturally built of materials from the old town. Close to it is a watch-tower and a spring of fresh water. The importance of Tharros may be inferred from the extent of its necropolis, which lies on the basaltic peninsula of S. Marco to the S.; on the summit of it are the remains of a *nuraghe*. Casual excavations are mentioned under the Spanish viceroys, but regular exploration only began in 1838, when the Roman tombs were examined. In 1850 Spano excavated many Phoenician tombs; they are rectangular or square chambers cut in the rock, measuring from 6 to 9 ft. each way, in which inhumation was the rule. The objects found—pottery, scarabs, jewelry, amulets, &c.—were of considerable interest. In 1851 Lord Vernon opened fourteen tombs, and after that the whole countryside ransacked the necropolis, without any proper records or notes being taken, and with great damage to the objects found. Some of these objects are in the museum at Cagliari, others in private collections, and many scarabs are in the British Museum, all of which by the coins found with them are dated later than the Roman occupation (*Catalogue of Gems*, London, 1888, pp. 13 sqq.). In 1885–86 regular excavations were made, the results of which may be seen in the museum at Cagliari. One tomb contained some fine gold ornaments, with Roman coins of the 1st to 3rd century A.D. (F. Vivanet in *Notizie degli Scavi*, 1886, 27; 1887, 46, 124). The objects, like those found at Sulcis, show considerable traces of Egyptian influence, but are probably all of Phoenician importation—the theory of the existence of Egyptian colonies in Sardinia being quite inadmissible. Some 3 m. to the N. is the church of S. Salvatore, with underground rock-cut chambers below it, used as a baptistery (?) by the early Christians, though the walls are decorated with paintings of a decidedly pagan nature. (T. As.)

THASOS, an island in the north of the Aegean Sea, off the coast of Thrace and the plain of the river Nestus (now the Kara-Su). The island was colonized at an early date by Phoenicians, attracted probably by its gold mines; they founded a temple of Heracles, which still existed in the time of Herodotus. Thasus, son of Phoenix, is said to have been the leader of the Phoenicians, and to have given his name to the island. In 720 or 708 B.C. Thasos received a Greek colony from Paros. In a war which the Parian colonists waged with the Saians, a Thracian tribe, the poet Archilochus threw away his shield. The Greeks extended their power to the mainland, where they owned gold mines which were even more valuable than those on the island. From these sources the Thasians drew great wealth, their annual revenues amounting to 200 or even 300 talents. Herodotus, who visited Thasos, says that the best mines on the island were those which had been opened by the Phoenicians on the east side of the island facing Samothrace. The place was important during the Ionian revolt against Persia. After the capture of Miletus (494 B.C.) Histiaeus, the Ionian leader, laid siege to Thasos. The attack failed, but, warned by the danger, the Thasians employed their revenues to build war ships and strengthen their fortifications. This excited the suspicions of the Persians, and Darius compelled them to surrender their ships and pull down their walls. After the defeat of Xerxes the Thasians joined the Delian confederacy; but afterwards, on account of a difference about the mines and marts on the mainland, they revolted. The Athenians defeated them by sea, and, after a siege that lasted more than two years, took the capital, Thasos, probably in 463, and compelled the Thasians to destroy their walls, surrender their ships, pay an indemnity and an annual contribution (in 449 this was $2\frac{1}{2}$ talents, from 445 about 30 talents), and resign their possessions on the mainland. In 411 B.C., at the time of the oligarchical revolution at Athens, Thasos again revolted from Athens and received a Lacedaemonian governor; but in 407 the partisans of Lacedaemon were expelled, and the Athenians under Thrasybulus were admitted. After the battle of Aegospotami (405 B.C.), Thasos again fell into the hands of the Lacedaemonians under Lysander who formed a decarchy there; but the Athenians must have recovered it, for it formed one of the subjects of dispute between them and Philip II. of Macedonia. In the embroilment between Philip III. of Macedonia and the Romans, Thasos submitted to Philip, but received its freedom at the hands of the Romans after the battle of Cynoscephalae (197 B.C.), and it was still a "free" state in the time of Pliny. After a period of Latin occupation, it was captured by the Turks in 1462; it was given by the Sultan Mahmud II. to Mehemet Ali of Egypt, and still remains the property of the khedive. Thasos, the capital, stood on the north side of the island, and had two harbours, one of which was closed. Archilochus described Thasos as "an ass's backbone crowned with wild wood," and the description still suits the mountainous island with its forests of fir. The highest mountain, Ipsario, is 3428 ft. high. Besides its gold mines, the wine, nuts and marble of Thasos were well known in antiquity. The mines and marble quarries are no longer worked; and the chief exports are now fir timber for shipbuilding, olive oil, honey and wax. The imports consist of manufactured goods, beasts of burden and corn, for the island is too mountainous to grow enough corn for the inhabitants.

The population, distributed in ten villages, is estimated at

8000. The people are Greek Christians, and do not differ in appearance from the inhabitants of the other Greek islands. The villages are mostly situated at some distance from the sea; for the island suffered from pirates. Even in the early part of the 19th century sentinels stood on duty night and day, and at a signal of alarm the whole population, including the Turkish aga himself, used to hide in the woods.

For a description of the island and its remains of antiquity, see A. Conze, *Reise auf den Inseln des thrakischen Meeres* (Hanover, 1860); for inscriptions see *Inscr. Gr.* xii. 8; the island is fully described by J. ff. Baker-Penoyre in *Journal Hell. Stud.* xxix. (1909).

THATCH (O.E. *thaec*; the word is common to many Teutonic languages in the sense of "roof," "cover"; cf. Du. *dak*, Ger. *Dach*; from Du. *dekken* comes "deck"; the Indo-European root is *stag*, whence Gr. *στέγος*, roof, Lat. *tegere*, to cover; the French equivalent is *chaume*), the material employed sometimes for roofs in the place of tiles or slates; it consists of wheat straw, of which several layers are required, to the depth of from 12 to 14 in., or even extending to 18 in. Unthreshed straw is said to last from twenty-five to thirty years, and is easily repaired. In Norfolk the reeds of marshland are employed, and they constitute a durable thatch lasting from thirty to forty years or more. Thatched roofs are not now allowed in London or other towns and their vicinity, but if saturated with a solution of lime the thatch is said to be incombustible. It forms an extremely good roof, warm in winter and cool in summer.

THATON, a town and district in the Tenasserim division of Lower Burma. The town is situated below a hill range, 10 m. from the sea. It was formerly the capital of the Talaing kingdom and a sea-port. Pop. (1901) 14,342. The district has an area of 5079 sq. m.; pop. (1901) 343,510, showing an increase of 29 per cent. in the decade. It was formerly a subdivision of Amherst district, but was formed in 1895 out of part of that and of Shwegyin district, which has now ceased to exist. The staple crop is rice, but a good deal of tobacco also is grown. The railway from Pegu to Martaban, recently opened, passes through this district and is calculated to increase its prosperity and population.

THAXTER, CELIA (1836–1894), American poet, was born at Portsmouth, New Hampshire, on the 29th of June 1836. Her father, Thomas B. Laighton, became offended with some of his associates in state politics, and retired about 1841 to the barren and isolated Isles of Shoals, ten miles off Portsmouth, where for about ten years he was keeper of the White Island lighthouse; and his daughter's girlhood was therefore spent in marine surroundings, which coloured the best of the verse she afterwards wrote. Her poems, mainly in lyrical form, deal with the beacon-light, the sea-storm, the glint of sails, the sandpiper, the flower among the rocks, &c., in characteristic and sympathetic fidelity. She also wrote prose sketches of life and scenery, *Among the Isles of Shoals* (1873); stories and poems for children, and letters; besides a book about floriculture, *An Island Garden* (1894). In 1896 appeared a complete edition of her poems, edited by Sarah Orne Jewett. She married in 1851 Levi L. Thaxter (d. 1884), a devoted student of Robert Browning's poetry, and spent most of her life on Appledore, one of the Isles of Shoals, where she died on the 26th of August 1894. Her son Roland Thaxter (b. 1858), a well-known cryptogamic botanist, became professor of botany at Harvard in 1891.

THAYER, ABBOTT HANDERSON (1849–), American artist, was born at Boston, Massachusetts, on the 12th of August 1849. He was a pupil of J. L. Gérôme at the École des Beaux Arts, Paris, and became a member of the Society of American Artists (1879), of the National Academy of Design (1901), and of the Royal Academy of San Luca, Rome. As a painter of portraits, landscapes, animals and the ideal figure, he won high rank among American artists. Among his best-known pictures are, "Virgin Enthroned," "Caritas," "In Memoriam, Robert Louis Stevenson," and "Portrait of a Young Woman"; and he did some decorative work for the Walker Art Building, Bowdoin College, Maine. Thayer is also well known as a naturalist. He developed a theory of "protective coloration" in animals (see Colours of Animals), which has attracted considerable attention among naturalists. According to this theory, "animals are painted by nature darkest on those parts which tend to be most lighted by the sky's light, and vice versa"; and the earth-brown of the upper parts, bathed in sky-light, equals the skylight colour of the belly, bathed in earth-yellow and shadow.

See his article, "The Law which underlies Protective Coloration," in the *Annual Report* of the Smithsonian Institution for 1897 (Washington, 1898); and *Concealing Coloration in the Animal Kingdom* (New York, 1910), a summary of his discoveries, by his son, Gerald H. Thayer.

THAYER, JAMES BRADLEY (1831–1902), American legal writer and educationist, was born at Haverhill, Massachusetts, on the 15th of January 1831. He graduated at Harvard College in 1852, and at the Harvard Law School in 1856, in which year he was admitted to the bar of Suffolk county and began to practise in Boston. In 1873–83 he was Royall professor of law at Harvard; in 1883 he was transferred to the professorship which after 1893 was known as the Weld professorship and which he held until his death on the 14th of February 1902. He took an especial interest in the historical evolution of law.

He wrote: *The Origin and Scope of the American Doctrine of Constitutional Law* (1893); *Cases on Evidence* (1892); *Cases on Constitutional Law* (1895); *The Development of Trial by Jury* (1896); *A Preliminary Treatise on Evidence at the Common Law* (1898), and a short life of John Marshall (1901); and edited the twelfth edition of Kent's *Commentaries* and the *Letters of Chauncey Wright* (1877), and *A Westward Journey with Mr Emerson* (1884).

THAYER, JOSEPH HENRY (1828–1901), American biblical scholar, was born at Boston on the 7th of November 1828. He studied at the Boston Latin School, and graduated at Harvard in 1850. Subsequently he studied theology at the Harvard Divinity School, and graduated at Andover Theological Seminary in 1857. He preached in Quincy, and in 1859–64 in Salem, Massachusetts, and in 1862–63 was chaplain of the 40th Massachusetts Volunteers. He was professor of sacred literature in Andover Seminary in 1864–82, and in 1884 succeeded Ezra Abbot as Bussey professor of New Testament criticism in the Harvard Divinity School. He died on the 26th of November 1901, soon after his resignation from the Bussey professorship. He was a member of the American Bible Revision Committee and recording secretary of the New Testament company. His chief works were his translation of Grimm's *Clavis Novi Testamenti* (1887; revised 1889) as *A Greek-English Lexicon of the New Testament*, and his New Testament bibliography (1890).

THAYETMYO, a town and district in the Minbu division of Upper Burma. The town is situated on the right bank of the Irrawaddy, opposite Allanmyo. Pop. (1901) 15,824. The cantonment contains the wing of a British battalion and a native regiment. It enjoys a high reputation for healthiness. There is a special industry of silver work.

The district has an area of 4750 sq. m.; pop. (1901) 239,706, showing a decrease of 4 per cent. in the decade. The total rainfall in 1905 was 41·30 in. On the west is the Arakan Yoma range, and on the east the Pegu Yomas; and the face of the country, where it does not rise into mountains, is everywhere broken by low ranges of hills, many of which are barren and destitute of all vegetation. The greater part of the district is wooded, and the Yomas east and west are covered with forests, now mostly preserved. The chief river is the Irrawaddy, which traverses Thayetmyo from north to south. The drainage finds its way to the Irrawaddy by three main streams (the Pwon, Ma-htún and Ma-de) on the west, and by two (the Kye-ni and Hput) on the east. Several salt and hot springs occur in many localities; petroleum is also found, and extensive lime quarries exist a few miles south of Thayetmyo. The principal wild animals are elephants, rhinoceros, tigers, leopards, black bears and wild hog. Silver pheasants and partridges are found in large numbers, especially in the mountains. The chief products are rice, cotton, oil-seeds and tobacco; cutch is also very abundant, and the manufacture of the dye-stuff is carried on extensively. Coal has been found in the district, and earth oil-wells exist, but neither coal nor oil has yet been extracted in any quantity. There are 403 sq. m. of reserved forest. Three oil-wells were sunk in 1883 at Pedaukpin, but they were found unprofitable and abandoned.

On the annexation of Pegu by the British in 1852–53, Thayetmyo was formed into a subdivision of Prome district; and in 1870 it was erected into a separate jurisdiction and placed under a deputy-commissioner. It was formerly in the Irrawaddy division of Lower Burma, but was transferred to Upper Burma for administrative purposes in 1896.

THEATRE (*θέατρον*, "a place for seeing," from *θεᾶσθαι*), a building specially devised for dramatic representations. The drama arose from the choric dances in honour of Dionysus, which were held in a circular dancing-place (*ὀρχήστρα*, Lat. *orchestra*) in his precinct at the foot of the Acropolis at Athens. When the leader of the chorus held a dialogue with the remaining *choreutae* he mounted the table which stood beside the altar of Dionysus in the centre of the *orchestra*; but as the number of actors and the importance of the dialogue increased, it became necessary to erect a platform at the side of the dancing-place and a booth in which the performers could change their dresses and masks. At the same time temporary wooden stands (*ἴκρια*) were set up for the spectators, who no longer ranged themselves around the whole ring, but only on the slope of the Acropolis, facing southward. We are told that the collapse of the *ἴκρια*, in 499 B.C. led to the erection of a permanent theatre; this was not, however, a stone building. Embankments were made for the support of the spectators' benches: the stage buildings were of wood, and, although some traces of a stone theatre belonging to the end of the 5th century have been pointed out, the "theatre of Dionysus," whose remains may still be seen (Pl. I. and II.), is in the main a work of the 4th century. It was completed soon after 340 B.C. under the administration of the statesman and financier Lycurgus. Alterations were made in the stage-buildings in the Hellenistic period, under Nero, and again in the 3rd century A.D. Although the prototype of Greek theatres, it is not the most perfectly preserved. Amongst those of purely Greek design the most typical is that of Epidaurus (Pl. I.), which was built in the latter part of the 4th century B.C. by Polyclitus the Younger. The largest known to Pausanias was that of Megalopolis, excavated by the British School at Athens in 1889–91, in which the stage buildings were replaced by the Thersilion, a large council-chamber. Others of importance for the study of the ancient theatre have been excavated at Delos, Eretria, Sicyon and Oropus. None of these, of course, is contemporary with the classical period of the Greek drama, and their stone stage-fronts belong to the Hellenistic period.

In Asia Minor we find a type of theatre (belonging to a somewhat later date) with a broader, lower and deeper stage; and

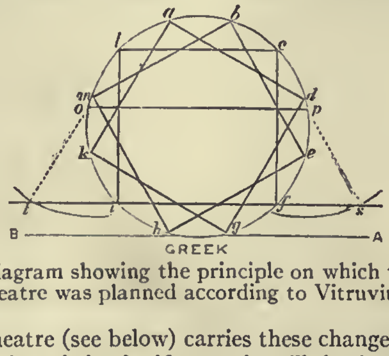
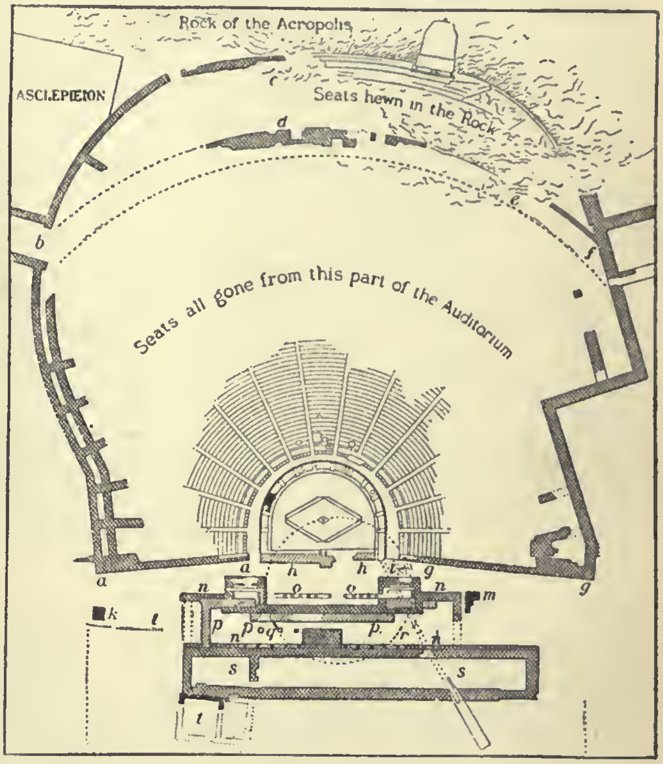


Fig 1.—Diagram showing the principle on which the Greek theatre was planned according to Vitruvius.

the Roman theatre (see below) carries these changes still further. Before discussing their significance it will be best to describe the parts of the ancient theatre, the fullest account of which is to be found in the fifth book of Vitruvius (written in the Augustan period).

Its three main divisions were the auditorium (Lat. *cavea*; it had no technical name in Greek), the orchestra, and the stage buildings (*σκηνή*, literally "tent" or "booth" Lat. *scena*). As the orchestra was the germ of the theatre, so it determined its shape, and in the Greek theatre preserved its circular form in many instances (as at Epidaurus). In the scheme of proportions given by Vitruvius, however (see fig. 1, which carries its own explanation), a segment (*ihgf*) was cut off by the stage-front (*προσκήνιον*, *proscenium*). The auditorium was divided by flights of seats into wedge-shaped blocks (*κερκίδες*, *cunei*) and also longitudinally by a gangway (*διάζωμα*, *praecinctio*). In Greece the slope of a hill was always chosen for the auditorium and furnished with stone seats in tiers like steps. The slope of the Acropolis faces south, which (as Vitruvius points out) was the worst aspect for the spectators; but this was unavoidable for religious reasons, since the performances had to be held in the precinct of Dionysus. At Athens the inner boundary was a semicircle with the ends prolonged in parallel straight lines, which gave the spectators in the wings a better view of the stage than that obtainable in those theatres where (according to the Vitruvian rule) the boundary was segmental. At Epidaurus



Scale —— 20 yards.

Fig. 2.

From Dörpfeld and Reisch, *Das griechische Theater*.

ab, double western wall.
bc, single wall.
aa, *gg*, walls terminating wings of auditorium.
b, *f*, entrances.
c, the "katatome" (where the rock of the Acropolis was met by the walls).
d, *e*, diazoma.
fg, eastern boundary wall.
hh, front wall of Neronian stage.
i, fragment 5th-century orchestra.
klm, ancient masonry (? of supporting walls).
nn, oldest stage buildings.
oo, stone proscenium (1st or 2nd century B.C.).
p, foundations of Neronian side wings.
qr, fragments 5th-century orchestra.
s, 4th-century portico.
t, old Dionysus temple.

a compromise was effected by prolonging the ends of the semicircle as segments of a curve with a longer radius. The best seats were in the lowest row; at Athens this was formed by a series of marble thrones assigned to various priests or officials whose titles may be read on those (60 out of 67) which are now preserved. The priest of Dionysus occupied the central throne. In some theatres benches with backs took the place of separate thrones. The right of sitting in reserved places was called *προεδρία*.

The orchestra, which was separated from the auditorium by a gutter and kerb and generally paved with slabs, contained an altar of Dionysus called the *θυμέλη*, whence the choral or musical contests which took place in it were called *ἀγῶνες θυμελικοί*. At Athens this altar stood in the middle of a lozenge-shaped marble pavement. In a few theatres subterranean passages have been found, leading from the stage-buildings to the middle of the orchestra, which may be supposed to have been used for the appearance of actors (*e.g.* as ghosts) in the orchestra: they do not exist, however, at Athens or Epidaurus, so that no general argument can be founded on their remains.

The stage buildings of the earliest Greek theatres have been destroyed save for the foundations and architectural fragments, and the interpretation of their remains presents a difficult problem. Whether built on level ground or (as at Sicyon and elsewhere) excavated in rock or earth they consisted of a rectangular structure two stories high, usually with projecting side wings (*παρασκήνια*). Between these wings was the *προσκήνιον* (stage), which at Athens and indeed in all early theatres was built of wood, but was afterwards reconstructed in stone, with a front formed by a row of columns from 10 to 13 ft. high; its depth varied from 8 to 10½ ft. It has been argued by Dörpfeld that the *προσκήνιον* was not a stage, but a background, which could be characterized as a palace, temple, &c., by means of painted *πίνακες* set up in the intervals between the columns, and that throughout the history of the Greek drama actors as well as chorus performed in the orchestra. This theory has been supported by arguments drawn from passages of the classical dramatists, which seem to imply that actors and chorus were on the same level, and by *a priori* considerations regarding the unfitness of so high and narrow a platform, unconnected with the orchestra by stairs (except such temporary wooden steps as may have left no trace in extant remains), for a stage. But these arguments are outweighed by the positive testimony of ancient writers and inscriptions that the actors in the Greek drama mounted on a platform (*ὀκρίβας*) which was also called the *λογεῖον* ("speaking-place"), and the description of the Greek theatre by Vitruvius, who tells us that the *λογεῖον* (Lat. *pulpitum*) was narrower than that of the Roman theatre, and was from 10 to 12 ft. high. Moreover the background afforded by the Hellenistic *προσκήνια* would have been diminutive in its proportions—it must be remembered that Greek actors stood some 6 ft. 6 in. high when wearing the *cothurnus* and tragic mask—and quite unlike a palace or temple. They never have more than one doorway in the centre, though Vitruvius prescribes three, and in some theatres (where the stage-buildings were partly excavated) there are no rooms at the back of them, but either virgin rock or earth. We may therefore dismiss Dörpfeld's theory: but it is more than probable that the wooden stage of the 5th century B.C. was much lower than that of Hellenistic times, when the chorus had either disappeared from dramatic performances or performed musical interludes unconnected with the action of the play. Horace, in fact, says of Aeschylus: "Aeschylus . . . modicis instravit pulpita tignis," and doubtless preserves a fragment of genuine tradition. When chorus and actors came into contact, wooden steps could be used, and that such were employed even in the later drama is proved by the evidence of South Italian vase-paintings which represent the Phylakes or burlesques popular at Tarentum.

The façade of the *σκηνή* furnished an architectural background, and this was supplemented by painted scenery, which, according to Aristotle, was introduced by Sophocles: Vitruvius, however, tells us that the first scene-painter, Agatharchus, worked for Aeschylus. In their days the *σκηνή* was, of course, a mere booth. Changes of scene were very rare—there are only two in the extant classical tragedies—and were brought about by the use of revolving prisms (*περίακτοι*). Other appliances used in the Greek drama were the *ἐκκύκλημα*, a low platform on rollers which was pushed forward in order to show an action supposed to take place in the interior of the *σκηνή* (the scene in a Greek play was always laid in the open air), and the *μηχανή*, a crane by which an actor representing a god could be suspended in mid-air (hence the phrase *deus ex machina*). In the upper part of the *σκηνή* was a balcony called the *διστεγία* ("second story"), and at the top a narrow platform called the *θεολογεῖον*, upon which gods supposed to be stationary in heaven could appear. Ghosts ascending from the underworld mounted the *χαρώνιοι κλίμακες*, whose position is uncertain. The *βροντεῖον* was a machine for imitating thunder by means of stones rolled in metal jars. It is far from certain whether a drop-scene was used in the classical period of the Greek drama; in later times and in the Roman theatre a curtain (*αὐλαία*, Lat. *aulaea*, *siparium*) was let down into a narrow slit in front of the stage before the play began and drawn up at the end.

It has been mentioned above that in the later Hellenistic theatres the stage was made broader, lower and deeper, and in the Roman theatre, the principle of whose construction, as explained by Vitruvius, is illustrated by fig. 3, the orchestra is reduced to a semicircle (*acd*). The line *ef* is that of the background (*scenae frons*) and its limits are those of the *cavea* or auditorium.

The Romans, by their use of the arch in construction and also of concrete for vaulting, were enabled to erect theatres on level ground, such as the Campus Martius at Rome, where an elaborate structure, usually in three stories of arcades,[1] took the place of the natural hill-slope of Greek theatres. The Roman theatre thus became an organic whole; the auditorium and stage-buildings were structurally connected, and the orchestra was entered from the wings, not by open passages (*πάροδοι*) as in Greece, but by vaulted corridors. The orchestra was no longer used for the performances (whether dramatic, musical or merely spectacular), but was reserved for senators and other persons of distinction. Hence (as Vitruvius points out) arose the necessity for lowering and enlarging the stage. It is hard to say when this change was made or at what date it was first introduced into Italy (if it did not originate in the west). The larger of the two theatres at Pompeii dates from the Hellenistic period, but was thrice reconstructed, and it is not clear to what date we are to assign the low stage of Roman pattern; possibly it belongs to the earliest period of the Roman colony at Pompeii founded by Sulla (B.C. 80). The theatre of Pompey (see below) is said by Plutarch to have been copied from that of Mytilene, which suggests that the Roman theatre was derived from a late Greek model; and this is made probable by the existence of transitional forms.

During the Republican period the erection of permanent theatres with seats for the spectators was thought to savour of Greek luxury and to be unworthy of the stern simplicity of the Roman citizens. Thus in 154 B.C. Scipio Nasica induced the senate to demolish the first stone theatre which had been begun by C. Cassius Longinus ("tanquam inutile et nociturum

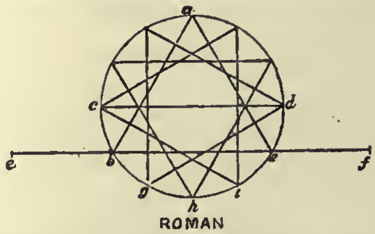


FIG. 3.—Diagram showing the principle on which the Roman theatre was planned according to Vitruvius.

publicis moribus," Liv. *Epit.* 48). Even in 55 B.C., when Pompey began the theatre of which remains still exist in Rome, he thought it wise to place a shrine to Venus Victrix at the top of the cavea, as a sort of excuse for having stone seats below it—the seats theoretically serving as steps to reach the temple. This theatre, which was completed in 52 B.C., is spoken of by Vitruvius as "the stone theatre" *par excellence*: it is said by Pliny to have held 40,000 people.[2] It was also used as an amphitheatre for the bloody shows in which the Romans took greater pleasure than in the purer intellectual enjoyment of the drama. At its inauguration 500 lions and 20 elephants were killed by gladiators. Near it two other theatres were erected, one begun by Julius Caesar and finished by Augustus in 13 B.C., under the name of his nephew Marcellus,[3] and another built about the same date by Cornelius Balbus (Suet. *Aug.* 29; Pliny, *H. N.* xxxvi. 59). Scanty remains exist of this last theatre, but the ruins of the theatre of Marcellus are among the most imposing of the buildings of ancient Rome.

A long account is given by Pliny (*H. N.* xxxvi. 5 and 114) of a most magnificent temporary theatre built by the aedile M. Aemilius Scaurus in 58 B.C. It is said to have held the incredible number of 80,000 people, and was a work of the most costly splendour. Still less credible is the account which Pliny gives (*H. N.* xxxvi. 116) of two wooden theatres built by C. Curio in 50 B.C., which were made to revolve on pivots, so that the two together could form an amphitheatre in the afternoon, after having been used as two separate theatres in the morning.

All Roman provincial towns of any importance possessed at least one theatre; many of these are partly preserved. On

[1] Vitruvius prescribes for the Roman theatre a portico running round the interior of the auditorium on the level of the topmost row of seats; remains of such a portico (or, as at Aspendus, of a series of arcades) can sometimes be traced.

[2] Huelsen has shown that this statement is exaggerated, and estimates the number of spectators at 9000 to 10,000.

[3] According to Livy (xl. 51), the theatre of Marcellus was built on the site of an earlier one erected by Aemilius Lepidus.

EPIDAURUS, THE THEATRE FROM THE WEST. *Photo, W. Leaf.*

XXVI. 730. ATHENS, THE THEATRE OF DIONYSUS FROM THE ACROPOLIS. *Photo, R. Elsey Smith.*

THEATRE

Photo, R. Elsey Smith.

ATHENS, PRINCIPAL SEATS IN THE THEATRE OF DIONYSUS.

Photo A. M. Woodward.

ASPENDUS, INTERIOR OF THE UPPER GALLERY OF THE THEATRE.

Photo, A. M. Woodward.

ASPENDUS, THE STAGE WALL.

Photo, Mansell & Co.

INTERIOR OF THEATRE, ORANGE.

Pl. II. will be found reproductions of two of the most important—that of Aspendus in Pamphylia, which illustrates the Eastern type showing Hellenistic influence, and that of Arausio (Orange) in South Gaul. Covered theatres were sometimes built, whether on account of climatic conditions (as at Aosta) or more commonly for musical performances. These latter were generally called *Odea* (Gr. *ᾠδεῖον*, a place for singing). The best preserved is the Odeum of Herodes Atticus, at the south-west angle of the Athenian Acropolis, which has a semicircular orchestra. It was built in the reign of Hadrian by Herodes Atticus,[1] a very wealthy Greek, who spent enormous sums in beautifying the city of Athens, in honour of his wife Regilla. Its cavea, which is excavated in the rock, held about 6000 people; it was connected with the great Dionysiac theatre by a long and lofty porticus or stoa, of which considerable remains still exist, probably a late restoration of the stoa built by Eumenes II. of Pergamum. It was also a common practice to build a small covered theatre in the neighbourhood of an open one, where performances might take place in bad weather. We have an example of this at Pompeii. The Romans used scenery and stage effects of more elaboration than was the custom in Greece. Vitruvius (iii. 7) mentions three sorts of movable scenery:—(1) for the tragic drama, façades with columns representing public buildings; (2) for comic plays, private houses with practicable windows and balconies;[2] and (3) for the satyric drama, rustic scenes, with mountains, caverns and trees.

Bibliography.—By far the fullest account of the Greek theatre is given in Dörpfeld and Reisch, *Das griechische Theater* (Athens, 1896). Its main thesis is, however, rejected by many archaeologists on the grounds stated above. Puchstein, *Die griechische Bühne*, endeavours to prove that a stone theatre was built at Athens in the 5th century B.C., and that the proscenium usually supposed to be Hellenistic dates from the time of Lycurgus (above). For English readers the best account of the Greek theatre is to be found in A. E. Haigh's *Attic Theatre* (3rd ed., revised by A. W. Pickard-Cambridge, 1907), where a bibliography of the voluminous literature of recent times is given. Albert Müller's *Lehrbuch der griechischen Bühnenaltertümer* (Freiburg, 1886) is indispensable to the student. For the Roman theatre reference may be made to Durm, *Baukunst der Römer*, ed. 2, pp. 645 ff.

(J. H. M.; H. S. J.)

The Modern Theatre

During the middle ages miracle plays with sacred scenes were the favourite kind of drama; no special buildings were erected for these, as they were represented either in churches or in temporary booths. In the 16th century the revival of the secular drama, which, in the reign of Elizabeth, formed so important a part of the literature of England, was carried on in tents, wooden sheds, or courtyards of inns, mostly by strolling actors of a very low class. It was not till towards the close of the century that a permanent building was constructed and licensed for dramatic representations, under the management of Shakespeare and Burbage.

The first building specially erected in London for dramatic purposes was built in 1576–77 by the actor James Burbage. It was constructed of timber, and stood in Holywell Lane, Shoreditch, till 1598, when it was pulled down; it was known as "The Theatre" *par excellence*. Of almost equally early date was the "Curtain" theatre, also in Shoreditch; so called from the plot of ground, known as "The Curten," on which it stood. It probably continued in use till the general closing of theatres by order of the parliament in 1642. The "Globe" theatre, famous for its association with Shakespeare, was built by James Burbage, who used the materials of "The Theatre," in the year 1599. Its site was in Southwark, in the Bankside, near the "Bear Gardens." It was an octagonal structure of wood, with lath and plaster between the main framework. It was burnt in 1613, rebuilt, and finally pulled down and its site built over in 1644. Its name was derived from its sign of Atlas supporting the globe. Near it were two less important theatres, "The Rose," opened in 1592 by Henslowe, and "The Swan" (see below), opened in 1598 and partly owned also by Henslowe; like the Globe, the latter was an octagonal wood-and-plaster building. The "Blackfriars" theatre, another of the Burbages' ventures, was built in 1596, near the old Dominican friary. The "Fortune" theatre was built by Edward Alleyn, the actor, in 1599, at a cost, including the site, of £1320. It stood between Whitecross Street and Golding Lane. It stood as late as 1819, when a drawing of it was given by Wilkinson (*Londina illustrata*, 1819). The "Red Bull" theatre was probably originally the galleried court of an inn, which was adapted for dramatic purposes towards the close of Elizabeth's reign. Other early theatres were the "Hope" or "Paris Garden" theatre, the "Whitefriars" and "Salisbury Court" theatres, and the "Newington" theatre. A curious panoramic view of London, engraved by Visscher in 1616, shows the Globe, the Hope and the Swan theatres.

The plan of the first English theatres appears to have had no connexion with those of classical times, as was the case in Italy: it was evidently produced in an almost accidental way by the early custom of erecting a temporary platform or stage in the middle of the open courtyard of an inn, in which the galleries all round the court formed boxes for the chief spectators, while the poorer part of the audience stood in the court on all sides of the central stage. Something similar to this arrangement, unsuitable though it now seems, was reproduced even in buildings, such as the Globe, the Fortune and the Swan, which were specially designed for the drama. In these and other early theatres there was a central platform for the stage, surrounded by seats except on one side, where there was a "green-room" or "tireynge-howse." The upper galleries or boxes completely surrounded the stage, even the space over the green-room being occupied by boxes. This being the arrangement, it is easy to see why the octagonal plan was selected in most cases, though not in all—the Fortune theatre, for example, was square. An interesting specification and contract for the building of the Fortune theatre (see below) is printed by Halliwell-Phillipps (*op. cit. infra*, p. 164). In all its details the Fortune is specified to be like the Globe, except that it is to be square in plan, and with timbers of heavier scantling. The walls are to be of wood and plaster, the roof tiled, with lead gutters, the stage of oak, with a "shadow" or cover over it, and the "tireynge-howse" to have glazed windows. Two sorts of boxes are mentioned, viz., "gentlemen's roomes" and "twoopennie roomes." A woodcut showing this arrangement of the interior is given in a collection of plays edited by Kirkman in 1672. The vexed question of the construction of these theatres has been much discussed in recent years. In 1888 a drawing of the Swan theatre (fig. 4), apparently copied from a rough drawing in a London letter from the traveller Johannes de Witt, was discovered by Dr Karl Gaedertz in a manuscript volume in the Utrecht University library, consisting of the commonplace book of Arend van Buchell (1565–1641). While undoubtedly authentic, and probably broadly accurate, this copied sketch cannot be accepted, however, as giving the regular or typical plan of the contemporary theatre, as in some respects it does not fulfil the known conditions of the stage. What that typical plan was, if (as is probable) one actually existed, has led to much learned conjecture and great difference of opinion as regards the details required by the interpretation of contemporary stage directions on the necessities of the action in contemporary drama. The ingenious reconstruction (fig. 5), drawn by W. H. Godfrey in 1907, of the Fortune theatre, following the builder's specification, appears to approach very nearly to satisfying all the requirements. (See "The Elizabethan Stage," in the *Quarterly Review* (London), April 1908.)

In the 16th and 17th centuries a favourite kind of theatrical representation was in the form of "masques," with processions of grotesquely attired actors and temporary scenic effects of great splendour and mechanical ingenuity. In the reigns of James I.

[1] This theatre was not begun when Pausanias wrote his book *Attica*, and was complete when he wrote the *Achaica* (see Paus. vii. 20). It is illustrated in *Mon. Inst.* vi., plate 16.

[2] These are shown on Graeco-Roman vases of the latest type, with paintings of burlesque parodies of mythological stories.

and Charles I., Ben Jonson and the architect Inigo Jones worked together in the production of these "masques," Jonson writing the words and Inigo Jones devising the scenic effects, the latter being very costly and complicated, with gorgeous buildings, landscapes, and clouds or mountains, which opened to display mimic deities, thrown into relief by coloured lights. These masques were a form of opera, in which Ben Jonson's words were set to music. Ben Jonson received no more for his libretto than Inigo Jones did for his scenic devices, and was not unnaturally annoyed at the secondary place which he was made to occupy: he therefore revenged himself by writing severe satires on Inigo Jones and the system which placed the literary and mechanical parts of the opera on the same footing. In an autograph MS. which still exists this satirical line occurs—"Painting and carpentry are the soul of masque" (see Cunningham, *Life of Inigo Jones*, London, 1848).

In Italy, during the 16th century, the drama occupied a more important position, and several theatres were erected, professedly on the model of the classic theatre of Vitruvius. One of these, the Teatro Olimpico at Vicenza, still exists; it was designed by Palladio, but was not completed till 1584, four years after his death. It has an architectural scena, with various orders of columns, rows of statues in niches, and the three doors of the classic theatre; but the whole is painted with strong perspective effects which are very unclassical in spirit. Scamozzi, Palladio's pupil, who completed the Teatro Olimpico,

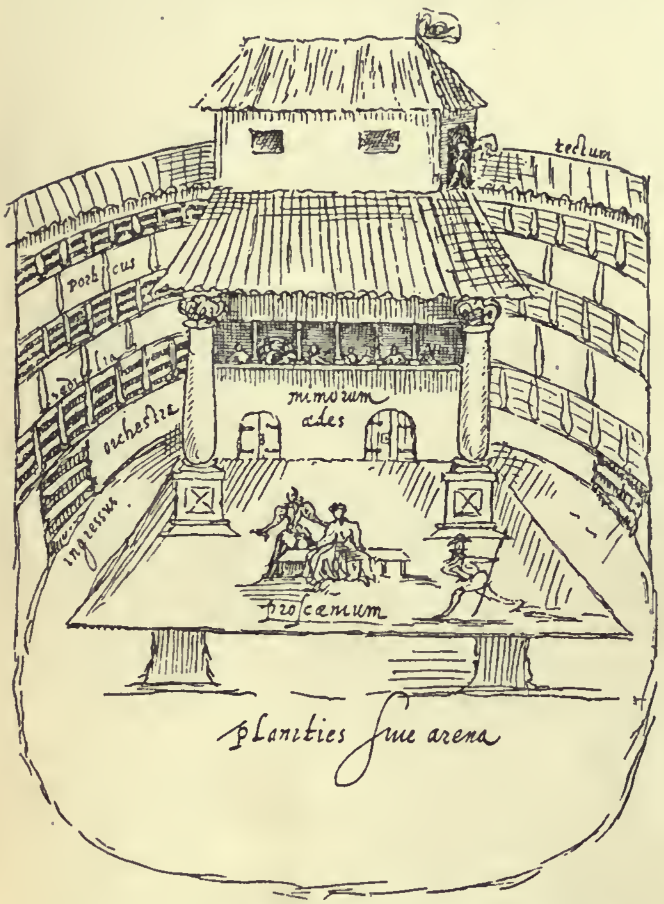


Fig. 4.—Swan Theatre; from Sidney Lee's *Life of William Shakespeare*, by permission.

built another pseudo-classical theatre in 1588 at Sabbionetta for the duke Vespasiano Gonzaga, but this does not now exist.

In France the miracle play developed into the secular drama rather earlier than in England. In the reign of Louis XI., about 1467, the "Brothers of the Passion" had a theatre which was partly religious and partly satirical. In the 16th century Catherine de' Medici is said to have spent incredible sums on the dresses and scenery for the representation of the Italian ballet; and in the middle of the 17th century the regular opera was introduced at Paris.

At the end of the 18th century the theatres of San Carlo at Naples, La Scala at Milan, and La Fenice at Venice were the finest in Europe; all these were rebuilt in the 19th century,

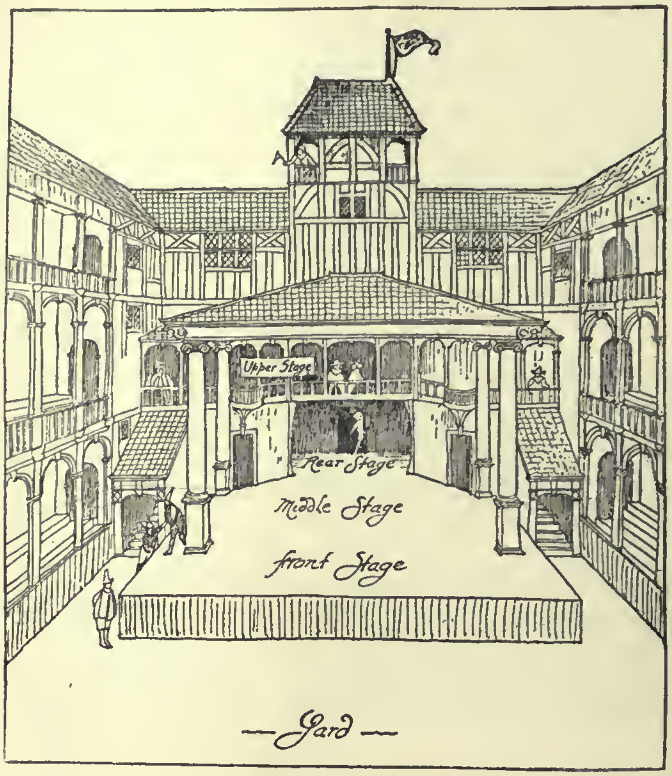


Fig. 5.—The Fortune Theatre; restoration of Walter H. Godfrey.

but have been eclipsed by the later theatres of London, Paris, St Petersburg and other great cities of Europe and America, both in size and architectural splendour.

Authorities.—Much valuable information about the early theatres of London is given by Wilkinson, *Londina illustrata* (1819), in which are engravings of some of them. See also Collier, *Hist. of Dramatic Poetry* (1879); Halliwell-Phillipps, *Life of Shakespeare* (1883); R. Lowe, *Life of T. Betterton;* Malone, *History of the Stage* (1790), republished by Boswell in 1821; the publications of the New Shakspere Society; the Ninth Report of the Historical MSS. Commission; and a series of articles on early London theatres, by T. F. Ordish, in *The Antiquary*, vols. xi., xii. and xiv. (1885–86). On the problems connected with the construction of the Elizabethan theatre, see Dr Cecil Brodmeier, *Die Shakespeare-Bühne nach den alten Bühneranweisungen* (Weimar, 1904); Dr Paul Mönkemeyer, *Prolegomena einer Darstellung der Englischen Volksbühne zur Elizabeth und Stuart Zeit* (Leipzig, 1905); Dr Richard Wegener, *Die Buhneneinrichtung des Shakespeareschen Theaters nach dem zeitgenossischen drama* (Halle, 1907); George F. Reynolds, *Some Principles of Elizabethan Staging* (Chicago University, 1905); E. K. Chambers, "The Stage of the Globe," in vol. x. of the Stratford *Shakespeare* (1904); Victor E. Albright, *A Typical Shakesperian Stage* (New York, 1908). (J. H. M.; H. Ch.)

Modern Stage Mechanism

A movement known as "Stage Reform" originated in Austria about 1880, with the primary object of encouraging the greatest possible imitation of nature in the presentation of opera and drama. The rudiments of art as understood by painters, sculptors, architects and the cultured public of the day were to be applied to the stage, and a true scenic art was to take the place of the nondescript mounting previously given. To facilitate the efforts of the scenic artist, the fullest application of modern science, notably of mechanics and hydraulics, and the introduction of up-to-date methods of lighting were considered essential. The numerous fatal conflagrations which had originated on the stage caused the question of protection from fire to be closely associated with this movement, and the enterprise made great headway, more particularly on account of the protective measures against fire proposed soon after the burning of the old Ring Theatre at Vienna. The movement gradually developed throughout Austria and Germany and spread beyond the frontiers of these countries. Concurrently, independent movements originated elsewhere, and from 1885 to 1895 a transitional period may be said to have existed for the stage, both in Europe and in the United States, but by the close of the 19th century the necessity for reform was recognized in every country. During the transitional time various unsatisfactory experiments were made, some of the boldest experiments proving costly failures, yet serving, because of such features as were valuable, as a basis for further developments. Great Britain and France were almost the last countries touched by this movement, although in England throughout the 'nineties there was considerable improvement in actual scenic art and stage-mounting, as far as this could be brought about without the aid of improved stage mechanism.

Among those primarily responsible for this new epoch in scenic art in Great Britain were Sir Henry Irving and Mr Beerbohm Tree, both actor-managers, Mr Hubert von Herkomer, R.A., Sir L. Alma-Tadema, R.A., and Mr Edwin O. Sachs, architect. Although almost last in the application of stage reform in its best sense, England really completed the experimental period with the modernization of the Royal Opera House, Covent Garden, where, by the opening of the season of 1902, the directorate were provided with the latest improvements of mechanical skill for the almost complete re-equipment of stage scenery. This work of remodelling was carried out by the Grand Opera Syndicate, with Mr Edwin O. Sachs as technical adviser and architect. Modern mechanism has also been applied at the Apollo Theatre, London, where, however, the stage equipment was bodily imported from the Continent and does not include any mechanically or electrically driven parts, manual labour alone being used. The stage mechanism which was employed in the equipment of the Royal Opera House, Covent Garden, embodies the Sachs system of dividing the stage-floor into a few large sections and working them with the aid of electrical power, the Brandt system of counter-weighting for the suspension of all scenery from above, the application of light in four colours by electricity, and the designing of all scenery to accord as much as possible with nature, the whole mounting being built up on the basis of a flat stage as distinct from the sloping stage of old.

Stage Mechanism. The classification of stages generally, both home and foreign, whether for the production of opera or plays, should be made as follows: wood stages, wood and iron stages, and iron stages, with subdivisions according to the power chiefly employed in working the appliances. These subsections are: manual labour, hydraulics and electricity. Owing to the almost entire absence of steam for motor power in connexion with stage machinery, a separate subdivision for appliances where steam is employed is not required. With the wood stage and the wood and iron stage manual labour alone is utilized. But in the iron stage manual labour, hydraulic power and electric power are either used individually, or a combination of any two or three of these classes is applied. The first series of stages built in accordance with the principles of Stage Reform was erected on what was termed the "asphaleia" system, in which direct hydraulic power was utilized throughout. The stage-floor is divided into innumerable small sections supported on rams (some working telescopically), whilst everything suspended from above is also worked mechanically by hydraulic power. Notable examples are the Budapest Opera House and the Municipal Theatre at Halle.

The next type is that of the stage of the Court Theatre, Vienna, which, although based to a considerable extent on the "asphaleia" system, showed somewhat larger sections. These are suspended by cables and worked indirectly by small hydraulic rams placed at the side, whilst the whole of the top work is manipulated by manual labour with the partial assistance of counter-weights. The next type is the Brandt type, where the number of divisions of the stage is further reduced to a few medium-sized sections, worked by means of a combination of a central hydraulic ram and suspended cables duly counter-weighted. The top work in this case is entirely counter-weighted, and requires the least possible manual labour for manipulation. An example will be found at the Wiesbaden Court Theatre. We next have the Sachs system, where electric power is substituted for hydraulic power, the number of stage divisions limited to several large sections, suspended on cables partly counter-weighted and partly worked by electric motors, while the whole of the top work is balanced on a system similar to that of the Brandt, with intermediate electric motors for the manipulation of particularly heavy loads. It is this last system that has been adopted at the Covent Garden Opera House, with the modification that the top work is entirely operated on the latest development of the Brandt system of manual labour and counter-weights. Another example of the Sachs system, as far as individual stage sections are concerned, will be found in a portion of the Theatre Royal, Drury Lane.

Regarding the question of expense and practicability, the hydraulic system has generally been found to be expensive and impracticable. The system of the Court Theatre, Vienna, though practicable, is costly both in capital and annual outlay. The Brandt method of equipping the upper stage mechanism has been found particularly suitable for medium-sized theatres, and not expensive. The Sachs system has been found practicable, of moderate initial cost and minimum annual outlay. The advantages of electricity over hydraulic power have been most marked both in capital and in annual expense. There is of course a far greater initial outlay required to-day than with the wooden stage of old, but the saving in staff and wear and tear of the scenery, and the absence of expensive temporary makeshifts, repairs and reinstatements, compensate for this by a material reduction of annual charges. It is known as a fact that upon an overhaul of the Covent Garden equipment being ordered after five years' running, the contractors could not find anything to do in the way of repairs or reinstatements. The stage carpenter has long reigned supreme in England and France, although in England there are already one or two notable exceptions of men who are advancing to the position of engineers rather than carpenters. In Germany and Austria the stage carpenter is already being replaced in most theatres by men of engineering or technical training, as the more complex arrangements of a modern stage demand intelligent and careful control. It is merely a question of time for the engineer to obtain general control in these matters.

Scene-painting. Regarding the actual designing and painting of the scenery, the English scene-painter may now be considered in advance of his Continental and American colleagues, although the productions of some notable ateliers at Vienna and Munich run the English scene-painter's work very closely. In 1890 Vienna was in advance of England in scene-painting, but the English scene-painters have since then rapidly come to the front, and it is to be anticipated that it will never again be necessary to import scenery from Austria, as has been the case, both at the Theatre Royal, Drury Lane, and at the Royal Opera House, Covent Garden. As a matter of fact, scenery from Covent Garden and Drury Lane is already exported to the United States. The position of the scene-painter is particularly difficult, inasmuch as whilst artistic temperament and thorough knowledge of art are essential for the practice of his vocation, it is equally essential that he should be thoroughly practical and to a considerable extent a mechanic. He lacks recognition among artists and there is unfortunately a tendency to depreciate his work.

Modern Inventions. During the period of interregnum in stage reform there appeared a number of faddist inventions which, while creating public interest, cannot be considered of lasting practical utility. Thus in the United States an attempt was made to have a large platform constructed like a lift, bodily rising and falling, with three different tiers or stages on which scenery could be mounted at different levels and then raised or lowered into position. Again, at Munich, a scheme of turn-tables based on the Japanese revolving stage was put forward, but this can only be looked upon as an interesting experiment of little practical value.

Light. Numerous methods of illuminating the stage have similarly been attempted, with the aid of search-lights, and proscenium-lights, or by the absence of foot-lights, and the like, but the general method of lighting the stage from the top with battens, from the side with wing-ladders, and from below with foot-lights, if carefully regulated and skilfully handled, produces excellent results. The lighting arrangements as practised at the Royal Opera House, Covent Garden, in which building the lighting engineer is Mr Crawshaw and the consulting engineer for the lighting installation was Mr Bowles, leave nothing to be desired from an artist's point of view. The great difficulty of the light coming too strongly from below, *i.e.* from the foot-lights, can be overcome by the regulation and colouring of the lights.

As examples of modern mechanism, two photographs have been reproduced showing views of the electrical stage "bridges" of the Royal Opera House, Covent Garden, and of the Theatre Royal, Drury Lane, respectively, both on the Sachs system (see Pl. III.). A small general plan and section of the Covent Garden stage are also shown (see fig. 6), and another illustration (see Pl. IV.) presents the "gridiron" at Covent Garden on the Brandt system.

The following is a detailed description of the Covent Garden installation.

The stage may be described as consisting of a series of six horizontal sections running parallel with the curtain line from front to back, each section being 8 ft. wide, and the whole being followed by a large back or rear stage. The first section contains nothing but a plain "carpet cut," and openings to take the old-fashioned "grave" trap, "star" trap, or other similar contrivances. The second and third sections comprise large bridges, which can be raised 6 ft. above the stage or lowered 8 ft. below the stage, constructed in two levels, on the lower level of which appliances can be installed for the purpose of raising minor platforms above stage level or sinking traps and the like. The fourth, fifth and sixth sections comprise large bridges running right across the stage front, which can be raised 9 ft. above the stage or lowered 8 ft. below it. The back stage has no openings or mechanism beyond certain trap-doors to a scenery store, and the necessary electrical mechanism for raising and lowering scenery for storage purposes. Between the various sections of the stage, long longitudinal flaps, 2 ft. wide, have been formed, which can be easily opened to allow scenery to be passed through below for transformation scenes and the like. Each section is equipped with what is termed a pair of chariots, to hold "wing" lights placed on so-called wing ladders. All the electrical bridges are worked from the "mezzanine" level and from ordinary switchboards, and can be raised and lowered at various speeds, and take loads up to 2 tons. They can be moved without vibration or noise at a cost of about ½d. for power on a full rise when loaded.

Above the stage level each section has its series of lines to take cloths, borders, &c. Each section has a batten, from which the electric battens are suspended, and has also a large wooden lattice girder, from which heavy pieces of scenery can be hung. There are, on the average, about ten lines for ordinary battens, a girder batten, and a light batten to each section; besides these lines, there are the equipments of flying apparatus and the like, whilst in front there are, of course, the necessary lines for tableaux curtains, act-drops and draperies. Everything that is suspended from above can be worked at stage level or at either of the gallery levels, every scene being counter-weighted to a nicety, so that one man can easily handle it. No mechanical contrivance is required, and in practice quite a number of scenes can be rapidly changed in a very short time. Throughout the structure and mechanism steel has been used, with iron pulleys and wire cable; and the inflammable materials have been absolutely reduced to the flooring of the gridiron and galleries and the hardwood flooring of the stage and mezzanine. In other words, an absolute minimum of inflammable material replaces what was almost a maximum; and seeing that the electric light has been installed, the risk of an outbreak of fire or its spread has been materially reduced.

No mention of stage mechanism would be complete unless mention were made of the necessity of providing a carefully made and easily worked fire-resisting curtain of substantial but light construction. On the Continent metal curtains are favoured. In England the double asbestos curtain is more common. The London County Council prefer a steel framing with asbestos wire-wove cloth on both faces, the intervening space being filled with slag wool, well rammed and packed. Such curtains are somewhat

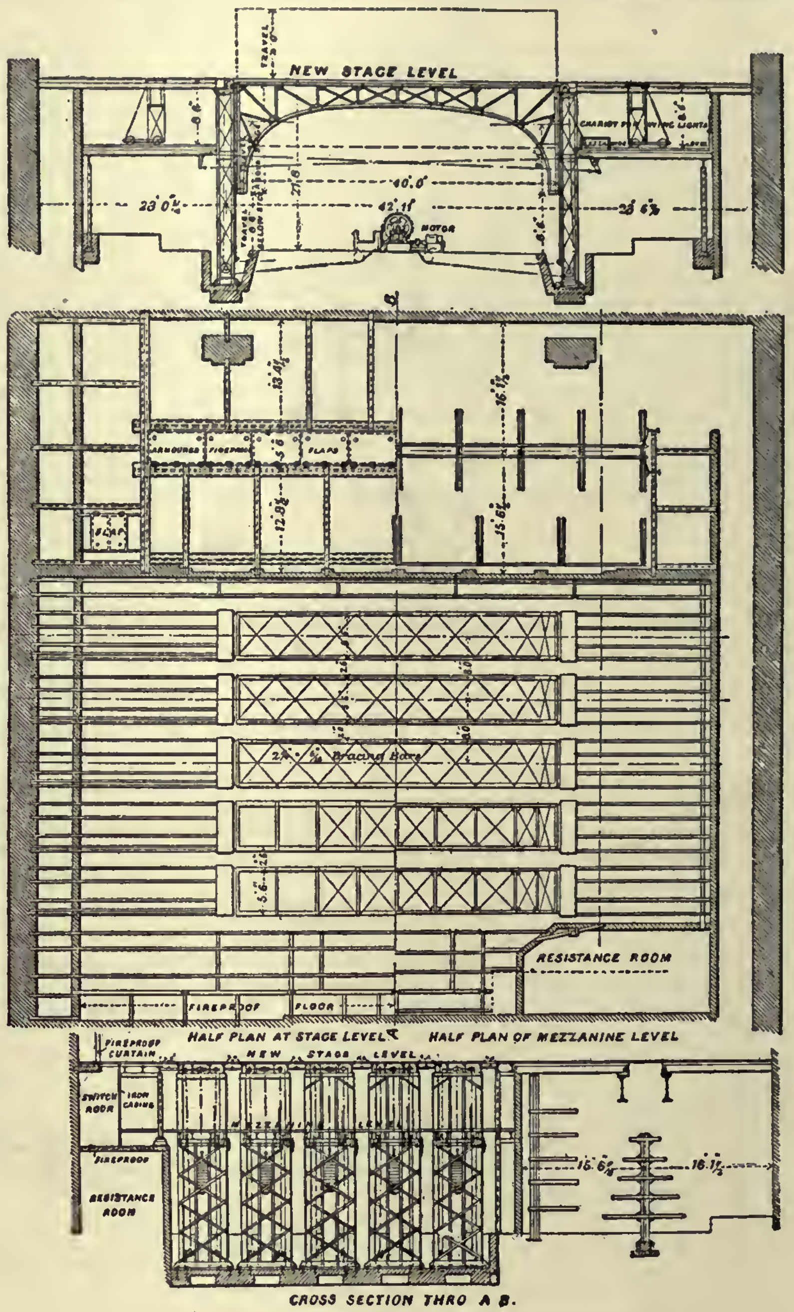
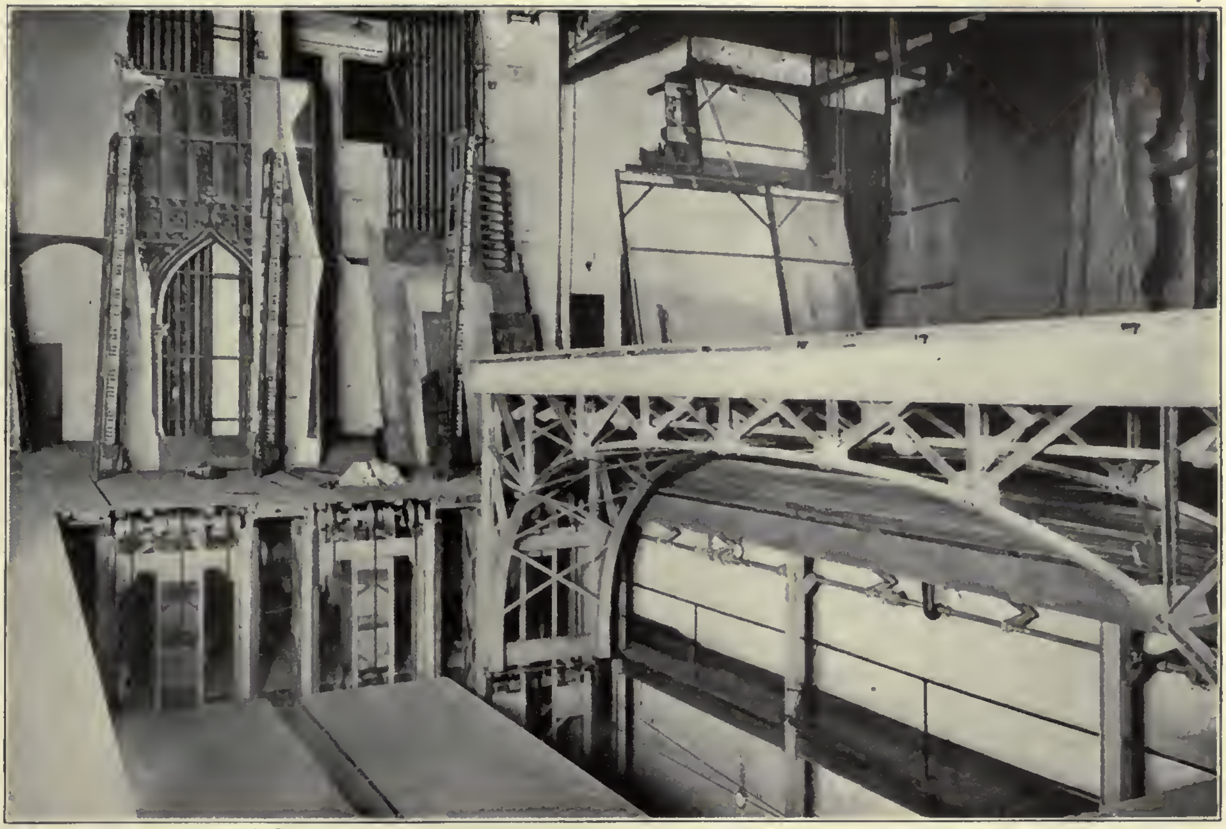


FIG. 6.—Plan and Section of Covent Garden Stage.

heavy and require counter-weighting to a nicety, but if well made and fitted may be deemed satisfactory. It is advisable to fit drenchers above fire-resisting curtains and to so arrange the working of the curtain that it can be lowered from four points, *i.e.* from both sides of the stage, from the prompt side flies and from the stage door. According to the Lord Chamberlain's rules, fire resisting curtains must be lowered once during a performance. This is a wise measure for testing the efficiency of the appliances.

AUTHORITIES.—*Modern Opera Houses and Theatres*, 3 vols. grand folio, by Edwin O. Sachs (1896–99); *Stage Construction*, 1 vol. grand folio, by Edwin O. Sachs (1896); "*Engineering*": *Articles on Stage Mechanism*, by Edwin O. Sachs (1895–97); *Fires and Public Entertainments*, 1 vol. quarto, by Edwin O. Sachs (1897); *Le Théâtre*, 1 vol. oct., by Charles Garnier (1871); *Les Théâtres*



From a Photograph by S. B. Bolas & Co.

SACHS' ELECTRICAL STAGE "BRIDGES," ROYAL OPERA HOUSE, COVENT GARDEN.

From a Photograph by Alfred Ellis & Walery.

SACHS' ELECTRICAL STAGE "BRIDGES," THEATRE ROYAL, DRURY LANE.

PLATE IV.

From a Photograph by Alfred Ellis & Walery.

THE NEW "GRIDIRON," ROYAL OPERA HOUSE, COVENT GARDEN.

Anglais, by Georges Bourdon (1902); *Die Theater*, Wien, 2 vols. quarto, by Josef Bayer (1894). (E. O. S.)

"SPECTACLE"

The appeal to the eye has been the essential feature of dramatic production in its many stages of development from the earliest times of the miracle plays and "moralities," mummers and morris-dancers, down through the centuries, in the form of masques and ballets, to the luxuriance of scenic and costume display that is lavished on the latest forms of theatrical entertainment. Considering the enormous advance that has been made in mechanical appliances, more especially in the increased powers of illumination supplied by gas and electricity[1] as compared with oil and candles, we must acknowledge that the artistic achievement of spectacle has hardly kept pace with the times. If we may credit the veracity of contemporary chroniclers, the most elaborate effects and illusions were successfully attempted in the various courtly entertainments that are recorded under the Tudor and Stuart dynasties, and found perhaps their most sumptuous expression in the courts of Louis XIV. and Louis XV. It would be a difficult task for the most experienced of modern stage managers to rival the splendours of apparel and the ingenious devices that were exploited in increasing magnificence during successive periods, as described by Froissart, Holinshed, Cavendish, Stow, Pepys and other writers. The sums expended on these entertainments were prodigious, and a perusal of the extraordinarily detailed descriptions of such lavishly appointed masques as those designed by Inigo Jones in particular renders credible the statement that a certain masque presented before Charles I. at the Inns of Court in 1633 cost £21,000. Spectacle in its earlier phases appears to have existed chiefly in connexion with court and civic ceremonial: as evidenced in the wonderful pageantry of the Field of the Cloth of Gold; in such princely entertainment as the Revels at Kenilworth, when the Earl of Leicester welcomed Queen Elizabeth in a series of splendid fêtes; and in the more accomplished imaginings of Ben Jonson, decorated by Inigo Jones, such as the Inns of Court masque, already cited. The scenic effects and illusions which had evidently been brought to great perfection in these masques were not devoted to the service of the drama in the public theatres until Davenant introduced them at the period of the Restoration, although simple scenery, probably mere background "cloths," had been seen on the stage as early as 1605. The built-up stage pictures, familiar to us as "set-scenes," are said to owe their origin to Philip James de Loutherbourg, R.A., and to have been first used in 1777; but it is difficult to believe that some such elaborate constructions had not already enjoyed a term of popularity in view of the contemporary paintings and engravings of the epoch of Louis XIV., who was himself not averse from appearing (in 1653) as "Le Roi Soleil" in the midst of an *entourage* combining much that was artistic and fanciful with the most pompous and most absurd incongruities of character and costume. A greater measure of elegance and refinement distinguished the spectacles of the reign of Louis XV., inspired by the delicate art of Watteau, Boucher and Lancret, and preserved for our delectation in their delightful canvases. Under the French Revolution the spectacular ballet lost much of its prestige; and its decorative features were for a time principally associated with the fêtes inaugurated by the Republic, and presented in the classic costume, which the severity of the new régime adopted as a reaction, or as a protest against the frivolities and furbelows of the obliterated monarchy. The Festival of the Supreme Being, decreed by the National Convention, designed by David and conducted by Robespierre, was perhaps the most impressive spectacle of the close of the 18th century.

The 19th century saw spectacle devoted almost exclusively to theatrical entertainment. In London, melodrama, both of the romantic and domestic description, claimed its illustrative aid. At Drury Lane Theatre (which, with Covent Garden, the Adelphi and Astley's, was first illuminated by gas in 1817–18) the *Cataract of the Ganges*, with its cascade of real water and its prancing steeds, made a great sensation in 1823, and the same stage in 1842, under Macready's management, displayed the "moving wave" effect in the Sicilian views, painted by William Clarkson Stanfield for *Acis and Galatea*. The Lyceum Theatre from 1847 to 1855 introduced a long series of elegant extravaganzas from the pen of J. R. Planché, elaborately illustrated by the scenery of William Beverly. The *Golden Branch*, the *King of the Peacocks* and the *Island of Jewels* (Christmas 1849) were the most remarkable of these productions, and were noteworthy as originating the fantastic fairy pictures that became known as "transformation scenes," and were copied and popularized in all directions. Beverly's skilful brush was at a later date employed at Drury Lane to enhance the attractions of a succession of spectacular versions of Sir Walter Scott's novels, *Amy Robsart* (1870), *Rob Roy* (with a beautiful panorama of the Trossachs scenery), *Rebecca*, *England in the Days of Charles II.*, and others. Later still, under the régime of Sir Augustus Harris and his successors, spectacle at Drury Lane assumed even more costly proportions, and modern melodramas, representing well-known localities with extraordinary fidelity and all kinds of disasters from earthquakes to avalanches, have been alternated with sumptuously mounted pantomimes (so-called), in which the nominal fairy-tales were almost smothered by the paraphernalia of scenery and costume. It is remarkable that, for a "run" of ten weeks only, such a sum as £16,000 each can have been profitably expended on more than one of these productions.

London playgoers will recall the processional glories of *A Dream of Fair Women*, designed by Alfred Thompson; *The Land of Fairy Tales*, by Percy Anderson; and *The Silver Wedding* (Puss in Boots), *The Paradise of the Birds* (Babes in the Wood), and *The Gods and Goddesses of Olympus* (Jack and the Beanstalk), for which Mr Wilhelm was responsible. *The Armada*, a historical drama (1888), also deserves to be remembered for the completeness and excellence of its spectacular features. In addition to the names of Clarkson Stanfield and Beverly, already cited as masters of scenic art, it must not be forgotten that the skill of David Roberts was also devoted to the embellishment of the stage; and the names of Grieve, the Telbins (father and son), Hawes Craven, and J. Harker have in successive years carried on the best traditions of the art. Alfred Thompson was one of the first to revise the conventionalities of fanciful stage costume, and to impart a French lightness of touch and delicacy of colour. A ballet, *Yolande*, which he dressed for the Alhambra in the 'sixties, was the first Japanese spectacle to grace the English stage; and he was also mainly responsible for the attractions of *Babil and Bijou*, which cost upwards of £11,000 at Covent Garden Theatre in 1872, and was at the time considered to have surpassed all former spectacular accomplishments. It achieved, however, merely a *succès d'estime*, and has bequeathed to a later generation only the recollections of its "Spring" choir of boys, and of the brilliant danseuse, Henriette d'Or, who revived memories of the great days of the ballet, when Taglioni, Cerito, Elssler, Duvernay and other "Déesses de la Danse," appeared under Lumley's management at the old Her Majesty's Theatre in the Haymarket. Since the memorable tenancy of Sadler's Wells Theatre by Phelps (1844–62), Shakespeare and spectacle have been honourably associated. Charles Kean's revivals at the Princess's Theatre (1850–59) deservedly attracted considerable attention for the splendour and accuracy of their archaeology. Byron's *Sardanapalus* was also a triumph for the same management in 1853; and the same theatre three

[1] The Savoy Theatre, London, was first entirely lighted by electricity in 1882. The various methods of lighting used have been an important item in the production of striking effects. The old system of a row of "foot-lights," with their unpleasant upward shadow, is now almost obsolete. Dip candles were used till 1720, when moulded candles were introduced into French theatres. The next improvement was the lamp of M. Argand, with its circular wick. In 1822 gas was first used in a Parisian theatre, next came the oxyhydrogen lime-light, used for special effects, and then electric lighting.

The old way of producing lightning was to blow lycopodium or powdered resin with bellows through a flame, and this is still used in realistic effects of conflagrations. More effective lightning is now made by flashing the electric light behind a scene painted with clouds, in which a zigzag aperture has been cut out and filled with a transparent substance. Thunder is made by shaking large sheets of iron. Wind is imitated by a machine with a cogged cylinder, which revolves against coarse cloth tightly stretched. The sound of rain is produced by shaking parched peas in a metal cylinder.

decades later witnessed the production (December 1883) by Wilson Barrett of *Claudian*, a romantic poetic drama of classic days, mounted so exquisitely as to gain Ruskin's enthusiastic praise. But undoubtedly the earliest noteworthy alliance of spectacle with Shakespeare was made by Sir Henry Irving at the Lyceum. The art of Royal Academicians was happily enlisted to add lustre and distinction to his productions. *Ravenswood* and the sumptuously presented *Henry VIII.* (1892) owed much to the co-operation of Mr Seymour Lucas. Sir Lawrence Alma-Tadema supervised *Cymbeline* and *Coriolanus* (1901), whilst Sir Edward Burne-Jones inspired the decoration of *King Arthur* (1895). In Tennyson's *Cup* (produced in January 1881) and in the beautiful revival of *Romeo and Juliet* it was felt that perfection of stage illusion could scarcely go farther, but the next production, *Much Ado about Nothing*, with its superb church scene by Telbin, was admittedly Irving's crowning success, alike from the artistic, the dramatic, the spectacular and the financial standpoints. Great praise was equally won by the version of *Faust*, which was frankly spectacular, and by the more recent *Robespierre* by Sardou. Shakespeare and the poetic drama were also finely illustrated by Mr Beerbohm Tree, who secured Sir Lawrence Alma-Tadema's interest for *Hypatia* at the Haymarket, and *Julius Caesar* at the new His Majesty's; whilst for his later productions, *King John*, *A Midsummer Night's Dream*, *Herod* (by Stephen Phillips), *Twelfth Night* (1901), and such later plays as his revival of *Antony and Cleopatra* (1907), he was assisted by the designs of Percy Anderson, an artist who made his mark in the costumes for a series of the operas at the Savoy Theatre, notably the 15th-century dresses for the *Beauty Stone*.

Spectacular features of exceptional refinement distinguished the pantomime of *Cinderella*, presented by Mr Oscar Barrett at the Lyceum Theatre in Christmas 1893, and designed by Mr Wilhelm. This production also enjoyed a prosperous season in New York. The system of international exchange seems to hold good in stage spectacle as in other cases, and in return for English successes that have been welcomed in America, Augustin Daly's Shakespearean productions were greatly admired in London. Other entertainments of a more absolutely spectacular order found acceptance in London. In connexion with Barnum and Bailey's Hippodrome, Imré Kiralfy's show, *Nero*, constituted a "mammoth combination," and attracted crowds to "Olympia" in 1890. The success of this latter spectacle of colour and movement, which was also designed by Mr Wilhelm, induced Mr Kiralfy to produce a still more ambitious entertainment the following season, *Venice*, designed by the same artist. A spectacle on these lines may be regarded as the outcome of such ballets as have long been popular on the continent of Europe—especially in Italy, where grace of movement and spontaneity of gesture are natural to the people, and greatly facilitate such an enterprise as the famous *Excelsior* ballet of Manzotti, which lasted a whole evening, in several acts, and required the services of hundreds of figurantes. *Excelsior* was originally produced at La Scala, Milan, in January 1881, and was subsequently given with great success at the Eden Theatre, Paris, in 1883. The revived popularity of the modern ballet, as at the Empire Theatre, London, has also been associated with some memorable triumphs of spectacle with which the name of Mr Wilhelm was closely identified as designer. (C. Wi.)

Law Relating to Theatres.

It was not until comparatively late in Roman history that acting became a distinct calling. The troops of public actors (*ministeria publica*) were generally slaves, and their earnings enriched their masters more than themselves.

The regulation of the theatre by legislation (except as to structure) belongs chiefly to the time of the lower empire, in which it depended almost wholly upon constitutions of Theodosius and Valentinian, incorporated in the Theodosian Code (Tit. xv. 5, 6, 7), and a century later to a large extent adopted by Justinian. In the whole of this law there is an evident attempt at a compromise between the doctrines of Christianity and the old Roman love of public spectacles of all kinds. It deals less with theatrical representations proper than with gladiatorial contests and chariot races.[1] The Theodosian Code provided that the sacraments were not to be administered to actors save where death was imminent, and only on condition that the calling should be renounced in case of recovery. Daughters of actors were not to be forced to go on the stage, provided that they lived an honest life. An actress was to be allowed to quit the stage in order to become a nun. There were also numerous sumptuary regulations as to the dress of actors. None of the law which has been mentioned so far was adopted by Justinian, but what follows was incorporated in *Cod.* xi. 40 (*De Spectaculis et Scenicis*), which consists entirely of extracts from the Theodosian Code of a very miscellaneous nature. Provision was made for the exhibition of public games and theatrical spectacles by magistrates, practically confining them to exhibiting in their own cities. Statues of actors were not to be placed in the public streets, but only in the proscenium of a theatre. A governor of a province was entitled to take the money raised for public games for the purpose of repairing the city walls, provided that he gave security for afterwards celebrating the games as usual. Municipalities were encouraged to build theatres (*Dig.* 1, 10, 3). By *Novel* cxvii., it was ground for divorce if a wife went to the theatre without her husband's knowledge. In *Cod.* iii. 12, 11 (*De Feriis*) is a constitution of Leo and Anthemius forbidding dramatic representations on Sunday. The *Digest* (iii. 2) classed all who acted for hire (*omnes propter pecuniam in scenam prodeuntes*) as infamous persons, and as such debarred them from filling public offices. A mere contract to perform not fulfilled did not, however, carry infamy with it. By *Novel* li. actresses could retire from the stage without incurring a penalty even if they had given sureties or taken an oath. There was probably a censorship at certain periods,[2] as well as provisions for safety of the building and the audience (Tacitus, *Ann.*, iv. 63; Leonine Constitutions, cxiii.). The seats were allocated by the state, and the care of the building committed to certain magistrates (*Novel* cxlix. 2).

England.—In England, as in other countries of western Europe, theatrical legislation was of comparatively recent introduction. Such legislation was unnecessary as long as the theatre was under the control of the Church and actors under its protection, the Church having turned to its own uses what it was powerless to prevent. The earliest regulations were therefore, as might be expected, made by the Church rather than by the state. The ecclesiastical ordinances were directed chiefly against the desecration of churches, though they sometimes extended to forbidding attendance of the faithful as spectators at plays even of a harmless kind.[3] Sacraments and Christian burial were denied by the canon law to actors, whose gains, said St Thomas, were acquired *ex turpi causa*,[4] and who, if they exceeded what was proper, might be in mortal sin. It was a doubtful point as to whether spectators might not be in similar case. The same law forbade plays to be acted by the clergy, even under the plea of custom, as in Christmas week, and followed the code of Justinian in enjoining the clergy not to consort with actors or be present at plays (see *Decretals*, iii. 1, 12 and 15, *De Vitæ et Honestate Clericorum*). As late as 1603, canon lxxxviii. of the canons of the Church of England enacted that churchwardens were not to suffer plays in churches, chapels or churchyards. The latest occurrence of such a play seems to have been at Oxford in 1592.

The Reformation marks the period of transition from the ecclesiastical to the non-ecclesiastical authority over the drama. Precautions began to be taken by the crown and the legislature against the acting of unauthorized plays, by unauthorized persons, and in unauthorized places, and the acting of plays objectionable to the government on political or other grounds. The protection of the Church being withdrawn, persons not enrolled in a fixed company or in possession of a licence from the crown or justices were liable to severe penalties as vagrants. The history of the legislation on this subject is very curious. An act of the year 1572 enacted that "all fencers, bearwards, common players of interludes, and minstrels (not belonging to any baron of this realm, or to any other honourable person of greater degree)," wandering abroad without the licence of two justices at the least, were subject "to be grievously whipped and burned through the gristle of the right ear with a hot iron of the compass of an inch about." This statute was superseded by 39 Eliz. c. 4, under which the punishment of the strolling player is less severe, and there is no mention of justices. The jurisdiction of justices over the theatre disappears from legislation

[1] The word *ludi* seems sometimes to include, sometimes to exclude, dramatic performances. Its meaning in a particular instance depends on the context.

[2] If one may judge from Horace's line (*Sat.*, i. 10, 38): *Quae neque in aede sonent certantia judice Tarpa.*

[3] A large number of such ordinances will be found cited in Prynne, *Histriomastix;* Bossuet, *Maximes et réflexions sur la comédie;* Mariana, *De Spectaculis.* They followed the almost unanimous condemnation by the Christian fathers. See, for example, Chrysostom, *Contra Ludos et Theatra;* Tertullian, *De Spectaculis;* Augustine, *De Civ. Dei*, i. 31, *Confessions*, iii. 2; Dill, *Roman Society*, pp. 47, 117.

[4] For this reason it appears to have been the custom in France for actors to be married under the name of musicians. See *Hist. parlémentaire de la Révolution française*, vi. 381. The difficulties attending the funeral of Molière are well known.

from that time until 1788. In 39 Eliz. c. 4 there is a remarkable exception in favour of persons licensed by Dutton of Dutton in Cheshire, in accordance with his claim to liberty and jurisdiction in Cheshire and Chester, established in favour of his ancestor by proceedings in *quo warranto* in 1499.[1] The stricter wording of this act as to the licence seems to show that the licence had been abused, perhaps that in some cases privileges had been assumed without authority. In 14 Eliz. c. 5 the privileges of a player attached by service of a noble or licence from justices, in the later act only by service of a noble, and this was to be attested under his hand and arms. The spirit of the acts of Elizabeth frequently appears in later legislation, and the unauthorized player was a vagabond as late as the Vagrancy Act of 1744, which was law till 1824. He is not named in the Vagrancy Act of 1824. The Theatre Act of 1737 narrowed the definition of a player of interludes, for the purposes of punishment as a vagabond, to mean a person acting interludes,[2] &c., in a place where he had no legal settlement.

Before the Restoration there were privileged places as well as privileged persons, *e.g.* the court, the universities, and the inns of court. With the Restoration privilege became practically confined to the theatres in the possession of those companies (or their representatives) established by the letters patent of Charles II. in 1662. In spite of the patents other and unprivileged theatres gradually arose.[3] In 1735 Sir John Barnard introduced a bill "to restrain the number of playhouses for playing of interludes, and for the better regulation of common players." On Walpole's wishing to add a clause giving parliamentary sanction to the jurisdiction of the lord chamberlain, the mover withdrew the bill. In 1737 Walpole introduced a bill of his own for the same purpose, there being then six theatres in London. The immediate cause of the bill is said to have been the production of a political extravaganza of Fielding's, *The Golden Rump*. The bill passed, and the act of 10 Geo. II. c. 28 regulated the theatre for more than a century. Its effect was to make it impossible to establish any theatre except in the city of Westminster and in places where the king should in person reside, and during such residence only. The act did not confine the prerogative within the city of Westminster, but as a matter of policy it was not exercised in favour of the non-privileged theatres, except those where the "legitimate drama" was not performed. The legitimate drama was thus confined to Covent Garden, Drury Lane and the Haymarket from 1737 to 1843. In the provinces patent theatres were established at Bath by 8 Geo. III. c. 10, at Liverpool by 11 Geo. III. c. 16, and at Bristol by 18 Geo. III. c. 8, the act of 1737 being in each case repealed *pro tanto*. The acting of plays at the universities was forbidden by 10 Geo. II. c. 19. It is not a little remarkable that the universities, once possessing unusual dramatic privileges, should not only have lost those privileges, but have in addition become subject to special disabilities. The restrictions upon the drama were found very inconvenient in the large towns, especially in those which did not possess patent theatres. In one direction the difficulty was met by the lord chamberlain granting annual licences for performances of operas, pantomimes and other spectacles not regarded as legitimate drama. In another direction relief was given by the act of 1788 (28 Geo. III. c. 30), under which licences for occasional performances might be granted in general or quarter sessions for a period of not more than sixty days. The rights of patent theatres were preserved by the prohibition to grant such a licence to any theatre within eight miles of a patent theatre. During this period (1737–1843) there were several decisions of the courts which confirmed the operation of the act of 1737 as creating a monopoly. The exclusive rights of the patent theatres were also recognized in the Disorderly Houses Act, 1751, and in private acts dealing with Covent Garden and Drury Lane, and regulating the rights of parties, the application of charitable funds, &c. (see 16 Geo. III. cc. 13, 31; 50 Geo. III. c. ccxiv.; 52 Geo. III. c. xix.; 1 Geo. IV. c. lx.). The results of theatrical monopoly were beneficial neither to the public nor to the monopolists themselves. In 1832 a select committee of the House of Commons recommended the legal recognition of "stage-right" and the abolition of theatrical monopoly. The recommendations of the report as to stage-right were carried out immediately by Bulwer Lytton's Act, 3 & 4 Will. IV. c. 15 (see COPYRIGHT). But it was not till eleven years later that the Theatres Act, 1843, was passed, a previous bill on the same lines having been rejected by the House of Lords. The act of 1843 inaugurated a more liberal policy, and there is now complete "free trade" in theatres, subject to the conditions imposed by the act. The growth of theatres since that time has been enormous. Nor does the extension seem to have been attended with the social dangers anticipated by some of the witnesses before the committee of 1832.

The suppression of objectionable plays was the ground of many early statutes and proclamations. While the religious drama was dying out, the theatre was used as a vehicle for enforcing religious and political views not always as orthodox as those of a miracle play. Thus the act of 34 & 35 Hen. VIII. c. 1 made it criminal to play in an interlude contrary to the orthodox faith declared, or to be declared, by that monarch. Profanity in theatres seems to have been a crying evil of the time. Stephen Gosson attacked it as early as 1579 in his *School of Abuse*. The first business of the government of Edward VI. was to pass an act reciting that the most holy and blessed sacrament was named in plays by such vile and unseemly words as Christian ears did abhor to hear rehearsed, and inflicting fine and imprisonment upon any person advisedly contemning, despising or reviling the said most blessed sacrament (1 Edw. VI. c. 1). A proclamation of the same king in 1549 forbade the acting of interludes in English on account of their dealing with sacred subjects. In 1556 the council called attention to certain lewd persons in the livery of Sir F. Leke representing plays and interludes reflecting upon the queen and her consort and the formalities of the mass. The same queen forbade the recurrence of such a representation as the mask given by Sir Thomas Pope in honour of the Princess Elizabeth at Hatfield, for she "misliked these follies." By the Act of Uniformity, 1 Eliz. c. 2, it was made an offence punishable by a fine of a hundred marks to speak anything in the derogation, depraving or despising of the Book of Common Prayer in any interludes or plays. In 1605 "An Act to restrain the Abuses of Players" made it an offence punishable by a fine of £10 to jestingly or profanely speak or use certain sacred names in any stage play, interlude, show, may-game or pageant (3 Jac. I. c. 21). In consequence of the appearance of players in the characters of the king of Spain and Gondomar, an ordinance of James I. forbade the representation on the stage of any living Christian king. The first act of the reign of Charles I. forbade acting on Sunday. Puritan opposition to the theatre culminated in the ordinance of 1648, making it a crime even to be present as a spectator at a play.[4] After the Restoration there are few royal proclamations or ordinances, the necessary jurisdiction being exercised almost entirely by parliament and the lord chamberlain. Among the few post-Restoration royal proclamations is that of the 25th of February 1664–65, restraining any but the company of the Duke of York's theatre from entering at the attiring house of the theatre, and that of the 27th of February 1698–99 against immorality in plays.

Preventive censorship of the drama by an officer of state dates from the reign of Elizabeth. The master of the revels (see REVELS) appears to have been the dramatic censor from 1545 to

[1] The "advowry," as it was called, over the Cheshire minstrels lasted until 1756, when the latest minstrel court was held at Chester.

[2] Interludes were acted in the open air at Berriew in Montgomeryshire as lately as 1819, when the players were indicted before the Great Sessions of Wales. They had been prohibited in the Declaration of Sports (1633) and in the Propositions of Uxbridge (1644).

[3] See W. Nicholson, *The Struggle for a free Stage in London* (1907).

[4] For the anti-theatrical Puritan literature see Courthope, *History of English Poetry*, ii. 381.

1624, when he was superseded by his official superior, the lord chamberlain.[1] In some cases the supervision was put into commission. Thus with Tilney, the master of the revels in 1581, were associated by order of the privy council a divine and a statesman. In other cases it was delegated, as to Daniel the poet by warrant in 1603. The proposal to give statutory authority to the jurisdiction of the lord chamberlain led, as has been already stated, to the withdrawal of Sir John Barnard's bill in 1735, and to considerable debate before the bill of 1737 became law. Lord Chesterfield's objection to the bill in the House of Lords was not unreasonable. "If the players," said he, "are to be punished, let it be by the laws of their country, and not by the will of an irresponsible despot." A stage play must now be duly licensed before performance. § 12 of the act of 1843 prescribes that a copy of every new play and of every addition to an old play, and of every new prologue or epilogue or addition thereto (such copy to be signed by the master or manager), shall be sent to the lord chamberlain, and, if the lord chamberlain does not forbid it within seven days, it may be represented. § 13 empowers the lord chamberlain to fix a scale of fees for examination; the fee is now two guineas for a play of three or more acts, one guinea for a play of less than three acts. All plays represented previously to the act are held to be licensed. A play once licensed is licensed once for all unless the licence be revoked under § 14. The examination is the duty of a special officer of the lord chamberlain's department, the examiner of stage plays. In spite of occasional lapses of judgment, a belief in the wisdom generally shown in the exercise of the censorship has been confirmed by the report of the select committee of the House of Commons in 1866, and also by the report of the joint committee of both Houses in 1909. The censorship has been consistently supported in recent years by theatrical managers, but violently opposed by an advanced section of dramatic authors. There have been instances, no doubt, where perhaps both the lord chamberlain and his subordinate officer, the examiner of stage plays, have been somewhat nice in their objections. Thus, during the illness of George III., *King Lear* was inhibited. George Colman, when examiner, showed an extraordinary antipathy to such words as "heaven" or "angel." The lord chamberlain's powers are still occasionally exerted against scriptural dramas, less frequently for political reasons. Later instances are Oscar Wilde's *Salomé* (1892), *Joseph of Canaan* (1896), Maeterlinck's *Monna Vanna* (1902), Housman's *Bethlehem* (1902), Gilbert and Sullivan's *Mikado* (temporarily in 1907), and a play by Laurence Housman dealing with George IV. (1910). Before 1866 the lord chamberlain appears to have taken into consideration the wants of the neighbourhood before granting a licence, but since that year such a course has been abandoned. The joint committee in 1909 recommended that it should be optional for an author to submit a play for licence, and legal to perform an unlicensed play whether submitted or not, the risk of police intervention being taken. They also recommended that the reasons for which a licence should be refused should be: indecency, offensive personalities, the representation in an invidious manner of a living person or a person recently dead, violation of the sentiments of religious reverence, the presence of anything likely to conduce to crime or vice, or to cause a breach with a friendly power, or a breach of the peace.

A theatre may be defined with sufficient accuracy for the present purpose as a building in which a stage play is performed for hire. It will be seen from the following sketch of the law that there are a considerable number of different persons, corporate and unincorporate, with jurisdiction over theatres. A consolidation of the law and the placing of jurisdiction in the hands of a central authority for the United Kingdom would probably be convenient. The committee of 1866 recommended the transfer to the lord chamberlain of the regulation of all places of amusement, and an appeal from him to the home secretary in certain cases, as also the extension of his authority to preventive censorship in all public entertainments; but no legislation resulted. The committee of 1909 recommended the abolition of any distinction between theatres and music-halls. Several bills for the amendment of the law have been introduced, but without success in the face of more burning political questions.[2]

Building.—A theatre (at any rate to make it such a building as can be licensed) must be a permanent building, not a mere tent or booth, unless when licensed by justices at a lawful fair by § 23 of the act of 1843. It must, if in the metropolis, conform to the regulations as to structure contained in the Metropolis Management Act 1878, and the Local Government Act 1888. These acts make a certificate of structural fitness from the county council necessary as a condition precedent for licence in the case of all theatres of a superficial area of not less than 500 sq. ft. licensed after the passing of the act, give power to the council in certain cases to call upon proprietors of existing theatres to remedy structural defects, and enable it to make regulations for protection from fire. The existing regulations were issued on the 30th of July 1901 and 25th of March 1902. As to theatres in provincial towns, the Towns Improvement Act 1847, and the Public Health Act 1875, confer certain limited powers over the building on municipal corporations and urban sanitary authorities. In many towns, however, the structural qualifications of buildings used as theatres depend upon local acts and the by-laws made under the powers of such acts.

Performance.—To constitute a building where a performance takes place a theatre, the performance must be (*a*) of a stage-play, and (*b*) for hire. (*a*) By § 23 of the act of 1843 the word "stage-play" includes tragedy, comedy, farce, opera, burletta, interlude, melodrama, pantomime or other entertainment of the stage, or any part thereof. The two tests of a stage-play appear to be the excitement of emotion and the representation of action. The question whether a performance is a stage-play or not seems to be one of degree, and one rather of fact than of law. A *ballet d'action* would usually be a stage-play, but it would be otherwise with a *ballet divertissement*. § 14 empowers the lord chamberlain to forbid the acting of any stage-play in Great Britain whenever he may be of opinion that it is fitting for the preservation of good manners, decorum, or the public peace to do so. § 15 imposes a penalty of £50 on any one acting or presenting a play or part of a play after such inhibition, and avoids the licence of the theatre where it appears. Regulations of police respecting the performance are contained in 2 & 3 Vict. c. 47, and in many local acts. A performance may also be proceeded against as a nuisance at common law, if, for instance, it be *contra bonos mores* or draw together a great concourse of vehicles, or if so much noise be heard in the neighbourhood as to interfere with the ordinary occupations of life. Very curious instances of proceedings at common law are recorded. In Sir Anthony Ashley's case (2 Rolle's Rep. 109), 1615, players were indicted for riot and unlawful assembly. In 1700 the grand jury of Middlesex presented the two play-houses and also the bear-garden on Bankside (the "Paris garden" of *Henry VIII.* act v. sc. 3) as riotous and disorderly nuisances. Performances on Sunday, Good Friday, and Christmas day are illegal. Regulations as to the sale of intoxicating liquors during the performance are made by the licensing acts and other public general acts, as well as by local acts and rules made by county councils. It is frequently a condition of the licence granted to provincial theatres that no excisable liquors shall be sold or consumed on the premises. The excise duty where such liquors are sold varies according to the annual value of the theatre up to a maximum of £20. The Dangerous Performances Acts, 1879 and 1897, forbid under a penalty of £10 any public exhibition or performance whereby the life or limbs of a child under the age of sixteen if a boy, eighteen if a girl, shall be endangered. It also makes the employer of any such child indictable for assault where an accident causing actual bodily harm has happened to the child, and enables the court on conviction of the employer to order him to pay the child compensation not exceeding £20. The Prevention of Cruelty to Children Act 1904 forbids a child to appear in any public entertainment without a licence from a petty sessional court. (*b*) The performance must be for hire. § 16 of the act of 1843 makes a building one in which acting for hire takes place, not only where money is taken directly or indirectly, but also where the purchase of any article is a condition of admission, and where a play is performed in a place in which excisable liquor is sold. In the case of *Shelley* v. *Bethell*, 1883 (Law Reports, 12 Q.B.D. 11), it was held that the proprietor of a private theatre was liable to penalties under the act, though he lent the theatre gratuitously, because tickets of admission were sold in aid of a charity.

Licensing of Building.—By § 2 of the act of 1843 all theatres (other than patent theatres) must be licensed. By § 7 no licence

[1] It was probably through his influence that the expletives in Shakespeare were edited. The quarto of 1622 contains more than the folio of 1623.

[2] Dryden's words in the "Essay on Satire" (addressed to the earl of Dorset, lord chamberlain) still describe the duties of the office. "As lord chamberlain I know you are absolute by your office in all that belongs to the decency and good manners of the stage. You can banish from thence scurrility and profaneness, and restrain the licentious insolence of poets and their actors in all things that shock the public quiet or the reputation of private persons under the notion of humour."

is to be granted except to the actual and responsible manager, who is to be bound by himself and two sureties for due observance of rules and for securing payment of any penalties incurred. The metropolitan theatres other than the patent theatres (as far at least as they are included in the boroughs named in the act of 1843) are licensed by the lord chamberlain. By § 4 his fee on grant of a licence is not to exceed 10s. for each month for which the theatre is licensed. The lord chamberlain appears to have no power to make suitable rules for enforcing order and decency. He can, however, by § 8, suspend or revoke a licence or close a patent theatre where any riot or misbehaviour has taken place. He has issued a code of regulations.

Provincial theatres fall under three different licensing authorities. The lord chamberlain licenses theatres in Windsor and Brighton, and theatres situated in the places where the king occasionally resides, but only during the time of such occasional residence (§ 3). Theatres at Oxford and Cambridge, or within 14 m. thereof, are licensed by the justices having jurisdiction therein, but before any such licence can come into force the consent of the chancellor or vice-chancellor must be given. The rules made by the justices for the management of the theatre are subject to the approval of the chancellor or vice-chancellor, who may also impose such conditions upon the licence as he thinks fit. In case of any breach of the rules or conditions, he may annul the licence (§ 10). All other provincial theatres are licensed by the county councils or county borough councils[1] under s. 7 of the act of 1888, except in case of a special and temporary performance, where justices still grant the licence as they did in all cases before that act came into operation. The regulations of the London County Council are dated the 27th of July 1897. Penalties are imposed by the act for keeping or acting in an unlicensed theatre, and for producing or acting in an unlicensed play. A contract to perform in an unlicensed theatre is unenforceable.

Music Halls.—Music was at no time the object of restrictions as severe as those imposed upon the drama. The present English act governing music halls, the Disorderly Houses Act 1751, was passed probably in consequence of the publication in 1750 of Fielding's *Inquiry into the Causes of the late Increase of Robbers.* It is remarkable that two works of the same writer should from opposite causes have led to both theatre and music-hall legislation of lasting importance. The act was originally passed for a term of three years, but was made perpetual by 28 Geo. II. c. 19. It applies only to music halls within 20 m. of London and Westminster. Every such music hall must be licensed at the Michaelmas quarter sessions, the licence to be signified under the hands and seals of four or more justices. The licence may be granted for music or dancing or both. Public notice of the licence is to be given by affixing over the door the inscription "Licensed in pursuance of act of parliament for," with the addition of words showing the purpose. The penalty for keeping an unlicensed music hall is £100. This act is amended as to Middlesex by the Music and Dancing Licences (Middlesex) Act 1894, putting the licensing into the hands of the county council. Regulations were made by the council under this act on the 31st of July 1900 and the 27th of June 1901. Music halls beyond the radius of 20 m. from London and Westminster are mainly governed by the Public Health Act 1890, the licensing authority being the licensing justices. There is no censorship of music-hall performance, the only remedy for anything objectionable is for the licensing authority to withdraw the licence or refuse to renew it.

See generally W. N. M. Geary, *Law of Theatres and Music Halls* (1885); C. Hamlyn, *Manual of Theatrical Law* (1891); A. A. Strong, *Dramatic and Musical Law* (1898); J. B. Williamson, *Law of Licensing* (1902).

Scotland.—In Scotland the theatre has always exercised a smaller amount of influence than in England, and there has been little exclusively Scottish legislation on the subject. 1555, c. 40, discountenanced certain amusements of a semi-theatrical kind by enacting that no one was to be chosen Robert Hude (*sic*), Little John, abbot of unreason, or queen of May. A proclamation of James VI. in 1574, and 1579, c. 12, followed the lines of English legislation by making persons using unlawful plays, such as jugglery or fast and loose, punishable as vagabonds. In 1574 the General Assembly claimed to license plays, and forbade representations on Sunday. As in England, the licensing power seems then to have passed from the church to the crown, for in 1599 James VI. licensed a theatre at Edinburgh. 1672, c. 21, exempted comedians while upon the stage from the sumptuary provisions of the act respecting apparel. The chamberlain of Scotland, while such an office existed, appears to have exercised a certain police jurisdiction over theatres. The Theatres Act 1843 extends to Scotland, as did also the previous act of 1737, and further provisions are made by the Burgh Police Act 1892.

Ireland.—Theatrical legislation, as far as it went, was based upon English models. Thus ridicule of the liturgy was forbidden by 2 Eliz. c. 2 (Ir.); common players of interludes and wandering minstrels were deemed vagabonds, 10 & 11 Car. I. c. 4 (Ir.). In 1786 an act was passed to enable the crown to grant letters patent for one or more theatres in Dublin city and county, 26 Geo. III. c. 57 (Ir.). The preamble alleges that the establishing of a well-regulated theatre at the seat of government will be productive of public advantage and tend to improve the morals of the people. Exceptions from the restrictions of the act were made in favour of entertainments for the benefit of the Dublin lying-in hospital and exhibitions of horsemanship or puppet-shows. The existing theatre and music-hall acts do not apply to Ireland, except the Public Health Act 1890, s. 51.

British Colonies.—There is a large amount of legislation. An example is the Victoria Act, No 1430 (1897), giving the chief secretary power to cancel or suspend the licence of any theatre if used on Sunday without special permit.

United States.—Public entertainments, dramatic or other, are usually under the control of the municipal authorities, and there is no act of Congress on the subject, except one of 1898 imposing a temporary war tax on the theatres. In most states there is state legislation, requiring places of public entertainment to be licensed by the proper authority. In many states it is a condition of the licence that intoxicating liquors shall not be sold in such places. Other conditions, more or less usual, are that there shall be no Sunday or dangerous performances, that acrobats shall be properly protected, and that female waiters shall not be employed. Structural qualifications are in some cases made necessary. Thus in 1885 the New York legislature passed an act containing many minute provisions for ensuring the safety of theatres against fire. A characteristic piece of legislation is the New York Act of 1873, c. 186, enacting that no citizen is to be excluded from a theatre by reason of race, colour or previous condition of servitude. This act of course merely carries out the important principle affirmed in art. xiv. of the amendments to the constitution of the United States. There are two curious and conflicting decisions of other states on the matter. Missouri held that a manager could discriminate against a person of colour, Michigan that he could not (see Green's *Digest*, vol. i. 642).

Continental Europe.—The principal points in which the continental theatre differs from the English are that Sunday is the most important day, and that the theatre is often owned or subsidized by the state or a municipality. In France there has been much legislation since the days of the Revolution, the principal law being one of 1864. A feature is the tax known as *le droit des pauvres*, which has been the subject of much discussion. The *censure préalable* was abolished in 1906. The object is attained by police penalties. Most of the authorities will be found in Dalloz, Supplement, vol. xvii., and, for the older law, Lacan, *La Législation et la jurisprudence des théâtres* (1853), and Maugras, *Les Comédiens hors de la loi* (1887), may be consulted. Italy has produced at least two modern works on the subject, Rivalta, *Storia e Sistema del Diritto dei Teatri* (1886), and Tabanelli, *Codice del Teatro* (1901). What strikes one is how little special legislation there is on the subject. The penal code meets most cases. Spain retained the *autos sacramentales* much longer than other countries retained the religious drama. Legislation begins very early. The *Siete Partidas* enacts that the clergy are not to take part as actors or spectators in scurrilous plays (*juegos por escarnio*). Cervantes in the first part of *Don Quixote* makes the canon of Toledo regret that the government had not appointed a censor to prevent the acting of plays not only injurious to morals but also offending against the classical rules of the drama. There is a considerable amount of law in the Ottoman empire; details will be found in G. Young, *Corps de droit ottoman*, vol. ii. 320 (1904). (J. W.)

THEBES (Θῆβαι), the Greek name of the ancient capital of Upper Egypt, presumably an Egyptian name (*e.g.* Zēmi, seen in -σημις, -τημις) assimilated to that of the Greek city. It occurs in Homer (*Il.* ix. 381–4) where it has the epithet ἑκατόμπυλος, "hundred-gated," probably derived in the first place from the gateways of its endless temples, though perhaps misunderstood as if it referred to a city with a hundred gates in the circuit of its walls. Thebes was never a walled city in this sense, though its vast temple enclosures in different quarters would form as many fortresses in case of siege or tumult. Its Egyptian name was Wesi (or Wis?), later Ne, "the city" (sometimes Ne-Amun, hence No-Amon in Nahum iii. 8), and different quarters were known by special names. In non-literary Greek Thebes was regularly called Diospolis the Great. Ammon, Amen-Rē, or Amenrasonther ("Ammon-Rē king of the gods") was its deity, with his consort Mut and their child Khons. Mont also was a local deity and Hathor presided over the western cliffs of Thebes. In very ancient times the city lay on the east bank, the necropolis on the west. As it grew, however, although the necropolis was still confined to the west bank, a vast city of temples, priests and necropolis people, to which

[1] The councils may delegate their authority to justices, a district council, or a committee of their own body, such as the Theatre and Music Hall Committee of the London County Council.

were added royal palaces and their accompaniments, covered the western shore as far back as the desert hills. The chief nucleus of the ancient Wēsi was a town about the temple of Karnak: it probably reaches back to the prehistoric period. At Drah abu'l nagga, opposite to it, are tombs of its princes under the VIth Dynasty. The temple of Karnak is no doubt of immemorial antiquity. Perhaps no sculpture earlier than the XIIth Dynasty has survived there, but Senwosri I. dedicated statues to his predecessors of the Vth Dynasty who had probably showed their devotion to Ammon in a substantial manner, and Cheops of the IVth Dynasty is named in it. After the end of the Old Kingdom Thebes grew from an obscure provincial town to be the seat of a strong line of princes who contended for supremacy with Heracleopolis and eventually triumphed in the XIth Dynasty of Manetho. The most important monument of the Middle Kingdom now extant at Thebes is the funerary temple of Menthotp III. of this dynasty, which has been revealed by the excavations of the Egypt Exploration Fund at Deir el Bahri (see ARCHITECTURE, section *Egyptian*, fig. 4): and the period is well represented by an abundance of statues of the XIIth and XIIIth dynasties from the temple of Karnak. The name Amenemhe, so common in the XIIth Dynasty, shows the importance of the Theban god at this time. It was not, however, till the XVIIIth Dynasty, the beginning of the New Empire, that the whole site began to be occupied by monuments which have survived to the present day. The early rulers of this dynasty down to Tethmosis III. developed Karnak, and on the west bank built the great funerary temple of Deir el Bahri and smaller temples as far south as Medinet Habu, and began the long series of royal tombs in the famous Valley of the Tombs of the Kings far back in the desert behind Deir el Bahri. Amenophis III. continuing, transformed western Thebes monumentally: built three great temples in addition, that of Mont on the north of Karnak, the temple of Mut on the south and the temple of Ammon at Luxor, and connected the last two with the state temple of Karnak by avenues of sphinxes. On the west bank of the huge colossi of Memnon marked the entrance of his funerary temple, a magnificent building which was afterwards destroyed, and the great lake of Birket Habu was dug and embanked in front of his brick palace at the extreme south. The chief energies of this king in fact were expended on developing the south extremity of Thebes on both banks. The city and its monuments now covered an area about three miles square. After this Thebes experienced a serious set-back with the heresy of Akhenaton, the son of Amenophis III. He moved his capital northward to Akhetaton (El Amarna) and strove to suppress the worship of Ammon, doing infinite damage to the monuments of Thebes by defacing his name and figure. After about twenty years, however, the reaction came, Thebes was again the capital, and a little later under Seti (Sethos) I. and Rameses II. of the XXth Dynasty it was raised to greater architectural magnificence than ever. These two kings built the great columnar hall of Karnak, added a large court with pylons to Luxor, and on the west bank built the funerary temple of Seti at Kurna, and the Ramesseum with its gigantic colossus, besides other edifices of which only traces remain. Under the XVIIIth and XIXth Dynasties Thebes was at the height of its greatness. Conquering Pharaohs brought home trains of prisoners and spoil, embassies came thither of strange people in every variety of costume and of every hue of skin, from Ethiopia, Puoni (Punt), Mesopotamia, Asia Minor, Libya, and the islands of the Mediterranean, bringing precious stones, rare animals, beautiful slaves, costly garments and vessels of gold and silver, while the ground shook with the movement of colossal architraves, statues and obelisks. The tombs of the XVIIIth Dynasty on the west bank and the sculptures in the temples reflect the brilliancy of these days, but even the reign of Rameses II. marks the beginning of the decline of Thebes. The enormous constructive energy of the proud Pharaoh, instead of being concentrated on the capital, was expended with almost equal lavishness on other parts of the country. In every city he left his mark. A great temple at Tanis boasted a larger colossus than existed in Thebes: Heliopolis and Memphis must have been lavishly adorned, and the temples of Abu Simbel (*q.v.*) alone would have been sufficient to satisfy the ambition of many of the great Pharaohs. After Rameses II. the efforts of all his successors combined could add little to the wonders of Thebes. The temple and tower of Rameses III. (XXth Dynasty) at Medinet Habu, his tomb in the Biban el Moluk, the temple of Khons (Rameses III. and later) and the court of Sheshonk I. (XXIInd Dynasty) at Karnak are the only great achievements.

For the rest there are the tombs of many kings in the Biban el Moluk and a good deal of comparatively petty construction and tinkering, with the help of stone robbed from older structures. Earlier and greater kings had remorselessly destroyed buildings which interfered with their own plans. The "Memnon" temple of Amenophis III. had already gone, sacrificed perhaps to Akhenaton's god. Rameses II. had plundered his predecessors' monuments for materials. Hitherto Thebes had been glorified by the process, but henceforth it was rather to perish. The tide of prosperity was flowing northward and such monumental energy as remained was expended more widely. For several centuries after the fall of the New Empire Thebes was but one of several alternating or contemporaneous capitals. Memphis, Tanis, Bubastis, Sais, Heracleopolis had at one time or another at least equal claims. The Ethiopian conquerors of Egypt made Thebes their Egyptian capital, but in 668 Assur-bani-pal sacked the city. Psammetichus did not neglect it, and during the XXVIth Dynasty Petemenopi, a wealthy priest and official, excavated for himself the greatest private tomb that ever was made. Probably every king that included Thebes in his realm, except the Assyrians and the Persians, left his memorial there in chapels erected or sculptures added. Of the Persians, however, not even Darius is traceable at Thebes; on the other hand, there is no support for the tradition that Cambyses destroyed its monuments. Ptolemy I. gave a new capital to the upper country in the Greek foundation of Ptolemais, and thus struck a fresh blow at the prosperity of Thebes. For a short period in the reign of Epiphanes, when Upper Egypt was in rebellion against the Ptolemaic rule, Thebes was the capital of independent native dynasts. In a later rebellion, Thebes was captured after a three years' siege and severely punished by Lathyrus (Ptolemy X., Soter II.). In the reign of Augustus, having joined in the insurrection against the tax-gatherers, it was destroyed by Cornelius Gallus and became a collection of villages. Though its vast buildings have since served as quarries for mill-stones and for the lime-burner, Thebes still offers the greatest assemblage of monumental ruins in the world.

We will now briefly enumerate the principal groups of monuments. On the east bank at Karnak stand the great state temple of Amen-Rē with its obelisks of Hatshepsut and Tethmosis I. and the vast columnar hall of Rameses II.; the temple of Mūt and the well-preserved temple of Khons; the temple of Luxor and avenues of rams and sphinxes connecting all these. These temples are described in the articles KARNAK, LUXOR and ARCHITECTURE: *Egyptian*. On the west bank, in front of the necropolis, on the edge of the desert or projecting into the cultivation, was a low row of temples: the northernmost, placed far in front of the others, is the well-preserved temple of Seti I. at Kurna; then follow the Ramesseum and Medinet Habu; and the foundations of many others can be traced. The temple of Amenophis III., to which the colossi of "Memnon" were attached, was again far forward of the line. The Ramesseum contains the remains of a stupendous seated colossus, in black granite, of its builder Rameses II., thrown on its face. When perfect it was probably 57 ft. high and weighed about 1000 tons, surpassing the "Memnon" statues of Amenophis III. in size and weight. The temple of Rameses III. at Medinet Habu, sculptured with very interesting scenes from his Syrian, Libyan and other wars and from religious festivals, is remarkable also for the unique entrance-tower which probably formed part of the royal palace. Northward and far back in the foot-hills is the Ptolemaic temple of Deir el Medina, and beyond under the cliffs of Deir el Bahri the terrace temple of Queen Hatshepsut, the walls of which are adorned with scenes from her expedition to Puoni (Somaliland) in search of incense trees, and many other subjects. The necropolis extends from Kurna in the north through Drah abu'l nagga, the Assasif, and Shekh abd el Kurna to Kurnet Murrai of Medinet Habu. The finest tombs are of the XVIIIth Dynasty. Far behind Medinet Habu are the Tombs of the Queens, where royal relatives of the XXth Dynasty are buried; and immediately behind the lofty cliffs of Deir el Bahri, but accessible only by a very circuitous route from Kurna, are the tombs of the kings (from Tethmosis I. onward to the end of the XXth Dynasty) in the Biban el Moluk and the Western Valley. They are decorated with religious scenes and texts, especially those which describe the passage of the sun through the underworld. Those of Seti I. and Rameses III. are the most remarkable. These royal sepulchres are long galleries excavated in the rock with chambers at intervals: in one of the innermost chambers was laid the body in its sarcophagus. In the XXIst Dynasty, when tomb robberies were rife and most of their valuables had been stolen, the royal mummies were removed from place to place and at last deposited for safety in the tomb of Amenophis II. and in the burial-place of the priest-kings at Deir el Bahri. The finding of the two *cachettes* nearly intact has been among the greatest marvels of archaeological discovery, and the systematic exploration of the Valley of the Tombs of the Kings by Theodore M. Davis has been annually rewarded with results of the highest interest.

See Baedeker's *Egypt;* E. Naville, (Temple of) *Deir el Bahari*, introduction and parts i.–v. (London, 1894–1906); W. M. F. Petrie, *Six Temples at Thebes* (ruined temples on west bank), (London, 1897); G. Daressy, *Notice explicative des ruines de Médinet Habu* (Cairo, 1897); G. Maspero, " Les Momies royales de Deir el Bahari " in *Mémoires de la mission archéologique française au Caire*, tome I.; and many other works. (F. Ll. G.)

THEBES (anciently Θῆβαι, *Thebae*, or in poetry sometimes Θήβα, in modern Greek *Phiva*, or, according to the corrected pronunciation, *Thivae*), an ancient Greek city in Boeotia, is situated on low hilly ground of gentle slope a little north of the range of Cithaeron, which divides Boeotia from Attica, and on the edge of the Boeotian plain, about 44 m. from Athens, whence it is reached by two carriage-roads and by railway since 1904. It has about 4800 inhabitants, and is the seat of a bishop. The present town occupies the site of the ancient citadel, the Cadmea; two fragments of ancient wall are visible on the north, and another, belonging either to the citadel or the outer wall, on the south. Two streams, rising a little south of the town, and separated by an average distance of about half a mile, flow on the two sides, and are lost in the plain. These are the ancient Ismenus on the east and Dirce (Δίρκη) on the west, which gave to the town its name διπόταμος. The Dirce, now Plakiótissa, has several springs. From the west side of the Cadmea another copious fountain (Paraporti) falls to the Dirce. In a suburb to the east is another (Fountain of St Theodore), and north-west are two more. The Cadmea itself is supplied with water brought from an unknown source to the south by works supposed of prehistoric antiquity. It now enters the town by an aqueduct of twenty arches of Frankish construction. The " waters " of Thebes are celebrated both by Pindar and by the Athenian poets, and the site is still, as described by Dicaearchus (3rd century B.C.), " all springs," κάθυδρος πᾶσα. One, from which a pasha of Negroponte (Euboea) is said to have supplied his table, is still called " the spring of the cadi." Some of the marble basins, seats, &c., remain, and, with the fragments of wall above mentioned, are the only relics of the classic time. The most curious of later buildings is the church of St Luke, south-east of the Cadmea, believed to contain the tomb of the evangelist. From the abundance of water the place is favourable to gardens, and the neighbouring plain is extremely fertile. But the population is scanty, and the town at present of no importance.

History.—The record of the earliest days of Thebes was preserved among the Greeks in an abundant mass of legends which rival the myths of Troy in their wide ramification and the influence which they exerted upon the literature of the classical age. Five main cycles of story may be distinguished: (1) the foundation of the citadel Cadmea by Cadmus, and the growth of the Sparti or " Sown Men " (probably an aetiological myth designed to explain the origin of the Theban nobility which bore that name in historical times); (2) the building of a " seven-gated " wall by Amphion, and the cognate stories of Zethus, Antiope and Dirce; (3) the tale of the " house of Laius, " culminating in the adventures of Oedipus and the wars of the " Seven " and the Epigoni; (4) the advent of Dionysus; and (5) the exploits of Heracles. It is difficult to extract any historical fact out of this maze of myths; the various groups cannot be fully co-ordinated, and a further perplexing feature is the neglect of Thebes in the Homeric poems. At most it seems safe to infer that it was one of the first Greek communities to be drawn together within a fortified city, that it owed its importance in prehistoric as in later days to its military strength, and that its original " Cadmean " population was distinct from other inhabitants of Boeotia such as the Minyae of Orchomenus.

In the period of great invasions from the north Thebes received settlers of that stock which in historical times was homogeneously spread over Boeotia. The central position and military security of the city naturally tended to raise it to a commanding position among the Boeotians, and from early days its inhabitants endeavoured to establish a complete supremacy over their kinsmen in the outlying towns. This centralizing policy is as much the cardinal fact of Theban history as the counteracting effort of the smaller towns to resist absorption forms the main chapter of the story of Boeotia. No details of the earlier history of Thebes have been preserved, except that it was governed by a land-holding aristocracy who safeguarded their integrity by rigid statutes about the ownership of property and its transmission. In the late 6th century the Thebans were brought for the first time into hostile contact with the Athenians, who helped the small fortress of Plataea to maintain its independence against them, and in 506 repelled an inroad into Attica. The aversion to Athens best serves to explain the unpatriotic attitude which Thebes displayed during the great Persian invasion. Though a contingent of 700 was sent to Thermopylae and remained there with Leonidas to the end, the governing aristocracy soon after joined the enemy with great readiness and fought zealously on his behalf at the battle of Plataea (479). The victorious Greeks subsequently punished Thebes by depriving it of the presidency of the Boeotian League, and an attempt by the Spartans to expel it from the Delphic amphictyony was only frustrated by the intercession of Athens. In 457 Sparta, needing a counterpoise against Athens in central Greece, reversed her policy and reinstated Thebes as the dominant power in Boeotia. The great fortress served this purpose well by holding out as a base of resistance when the Athenians overran and occupied the rest of the country (457–447). In the Peloponnesian War the Thebans, embittered by the support which Athens gave to the smaller Boeotian towns, and especially to Plataea, which they vainly attempted to reduce in 431, were firm allies of Sparta, which in turn helped them to besiege Plataea and allowed them to destroy the town after capture (427). In 424 at the head of the Boeotian levy they inflicted a severe defeat upon an invading force of Athenians at Delium, and for the first time displayed the effects of that firm military organization which eventually raised them to predominant power in Greece. After the downfall of Athens at the end of the Peloponnesian War the Thebans, finding that Sparta intended to protect the states which they desired to annex, broke off the alliance. In 404 they had urged the complete destruction of Athens, in 403 they secretly supported the restoration of its democracy in order to find in it a counterpoise against Sparta. A few years later, influenced perhaps in part by Persian gold, they forced on the so-called Corinthian War and formed the nucleus of the league against Sparta. At the battles of Haliartus (395) and Coroneia (394) they again proved their rising military capacity by standing their ground against the Spartans. The result of the war was especially disastrous to Thebes, as the general settlement of 387 stipulated the complete autonomy of all Greek towns and so withdrew the other Boeotians from its political control. Its power was further curtailed in 382, when a Spartan force occupied the citadel by a treacherous *coup-de-main*. Three years later the Spartan garrison was expelled, and a democratic constitution definitely set up in place of the traditional oligarchy. In the consequent wars with Sparta the Theban army, trained and led by Epaminondas and Pelopidas (*q.v.*), proved itself the best in Greece. Some years of desultory fighting, in which Thebes established its control over all Boeotia, culminated in 371 in a remarkable victory over the pick of the Spartans at Leuctra (*q.v.*). The winners were hailed throughout Greece as champions of the oppressed. They carried their arms into Peloponnesus and at the head of a large coalition permanently crippled the power of Sparta. Similar expeditions were sent to Thessaly and Macedonia to regulate the affairs of those countries. But the predominance of Thebes was short-lived. The states which she protected were indisposed to commit themselves permanently to her tutelage, and the renewed rivalry of Athens, which had been linked with Thebes since 395 in a common fear of Sparta, but since 371 had endeavoured to maintain the balance of power against her ally, prevented the formation of a Theban empire. With the death of Epaminondas in 362 the city sank again to the position of a secondary power. In a war with the neighbouring state of Phocis (356–346) it could not even maintain its predominance in central Greece, and by inviting Philip II. of Macedon to crush the Phocians it extended that monarch's power within dangerous proximity to its frontiers. A revulsion of feeling was completed in 338 by the orator Demosthenes, who persuaded Thebes to join Athens in a final attempt to bar Philip's advance upon Attica. The Theban contingent fought bravely on behalf of Grecian liberty in the decisive battle of Chaeroneia, and bore the brunt of the slaughter. Philip was content to deprive Thebes of her dominion over Boeotia; but an unsuccessful revolt in 335 against his son Alexander was punished by the complete destruction of the city, except, according to tradition, the house of the poet Pindar. Though restored in 315 by Cassander, Thebes never again played a prominent part in history. It suffered from the establishment of Chalcis as the chief fortress of central Greece, and was severely handled by the Roman conquerors Mummius and Sulla. Strabo describes it as a mere village, and in Pausanias's time (A.D. 170) its citadel alone was inhabited. During the Byzantine period it served as a place of refuge against foreign invaders, and from the 10th century became a centre of the new silk trade. Though severely plundered by the Normans in 1146 it recovered its prosperity and was selected by the Frankish dynasty de la Roche as its capital. In 1311 it was destroyed by the Catalans and passed out of history.

The most famous monument of ancient Thebes was the outer wall with its seven gates, which even as late as the 6th century B.C. was probably the largest of artificial Greek fortresses. The names of the gates vary, but four are constant—the Proetides, Electrae, Neistae or Neitae, and Homoloides; Pausanias gives the others as Ogygiae, Hypsistae, Crenaeae. There is evidence that the gate Electrae was on the south, and near it was the tomb of the Thebans who fell at the capture by Alexander. The gates shown to Pausanias as Neistae and Proetides led respectively north-west and north-east. Two of the springs have been identified with some probability—that of St Theodore with the Oedipodea, in which Oedipus is said to have purged himself from the pollution of homicide, and the Paraporti with the dragon-guarded fountain of Ares (see CADMUS). Dicaearchus, referring to the town of Cassander, gives two measurements for the circuit, equal to about 9 m. and 5½ m.; the smaller fairly corresponds to the 4½ m. over which the extant remains have been traced; it consisted of sun-dried brick on a stone foundation. Beyond this the topography is wholly uncertain. From the interest of the site in history and still more in literature, as the scene of so many dramas, the temptation to fix details has been specially strong. Conjectural plans or descriptions, differing widely, are given by Leake, Forchhammer, Ulrichs, Bursian, Fabricius and others (references below). There are two main difficulties to contend with. The description of Pausanias was written at a time when the lower city was deserted, and only the temples and the gates left; and the references to Thebes in the Attic dramatists are, like those to Mycenae and Argos, of little or no topographical value. The literary glory of Thebes is centred in the poet Pindar. It had a flourishing school of painting in the 4th century, of which the most famous representation was Aristides, who excelled in pathetic subjects.

AUTHORITIES.—Herodotus, bks. v.–ix.; Thucydides and Xenophon (*Hellenica*), *passim*; Diodorus xvii., xix.; Pausanias ix. 5–17; M. Müller, *Geschichte Thebens* (Leipzig, 1879); E. v. Stern, *Geschichte der spartanischen und thebanischen Hegemonie* (Dorpat, 1884), pp. 44–246; E. Fabricius, *Theben* (Freiburg im Breisgau, 1890); E. Funk, *De Thebanorum actis, 378–362* (Berlin, 1890); B. V. Head, *Historia Numorum* (Oxford, 1887), pp. 295–299. See also BOEOTIA throughout. (E. GR.)

THEBES, ROMANCE OF. The French *Roman de Thèbes* is a poem of some 10,000 lines which appears to be based, not on the *Thebaid* of Statius, but on an abridgment of that work. This view is supported by the omission of incidents and details which, in spite of the altered conditions under which the poem was composed, would naturally have been preserved in any imitation of the *Thebaid*, while again certain modifications of the Statian version can hardly be due to the author's invention but point to an ancient origin. As in other poems of the same kind, the marvellous disappears; the Greeks adopt the French methods of warfare and the French code of chivalric love. The *Roman* dates from the 12th century (*c.* 1150–55), and is written, not in the *tirades* of the *chansons de geste*, but in octosyllabic rhymed couplets. It was once attributed to Benoît de Sainte-More; but all that can be said is that the *Thèbes* is prior to the *Roman de Troie*, of which Benoît was undoubtedly the author. The *Thèbes* is preserved also in several French prose redactions, the first of which, printed in the 16th century under the name of *Edipus*, belongs to the early years of the 13th century, and originally formed part of a compilation of ancient history, *Histoire ancienne jusqu'à César*. The first volume of *Les histoires de Paul Crose traduites en français* contains a free and amplified version of the *Thèbes*. The *Romance of Thebes*, written about 1420 by John Lydgate as a supplementary Canterbury Tale, was printed by Wynkyn de Worde about 1500. From the *Roman de Thèbes* also were possibly derived the *Ipomedon* and its sequel *Prothesilaus*, two *romans d'aventures* written about the end of the 12th century by Hue de Rotelande, an Anglo-Norman *trouvère* who lived in Credenhill, near Hereford. The author asserts that he translated from a Latin book lent him by Gilbert Fitz-Baderon, 4th lord of Monmouth, but in reality he has written romances of chivalry on the usual lines, the names of the characters alone being derived from antiquity.

See L. Constans, *La Légende d'Oedipe étudiée dans l'antiquité au moyen âge et dans les temps modernes* (Paris, 1881), and in the section "*L'Épopée antique*" in De Julleville's *Hist. de la langue et de la litt. françaisc*; *Le Roman de Thèbes*, ed. L. Constans (*Soc. des anciens textes françois* (Paris, 1890); G. Ellis, *Specimens of Early English Metrical Romances*, iii. (1805).

THECLA, ST, one of the most celebrated saints in the Greek Church (where she is commemorated on the 24th of September) and in the Latin Church (where her festival is the 23rd of September). She is honoured with the title of "protomartyr." The centre of her cult was Seleucia, in Isauria. Her basilica, south of Seleucia, on the mountain, was long a very popular place of pilgrimage, and is mentioned in the two books of St Basil of Seleucia. The great popularity of the saint is due more particularly to her *Acta*, which in all their forms derive from the apocryphal work known as the *Acta Pauli et Theclae*. According to her *Acta*, Thecla was born of illustrious parentage at Iconium, and came under the personal teaching of the apostle Paul. In her eighteenth year, having broken her engagement with Thamyris, to whom she had been betrothed, she was accused by her relations of being a Christian. Armed with the sign of the cross, she threw herself on the pyre, but the flames were extinguished by a sudden rain. She then went to

Antioch, where she was exposed to wild beasts, then fastened to bulls in order that she might be torn asunder, and finally thrown into a pit full of serpents; but she was delivered from all these perils. She converted many heathen. Returning to Iconium, she withdrew into a mountain solitude, and became distinguished by many virtues and miracles. In spite of their highly fabulous character, which caused them to be more than once condemned by the Church, the *Acta* of Paul and Thecla, which date back to the 2nd century, are among the most interesting monuments of ancient Christian literature.

See *Acta Sanctorum*, September, vi. 546–568; J. A. Lipsius, *Acta apostolorum apocrypha* (Leipzig, 1891), i. 235–269; C. Schmidt, *Acta Pauli* (Leipzig, 1905), where an attempt is made to prove that the *Acta* of Paul and Thecla formed an integral part of the *Acta Pauli*; see also APOCRYPHAL LITERATURE. W. M. Ramsay, *The Church in the Roman Empire before* A.D. 170 (London, 1893), pp. 375 seq.; C. Holzey, *Die Thekla-Akten, ihre Verbreitung und Beurtheilung in der Kirche* (Munich, 1905). (H. DE.)

THEFT, the act of thieving or stealing. In English legal usage the practice is to call this act by its Norman-French name of "larceny," but properly theft is a wider term including other forms of wrongful deprivation of the property of another (see LARCENY).

The O.E. word *þeofðe* or *þiefðe* is formed from *þeof*, thief or *þeofian*, to thieve, cf. Ger. *Dieb*, Du. *dief*, Goth. *thiubs*. The origin is not known. It may be related to Lithuanian *tupēti*, to crouch or squat down; thus "thief" would mean "one who hides himself." The O.E. *stelan*, to steal, appears also in other Teut. languages, cf. Du. *stelen*, Swed. *stjäla*, Goth, *stilan*, &c. It has been doubtfully connected with Gr. *στερεῖν*, to deprive.

THEGN, or THANE, an Anglo-Saxon word meaning an attendant, servant, retainer or official, and cognate with Gr. *τέκνον*, a child. From the first, however, it had a military significance, and its usual Latin translation was *miles*, although *minister* was often used. J. Bosworth (*Anglo-Saxon Dictionary*, new ed. by T. N. Toller) describes a thegn as "one engaged in a king's or a queen's service, whether in the household or in the country," and adds, "the word in this case seems gradually to acquire a technical meaning, and to become a term denoting a class, containing, however, several degrees." The precursor of the thegn was the *gesīth*, the companion of the king or great lord, the member of his *comitatus*, and the word thegn began to be used to describe a military gesīth. It is only used once in the laws before the time of Aethelstan (*c.* 895–940), but more frequently in the charters. H. M. Chadwick (*Studies on Anglo-Saxon Institutions*, 1905) says that "the sense of subordination must have been inherent in the word from the earliest time," but it has no connexion with the German *dienen*, to serve. In the course of time it extended its meaning and was more generally used. The thegn became a member of a territorial nobility, and the dignity of thegnhood was attainable by those who fulfilled certain conditions. Thus from a document of uncertain date, possibly about the time of Alfred the Great, and translated by Stubbs (*Select Charters*) as "Of people's ranks and laws," we learn:—"And if a ceorl throve, so that he had fully five hides of his own land, church and kitchen, bell-house and burh-gate-seat, and special duty in the king's hall, then was he thenceforth of thegn-right worthy." And again—"And if a merchant throve, so that he fared thrice over the wide sea by his own means, then was he thenceforth of thegn-right worthy." In like manner a successful thegn might hope to become an earl. In addition to the thegns there were others who were thegns on account of their birth, and thus thegnhood was partly inherited and partly acquired. The thegn was inferior to the aethel, the member of a kingly family, but he was superior to the ceorl, and, says Chadwick," from the time of Aethelstan the distinction between thegn and ceorl was the broad line of demarcation between the classes of society." His status is shown by his wergild. Over a large part of England this was fixed at 1200 shillings, or six times that of the ceorl. He was the twelfhynde man of the laws, sharply divided from the twyhynde man or ceorl.

The increase in the number of thegns produced in time a subdivision of the order. There arose a class of king's thegns, corresponding to the earlier thegns, and a larger class of inferior thegns, some of them the thegns of bishops or of other thegns. A king's thegn was a person of great importance, the contemporary idea being shown by the Latin translation of the words as *comes*. He had certain special privileges. No one save the king had the right of jurisdiction over him, while by a law of Canute we learn that he paid a larger heriot than an ordinary thegn.

But, like all other words of the kind, the word thegn was slowly changing its meaning, and, as Stubbs says (*Const. Hist.*, vol. i.), "the very name, like that of the gesith, has different senses in different ages and kingdoms, but the original idea of military service runs through all the meanings of thegn, as that of personal association is traceable in all the applications of gesith." After the Norman Conquest the thegns appear to have been merged in the class of knights.

The twelve senior thegns of the hundred play a part, the nature of which is rather doubtful, in the development of the English system of justice. By a law of Aethelred they "seem to have acted as the judicial committee of the court for the purposes of accusation" (W. S. Holdsworth, *History of English Law*, vol. i. 1903), and thus they have some connexion with the grand jury of modern times.

The word thane was used in Scotland until the 15th century, to describe an hereditary non-military tenant of the crown. (A. W. H.*)

THEINNI, or HSENWI, one of the Northern Shan States of Burma. It is called by the Shans Hsenwi, and also officially so designated, but is better known by the Burmanized name of Theinni. It was by far the largest of the cis-Salween Shan states, and at one time included not only all the territory of the present states of North and South Hsenwi, but also Kehsi Mansam, Möng Hsu, Möng Sang, and Möng Nawng, besides having a sort of protectorate over Mang Lön and other Wa states east of the Salween. These had, however, fallen away in Burmese times, and at the period before the British annexation Theinni was divided into five parts by name; but there was no central authority, and the whole state was in hopeless disorder. This continued until the appearance of British troops in March 1888, when it was divided into two states—North Theinni, which was assigned to a successful adventurer, Hkun Sang, of Tôn Hông, and South Theinni, which went to Nawmöng, of the old Shan ruling house. North Theinni has an area of 6330 sq. m., and a population (1901) of 118,325 persons; estimated revenue, £6000. South Theinni has an area of 2400 sq. m., with a population (in 1901) of 67,836; estimated revenue, £4800.

The northern part of North Theinni is a mass of hills affected by the geological fault which has produced the rift that forms the Nam Tu or Myit-ngè valley, and has thrown up a series of parallel ranges which extend northwards to the Shweli (Lung Kiang), without altogether destroying the north and south trend which is the characteristic of the Shan hills as a whole. In the valleys between these hills are numerous tracts under rice cultivation, some circular or oval, some mere ribands along the river banks. The southern portion has much more flat land, along the line of the Nam Tu, its tributaries the Nam Yao and the Nam Nim, and the Nam Yek flowing into the Salween. This was formerly thickly populated, and still remains the most valuable portion of the state. A range running westwards from the Salween, and marking the southern border of the rift in the hills, divides North from South Theinni. Both north and south of the Nam Tu there are many peaks which rise to 6000 ft., and several over 7000 ft. The northern portion is almost consistent enough in its altitude of about 4000 ft. to be called a plateau. It has large, grassy, upland downs. This part of the state has fallen almost entirely into the hands of the Kachins. The Shans are found in the Nam Mao (Shweli or Lung Kiang) valley, and in the Nam Tu and other valleys in the southern part of the state. The line of the Nam Mao is the lowest portion of North Theinni, being little over 2000 ft. above sea-level. The southern valleys are about 500 or more ft. higher. South Theinni is practically bisected by the huge mass of Loi' Ling, nearly 9000 ft. above sea-level, and by the spurs which that peak sends north and south. Apart from this it consists of broken hill-country of no great height, or open rolling downs, the latter chiefly in the eastern half of the state. It is watered by numerous streams, of which the chief is the Nam Pang, an affluent of the Salween. The chief river in the northern state, apart from the Salween, is the Nam

Tu or Myit-ngè, which rises on the Irrawaddy-Salween watershed, not far from the latter river, and flows westwards through the state into Taungbaing or Thibaw, and eventually into the Irrawaddy at Amarapura. The Nam Mao or Shweli only skirts the state, but it receives a considerable tributary, the Nam Paw, which has its entire course in Theinni territory, and is large enough to be barely fordable in the dry weather, and only passable by boats in the rains. The deforestation caused by years of upland cultivation has dried up many of the springs, but as a whole North Theinni is very well watered. Considerable deposits of coal, or rather of lignite, exist in both North and South Theinni, but do not appear to be of high quality. Gold is washed in many of the streams in a fitful way. Limestone exists in large quantities. No valuable timber exists to any considerable extent. There is some teak in the Nam Yao valley, and scattered wood-oil trees exist. Pine forests cover some of the ranges, but, as elsewhere in the Shan states, varieties of the oak and chestnut are the commonest forest trees. The climate of the state as a whole is temperate. In the plains of the uplands there are yearly frosts in January, February and March, but in the greater part of the state the thermometer rarely falls to freezing-point, and in the hot weather does not exceed ninety degrees for any length of time. The average rainfall seems to be about 60 in. yearly. After the disruption of the ancient Shan empire at Tali by Kublai Khan, Theinni seems to have been the centre of the independent Shan kingdom, with various capitals in the Shweli and Nam Tu valleys. This kingdom of Kawsampi was ended by the Burmese about 1738, and the country was divided into various states, with appointment orders from Ava. Numerous rebellions and civil wars have reduced Theinni from its position as the most powerful and populous Shan state to a condition of fearful desolation. It has regained much population since the British occupation in 1888, but is still far from its old prosperity. Much may be expected from the cart roads that have been made, and from the Mandalay-Kun long Railway.

Hsenwi, the capital of North Theinni, stands near the north bank of the Nam Tu. The ruins of the old capital lie at a short distance, and show it to have been a large and well-built town, with a number of houses variously estimated at from three to ten thousand. Möng Yai is the capital of South Theinni, with a population of about 2000. Lashio, the headquarters of the superintendent of the Northern Shan State, is in North Theinni. The races found in Theinni comprise Shans, Kachins, Chinese, Burmese, Lihsaws, Wa, Palaungs and Yanglam. The Shans and Kachins vastly predominate, and are nearly equal in numbers. (J. G. Sc.)

THEISM (Gr. θεός, god), literally, and in its widest sense, the belief in a god or gods. The term has had several changes of meaning. (1) It appears for the first time in 18th-century English as an occasional synonym for "deism" (*q.v.*), and therefore as applying to those who believed in God but not in Christianity. Later criticism, orthodox and heterodox, upon the English deists inclines to charge them with the conception of a divine absentee, who wound up the machine of nature and left it to run untended. That was the general 18th-century way of thinking. God was apt to be thought of as purely transcendent, not immanent in the world. (2) In the 19th century theism is generally used of positive belief in God, either with or without belief in the claim of Christianity to be a revelation, but unassociated with any peculiarities of 18th-century deists. If the word "deism" emphasizes a negative element—rejection of church Christianity—"theism" generally emphasizes the positive element—belief in God. (3) There is also a third usage. "Theism" was reclaimed by Theodore Parker, F. W. Newman, Frances Power Cobbe, and others, for their more modern speculative belief in God, which, while non-Christian or at least non-orthodox, held to an immanent God, continually revealing himself—in the moral consciousness. The ambiguity cannot be cured. We use the word in this article in the second sense.[1]

Natural Theology.

I. From this point of view theism is a synonym for Natural Theology, or almost so. But the expression Natural Theology itself has a history. (1) The "three theologies"—recognized by the early Roman Stoics—probably on the suggestion of a passage in Aristotle's *Metaphysics*, xi. 8—are named by St Augustine (Latinizing the Greek terms) mythical, *natural*, and civil or political (*City of God*, iv. 27). There is probably a malicious echo in a well-known passage of Gibbon (*Decline and Fall*, chap. ii.): "The various modes of worship which prevailed in the Roman world were all considered by the people as equally true, by the philosopher as equally false, and by the magistrate as equally useful." Augustine rejects all three "theologies" as pagan figments, and not a few church writers follow him in this—borrowing his learning without naming him (*e.g.* the Protestant Grotius in his notes on Rom. i. 20). Yet the natural or physical theology of the philosophers—in contrast to mere myths or mere statecraft—seems a straightforward effort to reach faith in God on grounds of scientific reason. It deserves the name, in the modern sense, of Natural Theology. (2) Raymond of Sabunde's *Liber naturae sive creaturarum* (1434–36) bears also the title *Theologia Naturalis*—but not from the author's own hand,[3] though his introduction to the book in question, the *Prologue*, put upon the Index at Rome for its daring, describes the "book of nature" as "connatural to us," in contrast with the "supernatural" book, the Bible, which belongs to the clerics. Laymen may read the book of nature, and Man himself is the most important "leaf" in it. Raymond attempts to demonstrate the whole of church theology upon principles of reason. That is a task quite beyond what is generally recognized as Natural Theology. (3) With Francis Bacon (*Advancement of Learning*, 1605) the expression Natural Theology emerges in what has become the modern sense—as standing for a part of Christian theology, attainable by reason, and contrasted by most theologians with the "mysteries" of faith (Bacon uses that term too) on the principles of Albert the Great and Thomas Aquinas (see APOLOGETICS).

[It is not clear that Bacon is the first to use the term in the now accepted sense; but he and Theophilus Raynaudus, S. J., in his *Theologia Naturalis* (1622), of which there is a copy in the Bodleian, must at least be among the first in their respective communions to do so. Raynaudus's authorities, in favour of the recognition of a natural theology and against it, do not, so far as the present writer has been able to consult them, use the expression. So too H. Alsted, an early Protestant writer on Natural Theology (in his *Methodus Theologiae*, 1611, and in later works), defines it as moderns do—some of the *contents* of his Natural Theology are fantastic enough—and *his* authorities, again so far as consulted, differ upon the place to be assigned to Natural Theology within a system of study, but do not employ the term.]

Roman Catholic grouping.

In later times the expression is common; it is used *e.g.* by Locke, Leibnitz and Wolff. Wolff's influence made the usage habitual,[4] though Schleiermacher and Ritschl, like the Socinians earlier, deny the existence of a natural theology. Following the text and ordinary interpretation[5] of Aristotle's *Metaphysics*, it is believed that Aristotle already identified metaphysics with a theology: accordingly modern Roman Catholic learning, which owes a great debt to Aristotle through the schoolmen, includes Natural Theology in philosophy, not in theology properly so called. With Natorp's article W. Wallace's *Gifford Lecture*,[6] chap. i., may also be consulted; but Wallace does not distinguish the unusual sense which the term bears as applied to Raymond's book. R. Flint has remarked that Natural Theology ought not merely to *prove* the being of God, but to give a full systematic view of what (it is contended) can be learned of theological truth from the "light of nature" (St Augustine, and

[1] Imm. Kant's distinction of "deist" and "theist" may be found in the *Critique of Pure Reason*, "Transcendental Dialectic," Book II. chaps. iii. and vii. It is curious, but, unless for the study of Kant, unimportant.

[2] Cf. THEOLOGY. Natorp's article quoted there gives the reference to the passage in Aristotle, but does not recognize its connexion with the later Stoical distinction.

[3] See art. "Raimundus Sabiende" by Schaarschmidt in Herzog-Hauck, *Realencyklopädie* (ed. 1905). At this point we must also call to mind the wide currency given to the term theology by Abelard, and his editors or copyists.

[4] A. Harnack and some others use the expression in a wider sense. Any supposed principles (even if not worked out into a system of inferences) used as ready-made clues for the study and interpretation of Christianity are described by this school as natural theology (cf. THEOLOGY).

[5] Challenged by Natorp; see THEOLOGY.

[6] Published in *Lectures and Essays*.

theologians generally after him). The name "theism" makes that requirement less emphatic (see below).

Another kindred term is "Natural Religion." We meet with this in the titles of two Latin works[1] by German authors in reply to Lord Herbert of Cherbury. They use it with strong condemnation, from the standpoint of rigorous Christian orthodoxy; but it comes into England within very few years upon the Christian side—religion against irreligion—in Bishop John Wilkins's *Principles and Duties of Natural Religion* (1678). The author died 1672, and left the book unfinished; but the language of the title occurs in the first sentence; so it is undoubtedly Wilkins's, as well as sanctioned by his editor and connexion through marriage, Tillotson, afterwards the archbishop. We meet with "Natural Religion" again in Samuel Clarke's works, and notably in Bishop Joseph Butler's *Analogy* (1736). Thus, as employed by most writers, "Natural Religion" connotes neutrality or even friendliness towards Christianity; just as is the case with theism in sense (2), or with Natural Theology. "Deist," or sometimes "theist" in sense (1), or Naturalist, is a term of reprobation with English 18th-century apologists, but not "Natural Religion." If there is any difference between "theism" or "Natural Theology" on the one hand, and Natural Religion on the other, it is to be found in the more practical character attaching to natural "religion." While Romans i. 19 and 20 (yet cf. Acts xiv. 17, xvii. 24, &c.) is the main New Testament passage which seems to recognize a Natural Theology, Rom. ii. 14, 15 may be said to assert Natural Religion. When the expression Natural Theology comes to the front once more with Archdeacon W. Paley (1802), this is a sort of after-birth or anachronism.[2]

Natural Religion.

Natural Law.—We do not pretend that Law of Nature—the jurist's term, not of course that of inductive science—is strictly a synonym for theism. But it is a cognate conception, of great importance historically, bearing the marks of the Stoic doctrine of "nature," and helping to turn men's minds towards a "natural" theology. A pantheist may believe in Law of Nature and go no further; a theist who accepts Law of Nature has a large instalment of natural theology ready made to his hand; including an idealist, or else an intuitionalist, scheme of ethics. Both *jus naturale* and *lex naturalis* are as early as Cicero, and the *jus gentium* of the Roman lawyers is earlier still. Ambrose of Milan (*Epistles* ix. 71) quotes Romans ii. 14, 15—the passage already referred to, under "Natural Religion"—as asserting "Natural Law"; St Paul's words suggest that form of thought and may conceivably have been suggested by it. J. G. Ritchie's *Natural Rights*, from the point of view of a very hostile (evolutionary) idealism, sketches the early history of the phrase Natural Law.[3] The philosopher in Abelard's *Dialogus inter Judaeum Philosophum et Christianum* expects to be saved *ex sola lege naturali*; here "law of nature" is fully equivalent to Natural Religion, and the word *sola* sets it in contrast with Christianity. Not to speak of the canonists, Thomas Aquinas gives natural law an important place; while Melancthon, drawing from Aquinas, gives it an entrance into Protestant thought. Zwingli and Calvin on the other hand prefer the positive view of law as instituted by God far back in history in the days of the Old Covenant; but, when exegesis or controversy puts pressure upon them, they fall into line and reiterate the appeal to a Natural Law. Richard Hooker, again with traces of Aquinas, uses the conception as a weapon against Puritanism, with its aggressive positivism of scriptural precept. Natural Law, he claims, leaves room for discretionary arrangements like episcopacy; Scripture does not mean to supersede the light of reason. It is intelligible that Locke (*Treatises of Civil Government*) should have a relish in quoting Hooker against the divine-right royalism of Sir John Filmer; but in Locke there is already a revival of belief in the (beau-ideal) "state" of nature and a growing emphasis upon natural *rights*; ideas which, heralded by Rousseau, echoed round the world in the French Revolution. Locke had spent some years in Holland, the country of Grotius, who, with help from other great lawyers, and under a misapprehension as to the meaning of the Roman *jus gentium*, shaped modern concepts of international law by an appeal to law of nature.[4] This moral ideal rendered considerable services to civilization; we must not forget these, in the offence which the myth of a primitive golden age may offer to our historic sense. The kernel is sound enough though the husk is a poor thing. Finally, it is of some interest to note that Chr. Wolff, in the intervals of his chequered theological career, lectured and wrote as a jurist upon the Law of Nature.

Natural Law.

"Philosophy of religion" is the modern term. It again is not exactly a synonym, though more nearly so than the last. The new phrase indicates that we are to approach the thought of God through a study of religious beliefs and practices; "theism" tended to make God a purely scientific inference from the facts of nature. But "philosophy of religion" can be construed in many different ways. An investigator, pledging himself to no beliefs—even perhaps one who definitely disbelieves and rejects theism—may yet interest himself in tracking out the psychology of religion. Or a philosopher like Hegel, armed with a metaphysical theory, may descend upon the facts of religion and interpret them in its light, till they almost lose their original significance, which we might provisionally define as consisting in this, that the believer in any religion finds himself helped or (as he claims) saved by it. Again, we must not be misled by verbal idiosyncrasies. What James Martineau calls *A Study of Religion* is really in the main a re-statement of old theistic arguments.[5]

Philosophy of religion.

[Wallace's *Gifford Lecture* may be consulted upon this phrase also. He observes with truth that Natural Theology, if you remove from it the idea of subordination to Christianity as (claiming to be) a special revelation, tends to pass into a philosophy of religion. But it does not follow that the new standpoint involves what Wallace seems to hint, though he conceals his meaning behind complimentary rhetoric—rejection of church Christianity. A. M. Fairbairn's *Phil. of the Christian Religion* shows by its very title that an effort is being made to combine great confidence in metaphysics with strong belief in the uniqueness of Christianity; and the effort will be found to characterize all Fairbairn's work. Possibly, fuller study of religions may help theologians to formulate the imperial claims of Christianity more happily than in the dry contrast between what is "revealed" and what is "natural." But that contrast is traditional; and it is implied in the ordinary theological usage of such phrases as "natural theology" or "natural religion" and almost of "theism."]

Comparative religion, or, as some call it, history of religion, is yet another modern study, closely akin to the last discussed, although more strictly confined to registering the sequence of religious phenomena and less disposed towards criticizing religions or towards ranking them in an order of merit. We cannot, therefore, call it precisely synonymous with theism. And yet theism—or monotheism—constitutes a special *locus* in the history of religion. The historian observes and records, in different lands and ages, the rise or explicit utterance of belief in one God.

Comparative Religion.

Some uncertainty may be felt whether pantheism should rank as a theism. Is unity the main point? Or is not personality rather of prime importance, though doubtless presupposing unity? (Usage does not allow us to rank polytheism as a form of theism.) E. Troeltsch, *Kultur der Gegenwart*, Teil I. Abt. 4, p. 470, finds that the wisdom of the priests, in one land after another, rises to the thought of divine unity. That suggests pantheism, the usual form of such esoteric wisdom. Professor T. W. Rhys Davids (*American Lectures*, p. 37) sums up that, when the name of an earlier deity is

[1] Recorded in J. G. Walch's *Bibliotheca Theologica Selecta* (1751).
[2] See Wallace's *Gifford Lecture*.
[3] For the influence of that conception in theology, especially through the medium of Isidore of Seville, see successive chapters in A. J. Carlyle's *Hist. of Mediaeval Political Thought in the West*, vol. i.
[4] See (with writers already mentioned) Sir H. Maine's *Ancient Law*.
[5] See his *Introduction*.

attached to the object of supreme worship, monotheism proper is approached; while, when a new thought-construction is put in the supreme place, there is a tendency rather towards pantheism. So far as this is true, theism (proper) would seem to be an accident of language.

There is a further problem; whether monotheism is of very early occurrence. Belief in a primitive historical revelation, once universal among Christians, has almost disappeared; but belief in a very early and highly moral theism is stoutly defended, chiefly on Australian evidence, by Andrew Lang (*The Making of Religion* and later works). If Lang is right, "primitive" peoples drew typical theistic inferences, and argued to God from nature and from conscience, though without displacing other types of religious belief and practice. In many regions—Egypt, Babylonia, &c.—individual investigators of the great religions have thought they found traces of an early—one hesitates to write, of a "primitive"—monotheism. Perhaps J. Legge, who finds true theism at the dawn of Chinese history, is the most authoritative representative of such views.

Brahman theism.

Passing to later times, we can watch a theory of monotheism rising, and dying down again, during what our scholars distinguish as the Brahmanical period of Indian religion. The supreme god, Isvara, has the personal name Prajapati, Visvakarman or some other. But this theism is lifeless—a "pale and shallow deism, which India has often confessed with the lips, but which has never won the homage of her heart."[1] The thought of India is upon the side of pantheism. Again, the heretical Egyptian king Amenophis IV. or Akhenaton, one of the sovereigns to whose government the celebrated Tell el-Amarna letters from Palestine were addressed, was a zealous champion of the exclusive claims of the sun-disk God, Ra; but his policy died with him. In Babylonia a mutilated inscription printed by T. Pinches (*Transactions of Victoria Institute*, vol. 28), identifying (so far as preserved) thirteen other Gods with Marduk, has been hailed by Friedrich Delitzsch (*Babel und Bibel*) as the great fountain-head of monotheism, and has influenced the bold if highly precarious conjectures of H. Winckler.[2] Of more assured importance was the Zoroastrian faith—"pure moral dualism if not theism" (L. H. Mills)—which proved its zeal by persecutions. But later times nearly strangled Zoroastrian piety, not only by laws of ritual purity but also by newly evolved secondary deities—personified attributes, and the like. So that here again theism, if theism it was, did not continue in strength. If we understand by theism not simple belief in a divine unity, but such faith in one divine person as will constitute the basis for a popular religion, then—unless we allow a doubtful exception in Zoroastrianism—we must agree with those historians of religion who affirm that the world has known only a single living monotheism, viz. that of the Old Testament, along with what are historically the daughter faiths, Christianity and Islam.

Egyptian. ***Babylonian.*** ***Zoroastrian.***

Incomplete theistic impulses.

The theist believes that he can further trace many incomplete workings of the monothesitic instinct in the history of religion. Not only is it true, as A. Menzies observes, that "Reason knows only God, not Gods"; if we take religion as *saving help*, no worshipper possesses religion in full security until he has gone straight to the fountain-head, and gained the friendship of the God of Gods. Indian Vedic henotheism (otherwise called kathenotheism);[3] Semitic monolatry, so important as the probable starting-point of religious development in Israel; the Greek use of "Zeus" almost as we say "God"—even the attempt to arrange deities in a monarchical pantheon, all show the tendency, though it so seldom attains a real victory.

[1] A. Barth, *Religions of India*, Eng. trans., pp. 29, 30, 69. We may probably extend this hostile judgment to the theism of the modern Samaj-es.

[2] The centralizing of worship at Babylon by its last king, Nabonidos, hardly seems to have amounted to monotheism.

[3] The two terms are explicitly identified by F. Max Müller, their inventor (*e.g. Hibbert Lectures*, chap. vi. p. 271).

Subordinate elements of theism.

II. We have already suggested that theism covers more ground than the name at first may suggest. It can never quite confine attention to the problem of the being of God. Where God is believed in at all, it is believed that upon God everything else depends. With the thought of God, accordingly, there is correlated a modification in thoughts upon all other subjects; and a full system of theism must discourse "Of God, of the world, of the Soul," like Matthew Arnold's Moses. In other words there must be doctrines regarding matter and mind, the world and the self, as well as regarding that Absolute Being who is believed to exist behind both, revealing Himself through them. This way of approaching theism is illustrated in A. C. Fraser's Gifford Lectures, or in earlier times in the writings of Christian Wolff, whose sciences, according to the slightly different nomenclature which Kant imposed on them, were "rational psychology," "rational cosmology," and "rational theology." Kant swept away, so far as his influence extended, such "dogmatic metaphysics" and the old-fashioned theism which it constituted or included; but Kant himself introduced, in his own more sceptical yet also more moral type of theistic doctrine, a new trichotomy—God, Freedom, Immortality, the three "postulates" of the "practical reason." It is tempting to try to correlate the members of this triad with the individual members of the older triad. But that would only mislead us; free will and immortality are really predicates ascribed—on whatever grounds—to the soul; and it is natural that in theism the soul of man should be a topic second in importance only to God Himself. Every theistic system, or almost every one, makes provision in some way for Kant's three postulates. Accordingly, even in a hurried survey of the history of theism, we must try to question the systems we are reviewing upon their attitude towards human freedom and immortality, as well as upon their doctrine of God. Sometimes it will be found that free will is asserted as an assured fact, as a *datum*, and so as a ground of inference to God. But sometimes free will is rather a *probandum*. In Christian theology, much labour has been spent upon vindicating man's freedom against God's intrusion, or upon blotting out human power in order to leave room for the divine. Theism suggests at the very outset that we should rather expect to find a correlation between the two. If there is a God at all, he must be thought of as the guarantee of freedom in man and as the pledge of his immortality.

Kant's "postulates." ***Free will.***

Simplification of theism.

The mention of Christian theology may remind us that, for the majority of theists in medieval and modern times, theism proper has ranked only as a secondary wisdom. It is possible for Christians to work out natural theology in separate detail; but we cannot wonder if they rarely attempt the task, believing as they do that they have a fuller revelation of religious truth elsewhere. In point of fact, as we look to history, we find that theism has been much simplified and cut down. First of all, attention has been concentrated upon God. One does not suggest that this concentration was an error. On the contrary, even Christian theology makes at least the effort to show that the thought of God regulates the whole system of belief. Yet while an adequate doctrine of God may settle everything *in principle*, we ought to remember that there are *applications* of the principle, apart from which we do not see our way clearly. As a second step in concentration, attention is almost confined to the question "Does God exist?" and to theistic proofs as answering "Yes." The further question "What is God?" is slurred, as if there could be no two opinions regarding that; whereas in truth there are two hundred opinions. A. B. Bruce feels this so strongly that the natural theology section of his *Apologetics* entirely omits the question "Does God exist?" in favour of the question "What is God?" Perhaps that is equally one-sided. When we do find theism dealing with the question "What is God?" it tends to borrow from scholastic forms of Christian theology the scheme of Being and Attributes (see *e.g.* Wolff). But such a scheme gives at best an external preliminary description of the object to which it is applied.[1]

So our wealth of material narrows down in the ordinary handling to a single question. God, the world, the soul, free will, immortality, optimism; *What* then is God? All these questions, and perhaps others, tend to conceal themselves behind a single discussion: Does God exist? But further still. Either the fuller or the narrower way of dealing with theism will differ according to the philosophical standpoint of the particular theist who speaks to the question. As long as the battle of the philosophies endures, theism can hardly be unified. Its history is not so much that of a single evolving doctrine, but rather the history of many and diverse theistic schemes.

Difference of philosophical standpoint.

III. It may help us if we rapidly review at this point the leading types of philosophy in their application to the theistic problem. Grouping and naming are fixed here for one special purpose. From other points of view they may perhaps appear open to blame; but it is hoped they will throw light upon our present study.

The simplest basis for philosophy[2] is empiricism. Such a philosophy makes little serious attempt at constructive work in antiquity; but, upon the first great victories of physical science in modern times, a desire arose to extend the new and wonderfully fruitful method to the ultimate problems of speculation. Let us take experience as our teacher! Let us stand upon realities—upon facts! Difficulty may be found in carrying out this empiricist programme; but at the outset no one dreams of failure. Beginning with the certainties of everyday experience, it reaches theism at last by means of an analogical argument. Many objects in nature, organisms especially, seem to resemble the works of human *design;* therefore with high probability we infer a designing mind behind nature, adequate to the production of these special results.[3] Having got such a mind, we may next inquire whether, on the principle of parsimony, it will not account for more; perhaps for everything in nature! But the starting-point of the argument in question is the purely empirical evidence of a single fact or set of facts; it proceeds by way of analogy, not of strict demonstration; and it claims for its results nothing more than probability. From Socrates, in Xenophon's *Memorabilia*, downwards, the argument is tolerably common; it is notable in Cicero; in the modern discussion it dominates the 18th-century mode of thought, is confidently appealed to though not worked out by Butler, and is fully stated by Paley. The argument does not necessarily imply empiricism in philosophy; still, it is peculiarly characteristic of empiricism. In ethics empiricism begins by recognizing that man possesses sensations, and so is liable to pleasures and pains. Hence, early empiricism makes ethics simply a calculus of pleasures ("hedonism"). We may doubt, with W. E. H. Lecky,[4] whether such a philosophy affords a basis for natural theology at all; but the attempt is made. As J. S. Mill tried to reconcile criminal law and its punishments with his very hard type of determinism by saying that law was needed in order to weight the scale, and in order to hold out a prospect of penalties which might deter from crime and impel towards good citizenship, so Paley held that virtue was not merely obedience to God but obedience "for the sake of eternal happiness." A second type of hedonism—less ignoble, but perhaps also less logical—calls men to seek the happiness of *others*. Paley includes that too; virtue is "doing good to mankind," in obedience to God, for the sake of heaven.

Empiricism.

Argument from design.

Ethics; Hedonism.

The second type of philosophy, for our purpose, is intuitionalism. It finds its chance in the misadventures of empiricism. The Scottish philosophy of Thomas Reid and his successors believed that David Hume's scepticism was no more than the genuine outcome of Locke's sensationalist appeal to experience when ripened or forced on by the immaterialism of Bishop Berkeley—God and the soul alone; not God, world and soul. And so the Scotsmen fell back upon the witness of consciousness. They did not make much use of the word "intuition," which may indeed be taken in different senses, *e.g.* of visionary experiences as well as of the principles of "common sense" (*i.e.* universal beliefs). They spoke of "natural realism" and a "natural dualism" of mind and matter (reinstating here the element which Berkeley had struck out). Still, they do not repudiate the word "intuition," and kindred writers make it prominent. The term is borrowed from Sight, of all the physical senses the one which most rapidly instructs the mind. You see, at a glance, that things are so. Indeed, there is a further implication, when the term intuition is borrowed for mental vision; you see at a glance that things *must be* so. Here then characteristically intuitionalism occupies a half-way house between empiricism, with its appeal to real given fact, and idealism, with its appeal to necessity. The senses, in perception as contrasted with sensation, are held to give immediate knowledge. We perceive, beyond all possibility of doubt, that things *are* so and so. This is Reid's first reply to Hume. Define more carefully than Locke did, with his blunder about "ideas," the process of perception, and you cut up scepticism by the roots! So far, this philosophy has little bearing upon theism. But Intuitionalism has further arguments for the doubter. Besides testimony from outer sense, we have testimony and teachings from consciousness within—"first principles," as Reid generally calls them. There are some principles which, as soon as they are presented to the mind and correctly grasped, must be assented to; we *see* the truth! Two regions become prominent in the working out of intuitionalism, if still more prominent in the widely differing philosophy of Kant—the regions of mathematics and of morals. Though J. S. Mill boldly affirmed that there might be remote realms in space where $2+2$ did not make 4 but some different total, even empiricists may hestitate to concur; and yet Mill's assertion is at least the most obvious empiricist reading of the situation. If all knowledge is drawn from experience, statements universal in form are but generalizations, holding within the limits of actual experience, or advanced beyond them at our peril. Geometry again is regarded by thoroughgoing empiricists as hypothetical. It deals, according to Mill, with arbitrary and imaginary constructions. If there were such a thing as a triangle contained by absolutely straight lines, its three angles would no doubt measure what Euclid says; but straight lines and true triangles nowhere exist *in rerum natura*. Kant's point is ignored, that deductions from these "imaginary" figures *apply* to the "real" world of experience. Every time we survey a field, we go upon the principles, not of special experience, but of *a priori* necessity. Given certain linear and angular measurements, the area *must* be so and so. Great as is the difference when we pass from mathematics to morality, yet there are striking similarities, and here again intuitionalism claims to find much support. If we accept moral ideals at all, we are no longer in the world of mere phenomenal sequences, but in a new world. It is a problem for empiricism; given a world where nothing but phenomenal sequences exist, to account for moral ideals. Vulgar materialism sneers at the problem; duty is a fraud or hobgoblin, a mere superstition. Even Jeremy Bentham, restive under appeals to vague and intangible standards, breaks out in despairing indignation against the word "ought" as "the talisman of arrogance, indolence

Intuitionalism.

[1] Criticism of the scheme, from the point of view of an idealist theism, will be found in John Caird's *Introduc. to the Phil. of Religion*, chap. viii. Yet the formula is serviceable. Perhaps it is even indispensable as a preliminary statement. We find it substantially revived in the opening sentence and general scheme of a useful book, A. Caldecott's study of *The Phil. of Relig. in England and America*.

[2] An outline of the history of theism is reserved for Section IV.; but it has not proved possible to sketch the types of philosophy without introducing references to the history of philosophy and sometimes even to the history of theism as well.

[3] Of course the Design Argument is well known in antiquity, but not the type of philosophy which stands or falls by that line of "proof."

[4] Cf. *Hist. of European Morals*, pp. 58, 59.

and ignorance," and as "an authoritative imposture."[1] Later ethical empiricism is more refined. J. S. Mill recognizes an ultimate difference in quality between higher and lower pleasures. A. Bain finds that benevolence is one given element in man's original constitution. H. Sidgwick holds that intuition must justify the claims of the general happiness upon the individual, though everything subsequent is hedonistic calculus. Herbert Spencer finds that the modern individual has intuitions of duty which represent the inherited experience of what has been good for the race in the past. Sir Leslie Stephen finds that moral laws are the conditions needful for the good of the social organism, and are imposed as such by society upon its individual members. The problem has altered its form. What the modern empiricist needs is a rational bond uniting the individual with the community or with the aggregate of individuals—a rational principle distinguishing high pleasures from low, sanctioning benevolence, and giving authority to moral generalizations drawn from conditions that are past and done with. The non-empirical moralist will not of course admit that duty to the community or to mankind is a final definition of the ethical ideal. He will accept it as a stage, of no small importance, in progressive definition; but he will seek to go further.

Criticism of intuitionalism.

We have already remarked that the difficulties of empiricism constitute the strength of intuitionalism. A critic of intuitionalism might add that they are its whole strength; intuitionalism is sound upon the intellectual and moral *interests* of humanity, but it does little to justify them. It reasserts them, with resolute loyalty; but if philosophy ought to vindicate, to explain, perhaps incidentally to modify, even, it may be, to purify our primary beliefs, intuitionalism is hardly a philosophy at all. For good or for evil, so far as there is an accepted line of theistic doctrine, that doctrine is intuitionalist. Other schools of philosophy pay flying visits to theism; intuitionalism is at home there. Its leading argument is the cosmological, concluding to "God as cause" (Martineau). When David Hume (*Dialogues concerning Natural Religion*) protests that the universe is a "singular effect" and that we have no right to affirm a cause for it, unless we have experience of the origin of many universes, and can generalize the conclusion, They all have causes—he may be unassailable upon empiricist grounds. But intuitionalism claims to allege a higher certainty; everything (or every change) *must* have a cause—this is not merely actual fact but necessary truth. The universe exists—or, as otherwise stated, the universe is "contingent"—therefore, even without detailed knowledge of different universes, we can affirm that it must be caused, and in its "Great First Cause" we recognize God.[2] It is generally stated that this argument was for the first time definitely formulated in Aristotle's philosophy. Of course the cosmological argument is rarely or never left to stand quite alone. The design argument is available for the slightly bolder philosophy of intuitionalism as well as for empiricist theism. But there is yet another argument which is even more important. Moral elements must enter into theism at some point: and, as against empiricism, intuitionalism is morally strong. Hence it naturally has a moral argument in reserve. Moral law implies a law-giver; "we are conscious of moral dependence" (Robert Flint). Still the main weight of intuitionalist theism rests upon the conception of God as First Cause.

As a philosophy, intuitionalism leaves the mind in all the embarrassment of an indefinite number of separate starting-points. Every percept is such a starting-point; it is an immediate certainty, remaining with us unmodified as the basis of reliable inference. Every First Principle of the mind is a starting-point too. Reid—certainly a very unsystematic thinker—furnishes long and random lists of "first principles"; a later writer, J. M'Cosh, in his *Intuitions of the Mind*, attempts a more systematic study. (For ethics we may also compare Miss F. P. Cobbe. Contemporary with Reid and even more popular in treatment was James Beattie; Dugald Stewart with trivial modifications followed Reid; but in Sir W. Hamilton and H. L. Mansel there were sweeping changes in the direction of agnosticism—changes due partly or primarily to the influence of Kant.) Memory is included among First Principles. Testimony is also a First Principle (this is aimed against Hume's *Essay on Miracles*). Inevitably the question forces itself upon the mind, is not some fuller synthesis possible? All these isolated starting-points of thought are said to be, one by one, necessary. Is there no higher or broader necessity? Can we not attain to some farther-reaching philosophy?

A transition to idealism or scepticism.

If we answer "Yes" to that question, we pass on from intuitionalism to idealism—an idealism not on the lines of Berkeley (matter does not exist) but of Plato (things obey an ascertainable rational necessity). This third possibility in philosophy does not enter at all into Lecky's grouping referred to above; in fact, it is very generally strange to older British thinking,[3] which, if it conceives any *tertium quid* besides empiricism and intuitionalism, is apt to think of scepticism. The fixed given points of intuitionalism furnish Hamilton with one of his arguments in his unexpected development towards a sceptical or "faith philosophy." You cannot prove any first principle. You accept it by "faith." So—for this among other reasons—we infer that knowledge has narrow limits, beyond which doubt, or faith, presently begins. But is it really a matter of faith that two and two make four? Do we "believe where we cannot prove" that the whole is greater than its part? A less sophisticated intuitionalism would rejoin with great force, "These are matters of *sight;* it could not be otherwise, and you *see* that it could not!" Hamilton's line of thought may, however, impress on us the conviction that it is extremely natural for philosophy to pass beyond the limitations of a purely intuitionalist programme. It does so notably in Kant.

Kant as a transitional idealist.

He is a most difficult writer; different readers understand him differently; and he uses in the earlier parts of his *Critique of Pure Reason* much of the language of intuitionalism. But nothing is more certain than that his thought is a strong solvent of the intuitionalist way of thinking; and he has had an immense influence in many directions. We may state his chief results in our own words. First he breaks up the percept. It is no ultimate given point of departure; it is due to the reaction of thought upon sensation. Sense alone will never create orderly experience, as empiricism supposed; but a group of sensations reacted on by thought does so; it becomes, it is, a percept. Secondly: the "forms" of time and space, not referable to any sensation, and presupposed in every experience, come from the mind ("Transcendental Aesthetic"). Thirdly: we cannot explain how these three elements—sensation; time and space; thought—work together. True, Kant refers often to the ideal of a "perceptive" or "intuitive understanding," whose thought would produce the whole of knowledge out of its native contents. But our understanding, he is convinced, is of a different and inferior type. Incomprehensibly, we are dependent upon sensation; and incomprehensibly, we place our sensations in time and space. Fourthly: if we try to think of objects *not* built up out of sensations and *not* in time and space, we are

[1] *Deontology*, p. 42. F. H. Bradley (*Ethical Studies*, p. 2) quotes an even plainer attack on the conceptions as well as the terminology of ethics in a *Westminster Review* article (Oct. 1873, p. 311) which describes "responsibility" or (*sic*) "moral desert in the vulgar sense" as "horrid figments of the imagination."

[2] Any attempt to treat "cause" as pointing to a truth here, but inadequately, would lead us beyond intuitionalism into some phase of idealism. To revise one's first principles is to be an intuitionalist no longer.

[3] Austin's *Jurisprudence* explicitly assumes that the dilemma of "intuitive" and "utilitarian" is exhaustive. Hence F. H. Bradley's characteristic protest (*Ethical Studies*, pp. 82, 83): "If we wished to cross an unknown bog, and two men came to us of whom the one said 'Some one must know the way over this bog, for there must be a way, and you see there is no one here beside us two, and therefore one of us two must be able to guide you. And the other man does not know the way, as you can soon see: therefore I must'—should we answer, 'Lead on, I follow'?"

baffled by contradictions or absurdities. Kant admits that we necessarily aspire to think of such objects—"God, the World, the Soul"—possibly this alleged tendency of our thought is already implied in the dream of a "perceptive understanding." But speculative knowledge breaks down or breaks off at an earlier point. If we try to know the soul, we grasp at a phantom. The self is always subject in consciousness and never can become an object of knowledge ("Paralogism of Pure Reason"). If we try to know the real world, we find ourselves distracted by opposite arguments ("Antithetic of Pure Reason"), plausible and resistless in attack, helpless in defence. The only thing which the "Ideas" of "Reason" can do for theoretic knowledge is to exert a "regulative" function. They teach the inferior but working part of our intellect, the "Understanding," that its picture of sensuous reality envisaged in time and space must be as fully articulated as is possible—as much differentiated into detail, and as perfectly integrated again into unity and system. God, for Pure Reason, is an illegitimate personification of the idea of perfected experience ("Ideal of Pure Reason"). Fifthly. there are fixed limits to the possibility of improving the quality of experience. Sense-knowledge is an endless process, inconsistent with the requirements of thought. We can by no means regard the physical world as the real world. But we possess knowledge of the physical world and of it alone. "Things in themselves"—whether defined by Kant, illogically enough, as causes of sensations, or again defined by him as the ultimate realities towards which thought vaguely points—in either case, "things in themselves" are unattainable by any definite knowledge. Our "reach" exceeds our "grasp" with a vengeance.

Kant's practical certainty.

So far as a remedy for scepticism is found at all, Kant places it, not within theoretic knowledge, but in moral or "practical" experience. Pure knowledge, for man, moves among a world of shadows; duty is certain. Mansel charged Kant with inconsistency in this preferential treatment of the moral consciousness; all our knowledge, even in moral things, was "relative" and was "regulative."[1] But, whether consistent or inconsistent, Kant was deliberate in differentiating between the ethical and the theoretic knowledge of man. "Analytic" or tautological thought does not become "synthetic" or capable of embracing a real content except under the sting of sensation; why sensation should thus help it is obscure, yet the fact is plain. But analytic thinking is victorious in morals, where the test of *formal self-consistency* distinguishes virtue from vice. The good man is the perfectly rational or perfect self-consistent man; and that is a full account of virtue, though Kant professes to re-interpret it still further in a much more positive sense as implying the service of humanity. True, at a later stage, the opposition of sense and thought reasserts itself strongly with Kant even in ethics. We are allowed moral certainty, but are forbidden the hope of genuine moral victory. Just as our knowledge never can finish its task of reducing world-experience to an intelligible system, so our will is never once able perfectly to obey the law of reason. There is always a taint of feeling in man's goodness. This portion of the ethical theory does curious service in Kant's doctrine of religion. That doctrine runs, briefly, as follows. Duty must be accepted as a given certainty, or it is vindicated—unsatisfactorily enough, perhaps—in the way just explained. Next, from the certainty of duty we infer as our first moral postulate free will—"I can because I ought"; which, primarily at least, means "I know I can because I know I ought." But this strong assertion is greatly qualified when Kant recurs to what he considers the least discredited portion of our theoretical knowledge. In the world of phenomena, not freedom rules but determinism. Causality is one of the "categories" which our mind uses in building up orderly experience. So we are left with a see-saw. Will is noumenally free; but phenomenally, in all real exercises of will, we are determined by the past. Secondly: from the discrepancy between the pure abstract law of self-consistent reason and the pleasure-tinged nature of man, we infer or postulate Immortality. As we never can hit the bull's eye, we must have literally endless opportunities of aiming at it, so as to get indefinitely nearer the central spot. If we did hit the exact mark, apparently we need no longer be immortal. Lastly, God. We must not, we dare not, aim at happiness. It is an eternal weakness in our moral being which makes us constantly squint aside from the thought of duty towards the forbidden motive—wincing under pain, or hungering after joy. Yet, if the motive is forbidden us, it is plain from another point of view that good persons ought to be happy. And, as nature reveals no great care for this postulate, we must appeal away beyond nature to a power who shall make good men at the last as happy as they deserve to be. And this power is God. Such is the train of thought as stated for us in the *Critique of Practical Reason.*

Later form; Critique of Judgment.

In the *Critique of Judgment*, Kant restates his new type of theistic argument in a way which has had great subsequent influence. We must conceive nature as overruled by God not so much for the sake of man's happiness as for the sake of his moral development. Or, to state this as a theistic argument: we are bound to postulate a God who overrules nature for moral ends. This new statement has at least the merit of bringing God into touch with man's goodness as well as with his happiness. But the train of thought is deeply embedded among characteristic sceptical hesitations. In spite of the various details of the *Judgment* Critique (as to beauty; and as to the "internal" or as Hegel subsequently phrased it "immanent" adaptations seen in living organisms) Kant regards as extremely precarious all these hints of a higher view of nature. Nature as a machine, governed by changeless causal law, is necessary to thought. Were no such machine recognized, the thread of consciousness would be cut and orderly experience impossible; we must all go mad.[2] But nature breathing of life, or of beauty, or, however faintly, of a God immanent in the whole process, and shaping it towards moral purposes—that is or may be no better than a subjective dream. It is doubly uncertain. It has inferior guarantees, as compared with our knowledge of the mechanism of nature. And, after all, not even our knowledge of the mechanism of nature is a knowledge of reality. Things as they truly are lie wholly beyond our poor human vision.

Kant's imperfect unification.

Kant then has broken away from intuitionalism by substituting *one system of necessity* for the many necessary truths or given experiences from which intuitionalism takes its start. But there are gaps in Kant's system—a gap between sensation and the sense-forms of time and space; a gap between sense-forms and thought; a gap between the lower but practicable processes of the Understanding and the higher but unrealizable ideas of Reason. And thus Kant's idealism is incomplete. On one side, the world we know by valid processes of thinking cannot, we are told, be the real world. Or, beginning from the other side; neither the reality which ideal thought reaches after, nor yet the reality which our conscience postulates, is the valid world of orderly thinking. The great critic of scepticism has diverged from idealism toward scepticism again, or has given his idealism a sceptical colour, mitigated—but only mitigated—by faith in the moral consciousness. If there arises a system of philosophy in which all truths are grasped in unity, and it is seen that the principles of things *must* be what they *are*, such a philosophy will give us in perfection the idealistic conception of reality and the idealistic guarantees of truth which Kant gave brokenly. The Absolute Idealism of G. W. F. Hegel was such a system.

Hegel.

It ranks, up to our own day, as the last of the great philosophies, and the boldest of all. Kant had fewer isolated points of departure than intuitionalists; yet gaps and isolation recurred in Kant, and helped to make him the father of modern agnosticism. In the later intuitionalism of Hamilton, recoiling from Hegel, the many subjective necessities of the intuitionalist scheme were made to breathe the new agnostic suggestions. We *necessarily* think as we do—but only because of our entangling faculties. It is a mental "impotence" that makes us believe in such a law as Cause and Effect. Kant had substituted one great necessity, sprung from an ideal source. Reason—under conditions of sensation—created the world of (valid) knowledge; Reason created the practical world of duty. But, having said this, Kant went on to repeat the sceptical suggestion. The whole coherent necessary world of his philosophy became "our world," *as we necessarily think it*, but not by any means of necessity the world *as it is*. Hegel brushes aside all these hesitations. His *Philosophy of Nature*—one of the least admired parts of his system—is the answer from his point of view to Kant's assertion that a "perceptive understanding" is for us impossible. Hegel offers a supposed proof that Time and Space, Matter, Nature, are ascertainable and definable

[1] Mansel's term for Kant's "practical." It must be carefully distinguished from Kant's "regulative," which refers to knowledge—regulative in contrast to *constitutive* of knowledge—not to practice.

[2] This is Kant's positive refutation of Hume's scepticism.

necessities in a reasonable universe. Rational system is the first and last word in this philosophy. The element of givenness, dominant in empiricism, and partially surviving through intuitionalism even into Kant, is sublimated in Hegel's thinking. Everything is to be exhibited, in outline or in essence, as the working of necessary truth. You need not wish anything in the universe to be other than it is; as well grumble at once that two and two do not make five![1] Hegel will allow no dualism of fact and principles. Nothing is bare fact. Philosophy will show you that everything *has to be* so and so. The effect of this point of view in regard to moral perceptions is that they represent an important relative truth, but that philosophy "passes" beyond them "into a higher region, where imputation of guilt is" absolutely "meaningless"[2]—*jenseits des Guten und Bösen.* More peculiarly his own is Hegel's great doctrine of contradiction, whereby opposing views of truth rank as stages in one progressive definition. We may explain this to ourselves as an extraordinarily vehement recoil from Kant's deification of formal logic with its principle of "analytic" tautology. As a result, Hegel's system undertakes to show candid minds that incompatible assertions not only may but must both be true.[3] Through this unexpected and obscure principle of "dialectic"[4] Hegel claimed to fulfil his programme of interpreting everything as manifest necessary truth of ideal relationship. It all *must be so* and *you see it must.*

The "Dialectic" method.

Hegel wrote extensively upon religion, especially in his *Philosophy of Religion.* Yet it remains doubtful whether he was a theist with large pantheistic elements—such as every speculative mind will be likely to incorporate in theism—or a pantheist rejecting theism altogether. We may regard his ambitious programme as the last logical development of idealism and indeed of philosophy itself. If perfect knowledge be possible for us, it must take the form of such a system as Hegel offers. If the world exists purely to be known, and if every other working of reason comes into consideration *qua* incomplete knowledge, Hegel is right with his sweeping intellectualism. Or at least he has rightly seen what are the assertions to aim at; it is difficult to accept the principle or method upon which his answer to the riddle proceeds, the dialectic method. Perhaps it was necessary for human thought to try how far it would carry out this programme. And yet perhaps full success was neither possible nor desirable. If such are our conclusions, we return to a possible basis for theism not very far removed from that of intuitionalism. Certainly history shows that theism has generally been associated with some reduced or limited form of philosophy, usually with the intuitionalist scheme. It is not the first runnings of the stream of religious thinking which have given the world its theistic philosophies. Theism is an afterthought—the reply to doubt—the attempted reflective justification of what announced itself at first as a prophetic certainty. But no more is theism the first runnings of the stream of philosophy. It is philosophy harnessed to a practical and religious interest. It is philosophy called into court to answer selected questions.

Ambiguities on religion.

Theism then has its most habitual affinities with intuitionalism, but may fall under any one of our philosophical or *quasi* philosophical types. We have distinguished three types or tendencies: empiricism, intuitionalism, idealism. They deal respectively with what is—partly with what is and partly with what must be—with what must be. They are based on facts—upon facts in the light of principles—upon principles purely and ultimately upon one principle. They claim probability—moral certainty—mathematical certainty. They incline to the Design Argument and Analogy—to the Cosmological argument (with other elements in a subordinate place) and proof by inference—to the Ontological argument. This last and boldest argument is a system of idealistic philosophy in a nutshell. When such a system is worked out in full detail, it essays or ought to essay a proof of the following points: (1) God or the Absolute necessarily exists; (2) He necessarily is what He is; (3) He or it necessarily manifests itself in the finite, (4) and necessarily manifests itself in just this finite which we know from experience. If philosophy is able to fill up that programme, it justifies itself; it raises all belief to necessary truth; and whether its teaching be theistic or pantheistic, pantheism or theism, whichever turns out victorious, must henceforth rank as a demonstrated certainty.

Again, these contrasted philosophies throw light upon the meaning of *a posteriori* and *a priori* in Kant and subsequent writers.[5] To empiricism, all is *a posteriori.* To intuitionalism, half is *a posteriori* and half *a priori.* To idealism, all is *a priori.* Not that *a posteriori* is denied, or that idealism even in Hegel tries to evolve reality out of the philosopher's inner consciousness. Mere given fact may be the starting-point; but it is sublimated. We see by degrees—in general outline or upon general principles[6]—that *what is* is no other than *what must be.*

"A posteriori" and "a priori."

There is another conception of necessity which has established itself in the history of science and philosophy. We may call it mechanical necessity. If this conception is regarded as full and absolute truth, it involves materialism. When we recollect the empiricist starting-point of science, it is curious to observe with what vehemence the average man of science now rejects free will. To him, it *cannot* be true. William James stood almost alone in being prepared to go anywhere at the bidding of apparent facts, unconcerned about rational probabilities. On this ground James is a libertarian. The fact appears to be so; he reports it. Similarly, James is willing to believe in many universes *nebeneinander* or *durcheinander* but not *ineinander.* Dualism, pluralism, manifold parallel inconsistency may belong to the nature of fact. Does our intelligence demand unity? That may be a mere subjective fancy. Even polytheism,[7] or something indistinguishable from it, is suggested to this doggedly empiricist mind by the *Varieties of Religious Experience;* they are all good to those to whom they appeal; and what right have we to talk of objective standards?[8] Ordinary "inductive" empiricism shows that it has travelled far from this unprejudiced credulity when it asserts its hard determinism—uniform law, never broken, never capable of being broken. But what is mechanical necessity, if we admit that in some sense it exists? It is a *relative* necessity. The present and the future have to be what the past and the absent make them. Past events, "happening" to be what they were, have fixed subsequent processes to their channels. But you can never, at any one point, say, from the scientific or mechanical or materialistic standpoint, this "had to be."[9] The relative necessity never passes into an absolute one. A different primitive "collocation," as T. Chalmers[10] put it, would have yielded, by the same process of natural law as ours, quite a different universe from ours.[11] T. H. Huxley admitted that this contention could not be ruled out as impossible. Again, in the scheme of mechanism, everything is determined by everything else—in

"Mechanical necessity."

[1] "It may be asked, Why can God not *create* a triangle whose three angles shall not be equal to two right angles? *To abstraction and ignorance everything is possible.*" From notes of a class lecture by Dr E. Caird.

[2] F. H. Bradley, *Ethical Studies*, p. 4.

[3] J. E. MacTaggart (*Studies in Hegelian Dialectic*) contends that direct contradiction is confined to the elementary portions of Hegel's *Logic*: but he does not deny its existence there, though his interpretation, could one accept it, softens the paradox.

[4] Used by Kant sceptically of the limitations of reason, dialectic in Hegel becomes constructive; and scepticism itself becomes a stage in knowledge.

[5] (1) Aristotle and the schoolmen meant by a proof *a priori* reasoning from cause to effect. (2) Kant is often supposed to mean by *a priori*—see Hamilton's *Reid*, p. 762—"innate" as opposed to "acquired from experience." (3) If we accept the suggestion offered above—that *a priori* in Kant and later thinkers = necessary—we place ourselves on the track which leads from intuitionalism to some form of idealism.

[6] Why only in such general terms? But this limitation is always taken for granted.

[7] It does not seem as if James's "Pragmatism" could lend itself to anything so concrete as a theistic conclusion.

[8] A very different thinker, Dr J. E. MacTaggart, works round from idealism to an eternal *quasi* polytheistic society of equal souls.

[9] H. Spencer's "instability of the homogeneous" is perhaps an attempt to perform the impossible (*First Principles*, chap. xix.).

[10] Quoted in J. S. Mill's *Logic*, and with fuller sympathy in W. S. Jevons's *Principles of Science.*

[11] God has ordered the original "collocation"—a new statement of the argument which traces Design in nature.

space as well as in time; nothing does anything for itself. Yet again, nature is broken up into co-operating parts; the whole is the sum of these parts; or, if you prefer to say so, there is no whole. But, if we should take the view that nature is infinitely extended—part of the "Antithesis" in Kant's first "Antinomy"—relative necessity breaks down on the last analysis, since boundless nature may overwhelm that sequence which we thought most securely established. Who can say what may emerge from an infinite background? We reach similar conclusions when we recognize that the laws of nature are general or hypothetical; not in Mill's sense ("If you *had* such a non-existent thing as three perfectly straight lines united in a triangle"), but in a sense noted in F. H. Bradley's *Logic:* "If" or "*As often as you have* the cause working unimpeded, you get the effect." Pure scientific theory cannot tell you when you have got such a cause, or whether you ever get it at all. No law of nature contains in itself a promise that it shall pass into operation. Its doing so depends upon the totality of conditions. Materialism supposes that this mechanical order is the real world and the only real world—mechanical monism.[1] Intuitionalism supposes that there are two realms—of necessity and freedom, of nature and will, of matter and mind; contiguous, independent, yet interacting—dualism. Idealism in one way or other supposes that mind is more real than matter. And thus its first programme—*All is in accordance with reason*—may pass into the more doubtful programme *All is reason*, in one of the two forms (*a*) nothing exists but mind (*e.g.* Hegel, as often interpreted—pantheistically?) or (*b*) *nothing exists but minds* (*e.g.* Hegel, as interpreted by Dr MacTaggart). Anyhow, whatever the method or interpretation is to be, idealism, even more fully than materialism, is pledged to monism and to the rejection of dualism. The valid or scientific but metaphysically untrustworthy knowledge, to which Kant shut us up, was knowledge of a mechanical universe. His reply to

Kant's reply to Hume.

Hume was this—Mechanical causation is as real as the unity of consciousness. It is false to suggest that sequence is a fact and causal connexion a figment; apart from causal connexion, there could be no consciousness of sequences. Over against this "valid" mechanism, in some truer but vaguer region, Kant placed free will; and so left things. The English thinkers influenced by Hegel are inclined to assert mechanism unconditionally, as the very expression of reason—the only thinkable form of order. Thus libertarian free will has to disappear from their belief. In this interpretation of the universe, the difference between mechanical or relative necessity and absolute or ideal necessity is slurred, or dogmatically affirmed to be non-existent. It might be suggested in reply that free will, whether or not it be ultimate truth, is true to the same degree of analysis as mechanical necessity itself. Mechanism is that which obeys impulses from outside. It is profoundly unsatisfactory to regard mechanism as the whole ultimate truth. For such a rôle it is in no sense fitted. If it is ultimate truth in its own region, that region cannot be accepted as more than half the entire universe of reality (common sense intuitionalism; dualism). If mechanical determination applies to the whole universe, it cannot be ultimate truth at all (cf. H. Lotze; more drastic in Ward's *Naturalism and Agnosticism*).

Quite a different view of necessity is the *moral* necessity pointed to by Kant's "Practical Reason." And, as the sym-

Moral necessity; Kant.

pathizers with Hegel try to force mechanical necessity into the garb of absolute or ideal necessity, so they seek to show that moral necessity is only an inferior form of absolute or ideal or, we might say, mathematical necessity. Theists, on the other hand, will contend that the distinctiveness of moral necessity is vital to religion. Thus we might restate our grouping of philosophies in terms of the views they take regarding necessity. Theism is directly interested in this, since it affirms the *necessity* of God's existence. At least, it would be hard to name any school of theists which was content to affirm that there "happened" to be a God.[2] On the other hand, theism does not desire to see necessity—or Fate—ranked as superior to the living God.

Evolution.

One great change and only one since Kant's day has affected the outlook upon theistic problems—the increasing belief in evolution. It is a manifest weakness in intuitionalism that it finds such difficulty in leaving room for evolutionary change. All men may perhaps be aiming everywhere at the same moral ideal,[3] but it is absurd to say that all men actually formulate the same moral judgments. On the other hand, many evolutionists ignore the certainty that there must be a *continuum* in any real evolutionary process. In the light of that truth, a reformed intuitionalism might justify itself. But fuller conceptions of evolution raise further difficulties for intuitionalism in its wonted forms. Knowledge cannot be divided into the two components—immediate certainties, precarious inferences. The starting-point is reconsidered, modified, transformed, in the light of subsequent acquisitions. Knowledge grows, not by mechanical addition, but by organic transformation. This may help us to appreciate the meaning of Hegel's Dialectic. His thought then is not wholly paradox, whatever the expression may be. Hegel's system is, in its own way, a great evolutionary philosophy of an ideal type.[4] Evolution, repelled by the older intuitionalism, was thus incorporated in the greatest of all idealisms. It has also been largely applied to empiricism. Sometimes one questions whether empiricism is really still empiricist; so much of the *a priori* has come in under the name of evolution (*e.g.* in Herbert Spencer). But the change, if it has taken place, is unrecognized.

Outline history of theism. Socrates.

IV. Greek philosophy for our purpose begins with Socrates, who formulated the Design Argument. His ethics have sometimes been regarded as pure utilitarianism (so *e.g.* H. Schultz); but it is surely significant that the great idealism of Plato was developed from his suggestions. The new method of definition which Socrates applied to problems of human conduct was extended by Plato to the whole universe of the knowable. In the light of this, it may be possible (with J. R. Seeley in *Ecce Homo*) to call Socrates the "creator of science." The man who inspired Plato deserves that name. Those Ideas according

Plato.

to which all reality is objectively shaped—and therefore too, as a modern would add, subjectively construed—include the idea of the Good, which Plato identifies with God. We might mislead ourselves if we interpreted this expression as referring to moral goodness; on the other hand, Plato more than most of the Greeks thinks of moral virtue as an imitation of God. With all its idealism, Greek thought had difficulty in regarding rational necessity as absolute master of the physical world. Matter was a potentially recalcitrant element. Hence there are tendencies even in Plato to build up the ideal world in sharp contrast to the actual world—to the half interpenetrated or half tamed world of matter. His suggestions as to immortality are affected by this. The body is the soul's prison. He teaches (whether suggestively, metaphorically or deliberately), pre-existence[5] as well as survival; perhaps he is moved to this by non-Greek influences. Thus at several points Plato reveals germs of dualism and asceticism. Free will had not yet been formulated as a problem. Aristotle has impressed the ordinary mind chiefly by his criticism of Plato's

Aristotle.

ideal theory; and therefore he is often ranked as the father of *empiricists*. But those who treat him as the great

[1] Ernst Haeckel will not allow us to call his system "Materialism," because he affirms that the rudiments of matter are also rudimentary "mind stuff" (to use W. K. Clifford's term). But in spite of this its materialistic affinities are unmistakable.

[2] Still, Lotze's criticism of the cosmological argument reveals his realist side. On the other hand, in discussing the ontological argument, Lotze commits himself to a moral *a priori* (below, *ad fin.*).

[3] "We are all embarked upon a troublesome world, the children of one Father, *striving in many essential points to do and to become the same*" (R. L. Stevenson).

[4] The idea of evolution *in time* (physical evolution) was laughed at by Hegel.

[5] A belief hinted again at the close of Lessing's *Education of the Human Race*; also—more definitely—by J. E. MacTaggart (*Studies in Hegelian Cosmology*, p. 48; and elsewhere).

Realist make him almost if not quite *intuitionalist*; while there is also an *idealist* reading possible. The threatened dualism of ideal and material becomes for Aristotle mainly a contrast of matter and form; the lower stage in development desires or aims at the higher, matter more and more tending to pass into form, till God is form without any matter. But this God of Aristotle's is a cold consciousness, imitated only by the contemplative virtue of the philosopher, not by the morally active citizen. And the chief contribution of Aristotle to theism is a theory, found in his *Physics* as well as his *Metaphysics*, of God as first mover of the universe, himself unmoved. This theory is generally ranked as the earliest appearance in European thought of the cosmological argument. Free will is shaping itself towards discussion in Aristotle's *Ethics*, but is hardly yet a formulated problem. For anything like personal immortality the medieval Schoolmen searched him anxiously but in vain.

Epicureanism need not detain us. It is a system of empiricism and materialism, remarkable only for teaching free will. Atoms swerved as they fell endlessly downwards, and thus introduced an indeterminate or irrational element into the processes of the world. Theism can take but little interest in this peculiar type of free will doctrine, or again in Epicurus's professed admission of the existence of gods—made of atoms: inhabiting the spaces between the worlds; careless of men. **Stoicism.** Stoicism is a much more important system, but harder to classify. Perhaps in the department of thought where it is most in earnest—in ethics—it is an idealism. It tells men to "obey reason" and crush passion, or to live "according to nature." In physics—but in that region of speculation its positions are more perfunctory—it teaches pantheism on a *quasi*-materialistic basis. God is the soul of the world, although the gods of popular belief are (at least by the later Stoics) respectfully if exoterically acknowledged. Human survival is taught, but not ultimate immortality; and, as against Epicureanism, Stoicism on the whole tends to deny free will. There is perhaps a certain religious enthusiasm in the thought of being passively determined by Fate, the Universe, Zeus. Finally, the Stoic analysis of the process of knowledge is sensationalist and empiricist.

So far as a coherent body of theistic doctrine exists, it did not grow out of the great systems, but out of the lesser men who stood nearer to the apprehension of practical citizens. Perhaps the most important of these popular thinkers was Marcus Tullius Cicero—no great philosopher, but a graceful and effective man of letters. **Cicero.** It has been truly observed[1] that the lineaments of intuitionalism are very clear in him. He also gives us "natural law"[2]—a Stoic inheritance, preserving the form of an idealist appeal to systematic requirements of reason, while *practically* limiting its assumptions to those of intuitionalism. Formally, Cicero adhered to the Academic[3] philosophy during its "middle" or almost sceptical period. (The senses are so far from truth that we must be content with reaching probability.) In Cicero's *De Natura Deorum* the burden of theism rests mainly on the Stoic interlocutor. The conclusion, "academically" recognizing the contendings of one disputant as more "probable," is imitated in D. Hume's *Dialogues Concerning Natural Religion*. In the great Roman Stoics—Seneca, Epictetus; less material for theism perhaps in Marcus Aurelius—**Seneca.** we see the partial softening and religious deepening of the system, and a doctrine of the wise man's power over passion and circumstance which has all the essentials of Libertarianism. Philo of Alexandria should also be mentioned. **Philo.** He blends the tradition of the Old Testament with Greek philosophy, and, within the latter, exhibits that union of Platonism with Stoicism, especially in the doctrine of the Logos, which became dominant in the Christian apologists and the great theologians of the ancient church. Philo is Greek enough to believe in the eternity of matter; otherwise he preserves the main outlines of Old Testament theism. He teaches free will and immortality; and the design and cosmological arguments are both traceable in him. Augustine of Hippo transmits a type of Platonism as part of his legacy to the **St Augustine.** Western church. Against Manichaean dualism he had vindicated free will; but as against Pelagianism he taught the bondage of sinful man—a position accepted in the East but never welcome there, and not more than half welcome even in the West. From this theological entanglement the problem of free will did not escape for long centuries. In spite of some waverings towards what has lately been called "conditional immortality" (see APOLOGETICS) the doctrine of "natural immortality" championed by Augustine became dominant in the church; an instalment of what was afterwards to be called Natural Theology; and a postulate or presupposition to-day—like free will—in Roman Catholic apologetics.

[1] D. G. Ritchie, *Natural Rights*, p. 36.
[2] See above (*ad init.*).
[3] Platonic.

The middle ages, in the person of Anselm of Canterbury, contribute the first clear form of the Ontological argument for theism. If our grouping of philosophies, as given above, is sound, **Middle ages.** every idealist scheme contains potentially an ontological argument. In other words; whenever philosophy teaches a doctrine of the Absolute, and regards such doctrine as valid and certain, we have the essence of an ontological or *a priori* argument. Of course it remains debatable whether this philosophical Absolute is necessarily interpreted as a personal God, or perhaps even whether logically it can be. But the Christian bias is sure to make theologians, who borrow a doctrine of the Absolute, interpret it in a Christian sense; hence we may consider it something of an accident that even an Augustine fails exactly to put the argument in form. Anselm tells us that a most perfect being must exist, since the perfection which includes existence is manifestly greater than a perfection confined to an object of thought. Some of the impression of paradox here is due to Anselm's treating the Absolute simply as one among many other beings, and to his treating existence simply as one element in the quantitative sum of perfections. At least, idealist philosophy will hold that the substance if not the form of the argument is sound[4] though the question of its interpretation remains. In Anselm's case we have the further sanguine hope of justifying not theism merely but all Christian doctrine to the scientific reason. Thomas Aquinas, following Albertus Magnus, but with greater power and greater influence, occupies substantially intuitionalist ground. He will not have the Ontological argument; but he asserts Natural Law, and relies upon the cosmological and design arguments—with various refinements and distinctions, differently stated in his two *Summae*. In declaring the supreme doctrines of Christianity to be mysteries above reason, he marks off a lower region where reason is to reign; the study of that lower region may well be called, as later centuries have called it, Natural Theology; and as such it presents strong intuitionalist affinities. The critics of Aquinas—Duns Scotus and the later Nominalists—show some tendency towards rational scepticism. They exercise their acumen in multiplying difficulties; but all such questionable doctrines are presently re-established from a different point of view as truths of faith or findings of church authority. The Church of Rome has discouraged these daring tactics in favour of the more cautious and probably more defensible positions of Aquinas. In Raymond of Sabunde's form of moral argument—there must be a God to reward and punish, if human life is not to be "vain"—we see the kinship of that argument to the argument from design.

René Descartes, a faithful though not an unsuspected Roman Catholic, founded modern philosophy by his starting-point of universal doubt and by his arguments in **Descartes.** reply. One may regard him as an idealist, though Scottish intuitionalism—especially in the writings of Professor John Veitch—has claimed him for its own; and indeed Descartes's two substances of active mind and passive extended matter are very much akin to "Natural Dualism." Still, Descartes has marked idealist traits, as when he refurbishes the ontological argument with clearer emphasis on the perfect being as "necessarily" existent[5]—reasoning a shade less quantitative or a shade more subtle than Anselm's. Descartes's preliminary statement of the argument in somewhat popular form brings it very near the lines of the cosmological proof.[6] There must be a *cause* for nature, but particularly for the idea of perfection in us—that cause must be God. The radical side of Descartes appears again in his offering his own type of theism as a substitute for the old proofs—not a supplement. Design especially was under suspicion with him. He was even more definitely opposed to "final causes" than Francis Bacon, who excluded them from science but admitted them to theology. All this was connected with zeal for physical and mathematical science. Descartes was an expert; Bacon was the prophet of a great, if half comprehended, future; and the science they loved was struggling for its infant life against a mass of traditional prejudices, which sought to foreclose every question by confident assertions about the purposes of God and Nature. A difficult question arose for Descartes's philosophy, when it had to explain the union in man of the absolutely opposite substances,

[4] Cf. J. E. MacTaggart in regard to Hegel, *Studies in Hegelian Cosmology*, chap. iii.
[5] So *Meditation* 5, at least in the French version. Again: "Existence cannot be separated from the essence of God"; compare Spinoza's ethics, definition 1; "By *causa sui* I understand that the essence of which involves existence, or that which by its own nature can only be conceived as existing."
[6] *Meditation* 3.

mind and matter. Malebranche gave all causation to God; and the acosmist—as Hegel called him, in repudiation of Bayle's nickname "atheist"—Spinoza, from the premises of Cartesianism, and from other suggestions of the past, developed that great system of determinist pantheism which was a scandal and a terror to his generation. Really, he urged, there could be only one substance—Descartes himself had dropped a passing hint to that effect—and the bold deductive reasoning of Spinoza's *Ethics*, in process if not in result, betrays its kinship to the ontological argument, with its affirmation of what *must be*. Thought and extension are peaceable attributes in this one substance; there are infinitely many other attributes, but these only are known to us.

Spinoza.

In a different region, the tradition of Descartes passes on to G. W. Leibnitz. He accepts the ontological argument with a qualification—almost like his disciple Wolff, who tries to use it for *defining* the divine *attributes*. Leibnitz's Monadology—which has little influence on his theism—may be viewed as a strong recoil from Spinoza's all-swallowing substance. The more Spinozistic side of Leibnitz's thought—God as Monad of Monads—is a theistic postulate if hardly a theistic proof. The free will which Leibnitz teaches is not libertarian but determinist. Each monad works out necessary results, but these flow from its own nature; and so in a sense it is free. Reciprocal action is explained away into a "pre-established harmony" between every monad and all others. In his *Theodicy* Leibnitz argues, like not a few predecessors, that this universe must be regarded as the best of all *possible* universes. Pain and sin *must have been* reduced to a minimum by God; though they are so ingrained in the finite that we have to make up our minds even to the endless sin and endless punishments of hell. It has been truly said that such optimism is a profound relative pessimism. The best? Yes, perhaps the best *possible*; in familiar speech, the best of a very bad business. But why must universes be so bad? Leibnitz's philosophy has no answer for us. In another direction, Leibnitz—and Wolff—give emphasis to the contrast between the *necessary* and *the contingent*; with important results for popular philosophy, and indirectly for theism. The disciple, Christian Wolff, is one of the most typical figures in the history of theistic thought. He is a pure scholastic. The great thoughts of his master—or perhaps indeed rather Leibnitz's secondary thoughts—are dried and pressed by him, labelled and catalogued. Monadology drops out of Wolff's teaching. Pre-established harmony drops out—except that it is used to explain the union of soul and body. Wolff tells us that six Latin works contain his system:—*Ontology*, *General Cosmology*, *Empirical Psychology*, *Rational Psychology*, *Natural Theology*, i.; *Natural Theology*, ii. In the volume on *Empirical Psychology*, Wolff discusses free will. He decides that human actions are caused or determined by the nature of the agent, but that, as man is not a necessary being, his actions are contingent. This view seems to preserve all that is questionable in Libertarianism, while omitting its moral meaning. The *Rational Psychology* formulates immortality on the ground that the immaterial soul has no parts to suffer decay— the argument which Kant's *Critique of Pure Reason* "refutes" with special reference to the statement of it by Moses Mendelssohn. The earlier of the two volumes on *Natural Theology* relies on the cosmological argument; the later—obviously an afterthought—tries to vindicate the ontological argument as an alternative basis for theism, but awkwardly and with manifest uneasiness. In the end, this volume diverges into the *Attributes*, construing God in the likeness of man *via eminentiae*.[1] No writer can be less intrinsically worthy of study than Wolff. But he is immortal as the man against whom Kant directed his tremendous battery;[2] and he is also tolerably characteristic in outlook. He is no intuitionalist; but he is a drily common-sense mind, piling up in heaps the ruinous fragments of an idealist system.

Leibnitz.

Wolff.

[1] Human attributes magnified, or their weak points thought away. The Schoolmen sought to establish other divine attributes by *negation* of human weaknesses and by finding in God the *cause* of the varied phenomena of creation.

[2] On one side; another battery of Kant's was aimed against Hume.

In England, empiricist thought found a prophet in Bacon. He draws no inferences to theology or religion, whether friendly or hostile, from his new positions. He takes the line of separating the things of God from those of Caesar, and defends the traditional Protestant theology with obvious sincerity. Thomas Hobbes, a rough and anomalous but vigorous thinker, is the fountainhead of a more formidable empiricism. He is almost a materialist. In ethics, he is a hard determinist and hedonist, though not without qualifications (man's boundless desire for "gain and glory") and peculiarities. He saves himself theologically by affirming that the good citizen will be of the same faith as the government —which had best be a monarchy. In that sense, living under a professedly Christian ruler, Hobbes himself is a Christian. John Locke, the real father of English philosophy, took the field against what he regarded as Descartes's impossible programme of "Innate Ideas."[3] But Locke is a double-minded or half-hearted philosopher. He admits two sources of knowledge—sensation and *reflexion*; and God is to him the Great First Cause, especially of our own existence (or of the existence of *finite minds*). This is a form of the cosmological argument, and ought to go with an intuitionalist not an empiricist doctrine of causality. On ethics, Locke says very little, although that little is hedonist and determinist. But once again in his political writings he breaks away from empiricism in appealing to *natural law*—an intuitionalist or conceivably an idealist tradition. Locke is thus a sensationalist and empiricist, but incompletely, and without perfect coherence. His suggestions led to different developments. In France, through Condillac, the inconsistencies were purged out, and materialism was ready for the next comer to affirm—though it may be said with R. Flint that while materialism requires sensationalist psychology, yet the psychology in question allows no valid inference to matter, and therefore destroys materialism. Bishop George Berkeley, afraid of materialistic developments from a philosophy he was not prepared fully to recast, took refuge in immaterialism. Locke had treated ideas as testifying to the existence of matter. But can they? The inference seemed unwarrantable. Why should not God, a spirit like our own, though greater, speak to us in this language? In *Alciphron or the Minute Philosopher* Berkeley gives the fullest statement of this argument, while adding more commonplace attacks on the *pettiness* of religious scepticism. David Hume, following up Berkeley's leading suggestion, pointed out that the inference to God is as precarious as the inference to matter, and that the assertion of a continuous or immaterial mind in man also goes beyond the immediate facts. The truth is, that all truth is uncertain! Scepticism, with which P. Bayle had played as a historian—he amused himself, too, with praising the Manichaean solution of the riddle of the universe—became a serious power in the history of philosophy with the advent of David Hume. Still, it may be doubted how far Hume was in earnest. Nay, it may be questioned how far it is either psychologically or logically possible to turn general scepticism into a coherent doctrine. The *Dialogues Concerning Natural Religion* constitute Hume's formal profession of religious faith. The existence of God was no doubt probable; but what a number of difficulties there were! Still, one would not dispute whether God existed; but what he was—that was the hard question. This treatise must not be confused with the *Natural History of Religion*, in which Hume acts as a pioneer for comparative religion, with its study of facts. Even in that book Hume is able to play with sceptical solutions. Religion began in fear—as if it were no more than a lying superstition. Of course once more Hume saves himself by strong professions of admiration for rational or natural religion. It was not yet socially safe to be a confessed religious sceptic.

Bacon.

Hobbes.

Locke.

Condillac and materialism.

Berkeley.

Hume.

[3] And against similar views in Lord Herbert of Cherbury.

Samuel Clarke, who defended Newton's view of the world against Leibnitz's strictures, is perhaps chiefly interesting to us as one of the authorities of Bishop Joseph Butler. It is Clarke's defence of free will, Clarke's idealist theory of eternal "fitness" as the basis of ethical distinctions, perhaps Clarke's teaching on immortality, that Butler regards as "the common known arguments" and authoritative enunciations of truth in the regions of philosophy or Natural Theology.[1] Butler himself occupies a peculiar position in more respects than one. He has profoundly influenced British thinking, but is little known abroad. He is difficult to classify. We may be helped in assigning him his proper place if we observe that, almost invariably, he accepts certain beliefs which he forbears to press. Thus in his most important contribution to ethics, the *Three Sermons on Human Nature*—i., ii., iii. of the *Sermons*—he grants the validity of an appeal to "nature" upon the lines of a sort of Stoical idealism, but for his own part he prefers the humbler appeal to *human* nature. He makes the issue, as far as possible, a question of fact. We, from the altered modern point of view, may doubt whether Butler's curious account of the mechanism of moral psychology *is* a simple report of facts. There are (*a*) given instinctive "propensions"; (*b*) a part of higher principles, "benevolence" and "rational self-love," equally valid with each other, though at times they may seem to conflict; (*c*) there is the master principle of conscience, which judges between motives, but does not itself constitute a motive to action. Butler is opposing the *psychological hedonism*[2] of Hobbes. He does not find it true to experience that man necessarily acts at the dictation of selfish motives. But Butler—for reasons satisfactory to himself, and eminently characteristic of the man; he hoped to conciliate his age!—dwells so much upon the rewards of goodness, as bribes (we must almost say) to rational self-love, that some have called Butler himself an *ethical hedonist*; though his sermon on the "Love of God" ought surely to free him from that charge. In all this, Butler was convinced that he was giving a simple statement of facts. Any one introspectively apprehending the facts must grant, he thought, that benevolence was an integral part of human nature and that conscience was rightfully supreme. This reveals the empiricist temper, and points to an attempted empiricist solution of great problems. Butler holds that more ambitious philosophies are valid, but he shrinks from their use. The same thing is seen again in the *Analogy*. Butler divests himself in this book of the principles of "liberty" and "moral fitness" in which personally he believes.[3]

Butler.

Part i. of this book shows the "Analogy" of "Natural Religion" to the "Constitution and Course of Nature." Probably "Nature" is here employed in a more familiar or humbler sense than in the passing reference in the *Sermons*. The *Analogy* means by "nature," indisputable human experience. Deists believed in a God of unmixed benevolence; Butler's contention is that justice, punishment, hell-fire itself are credible in their similarity to the known experiences of man's life upon earth. What the *Three Sermons* sought to find written small within—a law of inflexible justice or righteousness—part i. of the *Analogy* seeks to discover written in larger characters without us. Butler is charged by Sir Leslie Stephen with arguing illegitimately—professing to make no appeal to "moral fitness," and yet contending that the facts of human life show (the beginnings of) *moral* retribution for good and evil. Assuredly Butler did not mean to give him his right of speaking about moral evil and good when he waived the "high priori" method of vindicating their real existence. Yet it is a very grave question whether the idea of God's moral government admits of being argued as pure matter of fact. Butler tries to do this. You call it unjust, he says in effect, that you should be punished. You argue, for example, that you have no free will. Well, what of that? Does it not look very much as though you *were* being punished? Does not nature seem to treat you *as if* you had free will?[4] One thing more should be noted about Butler. He nowhere formally argues for the truth of theism. He will not waste time upon triflers who deny what he thinks, in the light of the (empiricist!) Design argument, an absolutely clear truth.[5] On the whole then Butler in personal conviction is an intuitionalist, wavering towards the idealism of his age; but in argument he is an empiricist, trying to reason every question as one of given facts. None the less, in the issue, it is the very element which goes beyond an appeal to facts—it is the depth and purity of Butler's moral nature—which fascinates the reader, and wins praise from Matthew Arnold or Goldwin Smith or even Leslie Stephen. Precisely because he goes beyond phenomenal sequences, it is impossible to fling him aside unheard. On the other hand, no Christian, and perhaps no theist, is interested in maintaining that Butler grasps the whole truth. At the most we might say this: If theism is a growing doctrine, Butler in England like Kant in Germany stands for a fresh ethical emphasis.

Stephen accuses Butler of reasoning in a circle. The things which make for our ultimate welfare are the things we call morally good. No wonder if they prove to involve happiness; that is their definition! But is it? Does not Stephen himself rather say that morally good things are conditions of *social*, not personal welfare? Butler's argument is that the individual suffers (and feels that he suffers deservedly) from neglecting these. If George Eliot is guilty of a platitude when she says that "consequences are unpitying," then Butler's argument is empty: but not otherwise.

Butler on the soul may be studied in chap. i. of the *Analogy*—where we observe the old assumption of an immaterial and so immortal principle—and in his appendix on *Personal Identity*. Wherever moral postulates make their presence felt, Butler's doctrine of man, as of God, leaps into new vigour.

It is a moot point whether S. Clarke's *Demonstration of the Being and Attributes of God* is really *a priori*. Clarke appeals to the immensity of time and space as involving infinity in God. A modification of his views is the starting-point of W H Gillespie's able *Argument a priori for the Being and Attributes of the Godhead*, published part by part 1833–1872. We find something curiously similar in James Martineau's *Study of Religion* ("Implicit Attributes of God as Cause," *sub fin.*). One might also compare J. R. Seeley's *Natural Religion*—though he is no decided champion of a personal God—and F. Max Müller's *Gifford Lectures*. Dismissing his earlier intuitionalism, in order, like Butler, to conciliate an empiricist age, M. Müller tried to show that even sense experience throws us on the Infinite—which for him was the kernel of the idea of God. He therefore appealed to the Indian goddess Aditi or Immensity, a deity connected with a set of personal gods called Adityas. Looking into the immensity of space, man also looks into the depths of godhead. Whatever one may think of the cogency of such arguments, it seems safe to conclude that thinkers, who dislike constructive idealism, but accept time and space as boundless given quanta, reach in that way the thought of infinity, and if they are theists, necessarily connect their theism with reflexions on the nature of Time and Space.

We have already spoken of Kant's peculiar philosophical positions. One result of these is a very damaging attack upon traditional theism. Kant puts together, as belonging to "Rational Theology," three arguments—he is fond of triads, though they have not the significance for him which they came to have for Hegel. Then he attacks the arguments, one after another. Is there anything fresh in the attack? Or is it simply a reiteration of his sceptical contrast between phenomena and noumena, and of his confinement of (valid) knowledge to the former? Perhaps the attack on *cause* as used in the cosmological argument is independent of Kant's philosophical peculiarities. The argument affirms a first cause, or uncaused cause. Does it not then deny rather than assert universal causation? But that special criticism is a question of detail. A more entirely novel and more general principle of Kant's attack upon theism is the challenge of our right to build up the idea of God bit by bit out of different arguments. The arguments had been regarded as alternative or else as cumulative proofs, all pointing to one conclusion—God exists. Kant insists that they are incompatible with each

Kant as critic of theism.

[1] *Analogy*, part i. chap. i. ("the natural and moral proofs of a future life commonly insisted upon"); last sentence of part i., *Conclusion* ("the proper proofs of [natural] religion from our moral nature," &c.); part ii. chap. viii. *sub fin.*, "the proof" of religion, "arising out of the two . . . principles of liberty and moral fitness."

[2] These useful distinctions are stated and well explained in W. R. Sorley's *Ethics of Naturalism*.

[3] *Analogy*, iii. chap. viii.; following S. Clarke?

[4] Part ii. of the *Analogy* tries similarly to establish Christianity as credible matter of fact, sufficiently analogous to known facts of experience (APOLOGETICS) apart from any moral "value judgments" (as Ritschlians might say).

[5] See (*e.g.*) ii. chap. ix. The *Three Sermons* also point to a *moral* argument for theism, but forbear to press it (Sermon ii.; when the *third* sense of the word "Nature" is being explained).

other. They offer alternative and mutually exclusive conceptions of God. If the God of the cosmological argument is the "Great First Cause," we have no right to identify him with the "Most real being" of the Ontological argument. If the God of the Design argument seems a limited being, working as an artist upon given materials,[1] he is hardly God at all. Kant takes for granted that we cannot sum up these imperfect conceptions in a wider reconciling truth. It is a shrewd criticism, but needs arguing out. A great deal of popular theism is undoubtedly hard hit by it; for popular theism is apt to throw its arguments together in very random fashion.

It is no more than characteristic of Kant's whole speculative philosophy that he should think the Ontological argument the one which comes nearest to success (yet the Ontological argument is held to prove—or rather to point out—not that God must exist, but that we think of him as necessary if we think of him as existing at all). As a result of this, Kant is metaphysically a sort of pantheist. The God whom all our thinking feels after is the all-inclusive system of reality. On the other hand, Kant's religion is of a type which requires a sort of deistic God, standing outside the world and constraining it into moral paths, or standing outside our moral struggles and rewarding our goodness. Butler fears profoundly that there must be a just God who will punish us. Kant hopes, with tolerable strength of conviction, that there may be a just God who will reward us.

Hegel on theistic arguments.

The main line in pure philosophy runs on from Kant's wavering and sceptical idealism to the all-including gnosis of Hegel.[2] Hegel inherits from Kant the three arguments, and takes them as stages in one developing process of thought. The cosmological argument points to nature-pantheism, with the religions—especially those of India—which embody that attitude of mind. This involves a re-interpretation of the Cosmological argument, or a criticism of the view ordinarily taken of it. Trace out the clue of causation to the end, says Hegel in effect, and it introduces you, not to a single first cause beyond nature, but to the totality of natural process—a substance, as it were, in which all causes inhere. This is a suggestion which deserves to be well weighed. The Design argument is held to give a contrasted view. It suggests in every deed a personal but limited God, or a number of Gods—"Religions of spiritual Individuality," including, along with "Judaism," the anthropomorphic religions of Greece and Rome. Finally the Ontological argument sums up the truth in the two previous arguments, and gives it worthier utterance in its vision of the philosophical Absolute. This is the last word of religious truth, though pure philosophy stands still higher. And, in some sense not clearly explained, Hegel identifies this final religion with Christianity.

Theism after Kant.

The theism of Hegel is ambiguous.[3] Later theists may be grouped according as their thought has been remoulded or not by the influences of Kant. The distinguished writers, whom we have to regard as repeating in essence pre-Kantian theories, generally know Kant, and frequently show traces of him in detail. But it is a plain finding of history that he has brought no "Copernican revolution"[4] to their minds.

Paley.

Empiricism is restated by Paley, who is Kant's younger contemporary as a man and also on the whole as a writer. Doubtless the archdeacon knew nothing of the German professor, and would have cared nothing for him however well he had known him. A much more significant figure is that of J. S. Mill in the tentative approach to theism found in his posthumous volume (*Three Essays on Religion*; 1874).

[1] The Design argument has mainly to do with living bodies. Might one suggest that organisms *seem* at least to be a working up of inorganic matter for new ends, viz. those of life?

[2] The idealisms of Fichte and Schelling made contributions to Hegel's thought; Krause and the Roman Catholic Baader represent parallel if minor phases of idealism.

[3] Equally so the Hegelian attitude towards personal immortality.

[4] Such as Kant claimed to effect: *Critique of Pure Reason*, preface to 2nd ed.

J. S. Mill.

Mill directs his attention to the Design argument. The inference that organized bodies are due to an intelligent cause is only reached by the "Method of Agreement"—a full inductive proof requiring, according to Mill's *Logic*, the "Method of Difference." Still, the Design argument is a good sample of a proof by means of the inferior method. Although nothing more than probability is established, it is a high probability.[5] Unfortunately, however, the method of agreement is liable to be baffled by "plurality of causes." In this instance it may happen that the work of intelligence has only been mimicked in nature by blind forces which have accidentally produced organic life; and Mill is disposed to hold that if the evolution of species should be clearly established as due to natural law—if there has been no creation by special interposition—the argument falls to the ground and theism (apparently) is lost.[6] A further point is of some interest. If Mill's theism holds, what is it? The belief in a God of limited power. That is what Kant contended that the Design argument pointed to, and Mill, proceeding on the Design argument, claims nothing more for his conclusion. Of course that was not Mill's special or conscious motive for denying divine omnipotence. His extreme sensitiveness and hatred of pain constrained Mill to hold that, if a good God exists, he cannot possess infinite power. Yet the correspondence between Mill's conclusion and what Kant had alleged to be implied in the underlying metaphysical position is very striking indeed.

Intuitionalism repeated; Flint.

Intuitionalism also has its restatements of theistic reasoning little modified by Kant. R. Flint's theism carefully excludes the early random talk (*e.g.* Cicero) of an intuitive or innate knowledge of *God*. What is self-evident, Flint justly remarks, neither needs nor admits of argument. We have intuitions of *cause*, of *infinity*, of *good and evil*. The Cosmological argument proves, with the help of the first-named intuition, that there is one great First Cause; and the Design argument shows the First Cause to be intelligent or personal. The Ontological argument, though not wholly rejected as a proof, is taken rather as pointing to God's attribute of infinity; thought rather than experience making affirmation that the intuition in question must be attached to God. The moral argument, relying upon the third intuition named, certifies us of a good God. In this way, the attributes are suggestively allotted among the four traditional proofs;[7] but we miss an explicit rebutting of Kant's hostile assumption, that it is incompetent for us to take the thought of God piecemeal.

Martineau.

Martineau's *Study of Religion* is also essentially intuitionalist. It has two parts: "God as cause" and "God as perfection." The Design argument comes in as a special illustration or intensification of the former of these, *i.e.* of the cosmological proof; but Martineau follows a side modification of intuitionalism (Maine de Biran, &c.) in identifying cause with will. This involves a very high doctrine of Libertarianism. The only ultimate cause is God. Nature exists over against Him; but its forces or processes are His own power in immediate exercise, except in so far as God has delegated freedom to human wills; and there follows a theodicy, repeating Leibnitz in more modern form. Martineau's two main proofs yield two sets of attributes; those known as "natural" and "moral," R. Browning's "power" and "love." In "God as perfection" Martineau handles the basis of ethics without reference to his own modification of the intuitionalist position (*Types of Ethical Theory*), according to which "good" is the better or the best. We may infer that, whatever the merits of that modification, it does not affect the theistic problem. Martineau's *Study* also includes a section upon Immortality. The Ontological argument is omitted; but we have already observed that there is a discussion of divine

[5] Paul Janet's *Final Causes* seems to follow Mill in this ("the fact of Finality"), but without naming him.

[6] Janet naturally is in opposition here. Ultimately, he argues, if not immediately, there must be a rational cause to account for so rational an effect. But again of course Mill is not named.

[7] The three which Kant criticized, with the addition of the moral argument, which he favoured.

infinity in relation to time and space which from one point of view is parallel to the Ontological argument.

Definite theistic idealism; Lotze.

Definite theism, bearing the mark of Kant's thought throughout, is found in Hermann Lotze. From the point of view of our grouping, he is an idealist of anomalous type. He begins as an empiricist or realist, with given matter-of-fact; but from time to time (*e.g.* in his *Microcosmus*) he makes readjustments without perhaps very clearly informing the reader what is being done, and in the end he is unmistakably idealist. While a pronounced theist—though not a church Christian—he is hardly less an assailant of traditional theism than Kant (*e.g.* his Outline [Lecture headings] on *Philosophy of Religion*). He dissents as a realist from the Cosmological argument in the form[1] in which it concludes from "contingent" to "necessary" being. We do not wish to find our way to a being who "must be." That is an idle dream. We must keep to real and assured facts. Lotze was a man of considerable attainments in special science; perhaps he reveals here the bias of the scientific mind, and possibly even its limitations. He regards the Ontological argument strictly so called as having been exploded by Kant. Still it has a value for him if taken not as an argument, but rather as the expression of an immediate conviction; viz. The highest must exist. This is an intuitionalist touch, or a parallel to intuitionalism, and has called forth a gibe from that very confident ratiocinator, J. E. MacTaggart; Lotze's immediate convictions are matter of interest to a biographer but to no one else. The Design argument elicits from Lotze the criticism that some things look purposeful, but others decidedly purposeless. The only solid nucleus he finds in it is the fact that there is a great deal of beauty in this world. Obviously this writer is harder to focus than Kant or Hegel. He is not all of one piece. He holds—on grounds of fact and science—to the mechanical orderliness of nature, but claims that the *Weltanschauung* thus suggested may be reinterpreted in view of those undying human aspirations which MacTaggart dismisses to instant execution (unless they can dress themselves in syllogism). Thus, for Lotze, free will is possible; the consequences of action proceed regularly *a parte post*, and there is no such chaos as the critics of Libertarianism have pretended it would involve. Similarly, miracles—absolute new beginnings—are possible on God's side, if they are not mere anomalies but acts promotive of the general meaning or tendency of things, and of the divine plan of the universe.[2] But this appeal to "values" is only half of Lotze's constructive work. For the other half he falls back on ratiocination. All existences must be individuals, with an inner life (cf. Leibnitz). Since they interact, they must be elements in the life of one supreme being (cf. Spinoza: the Spinozistic affinities of Leibnitz are not so marked as Lotze's). God can be personal and doubtless is (though he has no Non-ego to define himself against) through contrast of passing conscious states with the abiding Ego. It is reasonable to hold that the supreme personality is the only fully personal being, while ours is a broken and imperfect personality, hindered by the Non-ego which in other ways helps it. Lotze resolves space into "ideal space"; and finally, in the philosophy of religion, or in view of the thought of God (in his *Metaphysics*), he denies the objective existence of time. God sees all history neither as future nor as present but as actual.

Further developments from Kant.

Besides the stream of tendency which flowed from Kant in the direction of idealism, two other streams emerged from him, often but not always blending. There was a new scepticism—at the very least a doctrine of limitation in human knowledge; but in its extremer forms an absolute agnosticism. And there was the positive ethical element in Kant's theism.

Ancient scepticism was frankly opposed to religious belief. Later, the emergence of a great body of doctrine attributed to divine revelation and of a great institution like the Christian church suggested the possibility of enlisting scepticism in the service of dogmatic faith. In a sense (see APOLOGETICS) this was done in the middle ages, and possibly repeated by Pascal after the Reformation. We now find Kant's intellectual scepticism borrowed by W. Hamilton and H. L. Mansel,[3] both of them, as J. S. Mill complained,[4] "bringing back under the name of belief what they banished as knowledge." The theory found a melodious echo in Tennyson's *In Memoriam*, a great hymn of God, Freedom and Immortality on a basis of speculative agnosticism. "We have but faith we cannot know, For knowledge is of things we see;" but the moral element which Mansel despised is dominant in Tennyson. "The heart Stood up and answered, I have felt." If there is a reading of the new theories of evolution in nature which revives rather than darkens hope in immortality and faith in God, Tennyson gave an early sketch of that tentative modern theism.

R. Browning has been charged by H. Jones with partial agnosticism. But at least we may say that agnosticism is much less clear in Browning than in Tennyson. Browning reasons as far as he can; if reasoning fails him, he gives a leap of faith. Jones, almost as merciless as MacTaggart, calls this procedure by the hard names of agnosticism and dualism. Another who "got the seed" and "grew the flower" was Herbert Spencer. He quotes pages from Mansel's Bampton Lectures in favour of his own type of agnosticism, which is to make peace between religion and science by permanently silencing the former. Religion may "feel," like Tennyson's "man in wrath," and may expatiate in an undefined awe; science alone is to possess the "knowable." This yields a characteristic type of pantheism, in the theory of the Unknowable which—rather paradoxically—is offered us. Alongside of this there are other elements in Spencer's composite system of "Naturalism and Agnosticism" (J. Ward's expression, see his *Gifford Lecture*). The element of naturalism stands for science with a leaning towards materialism ("explanation in terms of matter and motion"). The element of agnosticism tends rather towards pantheism, just as Indian pantheism long ago tended towards agnosticism. John Fiske, however, an able interpreter of Spencer, reached what he called "Cosmic Theism." He rejected all that is anthropomorphic in theism, but gave a positive not negative interpretation to Spencer's scientific generalizations, and broke away from pantheism—perhaps also from naturalism—when, like Tennyson, he pleaded for *human immortality* as the climax of evolutionary progress.

[The name agnosticism (*q.v.*) is T. H. Huxley's. Modern doubt does not say there is no God; it says, We don't know. Popular scepticism—perhaps even Charles Darwin's; Huxley himself was a student of Hume—understands by agnosticism that science is certain while philosophy and theology are baseless. Leslie Stephen gave this popular agnosticism its finest literary expression. Spencer goes much further in rejection of human knowledge: "The man of science more than any other truly knows that in its ultimate essence nothing can be known."] [5]

An interesting manifesto of agnosticism, with a religious conclusion, is A. J. Balfour's *Foundations of Belief*, welcomed in Germany by Julius Kaftan (see below). In "Some Consequences of (naturalistic) Belief," Balfour argues that the results of "naturalism" are unbearable. In "Some Reasons for Belief," the author institutes a rapid destructive criticism of all possible philosophies. In "Some Causes of Belief," he tries, standing outside the psychological process, to show how beliefs grow up under every kind of influence except that of genuine evidence. His constructive theory comes at the end, and seems to argue thus: Since (1) there is no discoverable reason why we

[1] Stated and criticized by Kant.

[2] Lotze is not to be understood as guaranteeing the actuality of Bible miracles. Such things are philosophically possible—that is all.

[3] Mansel's theism (or natural theology), and the revelation he believes in, seem both of them pure matters of assertion on his part, without evidence, or even in the teeth of the evidence as he conceives it.

[4] *Examination of Sir Wm. Hamilton's Philosophy*, chap. v.

[5] *First Principles*, p. 67.

should reach truth, beauty or goodness, but (2) *we do*, therefore (3) there must be a God outside the process, overruling and counteracting the natural tendencies of the human mind. It seems as if one foot rested on dogmatism and one on scepticism. The fact—assumed without any attempt at justification by argument—that, in spite of the multitude of logical reasons for scepticism, we *do* know truth and beauty, makes Balfour a theist. And the God he postulates is brought in *ex machina* like the God of the old Design argument in its roughest popular form. There must be a God, who could compel irrational matter to serve rational ends—so ran the old argument. There must be a God who can miraculously endow the irrational mind of man with truth—so runs the new.

Emphasis on moral motives is plain in Kant's theism as in Butler's. If this tendency is to take effect, a certain part of Kant's rational scepticism must be accepted. There is no chance for the moral consciousness to claim a decisive vote if a metaphysical system like Hegel's demonstrates all realities in every region, and if its janissaries crush out every movement of rebellion against the tyranny of abstract thought. Is it really impossible to claim for man something between omniscience and universal nescience? May we not cherish what A. C. Fraser calls "reasonable faith"? Granted that, ideally, scientific knowledge ought to be able to demonstrate all truth, is it safe, or humane, for a being who is imperfectly started in the process of knowledge to fling away with scorn those unanalysed promptings and misgivings "Which, be they what they may, Are yet the fountain light of all our day, Are yet a master light of all our seeing . . . truths which wake To perish never"? Those who assert the superior worth and importance of moral judgments speak of "values" (A. Ritschl, after J. F. Herbart and H. Lotze). As worked out by Ritschl, this is specially a basis for Christian belief. With what is specifically Christian we have nothing to do in the present article: but it is worth noticing that the appeal to "values," aesthetic and still more moral, forms a substitute for that natural theology which Ritschl despised and professed to reject. There are not a few difficulties in his programme. When Otto Ritschl[1] interprets values hedonistically—recoiling from Hegel's idealism the whole way to empiricism—he brings again to our minds the doubt whether hedonist ethics can serve as a foundation for any religious belief. Julius Kaftan—Balfour's German editor, and a highly influential theologian, occupying a position of modified Ritschlianism—is also a very thoroughgoing empiricist. On the other hand, W. Herrmann's appeal to Kant's moral teaching is in close analogy to the more thoughtful forms of intuitionalist ethics. But is the basis for religious belief to be constructed purely within the region of "values"? Can you contrast "judgments of value" with "judgments of fact"? Or, if, as the Ritschlians maintain, it is a slander invented by their enemy, C. E. Luthardt, to say that they draw this contrast, do you achieve much by calling the principles of moral and religious belief, with A. Ritschl, "independent judgments of value"? Independent of what? Surely not of fact? It is explained that they are in contrast with "accessory value-judgments." Perhaps the meaning is that they are of *independent importance*. But does that carry us far? It all seems a very hurried and imperfectly studied philosophical analysis. One might prefer as a theist to hold (1) that we need a philosophical doctrine of the nature of reality—the "Absolute"; given in popular form in the Cosmological argument; (2) that we take the risk of attaching a higher degree of significance and authority to the revelations of the moral consciousness, which, although moulded or educed by society, do not terminate in the authority of society, but point beyond it to God; this position has its popular form in the moral argument; possibly (3) that necessities of thought shut us up to belief in omnipotence or infinity; (4) that divine *help* is the supreme revelation. But such lines of thought might carry us outside the limits of traditional theism.

[1] Son of A. Ritschl. The younger theologian has accepted determinism.

If we try to bring the contents of theism under Kant's three traditional arguments, then moral and aesthetic considerations—the "values"—fall under the Design argument or the study of teleology; albeit there is a great gap between Paley's supernatural watchmaker and any moral argument or appeal to the beautiful. It might be argued that beauty bears witness against materialism, and moral values against pantheism; although such an anomalous type as *ethical pantheism* has its representatives—J. G. Fichte, Matthew Arnold, perhaps H. Höffding. Kant's reliance on the moral argument *alone* goes with his scepticism. Giving that argument the *highest place* seems to involve, as already said, a dash of the same scepticism. —The arguments, as already noted, may be differently *combined*. (1) Usually they are alternatives or else cumulative. (2) Flint spaces out the proof (and the attributes) among them. (3) Hegel regards them as phases.

Alternatives to theism.

V. What are the alternative conclusions to theism? The extremest form of antagonism is pure scepticism or pure agnosticism, the assertion that nothing can be known. Empiricism may lead to this conclusion; or it may lead to materialism. True materialism includes within itself dogmatic atheism, and is probably the only coherent or reasoned type of atheistic opinion.[2] Materialism further brings with it an extreme or "hard" determinism; and, denying the soul's separate existence in any sense, it naturally denies immortality. Once again, empiricism may lead to some qualified and restricted form of agnosticism, religious or anti-religious. If polytheism is to be seriously defended at all, the basis must be empiricist.[3] Intuitionalism in its turn may harden out of "natural" dualism into moral dualism; either a literally Manichaean scheme—a good God impeded by an evil personality or principle (Bayle)—or belief in a good God of limited powers (Mill). And idealism in some cases may interpret itself in favour of pantheism rather than of theism. Pantheism does not favour free will or immortality, and may move indefinitely near to materialism. Out of pantheism again pessimism develops. If the principle of the universe is impersonal or unconscious, personal consciousness in finite spirits comes to wear the appearance of a blunder. Conversely, if God cares for men, despair is impossible. For another systematic grouping, see A. C. Fraser's *Gifford Lectures*. Wolff's list is of some historical importance—atheism, deism (a God without care for men) and naturalism (denial of supernatural revelation); anthropomorphism (assigning a human body to God); materialism, and idealism (non-existence of matter); paganism (polytheism); Manichaeism, Spinozism, Epicureanism. R. Flint has dealt with the following antitheistic theories: atheism, materialism, positivism, secularism, pessimism, pantheism and (in a separate volume) agnosticism. It is hard to be certain that any systematic grouping will anticipate all the suggestions that may occur to a restlessly and recklessly inquiring age.

LITERATURE.—Two sets of writers have been considered:—first, the greater philosophers, who have incidentally furthered theism (Socrates, Plato, Aristotle, the Stoics, Descartes, Locke, Kant, Hegel, Mill, Lotze), or opposed it (Epicurus, Spinoza, Hume, Kant, Hegel, Mill, Spencer); and, secondly, the deliberate champions of theism—Cicero (especially in the *De Natura Deorum*), Philo, Raymond of Sabunde (in a sense), Wolff, Butler (in a sense), Paley, and a host of English and German 18th-century authors, who chiefly handle the Design argument; then recent writers like R. Flint, *Theism*, *Antitheistic Theories*, *Agnosticism*—all with valuable notes and references, and J. Martineau—especially in *A Study of Religion*. The theistic writers are usually intuitionalists; but it has been urged above that a fruitful study of theism must *in each case* inquire what is the writer's philosophical basis. The Bridgewater treatises have little more than historical interest to-day. A certain historical interest also attaches to the Burnett prize essays on theism: 1815, 1st prize, W. L. Bruce, 2nd J. B. Sumner, afterwards archbishop; 1855, 1st R. A. Thompson, 2nd J. Tulloch. Among many lectureships, the Gifford Lectures are supposed to be strictly appropriated to Natural Theology; yet subjects and

[2] Dr MacTaggart's beliefs once more present themselves as an unexpected modern type (*Studies in Hegelian Cosmology*, chap. iii.).

[3] Yet cf. once more MacTaggart's society of eternal spirits with no divine head.

treatment vary immensely. A. C. Fraser's Edinburgh lectures (*Phil. of Theism*) are central in topic and of distinct value. J. Caird (Glasgow: *Fundamental Ideas of Christianity*, comp. his earlier *Introduc. to the Phil. of Relig.*) and more unreservedly Ed. Caird (St Andrews: *The Evolution of Religion;* Glasgow: *The Evolution of Theology in the Greek Philosophies*) represent speculative treatment on a basis of Hegelianism. H. M. Gwatkin (Edinburgh: *The Knowledge of God*) pours out his historical knowledge, and W. James (Edinburgh: *Varieties of Relig. Exp.*) reveals his many-sided intellectual interests and ready sympathies. W. Wallace (*Lectures and Essays*, incorporating Glasgow lectures) gives some useful historical references. James Ward's masterly criticism of Herbert Spencer (*Naturalism and Agnosticism*) has been mentioned above. The student will rarely lose by reading Gifford Lectures; but it will not always be upon theism that he finds himself better informed. In France, Paul Janet (*Final Causes*, Eng. trans.) and Ch. Sécretan (*Philosophie de la Liberté*) may be named: in Germany, H. Ulrici; while R. Eucken represents to a later generation the spirit and tendency of Lotze and Ulrici, in original and powerful, if rather elusive, fashion. H. Höffding's *Phil. of Religion* (translated) is one of the most original books under that title, but it cannot be called theistic. F. C. S. Schiller, like W. James, opens up new suggestions in philosophy; the bearing of these upon theistic (or other) beliefs is hard to define. In history compare B. Pünjer's *Hist. of the Phil. of Relig.* (Eng. trans.; it includes a good deal of the history of general philosophy); A. Caldecott's *The Philosophy of Religion in England and America;* and A. Caldecott and H. R. Mackintosh's *Selections from the Literature of Theism* (useful texts with useful notes: nothing from Hegel). (R. MA.)

THEISS (Hungarian, *Tisza;* Lat., *Tisia* or *Tissus*), a large affluent of the Danube, next to which it is the greatest river of Hungary. It rises in the north-eastern part of the Carpathian mountains, in the county of Máramaros, at a height of above 6300 ft., and is formed by the confluence of two branches, the Black Theiss (Fekete Tisza), and the White Theiss (Fehér Tisza), which unite at about 20 m. E. of Máramaros-Sziget. The Theiss then follows a north-westerly direction until it leaves its mountainous valley, then runs west, and after a great curve to the north, takes a south-westerly direction and enters the great Hungarian plain (Alföld). From Szolnok it runs south in an almost parallel course with that of the Danube, from which it is separated by a distance of about 60 m., and flows into the Danube near the village of Titel, 20 m. E. of Ujvidek. Its length from source to mouth is, as the crow flies, only about 340 m., but its windings make its course about 870 m. long. The Theiss is clear and swift in its course through the mountains, but in the plain it becomes slow, somewhat muddy and very tortuous. Its basin covers an area of 56,600 sq. m., and comprises the whole eastern part of Hungary, and the greater part of Transylvania, and collects all the rivers descending from the Carpathians westward.

The Theiss is navigable for rafts almost everywhere, but for steamers only from Szolnok downwards, a distance of about 200 m., where the breadth of the river is 450 to 750 ft. The depth of the Theiss at low-water mark is 7 ft. at Tokaj, 20 ft. at Szeged and 11 ft. at Titel, near its mouth, while the difference between the low-water mark and the high-water mark is as high as 25 to 35 ft. During its course through the great Hungarian plain the Theiss flows between flat, low-lying banks, which are the cause of periodical and sometimes disastrous inundations and of extensive marshes. Therefore extensive works have been undertaken for the regulation and canalization of the river, which is now strongly dammed in many parts. By these works large tracts of marshes have been transformed into productive ground. Its chief tributaries are the Szamos, Körös, Maros, Latorcza, and the Sajó. In its lower course it is joined to the Danube by the Franz Josef canal, while it is also united with Temesvár by the Bega canal.

THEMIS, in Greek mythology, the personification of justice. In Homer θέμις is used both as a common and as a proper noun. As a common noun (plural θέμιστες, θέμιτες, θέμιδες), it is the body of rules and precedents established at the beginning of the world, as a guarantee of its order and harmony (see GREEK LAW); personified, Themis is the servant or companion of Zeus, her chief function being to summon the assemblies of both gods and men (*Odyssey*, ii. 68). In the Hesiodic theogony, she is the daughter of Uranus and Gaea, and according to Pindar the wife of Zeus, by whose side she sits, assisting him with her advice, which is even better than that of any of the gods. She is the mother of the Horae and of the Moirae (Fates), an indication of her influence in the physical and moral world. She is the representative of divine justice in all its relations to men, and takes special cognizance of the rights of hospitality. Her opposite is Hybris (ὕβρις), insolent encroachment upon the rights of others, on whose track she follows to punish, like Nemesis. In this aspect both Themis and Nemesis are called ἰχναία (ἴχνος, track). In the lexicon of Festus, Themis is described as the goddess who prescribes that which is right in accordance with divine law (*fas*) and is herself identical with this divine law. She is also a prophetic divinity, and there was a tradition that the oracle at Delphi had first been in the hands of Gaea, who transferred it to Themis (sometimes identified with her) by whom it was handed over to Apollo (Aeschylus, *Eumenides*, 2; Euripides, *Iphig. in T.* 1181). Orphic poetry makes her a daughter of Helios, whose eye is all-seeing (πανδέρκης) and penetrates all mysteries. She was especially honoured at Athens, Delphi, Thebes, Aegina and Troezene, where there was an altar dedicated to a triad of Themides (on the analogy of the triads of Horae, Charites, Moirae). In art she was represented as of dignified and commanding presence, with the cornucopiae (symbolizing the blessings resulting from order) and a pair of scales.

See article "Justitia" by J. A. Hild in Daremberg and Saglio's *Dict. des Antiquités;* H. Ahrens, *Die Göttin Themis* (1862); R. Hirzel, *Themis, Dike, und Verwandtes* (1907).

THEMISTIUS (317–?387), named εὐφραδής ("eloquent"), statesman, rhetorician and philosopher, was born in Paphlagonia and taught at Constantinople, where, apart from a short sojourn in Rome, he resided during the rest of his life. Though a pagan, he was admitted to the senate by Constantius in 355. He was prefect of Constantinople in 384 on the nomination of Theodosius. His paraphrases of Aristotle's *Posterior Analytics, Physics* and *De Anima* are valuable; but the orations in which he panegyrizes successive emperors, comparing them to Plato's "true philosopher," and even to the "idea" itself, are servile and unworthy. Against this, however, should be set the description given by Boetius, "*disertissimus scriptor ac lucidus, et omnia ad facilitatem intelligentiae revocans*," and that of Gregory Nazianzen—with whom Themistius corresponded—βασιλέα λόγων. Themistius's paraphrases of the *De Coelo* and of book Λ of the *Metaphysics* have reached us only through Hebrew versions. In philosophy Themistius was an eclectic. He held that Plato and Aristotle were in substantial agreement, that God has made men free to adopt the mode of worship they prefer, and that Christianity and Hellenism were merely two forms of the one universal religion.

The first edition of Themistius's works (Venice, 1534) included the paraphrases and eight of the orations. Nineteen orations were known to Petavius, whose editions appeared in 1613 and 1618; Hardouin (Paris, 1684) gives thirty-three. Another oration was discovered by Angelo Mai, and published at Milan in 1816. The most recent editions are W. Dindorf's of the orations (Leipzig, 1832), and L. Spengel's of the paraphrases (Leipzig, 1866). The Latin translations of the Hebrew versions of the paraphrases of the *De Coelo* and book Λ of the *Metaphysics* were published at Venice in 1574 and 1558 respectively. A new edition of the latter by S. Landauer appeared in 1903. See Fabricius, *Bibliotheca Graeca*, vi. 790 seq.; E. Zeller, *History of Greek Phil.;* E. Baret, *De Themist, sophista* (Paris, 1853); Jourdain's *Recherches critiques sur l'âge et l'origine des traductions latines d'Aristote* (Paris, 1819); see NEOPLATONISM. For Themistius's Commentaries on Aristotle, see *Commentaria in Aristotelem Graeca* (Berlin), and also *Themistii paraphrases Aristotelis librorum quae supersunt*, ed. L. Spengel (1866, Teubner series, mentioned above).

THEMISTOCLES (*c.* 514–449 B.C.), Athenian soldier and statesman in some respects probably the ablest and most far-sighted whom Greece produced in the first half of the 5th century. He was the son of Neocles, an Athenian of no distinction and moderate means, his mother being a Carian or a Thracian. Hence according to the Periclean law ἐξ ἀμφοῖν ἀστοῖν he would not have been a free Athenian at all (see PERICLES). Thucydides properly brings out the fact that, though he lacked that education which was the peculiar glory of the Periclean age, he displayed a marvellous power of analysing a complex situation together with a genius for rapid action. Plutarch similarly enlarges on his consuming ambition for power both personal and national, and the unscrupulous ability with which he pursued his ends. In all these points he is the antithesis of his great rival Aristides (*q.v.*). Of his early years little is known. He may have been strategus of his tribe at Marathon (Plut. *Arist.* 5) and we are told that he deeply envied the glory which Miltiades earned. At all events the death of Miltiades left the stage to Aristides and Themistocles. It is sufficiently clear that their rivalry, terminated in 483-82 by the ostracism of Aristides, turned largely on the fact that Themistocles was the advocate of a policy of naval expansion. This policy was unquestionably of the highest importance to Athens and indeed to Greece. Athens was faced by the equal if not superior power of Aegina, while the danger of a renewed Persian invasion loomed large on the horizon. Themistocles therefore persuaded his countrymen to put in hand the building of 200 triremes, and —what was of even greater importance—to fortify the three natural harbours of Peiraeus (see E. Gardner, *Ancient Athens*, 562 f.) in place of the open roadstead of Phalerum. For the building of the ships Themistocles persuaded the Athenians to allocate 100 talents obtained from the new silver mines at Laurium (*Ath. Pol.* 22) which were about to be distributed to the citizens (10 drachmae each). One hundred of the proposed 200 were built.

According to the *Ath. Pol.* it would seem that Themistocles was archon in 483-82 at the time when this naval programme began. Dionysius of Halicarnassus places his archonship in 493-92, in favour of which are several considerations. In 487 the office lost much of its importance owing to the substitution of the lot for election: the chance that the lot would at the particular crisis of 483 fall on Themistocles was obviously remote: and the *Ath. Pol.* is generally wrong about Themistocles. In any case the year prior to the invasion of Xerxes found Themistocles the chief man in Athens if not in Greece. Though the Greek fleet was nominally under the control of the Spartan Eurybiades, it was Themistocles who caused the Greeks to fight the indecisive battle of Artemisium, and still more it was he who, by his threat that he would lead the Athenian army to found a new home in the West, and by his treacherous message to Xerxes, precipitated the engagement at Salamis (*q.v.*). The retirement of the Persians left the Athenians free to restore their ruined city (see ATHENS). Sparta, nominally on the ground that it was dangerous to Greece that there should be any citadel north of the Isthmus which an invader might hold, urged that this should not be done, but Themistocles by means of diplomatic delays and subterfuges enabled the work to be carried sufficiently near to completion to make the walls defensible. He also carried out his original plan of making Peiraeus a real harbour and fortress for Athens. Athens thus became the finest trade centre in Greece, and this fact, coupled with Themistocles' remission of the alien's tax (*μετοίκιον*), induced many foreign business men to settle in Athens.

After the crisis of the Persian invasion Themistocles and Aristides appear to have composed their differences. But Themistocles soon began to lose the confidence of the people, partly owing to his boastfulness (it is said that he built near his own house a sanctuary to Artemis Aristoboulē "of good counsel") and partly to his alleged readiness to take bribes. Diodorus (xi. 54) and Plutarch (*Themist.* 23) both refer to some accusation levelled against him,[1] and some time between 476 and 471 he was ostracized. He retired to Argos, but the Spartans further accused him of treasonable intrigues with Persia, and he fled to Corcyra, thence to Admetus, king of the Molossians, and finally to Asia Minor. He was proclaimed a traitor at Athens and his property was confiscated, though his friends saved him some portion of it. He was well received by the Persians and was allowed to settle in Magnesia on the Maeander. The revenues (50 talents) of this town were assigned to him for bread, those of Myus for condiments, those of Lampsacus for wine. He died at Magnesia at the age of sixty-five, and a splendid memorial was raised by the people of the town, though it is said that his bones were secretly transferred to Attica. He was worshipped by the Magnesians as a god, as we find from a coin on which he is shown with a patera in his hand and a slain bull at his feet (hence perhaps the legend that he died from drinking bull's blood: cf. Aristoph. *Eq.* 83; Diod. xi. 58; Plut. *Them.* 31).

Though his end was discreditable, though his great wealth can hardly have been obtained by loyal public service, there is no doubt that his services to Athens and to Greece were great. He created the Athenian fleet and with it the possibility of the Delian League (*q.v.*) which became the Athenian empire, and there are many indications (*e.g.* his well-attested plan of expansion in the west) that the later imperialist ideal originated in his fertile brain.

There are monographs by Bauer (Merseburg, 1881) and Wecklein (Munich, 1882); but the best discussions of his career will be found in the chief Greek histories, *e.g.* Busolt; on the difficult chronology of his later years see Grote, *History of Greece* (and the one-vol. ed. by Mitchell and Caspari, 1907, p. 283, note 1, with the authorities there quoted); on the Magnesian coin, Rhousopoulos, in *Athen. Mitteil.* (1896), p. 22. On the walls, see Ed. Meyer in *Hermes*, xl. (1905), pp. 561–569. (J. M. M.)

[1] There is, however, much difficulty regarding this accusation. It may be simply a misunderstanding of his ostracism.

THÉNARD, LOUIS JACQUES (1777–1857), French chemist, was born on the 4th of May 1777 at Louptière, near Nogent-sur-Seine, Aube. His father, a poor peasant, managed to have him educated at the academy of Sens, and sent him at the age of sixteen to study pharmacy in Paris. There he attended the lectures of A. F. Fourcroy and L. N. Vauquelin, and succeeded in gaining admission, in a humble capacity, to the latter's laboratory. But his progress was so rapid that in two or three years he was able to take his master's place at the lecture-table, and Fourcroy and Vauquelin were so satisfied with his performance that they procured for him a school appointment in 1797 as teacher of chemistry, and in 1798 one as *repétiteur* at the *École Polytechnique.* In 1804 Vauquelin resigned his professorship at the *Collège de France* and successfully used his influence to obtain the appointment for Thénard, who six years later, after Fourcroy's death, was further elected to the chairs of chemistry at the *École Polytechnique* and the *Faculté des Sciences.* He also succeeded Fourcroy as member of the Academy. In 1825 he received the title of baron from Charles X., and in 1832 Louis Philippe made him a peer of France. From 1827 to 1830 he represented the department of Yonne in the chamber of deputies, and as vice-president of the *conseil superieur de l'instruction publique*, he exercised a great influence on scientific education in France. He died in Paris on the 21st of June 1857. A statue was erected to his memory at Sens in 1861, and in 1865 the name of his native village was changed to Louptière-Thénard.

Above all things Thénard was a teacher; as he himself said, the professor, the assistants, the laboratory—everything must be sacrificed to the students. Like most great teachers he published a text-book, and his *Traité de Chimie élémentaire, théorique et pratique* (4 vols., Paris, 1813–16), which served as a standard for a quarter of a century, perhaps did even more for the advance of chemistry than his numerous original discoveries. Soon after his appointment as *repétiteur* at the *École Polytechnique* he began a lifelong friendship with J. L. Gay-Lussac, and the two carried out many researches together. Careful analysis led him to dispute some of C. L. Berthollet's theoretical views regarding the composition of the metallic oxides, and he also showed Berthollet's "zoonic acid" to be impure acetic acid (1802); but Berthollet (*q.v.*), so far from resenting these corrections from a younger man, invited him to become a member of the *Société d'Arcueil.* His first original paper (1799) was on the compounds of arsenic and antimony with oxygen and sulphur, and of his other separate investigations one of the most important was that on the compound ethers, begun in 1807. His researches on sebacic acid (1802) and on bile (1807), and his discovery of peroxide of hydrogen (1818) also deserve mention. The substance known as "Thénard's blue," he prepared in 1799 in response to a peremptory demand by J. A. Chaptal for a cheap colouring matter, as bright as ultramarine and capable of standing the heat of the porcelain furnace.

Most of Thénard's memoirs, a list of which may be found in the Royal Society's *Catalogue of Scientific Papers*, were published in the *Annales de Chimie et de Physique*, the *Mémoires d'Arcueil*, the *Comptes Rendus* and the *Mémoires* of the Academy of Sciences.

THEOBALD (d. 1161), archbishop of Canterbury, was of Norman parentage, but the date of his birth is unknown. Early in life he entered the great abbey of Bec, of which he became prior in 1127 and abbot ten years later. In 1138 he was selected by Stephen, king of England, to fill the vacant see of Canterbury. Apparently he owed this advancement to his character for meekness, and as archbishop he behaved with a moderation which is in striking contrast to the conduct of his rival, Henry of Blois, bishop of Winchester. During the struggle between Stephen and Matilda it was Bishop Henry who fought for the privileges of the Church; Theobald, while showing a preference for Stephen's title, made it his rule to support the *de facto* sovereign. But as Stephen's cause gained ground the archbishop showed greater independence. He refused to consecrate the king's nephew to the see of York, and in 1148 attended the papal council of Reims in defiance of a royal prohibition. This quarrel was ended by the intercession of the queen, Matilda of Boulogne, but another, of a more serious character, was provoked by Theobald's refusal to crown Count Eustace, the eldest son of Stephen, the archbishop pleading the pope's orders as the excuse for this contumacy. He was banished from the kingdom, but Pope Eugenius terrified Stephen into a reversal of the sentence. In 1153 Theobald succeeded in reconciling Stephen with Henry of Anjou, and in securing for the latter the succession to the throne. On the accession of Henry in 1154, Theobald naturally became his trusted counsellor; but ill-health prevented the archbishop from using his influence to its full extent. He placed the interests of the Church in the hands of Thomas Becket, his archdeacon, whom he induced Henry to employ as chancellor. Theobald died on the 18th of April 1161. He is said to have recommended Becket as his successor.

In history Theobald lives chiefly as the patron of three eminent men: Becket, who began life as a clerk in his household; Master Vacarius, the Italian jurist, who was the first to teach Roman law in England; and John of Salisbury, the most learned scholar of the age. Theobald's household was a university in little; and in it were trained not a few of the leading prelates of the next generation.

See the *Vita Theobaldi* printed in J. A. Giles, *Lanfranci Opera*, vol. i. (Oxford, 1844); W. Hook, *Lives of the Archbishops of Canterbury*, ii. c. vi. (London, 1862); and K. Norgate, *England under the Angevin Kings*, vol. i. (London, 1887). (H. W. C. D.)

THEOBALD, LEWIS (1688–1744), English man of letters, playwright and Shakespearian commentator, the son of an attorney, was born at Sittingbourne, Kent, and was baptized on the 2nd of April 1688. He was educated under a clergyman named Ellis at Isleworth, and became a good classical scholar. He followed his father's profession, but soon abandoned it for literature. In 1713 he translated the *Phaedo* of Plato, and entered into a contract with Bernard Lintot the publisher to translate the tragedies of Aeschylus. He seems to have made other promises not carried out, but in 1714 and 1715 appeared versions of the *Electra*, the *Ajax*, and the *Oedipus Rex* of Sophocles, and the *Plutus* and the *Clouds* of Aristophanes. He became a regular hack-writer, contributing to *Mist's Journal*, and producing plays and poems of very small merit. The publication of his play *The Perfidious Brother* (acted 1715; printed 1716) involved Theobald in considerable difficulty. He apparently received a rough draft of the play from Henry Meystayer, a London watchmaker, with a commission to arrange it for the stage. Theobald brought it out as his own work. In the next year Meystayer produced a version, and charged Theobald with plagiarism, but there is no means of ascertaining the exact rights of the case. His poverty compelled him to produce rapidly. He translated the first book of the *Odyssey* (1716), wrote tragi-comedies, operas and masques, and helped John Rich in the production of pantomimes, then an innovation at Drury Lane. But in 1726 he produced *Shakespeare Restored, or a Specimen of the many Errors as well Committed as Unamended by Mr Pope in his late edition of this Poet; designed not only to correct the said Edition, but to restore the true Reading of Shakespeare in all the Editions ever published* (1726). However ill Theobald may have succeeded as a poet and dramatist, he showed great discrimination as a textual editor. Some of his happiest emendations are to be found in this work, which conclusively proved Pope's incompetence as a Shakespearian editor. Two years later a second edition of Pope's work appeared. In it he stated that he had incorporated some of Theobald's readings, in all amounting to about twenty-five words, and that he added the rest which could "at worst but spoil half a sheet of paper that chances to be left vacant here." He also insinuated that Theobald had maliciously kept back his emendations during the progress of the edition. All this was a gross misstatement of fact. He had in reality incorporated the majority of Theobald's best emendations. In the first edition of the *Dunciad* (1728) Theobald figured as the hero, and he occupied the place of chief victim until replaced by Colley Cibber in 1741. In spite of the critics, Theobald's work was appreciated by the public. In 1731 he undertook to edit Shakespeare for Tonson the publisher. The work appeared in seven volumes in 1734, and completely superseded Pope's edition. From 1729 to the date of its publication Theobald had been engaged in correspondence on the subject with Warburton, who after his friend's death published an edition of Shakespeare, in the preface of which he asserted that Theobald owed his best corrections to him. Study of the correspondence proves, however, that the indebtedness was on Warburton's side. Subsequent editors reaped, in most cases without acknowledgment or with actual scorn, the fruit of Theobald's painstaking labour, his wide learning and his critical genius. But Pope's satire, as Johnson justly remarked, blasted the characters that it touched. Theobald remained the type of the dry-as-dust commentator. His merits obtained a tardy recognition on the publication of a detailed study of his critical work by Mr Churton Collins in an essay entitled "The Porson of Shakespearian Criticism" (*Essays and Studies*, 1895). Theobald gave proof of the same happy gift in classical scholarship in some emendations of Aeschylus, Eustathius, Athenaeus and others, contributed to a learned journal started by John Jortin in 1731. He was a candidate for the laureateship in 1730, but Cibber gained the coveted post. His last years were harassed by poverty and disease. He began a critical edition of the plays of Beaumont and Fletcher, completed by Seward and Sympson after his death, which took place on the 18th of September 1744.

His correspondence with Matthew Concanen, Styan Thirlby and William Warburton is to be found in Nichols's *Illustrations of Literature* (ii. 204–654), which also gives the fullest account of his life.

THEOCRACY (Gr. *θεοκρατία*, the rule of God, from *θεός*, god, and *-κρατια*, *κρατεῖν*, to rule), a term applied to a form of government or to a state ruled by such a form of government, in which God or the divine power is looked to as the source of all civil power, and the divine commandments regarded as the laws of the community. The typical example of such a state is that of the Jews till the establishment of the kingship under Saul (see Jews).

THEOCRITUS, the creator of pastoral poetry, flourished in the 3rd century B.C. Little is known of him beyond what can be inferred from his writings. We must, however, handle these with some caution, since some of the poems ("Idylls") commonly attributed to him have little claim to authenticity. It is clear that at a very early date two collections were made, one of which included a number of doubtful poems and formed a *corpus* of bucolic poetry, while the other was confined to those works which were considered to be by Theocritus himself. The record of these recensions is preserved by two epigrams, one of which proceeds from Artemidorus, a grammarian, who lived in the time of Sulla and is said to have been the first editor of these poems. He says, "Bucolic muses, once were ye scattered, but now one byre, one herd is yours." The second epigram is anonymous, and runs as follows:—"The Chian is another. I, Theocritus, who wrote these songs, am of Syracuse, a man of the people, the son of Praxagoras and famed Philinna. I never sought after a strange muse." The last line may mean that he wrote nothing but bucolic poems, or that he only wrote in Doric. The statement that he was a Syracusan is confirmed by allusions in the "Idylls" (xi. 7, xxviii. 16–18). The information concerning his parentage bears the stamp of genuineness, and disposes of a rival theory based upon a misinterpretation of Idyll vii.—which made him the son of one Simichus. A larger collection, possibly more extensive than that of Artemidorus, and including poems of doubtful authenticity, was known to Suïdas, who says: "Theocritus wrote the so-called bucolic poems in the Dorian dialect. Some persons also attribute to him the following: *Daughters of Proetus*, *Hopes*, *Hymns*, *Heroines*, *Dirges*, *Lyrics*, *Elegies*, *Iambics*, *Epigrams*." The first of these may have been known to Virgil, who refers to the *Proetides* in the *Eclogues*.[1] The spurious poem xxi. may have been one of the *Hopes* (cf. l. 66, ἐλπὶς τῶν ὕπνων), and poem xxvi. may have been one of the *Heroines* (cf. l. 36, ἡρῷναι): elegiacs are found in viii. 33–60, and the spurious epitaph on Bion may have been one of the *Dirges*. The other classes are all represented in the larger collection which has come down to us.

The poems which are generally held to be authentic may be classified thus:—

I. *Bucolics and Mimes*.—The distinction between these is that the scenes of the former are laid in the country and those of the latter in a town. The most famous of the *Bucolics* are i., vii., xi. and vi. In i. Thyrsis sings to a goatherd how Daphnis, the mythical herdsman, having defied the power of Aphrodite, dies rather than yield to a passion with which the goddess had inspired him. In xi. Polyphemus is depicted as in love with the sea-nymph Galatea and finding solace in song: in vi. he is cured of his passion and naively relates how he repulses the overtures now made to him by Galatea. The monster of the *Odyssey* has been "written up to date" after the Alexandrian manner and has become a gentle simpleton. Idyll vii., the Harvest Feast (Θαλύσια), is the most important of the bucolic poems. The scene is laid in the isle of Cos. The poet speaks in the first person and is styled Simichidas[2] by his friends. Other poets are introduced under feigned names. Thus ancient critics identified Sicelidas of Samos (l. 40) with Asclepiades the Samian, and Lycidas, "the goatherd of Cydonia," may well be the poet Astacides, whom Callimachus calls "the Cretan, the goatherd." Theocritus speaks of himself as having already gained fame, and says that his lays have been brought by report even unto the throne of Zeus.[3] He praises Philetas, the veteran poet of Cos, and criticizes "the fledgelings of the Muse, who cackle against the Chian bard and find their labour lost."[4] Other persons mentioned are Nicias, a physician of Miletus, whose name occurs in other poems, and Aratus, whom the Scholiast identifies with the author of the *Phenomena*.

The other bucolic poems need not be further discussed. Several of them consist of a singing-match, conducted according to the rules of amoebean poetry, in which the second singer takes the subject chosen by the first and contributes a variation in the same air. It may be noted that the peasants of Theocritus differ greatly in refinement. Those in v. are low fellows who indulge in coarse abuse. This Idyll and iv. are laid in the neighbourhood of Croton, and we may infer that Theocritus was personally acquainted with Magna Graecia. Suspicion has been cast upon poems viii. and ix. on various grounds. An extreme view holds that in ix. we have two genuine Theocritean fragments, ll. 7–13 and 15–20, describing the joys of summer and winter respectively, which have been provided with a clumsy preface, ll. 1–6, while an early editor of a bucolic collection has appended an epilogue in which he takes leave of the Bucolic Muses.[5] On the other hand, it is clear that both poems were in Virgil's Theocritus, and that they passed the scrutiny of the editor who formed the short collection of Theocritean Bucolics.

The mimes are three in number, viz., ii., xiv., xv. In ii. Simaetha, deserted by Delphis, tells the story of her love to the moon; in xiv. Aeschines narrates his quarrel with his sweetheart, and is advised to go to Egypt and enlist in the army of Ptolemy Philadelphus; in xv. Gorgo and Praxinoë go to the festival of Adonis. It may be noticed that in the best MSS. ii. comes immediately before xiv., an arrangement which is obviously right, since it places the three mimes together. The second place in the MSS. is occupied by Idyll vii., the "Harvest Feast." These three mimes are wonderfully natural and lifelike. There is nothing in ancient literature so vivid and real as the chatter of Gorgo and Praxinoë, and the *voces populi* in xv.

It will be convenient to add to the *Bucolics* and *Mimes* three poems which cannot be brought into any other class, viz.: xii. (Αἴτης), a poem to a beautiful youth; xviii., the marriage-song of Helen (Ἐπιθαλάμιος); and xxvi., the murder of Pentheus (Λῆναι). The genuineness of the last has been attacked by U. von Wilamowitz-Möllendorff on account of the crudity of the language, which sometimes degenerates into doggerel. It is, however, likely that Theocritus intentionally used realistic language for the sake of dramatic effect, and the MSS. evidence is in favour of the poem. Eustathius quotes from it as the work of Theocritus.

II. *Epics*.—Three of these are Hymns, viz., xvi., xvii. and xxii. In xvi. the poet praises Hiero II. of Syracuse, in xvii. Ptolemy Philadelphus, and in xxii. the Dioscuri. The other poems are xiii., the story of Hylas and the Nymphs, and xxiv. the youthful Heracles. It cannot be said that Theocritus exhibits signal merit in his *Epics*. In xiii. he shows some skill in word-painting, in xvi. there is some delicate fancy in the description of his poems as "Graces" (Χάριτες), and a passage at the end, where he foretells the joys of peace after the enemy have been driven out of Sicily, has the true bucolic ring. The most that can be said of xxii. and xxiv. is that they are very dramatic. Otherwise they differ little from work done by other poets, such as Callimachus and Apollonius Rhodius. The flattery heaped upon Ptolemy is somewhat nauseous. From another point of view, however, these two poems xvi. and xvii. are supremely interesting, since they are the only ones which can be dated. In xvii. Theocritus celebrates the incestuous marriage of Ptolemy Philadelphus with his sister Arsinoë. This marriage is held to have taken place in 277 B.C., and a recently discovered inscription shows that Arsinoë died in 270, in the fifteenth year of her brother's reign.[6] This poem, therefore, together with xv., which Theocritus wrote to please Arsinoë (*Schol.* χαριζόμενος τῇ βασιλίδι) must fall within this period. The encomium upon Hiero II. would from internal reasons seem prior to that upon Ptolemy, since in it Theocritus is a hungry poet seeking for a patron, while in the other he is well satisfied with the world. Now Hiero first came to the front in 275 B.C. when he was made "General" (στρατηγός): Theocritus speaks of his achievements as still to come,[7] and the silence of the poet would show that Hiero's marriage to Philistis, his victory over the Mamertines at the Longanus and his election as "King" (βασιλεύς), events which are ascribed to 270 B.C., had not yet taken place. If so, xvii. and xv. can only have been written within 275 and 270.

III. *Lyrics*.—Two of these are certainly by Theocritus, viz., xxviii. and xxix. The first is a very graceful poem presented together with a distaff to Theugenis, wife of Nicias, a doctor of Miletus, on the occasion of a voyage thither undertaken by the poet. The theme of xxix. is similar to that of xii. A very corrupt poem, only found in one very late MS., was discovered by Ziegler in 1864. As the subject and style very closely resemble that of xxix., it is assigned to Theocritus by recent editors.

IV. The *Epigrams* do not call for detailed notice. They do not possess any special merit, and their authenticity is often doubtful. It remains to notice the poems which are now generally considered to be spurious. They are as follows:—

xix. "Love stealing Honey" (Κηριοκλέπτης). The poem is anonymous in the MSS. and the conception of Love is not Theocritean.

xx. "Herdsman" (Βουκολίσκος), xxi. "Fishermen" (Ἁλιεῖς), xxiii. "Passionate Lover" (Ἐραστής). These three poems are remarkable for the corrupt state of their text, which makes it likely that they have come from the same source and possibly are by the same author. The "Fishermen" has been much admired. It is addressed to Diophantus and conveys a moral, that one should work and not dream, illustrated by the story of an old fisherman who dreams that he has caught a fish of gold and narrates his vision to his mate. As Leonidas of Tarentum wrote epigrams on fishermen, and one of them is a dedication of his tackle to Poseidon by Diophantus, the fisher,[8] it is likely that the author of this poem was an imitator of Leonidas. It can hardly be by Leonidas himself, who was a contemporary of Theocritus, as it bears marks of lateness.

xxv. "Heracles the Lion-slayer" (Λεοντοφόνος). This is a long

[1] "Proetides implerunt falsis mugitibus agros."—*Ecl.* vi. 48.

[2] Two explanations are offered by the Scholiast: either that the poet was "snub-nosed" (σιμός), or that he was the son of Simichus. The second is obviously a mere guess.

[3] τά που καὶ Ζηνὸς ἐπὶ θρόνον ἄγαγε φάμα, l. 93. It is possible that Zeus refers to Ptolemy: cf. Horace, *Ep.* i. 19, 43, *Iovis auribus ista Servas*, where *Iupiter* = Augustus.

[4] Some think that there is an allusion to Apollonius Rhodius.

[5] Cf. Hiller, *ad loc.*

[6] The evidence is contained in a new fragment of the Mendes Stele. Cf. von Prott in *Rheinisches Museum* (1898), p. 464.

[7] ἔσσεται οὗτος ἀνὴρ ὃς ἐμεῦ κεχρήσετ' ἀοιδοῦ, l. 73.

[8] ὁ γριπεὺς Διόφαντος ἀνάκτορι θήκατο τέχνας (*Anth. Pal.* vi. 4, 7).

poem consisting of two episodes, viz. the interview of Heracles with the bailiff of Augeas and his recital to Phyleus, son of Augeas, of the story of the Nemean lion. The composition is not unworthy of Theocritus. It is, however, anonymous in the MSS. and comes next to another anonymous poem called "Megara, the wife of Hercules." It is probable from some metrical and linguistic peculiarities that xxv. and the "Megara" are both by the same author.

xxvii. "The wooing of Daphnis" ('Οαριστύς) is also anonymous. It contains imitations of Theocritus, but the tone and the language betray a later writer.

We have no sure facts as to the life of Theocritus beyond those supplied by Idylls xvi. and xvii. It is quite uncertain whether the bucolic poems were written in the pleasant isle of Cos among a circle of poets and students, or in Alexandria and meant for dwellers in streets. The usual view is that Theocritus went first from Syracuse to Cos, and then, after suing in vain for the favour of Hiero, took up his residence permanently in Egypt. Some have supposed on very flimsy evidence that he quarrelled with the Egyptian court and retired to Cos, and would assign various poems to the "later-Coan" period.[1] Wilamowitz-Möllendorff, laying stress on the fact that in the best MS. the poem to Ptolemy (xvii.) comes before that to Hiero (xvi.), very ingeniously puts the Egyptian period first and supposes it to have been of very short duration (*i.e.* 277 to 275), and then makes the poet, after his unsuccessful appeal to Hiero, retire to Cos for the rest of his life. This view would enable us to see a reference to Ptolemy in vii. 93, and even to the young Apollonius Rhodius in 47–48 of the same poem.

The poems of Theocritus were termed *Idylls* (εἰδύλλια) by the grammarians. The word is a diminutive from εἶδος, and is supposed to mean "little poems." The use of εἶδος in the sense of "poem" is somewhat doubtful, and so some have referred εἰδύλλια to εἶδος in its usual sense of "form" or "type." Thus εἶδος βουκολικόν, ἐπικόν, λυρικόν might be used to classify various kinds of poetry, and these poems might be called εἰδύλλια, since they include so many types.

Language and Metre.—Theocritus wrote in various dialects according to the subject. The Lyrics xxviii., xxix. (and xxx.) are in Aeolic, that being the traditional dialect for such poems. Two poems, xii. (Αἴτης) and xxii. (to Castor and Pollux), were written in Ionic, as is stated in titles prefixed to them, though a number of Doric forms have been inserted by the scribes. The epics in general show a mixture of Homeric, Ionic and Doric forms. The *Bucolics*, *Mimes*, and the "Marriage-song of Helen" (xviii.) are in Doric, with occasional forms from other dialects.

The metre used by Theocritus in the *Bucolics* and *Mimes*, as well as in the *Epics*, is the dactylic hexameter. His treatment of this may be compared both with Homeric usage and that of other Alexandrian poets, *e.g.* Callimachus. It was the tendency of these writers to use dactyls in preference to spondees with a view to lightness and rapidity. This tendency shows itself most in the third foot, the favourite caesura being the trochaic, *i.e.* after the second syllable (- ∪ !). On the other hand, the Alexandrians admitted a spondee in the fifth foot, especially when the verse ends with a quadrisyllable. Theocritus in the *Epics* conforms to the new technique in both these respects: in the *Bucolics* his practice agrees with that of Homer. The feature in his versification which has attracted most attention is the so-called bucolic caesura. The rule is that, if there is a pause at the end of the fourth foot, this foot must be a dactyl. This pause is no new invention, being exceedingly common in Homer. Theocritus uses it so frequently in the *Bucolics* that it has become a mannerism. In the *Epics* his practice agrees with that of Homer.

We always think of Theocritus as an original poet, and as the "inventor of bucolic poetry" he deserves this reputation. At the same time he had no scruple about borrowing from predecessors or contemporaries; in fact he did so in the most open manner. Thus xxix. begins with a line of Alcaeus,[2] and xvii., as the Scholiast points out, with words used by Aratus at the beginning of the *Phenomena*. The love of the Cyclops for Galatea had been treated by Philoxenus, and fragments quoted from this show that Theocritus copied some of his phrases closely. In the mimes Theocritus appears to have made great use of Sophron. Idyll ii. is modelled upon a mime of this writer which began in a very similar way.[3] The Scholiast thought that Theocritus showed want of taste in making Thestylis a *persona muta*, instead of giving her a share in the dialogue as Sophron had done. The famous poem about Gorgo and Praxinoë at the feast of Adonis was modelled on one by Sophron about women looking on at the Isthmian games ('Ισθμιάζουσαι), and fragments quoted from this are closely imitated by Theocritus. It is extremely interesting to find a similar poem in the recently discovered mimes of Herondas, the fourth of which is termed "Women making offerings to Aesculapius" ('Ασκληπιῷ ἀνατιθεῖσαι καὶ θυσιάζουσαι). The relation of Theocritus to Herondas is a subject of great interest. Herondas must have been a contemporary, as he refers to Ptolemy Philadelphus,[4] and was a native of Cos, so that he and Theocritus must have been acquainted. There are some curious parallels in the language and idioms of the two poets, but which of them copied the other it is impossible to determine.

Manuscripts.—The oldest authority for any part of Theocritus is a papyrus discovered by B. P. Grenfell and A. S. Hunt at Oxyrhynchus, written in the 2nd century A.D. and containing xiii. 19–34.[6] There are also fragments of another papyrus belonging to the 5th century, which contain some lines of i., v., xiii., xv., xvi. and xxvi.[6] These papyri are carelessly written and do not contain any notable variants. The most valuable of the existing MSS. belongs to the Library at Milan (*Ambros.* 222). It was written in the 13th century, and contains Idylls i.–xvii., xxix., and the *Epigrams*. Other good MSS. of the same family contain xviii. also. The other poems come from two sources. One of these is represented by several MSS. and contains xix., xx., xxi., xxii., xxiii., xxv. The other contains xxii. 69–223, xxiv., xxv., xxvi., xxvii., xxviii., xxix. This collection was first published in the *Juntine* edition (1515) from a *codex Patavinus* now lost. The only existing MS. of any value in which it is found is in Paris (2726), and was written in the 14th century. These two collections are termed φ and π by Hiller and other recent writers. It will be noticed that xxv. and a portion of xxii. are found both in φ and π. In these poems there are constant divergences, and π appears to give the better recension.

There are important Scholia to Theocritus, or rather to that portion of the poems (i.–xvii. and xxix.) which is found in the best MSS. The most valuable of these are those contained by *Ambros.* 222 (K). They are composite in character. The Argument to xii. is ascribed to Eratosthenes, a contemporary of Justinian, while reference is frequently made to the views of Munatius, who lived in the time of Herodes Atticus, and Amarantus, a contemporary of Galen. Wilamowitz-Möllendorff ascribes the nucleus of these Scholia to Theon, who wrote similar scholia on Lycophron and Apollonius Rhodius, and is stated to have written a commentary on Theocritus.[7] This Theon is stated to have been the son of Artemidorus, the first editor of Theocritus. It is, therefore, suggested that Theon formed the shorter collection of Theocritean poems, furnished them with *scholia*, and wrote the second epigram quoted at the beginning of this article. The other poems, which possess no *scholia* and have come down to us from the other collections, would, according to this ingenious theory, be those which appeared in the larger collection of Artemidorus but were excluded by Theon.

BIBLIOGRAPHY.—(i.) *Editions.* (*a*) Critical, H. L. Ahrens (1855); Ch. Ziegler (1879); U. von Wilamowitz-Möllendorff, in Oxford Classical Texts (1907). (*b*) epexegetical, E. Hiller (1881; German notes); R. J. Cholmeley (1901; English notes). (ii.) *Translations.* A. Lang (1880; prose); J. H. Hallard (1901; verse). (iii.) *Subject-matter.* Ph. E. Legrand, *Étude sur Théocrite* (1898); (iv.) *Textual Questions.* E. Hiller, *Beiträge zur Textgeschichte der Griechischen Bukoliker* (1888); U. von Wilamowitz-Möllendorff, *Die Textgeschichte der Griechischen Bukoliker* (1906). (v.) *Metre.* C. Kunst, *De Theocriti versu heroico* (1887). (vi.) *Scholia.* Ch. Ziegler, *Codicis Ambrosiani 222, Scholia in Theocritum* (1867).

(A. C. C.)

THEODECTES (*c.* 380–340 B.C.), Greek rhetorician and tragic poet, of Phaselis in Lycia, pupil of Isocrates and Plato, and an intimate friend of Aristotle. He at first wrote speeches for the law courts, but subsequently composed tragedies with success. He spent most of his life at Athens, and was buried on the sacred road to Eleusis. The inhabitants of Phaselis honoured him with a statue, which was decorated with garlands by Alexander the Great on his way to the East. In the contests arranged by Artemisia, queen of Caria, at the funeral of Mausolus, Theodectes gained the prize with his tragedy *Mausolus* (extant in the 2nd century A.D.), but was defeated by Theopompus in oratory. According to the inscription on his tomb, he was

[1] The chief argument is that in xii. 5 the poet says—

ὅσσον παρθενικὴ προφέρει τριγάμοιο γυναικός.

As Arsinoë had been married three times, it is thought that she might have been offended by this remark.

[2] οἶνος, ὦ φίλε παῖ, λέγεται καὶ ἀλαθέα.

[3] Sophron's mime began with πεῖ γὰρ ἁ ἄσφαλτος; Theocritus's begins with πᾷ μοι ταὶ δάφναι;

[4] l. 30, Θεῶν ἀδελφῶν τέμενος, ὁ βασιλεὺς χρηστός.

[6] *Oxyrhynchus Papyri*, iv. p. 139.

[6] C. Wessely in *Berliner Philologische Wochenschrift* (1906), p. 831.

[7] Θέων ἐν τῇ ὑπομνήσει Θεοκρίτου, Etym. on i. 39: Θέων ὁ 'Αρτεμιδώρου, *ib.* on iv. 5. Cf. Ahrens, ii. p. xxvii.

eight times victorious in thirteen dramatic contests. Of his tragedies (fifty in number) thirteen titles and some fragments remain (A. Nauck, *Tragicorum Graecorum Fragmenta*, 1887). His treatise on the art of rhetoric (according to Suïdas written in verse) and his speeches are lost. The names of two of the latter—*Socrates* and *Nomos* (referring to a law proposed by Theodectes for the reform of the mercenary service)—are preserved by Aristotle (*Rhetoric*, ii. 23, 13, 17). The *Theodectea* (Aristotle, *Rhet.* iii. 9, 9) was probably not by Theodectes, but an earlier work of Aristotle, which was superseded by the extant *Rhetorica*.

See monograph by C. F. Märcker (Breslau, 1835). There is a lengthy article on Theodectes in Smith's *Dictionary of Greek and Roman Biography*, in which the connexion of the tragedy with the Artemisian contest is disputed.

THEODOLITE,[1] a surveying instrument consisting of two graduated circles placed at right angles to each other, for the measurement of horizontal and vertical angles, a telescope, which turns on axes mounted centrically to the circles, and an alidade for each circle, which carries two or more verniers. The whole is supported by a pedestal resting on footscrews, which are also employed to level the instrument. The size varies from a minimum with circles 3 in. in diameter to a maximum with a 36-in. horizontal and an 18-in. vertical circle.

Theodolites are designed to measure horizontal angles with greater accuracy than vertical, because it is on the former that the most important work of a survey depends; measures of vertical angles are liable to be much impaired by atmospheric refraction, more particularly on long lines, so that when heights have to be determined with much accuracy the theodolite must be discarded for a levelling instrument. When truly adjusted the theodolite measures the horizontal angle between any two objects, however much they may differ in altitude, as the pole star and any terrestrial object.

The instrument is made in three forms—the Y pattern, the Everest and the transit. Certain parts are common to all the forms in use and to the level. The stand is generally made circular in section, each of the three legs being shod at the lower extremity with steel. Their upper ends are hinged to a flat plate provided with a screwed collar of large diameter (fig. 1). To the legs is screwed a plate OO, which supports the lower side of the plate PP. This receives the ends of the screws SS by which the instrument is levelled, its annular portion being larger than the collar in OO, so that, until clamped by the screwed plate above it, the whole of the instrument except the legs can be moved horizontally in any direction to the extent of about ½ in. This facilitates centring over a point. The upper plate PP is bored centrally to receive a parallel or conical pillar which supports the lower circle of the theodolite or the arm of the level which carries the telescope. In the theodolite the edge of the plate *rr* is bevelled and divided into 360 or 400 degrees, and to half degrees, or to 20 minutes or 10 minutes, according to the size of the instrument. A collar is provided, which when tightened on the vertical axis, otherwise free to move, holds it rigidly in position with respect to the plate PP. To this collar is attached a slow-motion screw, working against a reaction spring, by which the plate *rr* can be rotated through a small arc. The upper plate carrying two, three or four verniers *vv* is attached to a vertical coned pillar passing through the centre of the larger pillar and rotating in it; this plate can be clamped to the lower plate by means of the screw C, and can be rotated with respect to it by the slow-motion screw *d*. On the upper plate are placed two small levelling bubbles, and two standards *tt* are attached to the upper side of the plate for supporting the trunnions of the telescope T. The bearings for receiving these trunnions are V-shaped; the V on one side is fixed, while the other is cut through and can be narrowed or made wider, thus lifting or lowering the trunnion by means of two capstan-headed screws. To the telescope the vertical circle for reading angles in altitude is fixed, and rotates with it; both can be clamped to the standard, and motion can be given by a suitable double-ended motion screw. The verniers are attached to arms *uu* bearing on an enlargement of one trunnion of the telescope, one arm projecting downwards and embracing a projection on the standard *t*. To the same frame is attached a bubble, which should be parallel with the centre line of the verniers. The diagonal telescope *nn* is provided with cross hairs, and is used for the final centring of the instrument over an object. The use of aluminium in the construction of all parts not liable to much wear is to be commended, owing to the smaller weight. The Y theodolite differs from the transit in that the supports for the telescope are low, that the telescope rests in a cradle the trunnions of which rest on the supports, and that a segment of a circle attached to the cradle replaces

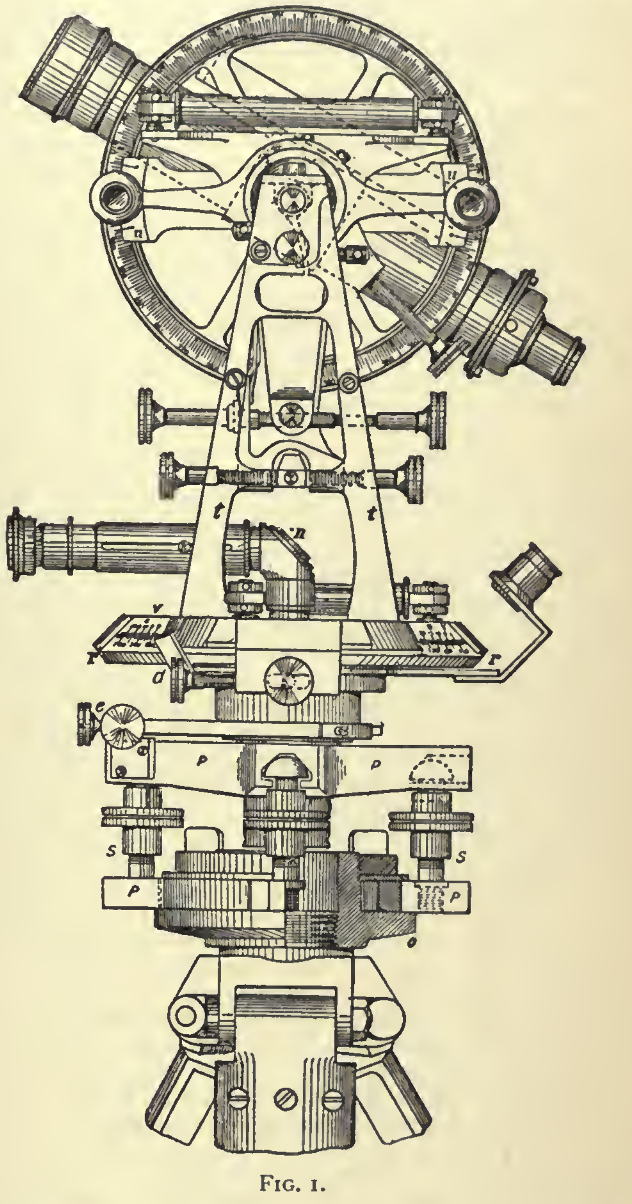


FIG. 1.

the vertical circle. When it is desired to read a line in the reverse direction the telescope is lifted out of the cradle, turned end for end, and replaced in the Y bearings of the cradle again. In the Everest theodolite the supports are low and the telescope cannot be transited. The instrument is similar to that described above, except that the vertical circle is not continuous, but is formed of two arcs.

In Germany and elsewhere refracting theodolites and transit instruments are sometimes employed. The eye end of the telescope tube is removed—a counterpoise to the object end being substituted in its place—and a prism is inserted at the intersection of the visual axis with the transit axis, so that the rays from the object-glass may be reflected through one of the tubes of the transit axis to an eye-piece in the pivot of this tube. In this case the pillars need only be high enough for the counterpoise to pass freely over the plate of the horizontal circle: but the observer has always

[1] This word has been a puzzle to etymologists. Various ingenious explanations have been given, all based on the apparent Greek form of the word; thus it has been derived from θεᾶσθαι, to see, ὁδός, way, and λιτός, smooth, plain; from θεῖν, to run, and δολιχός, long, and in other ways equally fanciful. Another imaginary origin has been suggested in a corruption of "the O deleted," *i.e.* crossed out, the circle being crossed by diameters to show the degrees; others have found in it a corruption of "the alidade" (*q.v.*). It would appear, however, to be taken from the O. Fr. *theodolet* or *theodelet*, the name of a treatise by one Theodulus, probably a mathematician (see *Notes and Queries*, 3rd series, vii. 337, 428, &c. Skeat, *Etym. Dict.*, 1910).

to place himself at right angles to the direction of the object he is observing.

Levelling Instrument.—This is another surveying instrument consisting essentially of a telescope bearing a level and mounted horizontally upon a frame. To the upper side of the parallel plates it is similar in construction to the theodolite. No provision is made for centring over a point. The upper plate is bored through the centre and carries a conical pillar, which rotates freely in it and supports a horizontal plate, to the extreme ends of which are attached, by means of capstan screws or otherwise, two vertical supports, on which the telescope, which is constructed to be perpendicular to the vertical axis of the instrument, rests and rotates with it. The level bubble, by which the instrument is brought into a position at right angles to the axis of the earth, is generally placed on the top of the telescope. In the best telescopes, whether for theodolite or level, the diaphragm on which the image is formed is made of glass, and the cross hairs are engraved thereon. In the level the eye-piece and object-glass are interchangeable, to facilitate adjustment for collimation.

THEODORA, the wife of the emperor Justinian (*q.v.*), was born probably in Constantinople, though according to some in Cyprus, in the early years of the 6th century, and died in 547. According to Procopius, our chief, but by no means a trustworthy authority for her life, she was the daughter of Acacius, a bear-feeder of the amphitheatre at Constantinople to the Green Faction, and while still a child was sent on to the stage to earn her living in the performances called mimes. She had no gift for either music or dancing, but made herself notorious by the spirit and impudence of her acting in the rough farces, as one may call them, which delighted the crowd of the capital. Becoming a noted courtesan, she accompanied a certain Hecebolus to Pentapolis (in North Africa), of which he had been appointed governor, and, having quarrelled with him, betook herself first to Alexandria, and then back to Constantinople through the cities of Asia Minor. In Constantinople (where, according to a late but apparently not quite groundless story, she now endeavoured to support herself by spinning, and may therefore have been trying to reform her life) she attracted the notice of Justinian, then patrician, and, as the all-powerful nephew of the emperor Justin, practically ruler of the empire. He desired to marry her, but could not overcome the opposition of his aunt, the empress Euphemia. After her death (usually assigned to the year 523) the emperor yielded, and as a law, dating from the time of Constantine, forbade the marriage of women who had followed the stage with senators, this law was repealed. Thereupon Justinian married Theodora, whom he had already caused to be raised to the patriciate. They were some time after (527) admitted by Justin to a share in the sovereignty; and, on his death four months later, Justinian and Theodora became sole rulers of the Roman world. He was then about forty-four years of age, and she some twenty years younger. Procopius relates in his unpublished history (Ἀνέκδοτα) many repulsive tales regarding Theodora's earlier life, but his evident hatred of her, though she had been more than ten years dead when the *Anecdota* were written, and the extravagances which the book contains, oblige us to regard him as a very doubtful witness. Some confirmation of the reported opposition of the imperial family to the marriage has been found in the story regarding the conduct of Justinian's own mother Vigilantia, which Nicholas Alemanni, the first editor of the *Anecdota*, in his notes to that book, quotes from a certain "Life of Justinian" by Theophilus, to which he frequently refers, without saying where he found it. Mr Bryce, however, discovered in Rome what is believed to be the only MS. of this so-called life of Justinian; and his examination of its contents makes him think it worthless as an authority (see THEOPHILUS).

Theodora speedily acquired unbounded influence over her husband. He consulted her in everything, and allowed her to interfere directly, as and when she pleased, in the government of the empire. She had a right to interfere, for she was not merely his consort, but empress regnant, and as such entitled equally with himself to the exercise of all prerogatives. In the most terrible crisis of Justinian's reign, the great Nika insurrection of 532, her courage and firmness in refusing to fly when the rebels were attacking the palace saved her husband's crown, and no doubt strengthened her command over his mind. Officials took an oath of allegiance to her as well as to the emperor (*Nov.*, viii.). She even corresponded with foreign ambassadors, and instructed Belisarius how to deal with the popes. Procopius describes her as acting with harshness, seizing on trivial pretexts persons who had offended her, stripping some of their property, and throwing others into dungeons, where they were cruelly tortured or kept for years without the knowledge of their friends. The city was full of her spies, who reported to her everything said against herself or the administration. She surrounded herself with ceremonious pomp, and required all who approached to abase themselves in a manner new even to that half-Oriental court. She was an incessant and tyrannical match-maker, forcing men to accept wives and women to accept husbands at her caprice. She constituted herself the protectress of faithless wives against outraged husbands, yet professed great zeal for the moral reformation of the city, enforcing severely the laws against vice, and immuring in a "house of repentance" on the Asiatic side of the Bosphorus five hundred courtesans whom she had swept out of the streets of the capital. How much of all this is true we have no means of determining, for it rests on the sole word of Procopius. But there are slight indications in other writers that she had a reputation for severity.

In the religious strife which distracted the empire Theodora took part with the Monophysites, and her coterie usually contained several leading prelates and monks of that party. As Justinian was a warm upholder of the decrees of Chalcedon, this difference of the royal pair excited much remark and indeed much suspicion. Many saw in it a design to penetrate the secrets of both ecclesiastical factions, and so to rule more securely. In other matters also the wife spoke and acted very differently from the husband; but their differences do not seem to have disturbed either his affection or his confidence. The maxim in Constantinople was that the empress was a stronger and a safer friend than the emperor; for, while he abandoned his favourites to her wrath, she stood by her protégés, and never failed to punish anyone whose heedless tongue had assailed her character.

Theodora bore to Justinian no son, but one daughter—at least it would seem that her grandson, who is twice mentioned, was the offspring of a legitimate daughter, whose name, however, is not given. According to Procopius, she had before her marriage become the mother of a son, who when grown up returned from Arabia, revealed himself to her, and forthwith disappeared for ever; but this is a story to be received with distrust. That her behaviour as a wife was irreproachable may be gathered from the fact that Procopius mentions only one scandal affecting it, the case of Areobindus. Even he does not seem to believe this case, for, while referring to it as a mere rumour, the only proof he gives is that, suspecting Areobindus of some offence, she had torture applied to this supposed paramour. Her health was delicate, and, though she took all possible care of it, frequently quitting the capital for the seclusion of her villas on the Asiatic shore, she died comparatively young. Theodora was small in stature and rather pale, but with a graceful figure, beautiful features, and a piercing glance. There remains in the apse of the famous church of S. Vitale at Ravenna a contemporaneous mosaic portrait of her, to which the artist, notwithstanding the stiffness of the material, has succeeded in giving some character.

The above account is in substance that which historians of the two centuries and a half prior to 1885 accepted and repeated regarding this famous empress. But it must be admitted to be open to serious doubts. Everything relating to the early career of Theodora, the faults of her girlhood, the charges of cruelty and insolence in her government of the empire, rest on the sole authority of the *Anecdota* of Procopius—a book whose credit is shaken by its bitterness and extravagance. If we reject it, little is left against her, except of course that action in ecclesiastical affairs which excited the wrath of Baronius, who had denounced her before the *Anecdota* was published.

In favour of the picture which Procopius gives of the empress it may be argued (1) that she certainly did interfere constantly and arbitrarily in the administration of public affairs, and showed herself therein the kind of person who would be cruel and unscrupulous in her choice of means, and (2) that we gather from other writers an impression that she was harsh and tyrannical, as, for instance, from the references to her in the lives of the popes in the *Liber Pontificalis* (which used to pass under the name of Anastasius, the papal librarian). Her threat to the person whom she commanded to bring Vigilius to her was "nisi hoc feceris, per Viventem in saecula excoriari te faciam." Much of what we find in these lives is legendary, but they are some evidence of Theodora's reputation. Again, (3) the statute (*Cod.*, v. 4, 23) which repeals the older law so far as relates to *scenicae mulieres* is now generally attributed to Justin, and agrees with the statement of Procopius that an alteration of the law was made to legalize her marriage. There is therefore reason for holding that she was an actress, and, considering what the Byzantine stage was (as appears even by the statute in question), her life cannot have been irreproachable.

Against the evidence of Procopius, with such confirmations as have been indicated, there is to be set the silence of other writers, contemporaries like Agathias and Evagrius, as well as such later historians as Theophanes, none of whom repeat the charges as to Theodora's life before her marriage. To this consideration no great weight need be attached. It is difficult to establish any view of the controversy without a long and minute examination of the authorities, and in particular of the *Anecdota*. But the most probable conclusions seem to be—(1) that the odious details which Procopius gives, and which Gibbon did not blush to copy, deserve no more weight than would be given nowadays to the malignant scandal of disappointed courtiers under a despotic government, where scandal is all the blacker because it is propagated in secret; (2) that apparently she was an actress and a courtesan, and not improbably conspicuous in both those characters; and (3) that it is impossible to determine how far the specific charges of cruelty and oppression brought against her by Procopius deserve credence. We are not bound to accept them, for they are uncorroborated; yet the accounts of Justinian's government given in the *Anecdota* agree in too many respects with what we know *aliunde* to enable us to reject them altogether; and it must be admitted that there is a certain internal consistency in the whole picture which the *Anecdota* present of the empress. About the beauty, the intellectual gifts, and the imperious will of Theodora there can be no doubt, for as to these all our authorities agree. She was evidently an extraordinary person, born to shine in any station of life.

Her fortunes have employed many pens. Among the later serious works dealing with them may be mentioned M. Antonin Débidour's *L'Impératrice Theodora: Étude Critique* (Paris, 1885), which endeavours to vindicate her from the aspersions of Procopius; and among more imaginative writings are Sir Henry Pottinger's interesting romance *Blue and Green* (London, Hurst and Blackett, 1879), M. Rhangabé's tragedy Θεοδώρα (Leipzig, 1884), and M. Sardou's play *Theodora*, produced in Paris in 1884. See also Dr F. Dahn's *Prokopios von Cäsarea* (1865), and, in addition, the works cited under Justinian. (J. Br.)

THEODORA, wife of the Roman emperor Theophilus. In the last year of her husband's reign (842) she overrode his ecclesiastical policy and summoned a council under the patriarch Methodius, in which the worship of images was finally restored and the iconoclastic clergy dispossessed. Appointed guardian of her infant son, Michael III., she carried on the government with a firm and judicious hand; she replenished the treasury and deterred the Bulgarians from an attempt at invasion. In order to perpetuate her power she purposely neglected her son's education, and therefore must be held responsible for the voluptuous character which he developed under the influence of his uncle Bardas. Theodora endeavoured in vain to combat Bardas's authority; in 855 she was displaced from her regency at his prompting, and being subsequently convicted of intrigues against him was relegated to a monastery. She was sainted in recompense for her zeal on behalf of image-worship.

THEODORA (d. 1057), daughter of the emperor Constantine VIII. Possessed of a strong and austere character, she refused the hand of the heir-presumptive, Romanus, who was married instead to her sister Zoë (1028). Though living in retirement she excited Zoë's jealousy, and on a pretext of conspiracy was confined in a monastery. In 1042 the popular movement which caused the dethronement of Michael V. also led to Theodora's instalment as joint-empress with her sister. After two months of active participation in government she allowed herself to be virtually superseded by Zoë's new husband, Constantine IX. Upon his death in 1054, in spite of her seventy years, she reasserted her dormant rights with vigour, and frustrated an attempt to supersede her on behalf of the general Nicephorus Bryennius. By her firm administration she controlled the unruly nobles and checked numerous abuses; but she marred her reputation by excessive severity towards private enemies and the undue employment of menials for advisers. She died suddenly in 1057.

See G. Finlay, *History of Greece*, vol. ii. (Oxford, 1877); G. Schlumberger, *L'Épopée Byzantine*, vol. iii. (Paris. 1905).

THEODORE, the name of two popes. Theodore I., pope from November 642 till May 649, succeeded John IV. He was the son of a bishop, and was born in Jerusalem. A zealous opponent of monothelitism, in the course of the protracted controversy he in a Roman synod excommunicated Pyrrhus, patriarch of Constantinople, and signed the document with ink mingled with consecrated wine. Theodore II. had a pontificate of only twenty days (Nov.–Dec. 897).

THEODORE (Rus. Fedor, or Feodor), the name of three tsars of Russia.

Theodore I. (1557–1598), tsar of Russia, the son of Ivan the Terrible and Anastasia Romanova, nominally succeeded his father in 1584, but being of weak intellect was governed throughout his reign by the boyar, Boris Godunov, whose sister Irene he married in 1580. On his death-bed he is said to have left the throne to his consort, with the Patriarch Job, Boris Godunov, and Theodore Romanov, afterwards the Patriarch Philaret, as her chief counsellors. Irene, however, retired into a monastery and her brother Boris stepped into her place.

See S. M. Solovev, *History of Russia* (Rus.), vol. viii. (Petersburg, 1895, &c.).

Theodore II. (1589–1605), tsar of Russia, was the son of Tsar Boris Godunov and one of the daughters of Malyuta-Skuratov, the infamous favourite of Ivan the Terrible. Passionately beloved by his father, he received the best available education for those days, and from childhood was initiated into all the *minutiae* of government, besides sitting regularly in the council and receiving the foreign envoys. He seems also to have been remarkably and precociously intelligent, and the first map of Russia by a native, still preserved, is by his hand. On the sudden death of Boris he was proclaimed tsar (13th of April 1605). Though his father had taken the precaution to surround him with powerful friends, he lived from the first moment of his reign in an atmosphere of treachery. On the 1st of July the envoys of Pseudo-Demetrius I. arrived at Moscow to demand his removal, and the letters which they read publicly in the Red Square decided his fate. On the 10th of July he was most foully murdered in his apartments in the Kreml.

See D. I. Ilovaisky, *The Anarchical Period in the Realm of Moscovy* (Rus.) (Moscow, 1894).

Theodore III. (1661–1682), tsar of Russia, was the eldest surviving son of Tsar Alexius and Maria Miloslavskaya. In 1676 he succeeded his father on the throne. He was endowed with a fine intellect and a noble disposition; he had received an excellent education at the hands of Simeon Polotsky, the most learned Slavonic monk of the day, knew Polish, and even possessed the unusual accomplishment of Latin; but, horribly disfigured and half paralyzed by a mysterious disease, supposed to be scurvy, he had been a hopeless invalid from the day of his birth. In 1679 he married his first cousin Agatha and assumed the sceptre. His native energy, though crippled, was not crushed by his terrible disabilities; and he soon showed that he was as thorough and devoted a reformer as a man incompetent to lead armies and obliged to issue his orders from his litter, or his bed-chamber, could possibly be. The atmosphere of the court ceased to be oppressive; the light of a new liberalism shone in the highest places; and the severity of the penal laws was considerably mitigated. He founded the academy of sciences in the Zaikonospassy monastery, where everything not expressly forbidden by the orthodox church, including Slavonic, Greek, Latin and Polish, was to be taught by competent professors. The chief difference between the

Theodorean and the later Petrine reforms was that while the former were primarily, though not exclusively, for the benefit of the church, the latter were primarily for the benefit of the state. The most notable reform of Theodore III., however, was the abolition, at the suggestion of Vasily Golitsuin, of *Myestnechestvo*, or "place priority," which had paralyzed the whole civil and military administration of Muscovy for generations (see GOLITSUIN). Henceforth all appointments to the civil and military services were to be determined by merit and the will of the sovereign. Theodore's consort, Agatha, shared his progressive views. She was the first to advocate beard-shearing. On her death (4th of July 1681) Theodore married Martha Apraksina. He died on the 27th of April 1682, without issue.

See M. P. Pogodin, *The First Seventeen Years of the Life of Peter the Great* (Rus.) (Moscow, 1875). (R. N. B.)

THEODORE (602–690), seventh archbishop of Canterbury, was born at Tarsus in Cilicia in 602. On the death of Wighard, who had been sent to Pope Vitalian by Ecgberht of Kent and Oswio of Northumbria in 667, apparently for consecration as archbishop, Theodore, who had become prominent in the Eastern work of the church, was recommended by Hadrian of Niridanum to fill the vacant see. Vitalian consecrated Theodore in April 688 on condition that Hadrian, afterwards abbot of St Peter's, Canterbury, should go with him. Hadrian was detained for some time by Ebroin, the Neustrian mayor of the palace, but Theodore reached England in May 669. According to Bede's account he made a tour of the whole of Anglo-Saxon England, reforming abuses and giving instruction as to the monastic rule and the canonical Easter. Bede also declares that he was the first archbishop to whom all the "church of the Angles" submitted. From the first he seems to have ignored the scheme for a separate province of York, but he reorganized the episcopate, assigning Bisi to East Anglia, Putta to Rochester, Hlothhere to Wessex, and Ceadda after reconsecration to Mercia. He brought the monastic education up to date by introducing literary, metrical and musical studies. In 673 Theodore presided at the first synod of the clergy in England which was held at Hertford. Various disciplinary regulations were emphasized, and an annual meeting arranged at a place called Cloveshoe. After this council Theodore revived the East Saxon bishopric, to which he appointed Earconwald. Soon after the first expulsion of Wilfrid in 678 he divided the Northumbrian diocese, appointing Trumwine bishop to the Picts. This led to a quarrel with Wilfrid which was not finally settled until 686–687. In 679 Theodore intervened to make peace between Ecgfrith of Northumbria and Aethelred of Mercia. He presided at other synods held in 680 at Hatfield and in 684 at Twyford, and died in 690. A penitential composed under Theodore's direction is still extant.

See Bede, *Hist. Eccl.*, edited by C. Plummer (Oxford, 1896); Eddius, *Vita Wilfridii* in J. Raine's *Historians of the Church of York*, vol. i. (London, 1879); *Anglo-Saxon Chronicle*, edited by Earle and Plummer (Oxford, 1899); Haddan and Stubbs, *Councils and Ecclesiastical Documents* (Oxford, 1869–78), iii. 173–213.

THEODORE LASCARIS (d. 1222), emperor of Nicaea, was born of a noble Byzantine family. He became the son-in-law of the Emperor Alexius III. and distinguished himself during the sieges of Constantinople by the Latins (1203–4). After the capture of the city he gathered a band of fugitives in Bithynia and established himself in the town of Nicaea, which became the chief rallying-point for his countrymen. Relieved of the danger of invasion by a Latin force which had defeated him in 1204 but was recalled to Europe by a Bulgarian invasion, he set to work to form a new Byzantine state in Asia Minor, and in 1206 assumed the title of emperor. During the next years Theodore was beset by enemies on divers sides. He maintained himself stubbornly in defensive campaigns against the Latin emperor Henry, defeated his rival Alexius Comnenus of Trebizond, and carried out a successful counter-attack upon Gayath-ed-din, the sultan of Koniah, who had been instigated to war by the deposed Alexius III. Theodore's crowning victory was gained in 1210, when in a battle near Pisidian Antioch he captured Alexius and wrested the town itself from the Turks. At the end of his reign he ruled over a territory roughly conterminous with the old Roman provinces of Asia and Bithynia. Though there is no proof of higher qualities of statesmanship in him, by his courage and military skill he enabled the Byzantine nation not merely to survive, but ultimately to beat back the Latin invasion.

See E. Gibbon, *The Decline and Fall of the Roman Empire*, vol. vi., ed. J. B. Bury (London, 1896); G. Finlay, *History of Greece*, vol. iii. (Oxford, 1877); and A. Meliarakes, Ἱστορία τοῦ Βασιλέιου τῆς Νικάιας καὶ τοῦ Δεσποτάτου τῆς Ἠπέιρου (Athens, 1898).

Theodore's grandson, THEODORE II. (Lascaris), emperor from 1254 to 1258, is chiefly noticeable for two brilliant campaigns by which he recovered Thrace from the Bulgarians (1255–56). His ill-health and early death prevented his making full use of his ability as a ruler.

See M. J. B. Pappadopoulos, *Théodore II. Lascaris, empereur de Nicée* (Paris, 1908).

IRENE LASCARIS, daughter of Theodore I. (Lascaris), was first married to the general Andronicus Palaeologus, and after his death became the wife of Theodore's successor, John Vatatzes (*q.v.*), and mother of Theodore II. She is much praised by historians for her modesty and prudence, and is said to have brought about by her example a considerable improvement in the morals of her nation. She died some ten years before her husband.

THEODORE OF MOPSUESTIA (*c.* 350–428), early Christian theologian, the most eminent representative of the so-called school of Antioch, was born at Antioch about the middle of the 4th century and was a friend of John Chrysostom; in rhetoric the celebrated Libanius was his teacher. Soon, however, he attached himself to the school of the great exegete and ascetic, Diodorus, a presbyter in Antioch, and with only a transitory period of vacillation, from which he was won back by Chrysostom, he remained faithful to the theology and ascetic discipline of this master. Under Diodorus he became a skilful exegete, and ultimately outstripped his master in biblical learning. About 383 Theodore became a presbyter in Antioch, and began to write against Eunomius the Arian and against the christology of Apollinaris. Soon after 392 he became bishop of Mopsuestia in Cilicia (the modern Missis near Adana). As such he was held in great respect, and took part in several synods, with a reputation for orthodoxy that was never questioned. It was greatly to his advantage that in the Eastern Church the period between the years 390 and 428 was one of comparative repose. He was on friendly terms even with Cyril of Alexandria. He died in 428 or 429, just at the beginning of the Nestorian controversy.

Theodore was a very prolific writer, but, before all, an exegete. He wrote commentaries on almost every book of the Old and New Testaments, of which, however, only a small proportion is now extant, as at a later period he lost credit in the church. We still possess in Greek his commentary on the Minor Prophets, in a Syriac version his commentary on St John,[1] and, in Latin translations, commentaries on the shorter Pauline epistles, besides very many fragments, especially on the epistle to the Romans. Theodore's importance as an exegete lies in two characteristics: (1) in opposition to the allegorical method he insists on getting at the literal meaning, and adheres to it when found; (2) in his interpretation of the Scriptures he takes into account the historical circumstances in which they were produced, and substitutes the historical-typological for the pneumatico-christological interpretation of prophecy; in other words, he interprets all Old Testament passages historically in the first instance, and sees the fulfilment of Old Testament prophecy in the history of Christ and His church only in so far as the entire Old Testament is a "shadow of things to come." Following his master Diodorus, who had already written a treatise Τίς διαφορὰ θεωρίας καὶ ἀλληγορίας, Theodore also was the author of a special dissertation against the allegorists, *i.e.* against Origen and his followers, which, however, has unfortunately perished. The comparative freedom of Theodore's view of inspiration is also noteworthy. He discriminates between historical, prophetical and didactic writings, and in accordance with this distinction assumes varying degrees of inspiration. Finally, he entertained very bold opinions about the canon and several of the books included in it.

[1] Ed. P. B. Chabot (Paris, 1897).

He esteemed very lightly the Solomonic writings and the book of Job; Canticles he explained as a nuptial poem of Solomon's; the book of Job appeared to him in many places hardly worthy of its subject, and he censures the writer sharply; Chronicles, Ezra and Nehemiah he entirely rejected; he denied the accuracy of the titles of the Psalms, anticipated the hypothesis that many of them belong to the Maccabean age, and referred the so-called Messianic element almost invariably to the kings of Israel; he even criticized the Catholic epistles and rejected the epistle of James. Characteristics such as these bring Theodore, of all patristic writers, nearest to the modern spirit. His commentaries contain a great deal of learned matter, and his grammatico-historical observations are still to some extent useful. But, on the other hand, his learning must not be overestimated. It falls behind that of Origen, Eusebius and Jerome, notwithstanding the superiority of his method It is specially noticeable that Theodore troubled himself little about textual criticism. He simply accepts the text of the LXX as that or revelation, and never manifests the slightest effort to control it by the original or even by the Syriac. He is a prosaic and often monotonous writer, and has other faults, *e.g* a lack of insight into the deeper movements of scriptural thought, and a want of spiritual and devotional fervour.

In addition to his commentaries Theodore also wrote extensive dogmatico-polemical works, which were destined to operate long after his death disastrously for his fame. As a disciple of Diodorus, Theodore accepted the Nicene teaching on the doctrine of the Trinity, but at the same time in christology took up a position very closely approaching that of Paul of Samosata. The violence of his opposition to his fellow-countryman, Apollinaris of Laodicea, perhaps the most acute and far-seeing theologian of the century, made it necessary for Theodore to formulate his christology with precision (in fifteen books on the Incarnation—all lost except a few fragments—and in special treatises against Apollinaris). He starts with a theory of man's relation to the world. Man is the *vinculum* of the cosmos, uniting in his person the material and the spiritual. This bond, broken by sin, was restored by Christ. According to Theodore the Logos assumed a complete manhood, which had to pass through the stages of ethical development just as in the case of any other human being. In this the Logos only supported the man Christ Jesus, but was not essentially connected with him; the Logos dwelt in him (ἐνοικεῖν), but any such thing as ἕνωσις φυσική did not and could not exist, because the finite is not "capax infiniti," and because any ἕνωσις would have destroyed the reality of the human nature. The same sober and thoughtful way of looking at things, and the same tendency to give prominence to the moral element, which characterize the commentaries of Theodore, appear also in his dogmatic. When, accordingly, the Nestorian controversy broke out, his works also were dragged into the discussion. At Ephesus, indeed, the memory of Theodore does not appear to have been attacked,[1] but soon afterwards the assault began. Marius Mercator, Rabbula of Edessa, Cyril, and other monophysites brought the charge of heresy against his writings, and sought to counteract their influence. But it was not until more than a century afterwards that his fanatical adversaries succeeded—in spite of the strong opposition of the best theologians of the West—in obtaining from Justinian the condemnation of his works in the controversy of the Three Chapters; this act of the emperor was confirmed by the fifth oecumenical council, and Theodore's name was accordingly deleted from the list of orthodox writers. From that day Theodore's works ceased to be read within the Byzantine Church, and hence have been lost. The Syrians, on the other hand, have always held in high esteem the memory of the great teacher, and have even carried back their liturgy to his name. The Nestorians, who called him "the Interpreter," possess, or possessed, a very large number of writings by him in Syriac translations.[2]

Theodore took part also in the Pelagian controversy at the time when it raged in Palestine. In the treatise, only partially preserved,[3] Πρὸς τοὺς λέγοντας φύσει καὶ οὐ γνώμῃ πταίειν τοὺς ἀνθρώπους, he sharply controverts the doctrine of original sin and Jerome its advocate. In his view the theory of Augustine is "a new heresy," a "malady"; he regarded it as a doctrine which necessarily led to dualism and Manichaeism. The attitude thus taken by Theodore is not surprising; he more nearly takes up the ground of the old church doctrine as set forth in the apologists and in the great Greek fathers of the 3rd and 4th centuries. The Pelagians driven from the East were received by him in Cilicia.

A brother of Theodore, Polychronius by name, bishop of Apamea in Syria (d. 430) also achieved high fame as an exegete, and expounded the theology of the school of Antioch.[4]

LITERATURE.—Migne, *Patrol.*, ser. Gr., lxvi. The Greek fragments of Theodore's New Testament commentaries have been collected by O. Fr Fritzsche (*Theod. Mops. in N.T. Comm.*, Turin, 1847). The commentaries on the Pauline epistles (Pitra, *Spicilegium Solesmense*, Paris, 1852, i. 49 seq.) have been edited by H. B. Swete (*Theod. Mops. in Epp. B. Pauli Comm.*, i., ii., Cambridge, 1880–82), along with the Greek fragments and the fragments of the dogmatical writings; on this edition, see E. Schürer, *Theol. Lit. Ztg.*, 1880–82. The commentary on the Minor Prophets will be found in Mai's *Nov. Patr. Biblioth.*, vii. 1854 (Berlin, 1834; Mai, *Script. Vet. Nov. Coll.*, vi., 1832). See also E. Sachau, *Theod. Mops. Fragm. Syriaca* (Leipzig, 1869); Fr. Bäthgen, "Der Psalmencommentar des Theod. v. Mops. in Syr. Bearbeitung," in *Ztschr. f. Alt-Test. Wissensch.*, v. 53 seq., vi. 261–288, vii. 1–60; and H. Lietzmann in *Sitzungsberichte der Kgl. preuss. Akad. der Wissensch. zu Berlin*, 1902, pp. 334 seq. Extracts from the writings of Theodore occur in the *Catenae* of Marius Mercator, in the *Acta* of the third and fifth oecumenical councils in Facundus, Liberatus, and Theodore's chief adversary Leontius Byzantinus. E. von Dobschütz, in *Amer. Journ. of Theol.*, ii. 353–387, published the Greek prologue of a commentary on *Acts* that is probably the work of Theodore.

The principal monograph on Theodore, apart from the prolegomena of Swete, and the same writer's article in *Dict. Christian Biog.*, iv. (1887), is that of H. Kihn (*Th. v. Mops. u. Junilius Afric. als Exegeten*, Freiburg, 1880). On his importance for the history of dogma see the works of Baur, Dorner, Harnack, Loofs and Seeberg. Literary and biographical details will be found in O. Fr. Fritzsche, *De Theod. Mops. Vita et Scriptis* (Halle, 1836); Fr. A. Specht, *Theod. v. Mops. u. Theodoret* (Munich, 1871); H. Kihn in the *Tüb. Quartalschr.*, 1879; E. Nestle in *Theol. Stud. aus Würtemb.*, ii. 210 seq.; P. Batiffol, "Sur une Traduction Latine de Th. de Mops.," in *Ann. de Philos. Chrét.*, 1885; Th. Zahn, "Das N. T. Theodors von Mop.," in *Neue Kirchl. Zeitschr.*, xi. 788–806; W. Wright, *Syriac Literature* (London, 1894); R. Duval, *La littérature syriaque* (Paris, 1899). (A. HA.)

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[1] A confession, however, drawn up by him was spoken of; see Hahn, *Biblioth. der Symbole*, 2nd ed., p. 229 seq.

[2] See the catalogue in Assemani, *Bibl. Or.*, iii. 1, p. 3 seq., based on Ebedjesu, the Nestorian metropolitan (d. 1318).

[3] See Photius, *Biblioth.*, c. 177; Mercator, p. 339 seq., ed. Baluz.

[4] See O. Bardenhewer, *Polychronius* (Freiburg, 1879).

THEODORET, bishop of Cyrrhus, an important writer in the domains of exegesis, dogmatic theology, church history and ascetic theology, was born in Antioch, Syria, about 386. At an early age he entered the cloister; and in 423 he became bishop of Cyrrhus, a small city in a wild district between Antioch and the Euphrates, where, except for a short period of exile, he spent the remainder of his life. The date of his death is uncertain, but it must have been at least six or seven years later than the council of Chalcedon (451). Although thoroughly devoted to the ideals of monasticism, he discharged his episcopal duties with remarkable zeal and fidelity. He was diligent in the cure of souls, labouring hard and successfully for the conversion of the numerous Gnostic communities and other heretical sects which still maintained a footing within the diocese. He himself claims to have brought more than a thousand Marcionites within the pale of the church, and to have destroyed many copies of the *Diatessaron* of Tatian, which were still in ecclesiastical use; and he also exerted himself to improve the diocese, which was at once large and poor, by building bridges and aqueducts, beautifying the town, and by similar works.

As an exegete Theodoret belongs to the Antiochene school, of which Diodorus of Tarsus and Theodore of Mopsuestia were the heads. He was not actually the personal disciple of either, but he adopted their methods, though without the consistency and boldness of the first-named. His extant commentaries (those on Canticles, on the Prophets, on the book of Psalms and on the Pauline epistles—the last the most valuable) are among the best performances of the fathers of the church. They are brief, yet not wanting in that element of practical edification on which Chrysostom lays special weight as characteristic of the Antiochenes. In addition to these complete commentaries, we have fragments of some others (of that on Isaiah, for example), principally met with in catenae. There are also special elucidations of some difficult Scripture texts.

Theodoret's chief importance is as a dogmatic theologian, it having fallen to his lot to take part in the Nestorian controversy and to be the most considerable opponent of the views of Cyril and Dioscurus of Alexandria. For more than twenty years he maintained the struggle against the Alexandrian dogmatic and its formulae (θεοτόκος, ἕνωσις καθ' ὑπόστασιν, μία ὑπόστασις, ἕνωσις φυσική, and the like), and taught that in the person of Christ we must strictly distinguish two natures (*hypostases*), which are united indeed in one person (*prosopon*), but are not amalgamated in essence. For these years his history coincides with that of the Eastern Church from 430 to 451, and for this very reason it is impossible to sketch it even briefly here (see Hefele, *Conc.-gesch.*, vol. ii.). The issue was not unfavourable to Theodoret's cause, but melancholy enough for Theodoret himself: the council of Chalcedon condemned monophysitism, but he unhappily yielded to pressure so far as also to take part in pronouncing "anathema upon Nestorius, and upon all who call not the Holy Virgin Mother of God, and who divide the one Son into two." As Theodoret had previously been a constant defender of Nestorius it was impossible for him to concur in this sentence upon his unfortunate friend with a clear conscience, and in point of fact he did not change his own dogmatic position. It is painful, therefore, to find him in his subsequent *Epitome* classing Nestorius as a heretic, and speaking of him with the utmost hostility. Some of Theodoret's dogmatic works are no longer extant: of his five books Περὶ ἐνανθρωπήσεως, for example, directed against Cyril after the council of Ephesus, we now possess fragments merely. A good deal of what passes under his name has been wrongly attributed to him. Certainly genuine are the refutation (Ἀνατροπή) of Cyril's twelve ἀναθεματισμοί of Nestorius, and the Ἐρανίστης, or Πολύμορφος, (written about 446), consisting of three dialogues, entitled respectively Ἄτρεπτος, Ἀσύγχυτος, and Ἀπαθής, in which the monophysitism of Cyril is opposed, and its Apollinarian character insisted on. Among the apologetico-dogmatic works of Theodoret must be reckoned his ten discourses Περὶ προνοίας.

Theodoret gives a valuable exposition of his own dogmatic in the fifth book of his Αἱρετικῆς κακομυθίας ἐπιτομή, already referred to.[1] This, the latest of his works in the domain of church history (it was written after 451), is a source of great though not of primary importance for the history of the old heresies. In spite of the investigations of Volkmar and Hilgenfeld, we are still somewhat in the dark as to the authorities he used. The chief uncertainty is as to whether he knew Justin's *Syntagma*, and also as to whether he had access to the *Philosophumena* of Hippolytus in their complete form. Besides this work Theodoret has also left us a church history in five books, from 324 to 429, which was published shortly before the council of Chalcedon. The style is better than that of Socrates and Sozomen, as Photius has remarked, but as a contribution to history the work is inferior in importance. Its author made use of Eusebius's *Life of Constantine*, and of the histories of Rufinus, Socrates and Sozomen, and probably of Philostorgius as well. He also used other sources, and made a thorough study of the writings of Athanasius, but apart from some documents he has preserved, relating to the Arian controversy, he does not contribute much that is not to be met with in Socrates. As regards chronology he is not very trustworthy; on the other hand, his moderation towards opponents, not excepting Cyril, deserves recognition. The Ἑλληνικῶν θεραπευτικὴ παθημάτων (*De Curandis Graecorum Affectionibus*)—written before 438—is of an historical and apologetic character, very largely indebted to Clement of Alexandria and Eusebius; it aims at showing the advantages of Christianity as compared with "the moribund but still militant" Hellenism of the day, and deals with the assaults of pagan adversaries. The superiority of the Christian faith both philosophically and ethically is set forth, the chief stress being laid on monachism, with which heathen philosophy has nothing to compare. Much prominence is also given to the cult of saints and martyrs.

On this side of his character, however, Theodoret can best be studied in the thirty ascetic biographies of his Φιλόθεος ἱστορία. This collection, which has been widely read, is a pendant to the *Historia Lausiaca* of Palladius and the monkish tales of Sozomen. For the East it has had the same importance as the similar writings of Jerome, Sulpicius Severus and Cassian for the West. It shows that the "sobriety" of the Antiochene scholars can be predicated only of their exegesis; their style of piety was as exaggerated in its devotion to the ideals of monasticism as was that of their monophysite opponents. Indeed, one of the oldest leaders of the school, Diodorus of Tarsus, was himself among the strictest ascetics.

181 letters of Theodoret have come down to us, partly in a separate collection, partly in the *Acta* of the councils, and partly in the Latin of Marius Mercator; they are of great value not only for the biography of the writer, but also for the history of his diocese and of the church in general.

The edition of Sirmond (Paris, 1642) was afterwards completed by Garnier (1684), who has also written dissertations on the author's works. Schulze and Nösselt published a new edition (6 vols., Halle, 1769–74) based on that of their predecessors; a glossary was afterwards added by Bauer. The reprint will be found in vols. lxxx.–lxxxiv. of Migne, and considerable portions occur in Mansi. The church history has been published frequently in connexion with the histories of Socrates, Sozomen and others, *e.g.* by Valesius (1693) and Reading (1720). There is an English translation of the history by Bloomfield Jackson in the *Nicene and Post-Nicene Fathers*, series ii., vol. iii.; the translation including also the dialogues and letters.

Besides the earlier labours of Tillemont, Ceillier, Oudin, Du Pin and Fabricius and Harless, see Schröckh, *Kirchengesch.*, vol. xviii.; Hefele, *Conc.-gesch.*, vol. ii.; Richter, *De Theodoreto Epp. Paul. Interprete* (Leipzig, 1822); Binder, *Études sur Théodoret* (Geneva, 1844); Stäudlin, *Gesch. u. Lit. der Kirchengesch.* (Hanover, 1827); Kihn, *Die Bedeutung der antioch. Schule* (1866); Diestel, *Das A. T. in der christl. Kirche* (Jena, 1869); Specht, *Theodor v. Mopsvestia u. Theodoret v. Cyrus* (Munich, 1871); Roos, *De Theodoreto Clementis et Eusebii Compilatore* (Halle, 1883); Nolte in the *Tübing. Quartalschr.* (1859), p. 302 seq.; Möller, art. "Theodoret," in Herzog-Hauck's *Realencykl.*; Venables's article in Smith and Wace's *Dict. of Christian Biography*; also Bardenhewer's *Patrologie*, p. 345 ff. On the sources of Theodoret's church history see Jeep, *Quellenuntersuchungen z. d. Griech. Kirchenhistorikern* (Leipzig, 1884); and especially Güldenpenning, *Die Kirchengesch. des Theodoret von Kyrrhos* (Halle, 1889). (A. Ha.; A. C. McG.)

[1] Roman Catholic writers vary greatly in their estimate of Theodoret's christology and of his general orthodoxy. On Bertram's essay on this subject (*Theodoreti, Episcopi Cyrensis, Doctrina Christologica*, Hildesheim, 1883), see *Theol. Lit.-Ztung.* (1883), 563 seq.

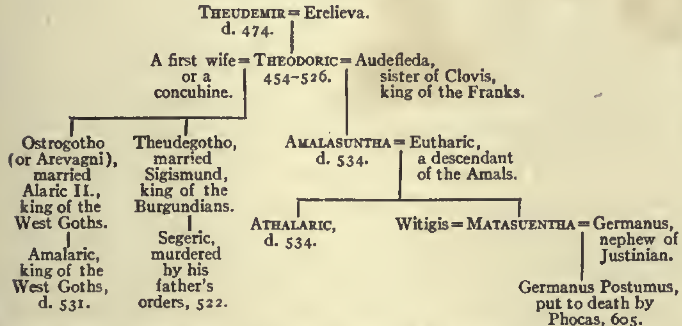
THEODORIC, king of the Ostrogoths (*c.* 454–526). Referring to the article Goths for a general statement of the position of this, the greatest ruler that the Gothic nation produced, we add here some details of a more personal kind. Theodoric was born about the year 454, and was the son of Theudemir, one of three brothers who reigned over the East Goths, at that time settled in Pannonia. The day of his birth coincided with the arrival of the news of a victory of his uncle Walamir over the sons of Attila. The name of Theodoric's mother was Erelieva, and she is called the concubine of Theudemir. The Byzantine historians generally call him son of Walamir, apparently because the latter was the best known member of the royal fraternity. At the age of seven he was sent as a hostage to the court of Constantinople, and there spent ten years of his life, which doubtless exercised a most important influence on his subsequent career. Soon after his return to his father (about 471) he secretly, with a *comitatus* of 10,000 men, attacked the king of the Sarmatians, and wrested from him the important city of Singidunum (Belgrade). In 473 Theudemir, now chief king of the Ostrogoths, invaded Moesia and Macedonia, and obtained a permanent settlement for his people near Thessalonica. Theodoric took the chief part in this expedition, the result of which was to remove the Ostrogoths from the now barbarous Pannonia, and to settle them as *foederati* in the heart of the empire. About 474 Theudemir died, and for the fourteen following years Theodoric was chiefly engaged in a series of profitless wars, or rather plundering expeditions, partly against the emperor Zeno, but partly against a rival Gothic chieftain, another Theodoric, son of Triarius.[2] In 488 he set out at the head of his people to win Italy from Odoacer. There is no doubt that he had for this enterprise the sanction of the emperor, only too anxious to be rid of so troublesome a guest. But the precise nature of the relation which was to unite the two powers in the event of Theodoric's success was, perhaps purposely, left vague. Theodoric's complete practical independence, combined with a great show of deference for the empire, reminds us somewhat of the relation of the old East India Company to the Mogul dynasty at Delhi, but the Ostrogoth was sometimes actually at war with his imperial friend. The invasion and conquest of Italy occupied more than four years (488–493). Theodoric, who marched round the head of the Venetian Gulf, had to fight a fierce battle with the Gepidae, probably in the valley of the Save. At the Sontius (Isonzo) he found his passage barred by Odoacer, over whom he gained a complete victory (28th of August 489). A yet more decisive victory followed on the 30th September at Verona. Odoacer fled to Ravenna, and it seemed as if the conquest of Italy was complete. It was delayed, however, for three years by the treachery of Tufa, an officer who had deserted from the service of Odoacer, and of Frederic the Rugian, one of the companions of Theodoric, as well as by the intervention of the Burgundians on behalf of Odoacer. A sally was made from Ravenna by the besieged king, who was defeated in a bloody battle in the Pine Wood. At length (26th of February 493) the long and severe blockade of Ravenna was ended by a capitulation, the terms of which Theodoric disgracefully violated by slaying Odoacer with his own hand (15th of March 493). (See Odoacer.)

The thirty-three years' reign of Theodoric was a time of unexampled happiness for Italy. Unbroken peace reigned within her borders (with the exception of a trifling raid made by Byzantine corsairs on the coast of Apulia in 508). The

[2] In one of the intervals of friendship with the emperor in 483 Theodoric was made master of the household troops and in 484 consul.

venality of the Roman officials and the turbulence of the Gothic nobles were sternly repressed. Marshes were drained, harbours formed, the burden of the taxes lightened, and the state of agriculture so much improved that Italy, from a corn-importing, became a corn-exporting country. Moreover Theodoric, though adhering to the Arian creed of his forefathers, was during the greater part of his reign so conspicuously impartial in religious matters that a legend which afterwards became current represented him as actually putting to death a Catholic deacon who had turned Arian in order to win his favour. At the time of the contested papal election between Symmachus and Laurentius (496–502), Theodoric's mediation was welcomed by both contending parties. Unfortunately, at the very close of his reign (524), the Emperor Justin's persecution of the Arians led him into a policy of reprisals. He forced Pope John to undertake a mission to Constantinople to plead for toleration, and on his return threw him into prison, where he died. Above all, he sullied his fame by the execution of Boetius and Symmachus (see BOETIUS). It should be observed, however, that the motive for these acts of violence was probably political rather than religious—jealousy of intrigues with the imperial court rather than zeal on behalf of the Arian confession. Theodoric's death, which is said to have been hastened by remorse for the execution of Symmachus, occurred on the 30th of August 526. He was buried in the mausoleum which is still one of the marvels of Ravenna (*q.v.*), and his grandson Athalaric, a boy of ten years, succeeded him, under the regency of his mother Amalasuntha.

Genealogy of Theodoric.



Amalafrida, a full sister of Theodoric, married Thrasamund, king of the Vandals, and was mother, by an earlier marriage, of Theodahad (d. 536).

AUTHORITIES.—The authorities for the life of Theodoric are very imperfect. Jordanes, Procopius, and the curious fragment known as Anonymus Valesii (printed at the end of Ammianus Marcellinus) are the chief direct sources of narrative, but far the most important indirect source is the *Variae* (state-papers) of Cassiodorus, chief minister of Theodoric. Malchus furnishes some interesting particulars as to his early life, and it is possible to extract a little information from the turgid panegyric of Ennodius. Among German scholars F. Dahn (*Könige der Germanen*, ii., iii. and iv.), J. K. F. Manso (*Geschichte des Ostgothischen Reichs in Italien*, 1824), and Sartorius (*Versuch über die Regierung der Ostgothen*, &c.) have done most to illustrate Theodoric's principles of government. The English reader may consult Gibbon's *Decline and Fall*, chap. xxxix., and Hodgkin's *Italy and her Invaders*, vol. iii. (1885), his introduction to *Letters of Cassiodorus* (1886) and *Theodoric the Goth* (London and New York, 1891). For the legends connected with the name of Theodoric see the article DIETRICH OF BERN.

(T. H.)

THEODORUS, FLAVIUS MALLIUS, Roman consul A.D. 399, author of an extant treatise on metres, one of the best of its kind (H. Keil, *Grammatici Latini*, vi.). He also studied philosophy, astronomy and geometry, and wrote works on those subjects, which, together with his consulship, formed the subject of a panegyric by Claudian.

THEODORUS STUDITA (A.D. 759–826), Greek theological writer, abbot of the monastery of Studium, was born at Constantinople. In 794 he succeeded his uncle Plato, who had persuaded him to become a monk some ten years before, as head of the monastery of Saccudium in Bithynia. Soon afterwards he was banished to Thessalonica for having excommunicated Constantine VI., who had divorced his wife Maria in order to marry Theodotē. After the emperor's death in 797 he was recalled with every mark of favour, and removed with his monks to the monastery of Studium in Constantinople, where he carried on a vigorous campaign in favour of asceticism and monastic reform. In 809 he was again banished in consequence of his refusal to hold communion with the patriarch Nicephorus, who had pardoned the priest Joseph for his part in the marriage of Constantine and Theodotē. In 811 he was recalled by Michael Rhangabes, and again banished in 814 for his resistance to the edict of Leo the Armenian, which forbade the worship of images. Liberated in 821 by the Emperor Michael the Stammerer (Balbus), he soon got into trouble again. In 824 he violently attacked Michael for showing too great leniency towards the iconoclasts and even favoured an insurrection against him. When the attempt failed, Theodorus found it prudent to leave Constantinople. He lived at various monasteries in Bithynia, on Chalcitis (one of the Princes' Islands) and on the peninsula of Tryphon, near the promontory of Acrita, where he died on the 11th of November 826. He was buried at Chalcitis, but his body was afterwards (26th of January 844) removed to Studium. He subsequently received the honours of canonization. Of his extant works the following are the most important:—*Letters*, which are of considerable value as giving an insight into the life and character of the writer, and throwing light upon the ecclesiastical disputes in which he was involved; *Catecheses* (divided into *Magna* and *Parva*), two collections of addresses to his monks on various subjects connected with the spiritual life; funeral orations on his mother and his uncle Plato; various polemical discourses connected with the question of image-worship. He was also the author of epigrams on various subjects, which show considerable originality, and of some church hymns. Like all the monks of Studium, Theodore was famous for his calligraphy and industry in copying MSS.

BIBLIOGRAPHY.—General edition of his works in J. P. Migne, *Patrologia Graeca*, xcix., to be supplemented (for the *Letters*) by A. Mai's *Patrum Nova Bibliotheca*, viii. (1871) and (for the *Catecheses*) by *ib.*, ix. (1888), which contains the Greek text of the *Parva* (also ed. separately by E. Auvray, 1891); hymns in J. B. Pitra, *Analecta Sacra*, i. (1876). See also Alice Gardner, *Theodore of Studium: his Life and Times* (1905), containing specimens of English translation and an account of his published works; C. Thomas, *Theodor von Studion und sein Zeitalter* (1892); G. A. Schneider, *Theodor von Studion*, in "Kirchengeschichtliche Studien," v. 3 (Münster, 1900); S. Schiwietz, *De Sancto Theodoro Studita* (Breslau, 1896); E. Marin, *De Studio coenobio Constantinopolitano* (1897); C. Schwarzlose, *Der Bilderstreit* (1890); A. Tougard, *La Persécution iconoclaste d'après la correspondance de saint Théodore Studite* (1891). Some of the hymns have been translated by J. M. Neale in his *Hymns of the Eastern Church*. For further bibliographical details see C. Krumbacher, *Gesch. der byz. Litt.* (2nd ed., 1897) and article by Von Dobschütz in Herzog-Hauck's *Realencyclopädie für protestantische Theologie*, xix. (1907). On his relation to Theophanes Confessor (*q.v.*), see J. Pargoire, "Saint Théophane le Chronographe et ses rapports avec saint Théodore Studite" in Βυζαντινὰ Χρονικά, ix. (St Petersburg, 1902).

THEODOSIA, formerly KAFFA, a seaport and watering-place of South Russia, on the east coast of the Crimea, 66 m. E.N.E. of Simferopol and 72 m. by a branch line from the Sebastopol-Ekaterinoslav railway. It has an excellent modern harbour, and its roadstead, which is never frozen, is well protected from east and west winds, and partly also from the south, but its depth is only 11 to 14 ft., reaching 35 ft. in the middle. The population was 10,800 in 1881, and 27,236 in 1897. Among the motley population of Russians, Tatars, Armenians, Germans and Greeks are several hundred Qaraite Jews. Few remains of its former importance exist, the chief being the Citadel built by the Genoese and still showing Latin inscriptions on some of its towers, the one or two detached towers left when the town walls were pulled down, and two or three mosques, formerly Genoese churches. The town also possesses a museum of antiquities and a picture gallery containing the works of the marine painter Ayvazovsky. Theodosia is an episcopal see of the Orthodox Greek Church. Gardening is one of the leading industries; fishing, a few manufactures, and agriculture are carried on. Theodosia has gained much of the trade of Sevastopol since that town was made a military port in 1894, and the value of its exports (1½–2½ millions sterling annually), principally grain and oil-seeds, is increasing year by year. A bronze statue of Alexander III. was put up on the sea-front in 1896.

The ancient Theodosia, the native name of which was Ardabda, was a colony founded from Miletus. Archaic terra-cottas show it to have been inhabited in the 6th century B.C., but it is first heard of in history as resisting the attacks of Satyrus, ruler of the Cimmerian Bosporus, *c.* 390 B.C. His successor Leucon took it and made it a great port for shipping wheat to Greece, especially to Athens. This export of wheat continued until the days of Mithradates VI. of Pontus, against whom the city revolted. Later it became a special part of the Bosporan kingdom with its own governor. In the 3rd century A.D. it was still inhabited, but seems to have been deserted not long afterwards. Besides the terra-cottas and pottery very beautiful Greek jewelry has been found near Theodosia. It coined silver and copper during the 5th and 4th centuries B.C. The name Kaffa (Genoese *Capha*, Turkish *Kefe*) first occurs in a writer of the 9th century. The Genoese established themselves on the site shortly after 1266, and the settlement flourished exceedingly, being the depôt of a trade route reaching to China. It became the head of the Genoese establishments in Gazaria, the see of a bishop, and the chief port on the northern shore of the Black Sea, far surpassing the Venetian Tana. Its population is said to have reached 80,000 souls of many creeds and nationalities. There was a citadel (still remaining) and magnificent walls. These were rendered necessary by the occasional hostility of the Tatar khans. When the Turks took Constantinople the colony was almost cut off from the mother city, which handed it over to the enterprising bank of St George; but it could not be saved and fell in 1475 to the Turks, who sometimes called it Kuchuk-Stambul (Little Stambul or Constantinople) or Krym-Stambul (Stambul of Crimea). Its new masters kept it under their own direct rule and its prosperity was not entirely destroyed. In 1771 it was taken by the Russians, and in 1783 annexed by them, whereupon the greater part of its population deserted it. Its prosperity did not return until about 1894, when new harbour works made it a convenient port for grain ships coming light out of the Sea of Azov and wishing to complete their cargoes.

See E. von Stern, *Theodosia* (German and Russian, Odessa, 1906); E. H. Minns, *Scythians and Greeks* (Cambridge, 1909); for the history of Kaffa see Heyd, *Histoire du commerce du Levant au moyen âge* (Paris, 1886), vol. ii. (E. H. M.)

THEODOSIUS, the name of three Roman emperors of the East.

THEODOSIUS I., "the Great," son of Theodosius, Valentinian's great general, who in 368–69 drove back the Picts and Scots from the Roman territories in Britain and suppressed the revolt of Firmus in Mauretania (372). Shortly after (376), the elder Theodosius was put to death by order of Valens, probably through fear lest he should be the Theodosius or Theodore whom a magician had indicated as the future emperor. The younger Theodosius was born about the year 346. He was a native of Spain, but the exact place of his birth is uncertain (Cauca in Galicia according to Idatius and Zosimus, Italica according to Marcellinus). He accompanied his father into Britain (368), and a little later distinguished himself by defeating the Sarmatians who had invaded Moesia (374). On his father's death he retired to his native place, where he lived quietly till after the great battle of Adrianople (August 9, 378), when Gratian summoned him to share the empire. After gaining some fresh victories over the Sarmatians, Theodosius was made Augustus at Sirmium on the 19th of January 379, and was assigned all the eastern provinces, including part of Illyricum. It was a time of great peril for the Roman state. While the Visigoths were carrying their raids up to the walls of Constantinople, bands of Ostrogoths, Taifali, Huns and Alans joined them in overrunning the Balkan countries. In 379 Theodosius, after reorganizing the army at Thessalonica, carried on a successful campaign of skirmishes along the Danube and induced numerous Gothic bands to give in their allegiance; his lieutenant Modares, a Gothic refugee, defeated the invaders severely in Thrace. At the end of the year Theodosius went to Constantinople to be crowned. Returning to Thessalonica in 380 he was kept out of the field for some time by a serious illness. In this year or the next he was called upon to meet two armies of invaders. He conducted in person the war against the Visigoths under Fritigern (in Macedonia and Epirus), and on one occasion was nearly betrayed into the enemy's hands; this campaign, in which Gratian's general Arbogast eventually lent help, was ended by Fritigern's death. The defence of the Danube against the Ostrogoths under Alatheus and Safrax was entrusted to the general Promotus, who severely defeated the enemy in an attempt to cross the river. Theodosius attained even greater successes by his diplomacy. He persuaded the fugitive Visigoth king Athanaric to enter his service, and enlisted 40,000 of his former enemies as *foederati*, providing them with settlements in various parts of the realm. Though this kindness towards the Germanic tribes was resented by the Romans, and in some cases ill requited, yet it may be said that it not only averted a great danger to the empire, but considerably strengthened Theodosius' army. In 382 the pacification of the Balkans was complete. In 386 Promotus checked a new attempt at invasion on the Danube.

In 383 Theodosius created his eldest son Arcadius Augustus. The same year saw the revolt of Maximus in Britain and the murder of Gratian. For five years Theodosius consented to accept the usurper as his colleague; but when Maximus attempted a few years later to make himself master of Italy Theodosius advanced against the invader and overthrew him near Aquileia (July 28, 388). This victory was followed by the murder of Maximus and his son Victor, after whose death Theodosius conferred upon Valentinian II. all that part of the empire which his father had held. After celebrating a triumph in Rome (389) he stayed to arrange the government of Italy for another two years. If we may trust the evidence of Zosimus, from the end of the year 388 Theodosius resigned himself to gluttony and voluptuous living, from which he was only roused by the news that in the Western empire Arbogast had slain the young Emperor Valentinian and set up the grammarian Eugenius in his stead (May 15, 392).

Theodosius made extensive levies and with a force partly composed of barbarian auxiliaries marched out against Eugenius. The armies met near the river Frigidus, some thirty-six miles distant from Aquileia. On the first day Theodosius' barbarians, engaging with those of the hostile army, were almost destroyed, and the victory seemed to be with Eugenius. After a night of prayer, towards cockcrow the emperor was cheered by a vision of St Philip and St John, who, mounted on white steeds, promised him success. On the second day the issue was doubtful till, if we may trust the concurrent testimony of all the contemporary church historians, a sudden gust of wind blew back the enemy's arrows on themselves. This was the turning-point of the battle: Eugenius was slain by the soldiers; and two days later Arbogast committed suicide (September 5–9, 394). From the north-eastern parts of Italy Theodosius passed to Rome, where he had his son Honorius proclaimed emperor under the guardianship of Stilicho. Thence he retired to Milan, where he died of dropsy (January 17, 395), leaving the empire to be divided between his two sons Honorius and Arcadius.

Important as the reign of Theodosius was from the political point of view, it is perhaps still more so from the theological. According to Sozomen, his parents were both orthodox Christians, according to the creed sanctioned by the council of Nicaea. It was not, however, till his illness at Thessalonica that the emperor received baptism at the hands of Bishop Ascholius, whereupon, says the same historian, he issued a decree (February 380) in favour of the faith of St Peter and Pope Damasus of Rome. This was to be the true Catholic faith; the adherents of other creeds were to be reckoned as heretics and punished. The great council of

Constantinople, consisting of 150 orthodox and 36 Macedonian bishops, met in the following year, confirmed the Nicene faith, ordered the affairs of the various sees, and declared the bishop of Constantinople to rank next to the bishop of Rome. The emperor cannot be acquitted of the intolerance which marks edicts such as that depriving apostatizing Christians of the right of bequest. It was not till 389 or 390 that he issued orders for the destruction of the great image of Serapis at Alexandria. Other edicts of an earlier or later date forbade the unorthodox to hold assemblies in the towns, enjoined the surrender of all churches to the catholic bishops, and overthrew the heathen temples "throughout the whole world." During the reign of Theodosius Gregory of Nazianzus was made bishop of Constantinople. In 383 Theodosius called a new council for the discussion of the true faith. The orthodox, the Arians, the Eunomians and the Macedonians all sent champions to maintain their special tenets before the emperor, who finally decided in favour of the orthodox party. He seems to have suffered the Novatians to hold assemblies in the city. Perhaps the most remarkable incident in the life of Theodosius from a personal point of view is the incident of his submission to the reprimands of Ambrose, who dared to rebuke him and refuse to admit him to the Eucharist till he had done public penance for punishing a riot in Thessalonica by a wholesale massacre of the populace. Equally praiseworthy is the generous pardon that the emperor, after much intercession, granted to the seditious people of Antioch, who, out of anger at the growing imposts, had beaten down the imperial statues of their city (387). When the Christians in the eastern part of the empire destroyed a Jewish synagogue and a church belonging to the Valentinians, Theodosius gave orders for the offenders to make reparation. Such impartial conduct drew forth a remonstrance from Ambrose, who, where the interests of his creed were concerned, could forget the common principles of justice.

Theodosius was twice married—(1) to Aelia Flacilla, the mother of Arcadius (377–408) and Honorius (384–423); (2) to Galla (d. 394), the daughter of Valentinian I.

The chief authorities for the age of Theodosius are Ammianus Marcellinus, Zosimus, Eunapius and the ecclesiastical historians (Socrates, Sozomen, Theodoret). Much information may also be gleaned from the writings of St Ambrose, St Gregory of Nazianzus, Isidore of Seville, and the orators Pacatus, Libanius, Themistius. Among modern authorities see: E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1896), chaps. 25 and 27; T. Hodgkin, *Italy and her Invaders* (Oxford, 1892), chaps. 5, 6, 8–11; A. Güldenpenning and J. Ifland, *Der Kaiser Theodosius der Grosse* (Halle, 1878); G. R. Sievers, *Studien zur Geschichte der römischen Kaiser* (Berlin, 1870), pp. 283–333.

Theodosius II. (401–450) succeeded his father Arcadius as emperor of the East in 408. During his minority the empire was ably ruled by the praetorian prefect Anthemius and Pulcheria, who became her brother's guardian in 414. Under his sister's care the young emperor was trained in divers accomplishments which won him the name of *Calligraphēs* ("the Penman"), but grew up into a weak though amiable character. Through his generals Ardoburius and Aspar he waged two fairly successful wars against the Persians (421 and 441), and after the failure of one expedition (431) by means of a gigantic fleet put an end to the piracies of the Vandal Genseric. A Hunnish invasion in 408 was skilfully repelled, but from 441 the Balkan country was repeatedly overrun by the armies of Attila, whose incursions Theodosius feebly attempted to buy off with ever-increasing payments of tribute. His internal administration, though not sufficiently rigorous to check abuses, was upright and thoughtful. Among its chief events may be mentioned the endowment of the university of Constantinople (425), the conciliatory council of Ephesus (434) and the publication of the *Codex Theodosianus* (438), a collection of imperial constitutions for the benefit of public officials, which is our chief source of information about the government of the empire in the 5th century. In 450 Theodosius died of injuries sustained through a fall from his horse.

See E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1896), iii. pp. 381–444; A. Güldenpenning, *Geschichte des oströmischen Reiches unter den Kaisern Arkadius und Theodosius II.* (Halle, 1885), pp. 172 sqq.; T. Mommsen and P. Meyer, *Theodosii libri XVI*. (Berlin, 1904–5).

Theodosius III., emperor of the East (716–717), was a financial officer whom a Byzantine army rebelling against Anastasius III. unexpectedly proclaimed monarch in his stead. He captured Constantinople after a six months' siege and deposed Anastasius, but in the following year was himself forced to resign by a new usurper, Leo III. (*q.v.*). Theodosius ended his life in a monastery.

See G. Finlay, *History of Greece* (ed. 1877, Oxford), i. p. 396).

(M. O. B. C.)

THEODOSIUS OF TRIPOLIS, Greek geometer and astronomer, three of whose works were contained in the collection of lesser writings named ὁ μικρὸς ἀστρονομούμενος (sc. τόπος), or ὁ μικρὸς ἀστρονόμος.[1] Suīdas erroneously identifies him with a sceptical philosopher of the same name who lived in the second half of the 2nd century A.D. or later, but, on the other hand, distinguishes him from a native of Tripolis who wrote a poem on spring. He is doubtless the same as Theodosius the mathematician, who is mentioned by Strabo amongst the natives of Bithynia distinguished for their learning, and whose sons were also mathematicians, the same, too, as the inventor of a universal sun-dial (*horologium* πρὸς πᾶν κλίμα) of that name who is praised by Vitruvius (*De Architectura*, ix. 9). His date, therefore, could not have been later than the 1st century B.C.; he may, however, have lived in the preceding century, inasmuch as the names mentioned by Strabo in the passage referred to above are, as far as we know, arranged chronologically, and Theodosius immediately follows Hipparchus, who made astronomical observations between 161 and 126 B.C., and precedes Asclepiades the physician, who lived at Rome at the beginning of the 1st century B.C.

His chief work—σφαιρικά, in three books—is a tolerably complete treatise on the pure geometry of the surface of a sphere, and was still the classical book on the subject in Pappus's time. It does not contain (except for a faint suggestion in iii. 11–12) any trace of spherical trigonometry, which, on the other hand, was the special subject of the work having the same title, and included in the same collection, of Menelaus of Alexandria, who lived at the end of the 1st century.

A. Nokk (*Ueber die Sphärik des Theodosius*; Karlsruhe, 1847), Heiberg (*Litterargeschichtliche Studien über Euklid*, pp. 43 seq.; Leipzig, 1882), and Hultsch (*Jahrbücher für classische Philologie*, 1883, pp. 415–420, and *Autolycus*; Leipzig, 1885) have proved that as early as the middle of the 4th century B.C. there existed a Greek text-book on *Spherics* which, in its essential contents, scarcely deviated from the three books of Theodosius. He must therefore be regarded as merely the editor, or at most the elaborator and expounder, of a doctrine which existed some centuries before him. A careful analysis of Theodosius' work, from this point of view, will be found in A. A. Björnbo's *Studien über Menelaos Sphärik* (*Abhandlungen zur Geschichte der mathematischen Wissenschaften*, xiv.; Teubner, 1902).

The *Spherics* of Theodosius was translated into Arabic at the beginning of the 10th century, and from the Arabic into Latin in the 12th century by Plato of Tivoli (Tiburtinus) This translation was published in 1518 at Venice, but was found so faulty by J. Voegelinus that he published a new Latin version, together with additions from the Arabian commentators (Vienna, 1529, 4to); other Latin translations were published by F. Maurolycus (Messina, 1558, fol.); by C. Clavius (Rome, 1586, 4to); and by Barrow under the title, *Theodosii Sphaerica, Methodo Nova Illustrata et Succincte Demonstrata* (London, 1675, 4to). The Greek text was first published, and with it a Latin translation, by J. Pena (Paris, 1558, 4to); it has been edited since by Joseph Hunt (Oxford, 1707), and by E. Nizze (Berlin, 1852), but these two editions are founded on that of Pena. There is also a German translation by Nizze (Stralsund, 1826). His two editions are accompanied with valuable notes and an appendix containing additions from Voegelinus and others.

The two other works of Theodosius which have come down to us have not as yet been published in the original. The propositions, without demonstrations, in the work περὶ ἡμερῶν καὶ νυκτῶν (*On Days and Nights*), in two books, were given by Dasypodius, in Greek and Latin, in his *Sphaericae Doctrinae Propositiones* (Strasburg, 1572, 8vo). A Latin version of the complete work, with ancient *scholia* and figures, was given by Joseph Auria (Rome, 1591, 4to). Pappus has given a pretty full commentary on the

[1] This collection contained, according to Fabricius, *Bibliotheca Graeca*, ed. Harles, iv. p. 16, the following books:—"Theodosii Tripolitae, *Sphaericorum*, libri iii.; Euclidis, *Data, Optica, Catoptrica, ac Phaenomena*; Theodosii Tripolitae, *De Habitationibus* et *Noctibus ac Diebus*, libri ii.; Autolyci Pitanaei, *De Sphaera Mota*, et libri ii. *De Ortu atque Occasu Stellarum Inerrantium*; Aristarchi Samii, *De Magnitudinibus ac Distantiis Solis ac Lunae*; Hypsiclis Alexandrini, Ἀναφορικὸς sive *De Ascensionibus*; Menelai, *Sphaericorum*, libri iii." Euclid's *Data* is, however, wrongly included, for Pappus, vii., makes it part of analysis (ὁ ἀναλυόμενος τόπος).

first book of this work of Theodosius. His work περὶ οἰκήσεων (*On Habitations*) also was published by Auria (Rome, 1588). It gives an account of how, for every inhabitant of the earth from the equator to the pole, the starry firmament presents itself in the course of a year. The propositions in it were also given by Dasypodius in his work mentioned above. (T. L. H.)

THEODULF, bishop of Orleans, was born about the middle of the 8th century, of a noble family of Gothic extraction, probably in Spain. He found favour at the Frankish court, was made abbot of Fleury and of Saint-Aignan, and in 781 became bishop of Orleans. He was a staunch supporter of Charlemagne's principles of government and educational reforms; he established schools, and by his own literary achievements showed himself a worthy member of the learned circle which graced the Carolingian court. He was likewise a good churchman and an able administrator of his diocese; he encouraged the reformation of the clergy and the monasteries. In 798 he was appointed *missis dominicus*, and two years later performed so great services for Leo III. as judge in the cause between the pope and his enemies, that he returned from Rome with the pallium. After the death of Alcuin he became the foremost councillor to the king on theological matters: it was he who made, on Charlemagne's request, a collection of the opinions of the fathers on the much-disputed point of the procession of the Holy Ghost. Theodulf maintained his influence a short time after the death of Charlemagne, being sent as escort to Pope Stephen V. who came in 816 to crown Louis the Fair. Later, however, he was accused of having taken part in the conspiracy of Bernard of Italy, and in 818 was deposed from all his dignities and imprisoned in a monastery at Angers. Theodulf asserted his innocence to the end, and no proof of his guilt has come down to us; in fact, from what we know of the bishop's life and political principles we should presuppose his innocence. He died in prison, probably from poison, in 821.

Theodulf was called Pindar in the palace school of Charlemagne. Fond of Latin literature, whether Christian or pagan, and a friend of the arts, he was himself one of the best writers of the period. His prose works include sermons, treatises on vices and on baptism, a penitential, capitularies and exhortations to bishops, priests and judges. His poems are his best work, and afford us a vivid picture of the times. Theodulf was the author of at least part of the hymn for Palm Sunday, the *Gloria laus*. The complete works of Theodulf are in J. P. Migne, *Patrol. Lat.*, vol. 105 (Paris, 1851). The best edition of his poetry is that of E. Dümmler in the *Mon. Germ. Hist. Poetae latini aevi carolini*, vol. i. (Berlin, 1881).

See C. Cuissard, *Théodulphe évêque d'Orléans, sa vie et ses œuvres*, (Orleans, 1892); and a critical study of the writings by M. Manitius in *Neues Archiv der Ges. für ä. deutsche Gesch.* xi. (1886).

THEOGNIS OF MEGARA (6th century B.C.), Greek poet. More than half the elegiac poetry of Greece before the Alexandrian period is included in the 1400 lines ascribed to Theognis. This collection contains several poems acknowledged to have been composed by Tyrtaeus, Mimnermus and Solon; with two exceptions (T. W. Allen in *Classical Review*, Nov. 1905, and E. Harrison) modern critics unanimously regard these elegies as intruders, that is, not admitted into his works by Theognis himself; for this and other reasons they assume the existence of further interpolations which we can no longer safely detect. Generations of students have exhausted their ingenuity in vain efforts to sift the true from the false and to account for the origin and date of the Theognidea as we possess them; the question is fully discussed in the works of Harrison and Hudson-Williams.

The best-attested elegies are those addressed to Cyrnus, the young friend to whom Theognis imparts instruction in the ways of life, bidding him be true to the "good" cause, eschew the company of "evil" men (democrats), be loyal to his comrades, and wreak cruel vengeance on his foes. Theognis lived at Megara on the Isthmus of Corinth during the democratic revolution in the 6th century B.C.; some critics hold that he witnessed the "Persian terror" of 590 and 580; others, including the present writer, place his *floruit* in 545 B.C. We know little about his life; few of the details usually given in text-books are capable of proof; we are not certain, for instance, that the poem (783–88) which mentions a visit to Sicily, Sparta and Euboea comes from the hand of Theognis himself; but that is of little concern, for we know the man. Whether, with Harrison, we hold that Theognis wrote "all or nearly all the poems which are extant under his name" or follow the most ruthless of the higher critics (Sitzler) in rejecting all but 330 lines, there is abundant and unmistakable evidence to show what Theognis himself was. However much extraneous matter may have wormed its way into the collection, he still remains the one main personality, and stands clearly before us, a living soul, quivering with passion and burning with political hate, the very embodiment of the faction-spirit (*stasis*) and all it implied in the tense city-state life of the ancient Greek.

There is neither profound thought nor sublime poetry in the work of Theognis; but it is full of sound common-sense embodied in exquisitely simple, concise and well-balanced verse. As York Powell said, "Theognis was a great and wise man"; he was an able exponent of that intensely practical wisdom which we associate with the "seven sages of Greece." Had he lived a century later, he would probably have published his thoughts in prose; in his day verse was the recognized vehicle for political and ethical discussion, and the gnomic poets were in many ways the precursors of the philosophers and the sophists, who indeed often made their discourse turn on points raised by Theognis and his fellow-moralists. No treatment of the much-debated question "Can virtue be taught?" was regarded as complete without a reference to Theognis 35–36, which appears in Plato, Xenophon, Aristotle, Musonius and Clement of Alexandria, who aptly compares it with Psalm xviii. 26. Another famous couplet is 177–78: "In poverty, dear Cyrnus! we forego | Freedom in word and deed—body and mind, | Action and thought, are fetter'd and confin'd" (trans. Frere), discussed by Aristotle, mercilessly criticized by Lucian and the Stoics, and warmly commended by Ammianus Marcellinus, who introduces the author as "Theognis poeta vetus et prudens." For many generations Theognis was to the Greeks the moralist *par excellence*; Isocrates says that Hesiod, Theognis and Phocylides were admitted to be the best teachers of practical morality; and the Emperor Julian in his defence of paganism asks whether "the most wise Solomon is equal to Phocylides or Theognis or Isocrates."

Besides the elegies to Cyrnus the Theognidea comprise many maxims, laments on the degeneracy of the age and the woes of poverty, personal admonitions and challenges, invocations of the gods, songs for convivial gatherings and much else that may well have come from Theognis himself. The second section ("Musa Paedica") deals with the love of boys, and, with the exceptions already noted, scholars are at one in rejecting its claim to authenticity. Although some critics assign many elegies to a very late date, a careful examination of the language, vocabulary, versification and general trend of thought has convinced the present writer that practically the whole collection was composed before the Alexandrian age.

Editions.—Imm. Bekker (1815, 2nd ed. 1827); F. G. Welcker (1826); both these are epoch-making books which no serious student can ignore; Th. Bergk (1843, 4th ed. 1882; re-edited by E. Hiller, 1890, and O. Crusius, 1897); J. Sitzler (1880); E. Harrison (1902); T. Hudson-Williams (1910). For further bibliographical references see the two last-mentioned books. There is a prose translation by J. Banks in Bohn's Classical Library (1856), which also includes verse translations by J. Hookham Frere.

(T. H. W.)

THEOLOGY, literally the science which deals with God or the gods. The word is Greek (Θεός, God; λόγος, theory). But doctrine counted for less in Greek or Roman religion than in Christianity, and forms of worship for more. In the oldest usage θεολόγοι were those who dealt in myths, like Hesiod and like the supposed Orpheus, the θεολόγος *par excellence*. Paul Natorp[1] contends that θεολογία in Plato's *Republic* refers wholly to the control of myths. He further denies that Aristotle identified his First Philosophy with a "theology," holding the text of the *Metaphysics* to be out of order and

[1] *Philosophische Monatshefte* (1888), Heft 1 and 2. See also Theism.

corrupted, though from a very early period. He regards the Stoics as having initiated a philosophical theology, and gives numerous references for the "three theologies" which they distinguished. Philo the Jew is also quoted as using θεολόγος of poets, of Moses *par excellence*, and of Greek philosophers. It is possible that the epithet θεολόγος for St John may go back as far as Papias. This is the first appearance of the term upon Christian ground. The primitive application of θεολόγοι to the poets and myth-fanciers meets us again in Church writers; but there is also a tendency to use the name for a philosophical theology based on the doctrine of the Logos. In this sense Gregory Nazianzen also receives the title θεολόγος. His περὶ θεολογίας is a dissertation on the knowledge of God.[1] Many centuries later Abelard generalized the expression in books which came to bear the titles *Theologia Christiana* and *Introductio ad Theologiam*. (Abelard speaks himself of "theologia nostra.")[2] It is of interest to note that even in these books the Trinity and Christology are the topics of outstanding importance. In the *Summa Theologiae* of Thomas Aquinas the technical sense is fully established. Except in special circumstances which generally explain themselves, *e.g.* "Homeric Theology" (a book by Nägelsbach), Old Testament Theology, Comparative Theology, Natural Theology, the word in modern languages means the theology of the Christian Church. What follows here will be confined to that subject.

Contents of theology.

While the word points to God as the special theme of the theologian, other topics inevitably find entrance. Theistic philosophy thinks of God as the absolute being; and every monotheistic religion insists, not indeed that the knowledge of God includes all knowledge, but that this supremely important knowledge throws fresh light upon everything. So, with an added Christian intensity, St Paul declares: "If any man is in Christ, he is a new creature; the old things are passed away; behold, they are become new. But all things are of God, who reconciled us to himself through Christ" (2 Cor. v. 17, 18). A minimum division might be threefold—*Gottesbegriff*, *Selbstbeurteilung*, *Weltanschauung*.[3] But historically it is more important to note that Christian theology has developed as a doctrine concerning Christ: his relation to God, our relation to God in or through him. For Christ is viewed as bringing redemption—a conception of importance in many religions, but in none so important as in Christianity. Indeed, another possibility opens up here. Instead of being mainly a doctrine concerning God, or one concerning Christ, theology may be construed as being mainly the theory of Christian experience. Most schools of theology will concur, however, in giving prominence to a complementary point of view and making their systems a study of Divine *revelation*. Even if they accept Natural Theology, they generally hold that Christian theology, properly so called, begins at a further point. Those who deny this were formerly called Naturalists, *i.e.* deniers of *supernatural* revelation; those who extend the province of reason in theology, and push back the frontier of revelation, are often called Rationalists.[4] Such being the usual point of view, it is plain that the claim of theology to be a science, or a group of sciences, is made in a sense of its own. In so far as theology is orderly, coherent, systematic, and seeks to rest upon good grounds of some sort, it may be called a science. But, in so far as it claims to deal with special revelation, it lifts itself out of the circle of the sciences, and turns away from natural knowledge towards what it regards as more intimate messages from God.

Theology as a science.

Two special usages should be noted: (1) a medieval use of "theology" for mystical or intuitive knowledge of God, as in the well-known book called *Theologia Germanica;* (2) "theology proper," in Protestant systems, is the portion of theology which deals directly with the doctrine of God.

Theology and Religion.

Another characteristic of theology is its secondary and reflective character. Religion, therefore, is earlier than theology. Or the theology which religion contains is in a state of solution—vaguely defined and suffused with emotion; important practically, but intellectually unsatisfying. "Scientific" theology contrasts with this as a laboratory extract. History may soften the contrast by discovering transitional forms, and by showing the religious interest at work in theology as well as the scientific interest affecting early utterances of religion. Still, this contrast enters into the meaning of divines when they say that they are at work upon a science. A religious man need no more be a theologian than a poet need have a theory of aesthetics.

Sources.

Where, then, are we to look for Christian theology? It is not the truism it may seem if we reply that we are to find it in the writings of theologians. As authorities controlling their work, theologians may name the Bible, or tradition, or the religious consciousness, or the Church, or some combination of these. But the teaching of the Bible is not systematic, and the authority of consciousness is vague; while the creeds into which Church tradition crystallizes emerge out of long theological discussions. Ordinarily, doctrine has been in close connexion not only with edification but with controversy. Anselm of Canterbury stands almost alone among the great theological masters in working purely from a scientific interest; this holds alike of his contribution to theism and of his doctrine of Atonement. Among the earlier theological statements are catechetical books, *e.g.* Cyril of Jerusalem. These books record doctrinal instruction given, for practical ends, to laymen of adult years who were candidates for baptism. Disinterested discussions by experts for experts is medieval rather than primitive. Modern catechisms in the form of question and answer for the instruction of baptized children are sometimes convenient if dry summaries of doctrine (*e.g.* the Westminster Assembly's *Shorter Catechism*); but sometimes they have the glow of religious tenderness, like Luther's *Lesser Catechism*, or the *Heidelberg Catechism*. They generally expound (1) The Apostles' Creed, (2) the Ten Commandments, (3) the Lord's Prayer. Medieval theology has an appearance of keeping in touch with the Apostles' Creed when it divides the substance of doctrine into (usually) twelve "articles"—not always the same twelve—a reminiscence of the legendary composition of the Creed in twelve sections by the twelve apostles. This treatment, however, has little real influence upon the structure of medieval theology. German Protestant writers, again, following their catechisms, often distinguish three articles—of the Father, of the Son, and of the Holy Spirit. This, too, is no more than convenient phraseology.

Jewish theology.

Before the Christian age, there had been a good deal of reflective thinking in the Jewish schools, though the interest there was legal rather than speculative. To some extent Christianity inherited this Jewish theology. True, Jesus Christ sprang from the people. He was a "layman" (Paul Wernle), without technical Jewish lore. The great attainment of the Old Testament, ethical monotheism, had become the common property of the nation; it occurs in Christianity as a simple presupposition. Early Christian writers find it unnecessary to prove what no one dreams of questioning. Along with this great doctrine there pass on into Christianity the slowly attained hope of resurrection and the dreadful doctrine of future punishment for the wicked. Leading thoughts in the teaching of Jesus, so far as they are new, are the Fatherhood of God—new at least in the central place given it—the imminence of the "kingdom" or judgment of God, and Jesus' own place as "Messiah," *i.e.* as king (and as judge). The "second founder" of Christianity, Paul of Tarsus, was indeed rabbinically trained. His recoil from Judaism is all the more intense because of the special intellectual presuppositions which he continues to share with Judaism. In many respects, Pauline Christianity is the obverse of the Pharisaic creed. Modern Christians are

St Paul.

[1] Other usages of θεολογία are the Divine nature of Christ (St John Chrysostom, quoted in Konstantinides' Greek Lexicon), Old and New Testaments (Theodoret, *ib.*); Greek theology and Mosaic or revealed theology (Theodoret).

[2] F. Nitzsch in Herzog-Plitt, *Realencyk.* (1877). Fuller details regarding Abelard's writings in the same author's art. in Herzog-Hauck (1896).

[3] So Ritschl, following Schleiermacher, *Der Christliche Glaube*, § 30.

[4] A. W. Benn (*History of English Rationalism in the 19th Cent.*) goes beyond ordinary usage in defining rationalism as a militant theory opposed to all belief in God.

tempted to charge the seeming extravagance of St Paul's thought upon his Jewish inheritance, while modern Jews are tempted to stigmatize them as grotesque exaggerations of reasonable rabbinical doctrines. Probably both are right, and both wrong. The germs were Jewish; but, transported to a new soil, and watered with a new enthusiasm, they assumed new forms. These cannot claim the merit of correctness, but they are works of religious genius. At the same time, they employ all the resources of dialectic, and have, therefore, taken quite half the journey from primary religion to theology. But the dislocation of religious thinking, when Christianity ceased to be a Jewish faith and found a home with Gentiles, destroyed the continuity of Paulinism and of Jewish thought working through St Paul. In later times, when Paulinism revived, the epistles spoke for themselves, though they were not always correctly understood. It should be added that, according to A. Harnack, Hellenistic Judaism had worked out the principles of a theology which simply passed on into the Greek-speaking Christian Church.

Contents of New Testament.

Besides the teaching of Jesus (best preserved in the first three gospels) and the teaching of Paul (in six, ten, or thirteen epistles), the recent "science" of New Testament theology finds other types of doctrine. The Epistle to the Hebrews is a parallel to Paulinism, working out upon independent lines the finality of Christianity and its superiority to the Old Testament. The Johannine Gospel and Epistles are later than Paulinism, and presuppose its leading or less startling positions. Whatever historical elements may be preserved in Christ's discourses as given in the Fourth Gospel, these discourses fit into the author's type of thought better than into the synoptical framework. They have been transformed. 1 Peter is good independent Paulinism. The Epistle of James may breathe a Christianized Jewish legalism, or, as others hold, it may breathe the legalism (not untouched by Jewish influences) of popular Gentile-Christian thought. The Johannine Apocalypse is chiefly interesting as an apocalypse. F. C. Baur and his school interpreted it as a manifesto of anti-Pauline Jewish Christianity; on the contrary, it closely approaches Paul's doctrine of the Atonement and his Christology. Other writings are of less importance. Acts is indeed of interest in showing us Paulinism in a later stage; the writer wishes to reproduce his great master's thought, but his Paulinism is simplified and cut down. Possibly the Pastoral Epistles show the same process. When we go outside the New Testament, this involuntary lack of grasp becomes even more marked.

Neither the theory of infallible inspiration, with its assertion of absolute uniformity in the New Testament, nor Baur's criticism, with its assertion of irreconcilable antagonisms, is borne out by facts. The New Testament is many-sided, but it has a predominant spiritual unity. Only in minor details do contradictions emerge. It is to be remembered that criticism has broken up the historical unity of the New Testament collection and placed many of its components side by side with writings which have never been canonized, and which conservative writers had supposed to be distinctly later. But in regard to date there has been a remarkable retreat from the earlier critical assertions. And at any rate, since the New Testament canon was set up, New Testament writings have had a theological influence which no others can claim.

"Enthusiasm."

On both sides of the great transition from being a Jewish to being a Gentile faith, Christianity, according to recent study, manifested itself as "enthusiastic." We may distinguish several points in this conception. (1) Most important, perhaps—the end of the world was held to be close at hand. "Kingdom of God" as generally used was an eschatological concept; and, whatever difficulties there may be as to certain gospel passages, Christ, to say the least, cannot have disclaimed this view. The watchword rings through all the New Testament—"the Lord is at hand." A broader popular form was given to this expectation in "Chiliasm"—the doctrine of the "Thousand" years' reign[1] of Christ on earth (Rev. xx. 1-7). But even Chiliasm—which itself has its subtler and its grosser modifications—is found in early Gentile as well as in early Jewish Christianity. (2) 1 Corinthians shows us a Christian community filled with disturbances, and apparently without recognized officials. The democratic, or rather theocratic, rights of the spiritual man were for a time relied on to extemporize so much Church government as might be needed till the Master returned. Yet the beginnings of Church order come earlier than those of doctrine proper, and much earlier than the cooling of eschatological hopes. (3) There are traces inside and outside the New Testament of aversion to receiving back into Church fellowship those who, after confessing Christ, had been guilty of grave sins. The New Testament evidence is by no means uniform (contrast Heb. vi. 4-6, x. 26-31; 1 John v. 16; with 2 Cor. ii. 7); but this high conception of Church *holiness* is attested by a series of rigorist "heresies" during the early centuries; and nothing could be more characteristic of eschatological enthusiasm. Those who had fallen were not banished from hope, even by the rigorists. Still, their case was held over for a higher Judge; while the Church, especially in these more Puritan and separatist groups, kept her garments white. (4) The enthusiastic view of the possibilities of the Christian life—associated, as modern and especially Western Christians must suspect, with shallow external views of sin—lent itself to belief in sinless perfection. Even St Paul has been supposed, not without a certain plausibility, to teach the sinless perfection of real Christians. The West, with its theology protesting in the background, but in vain, still sings the prayer of the *Te Deum:* "Vouchsafe, O Lord, to keep us this day without sin."

Material for theology.

Such an enthusiastic temper does not lend itself to cool theory. Why should theology labour at definitions? "The Lord is at hand;" a Christian's one wisdom is to be ready to meet him. And yet materials for theology were richly provided even during this period. That is true above all of the man whom we know best in New Testament days—St Paul. Himself through and through animated with the joyful hope, even when prepared to surrender (2 Cor. v. 8; Phil. i. 23, ii. 17) the prospect of personal survival (1 Thess. iv. 17; 1 Cor. xv. 51, 52) until that bright day, yet as a teacher he lays such stress upon Christ's first coming that the emphasis on the second Advent may be struck out—leaving still, we might almost claim, a complete Paulinism. He who planned his campaigns to the great civilized centres of Corinth, Ephesus and Rome, and thus prepared for a historic future of which he did not dream, drew his parallels of thought with no less firm hand, and showed himself indeed "a wise master-builder."

In one aspect Montanism is the central reaction of the primitive Christian enthusiasm against the forces which were transforming its character. Of course it had other aspects and elements as well. Hippolytus and Novatian repeat the protest less vehemently; Donatism shows it blended with later hierarchical ideas.

Greek influence.

But, when the enthusiasm cooled, it was Greek thought which interpreted the contents of Christianity. The process of change is called by Harnack sometimes "secularization" and sometimes "Hellenization." "Acute Hellenizing," we are told, took the form of Gnosticism. The Gnostics were the "first theologians." When the Church in turn began to produce a theology of her own she was imitating as well as guarding against those wayward spirits. What was to be the central topic? The Church's first creed had been "the Fatherhood of God and the Messiahship of Jesus" (A. Ritschl); but the "Rule of Faith" (Irenaeus; Tertullian, who uses the exact expression; Origen)—that summary of religiously important facts which was meant to ward off error without reliance on speculations such as the Logos doctrine—built itself up along the lines of the baptismal formula of Matt. xxviii. 19.[2] There are traces in the New Testament of a baptismal confession simply of the name of Christ (1 Cor. i. 13, 15; Rom. vi. 2; cf. even the late verse Acts viii. 37), not of the threefold name. Moreover, textual criticism points to an early type of reading in Matt. xxviii. 19 without the threefold formula. Still, it is strange how completely this seemingly isolated passage takes command of the development of early theology.

Doctrine of Trinity and of Person of Christ.

Out of the Rule of Faith there came in time what tradition miscalls the Apostles' Creed—the Roman baptismal creed, a formulary of great importance in all the West; then other creeds, which also are in a sense expansions of the Rule of Faith. The Greek mind threw itself upon the problem—who precisely is Jesus Christ the Lord? His Messiahship is asserted; who then is the Messiah? and this second figure in the baptismal confession? A provisional answer, linking Christian theology with the philosophical theology of antiquity, asserted Jesus Christ to be the divine Logos. But this assertion was expanded and refined upon till two great doctrines had been built up—that of the Trinity of divine Persons in the unity of the Godhead, and that of the union of two distinct natures, divine and human, in the person of Jesus Christ. It is curious that the Syrian church of the 4th century (*e.g.* Aphraates) was almost unaffected by the great dogmatic debates. But there is no hint of a reasoned rejection of Greek developments in favour of primitive simplicity, still less of any independent theological development. Aphraates accepts the Logos Christology, and, soon after his time, his church is found on the beaten track of orthodoxy.

[1] *Four hundred* years is another significant figure in the Jewish book, 4 Ezra.

[2] If Harnack is right in regarding a New Testament canon as one of the "Apostolical authorities" which the Church brought into the field against Gnosticism, we see the truth on historical grounds of the position taught on dogmatic grounds by R. Rainy (*Delivery and Development of Christian Doctrine*)—scriptural faith not the starting-point but the goal of theological development. The starting-point is rather the "Rule of Faith."

Modern Christians generally trust this development; and all of them must admit that it seeks to answer a question arising out of the elements of New Testament belief. There is one God; but also there is one Lord; how are the two related? The strongest claim that can be put forward for the doctrine of the Trinity is that it is loyal to Christ without being disloyal to the Divine unity. Concurrently, there was a speculative or philosophical interest; and some prefer to defend Trinitarianism as a reconciliation of the personality with the infinity of God. But the biblical materials worked up in the doctrine betray little sign of any except a religious interest. We may take it as well established that St Paul (2 Cor. viii. 9: Phil. ii. 5–11) taught the personal pre-existence of Christ. A. M. Fairbairn (*Phil. of Christian Religion*, p. 476) has argued that Paul could not have given this teaching unless he had known of Christ's advancing the claim. Fairbairn barely refers to the Fourth Gospel in this connexion, and it is doubtful whether Matt. xi. 27 will bear such weight as he puts upon it. Of course, we might seek to infer an unwritten tradition of Christ's words; but without pedantic ultra-Protestant devotion to written scripture, one may distrust on scientific grounds the attempt to reconstruct tradition by a process of inference. If such records as John vi. 36, viii. 58, xvii. 3, 4 can be taken as historical, we may feel certain that Jesus taught his pre-existence. If not, modern Christian minds will hardly regard the doctrine as more than a speculation. Yet we should mention another argument of some weight. There is no trace that any Jewish Christian critics challenged St Paul's Christology. This may point to its being the Christology of the whole Church. If so, who could first teach it except the one Master?

W Bousset has suggested that the title "Son of Man" (Dan. vii. 13), used by Jesus, may have come to imply for all early Christians personal pre-existence. W. Wrede and others have more boldly conjectured that the Christ's pre-existence had become an accepted element in Jewish Messianic—it certainly occurs in one portion of the Book of Enoch and in 4 Ezra[1]—and that Paul merely transferred to Jesus a doctrine which he had held while still in the Jews' religion. "Son of God" might seem to carry us further still; but the Old Testament makes free use of the title as a metaphorical honour, and we have no proof that any Jewish school interpreted the phrase differently.

Adoptionism. The rival type of early theology is known as Adoptionism or Adoptianism (*q.v.*). According to it, the man Jesus was exalted to Messianic or divine rank. It has been argued that the narrative of Christ's baptism points to an Adoptionist Christology, and that the genealogies of Jesus (through Joseph) presuppose this type of belief, if not a still lower view of Christ's person. It has further been argued that the narratives of the Virgin birth (Matthew, Luke) are an intermediate stage in Christology. When pre-existence is clearly taught (Paul, John), virgin birth, it is suggested, loses its importance; another theory of Divine Sonship has established itself. This trenchant analysis is, however, not universally admitted. Further development of doctrine weeded out the last traces of Adoptionist belief,[2] though Christ's exaltation continued to be taught in correlation to His humiliation (Phil. ii. 8), and became in due time a dogmatic locus in Protestantism.

Justin, Irenaeus, Tertullian. The lineaments of Greek Christian theology show themselves more clearly in Justin Martyr than in the other Apologists, but still more plainly in Irenaeus, who, with little speculative power, keeps the safe middle path. Tertullian's legal training as a lawyer was a curious coincidence, if nothing more, and those legal concepts which show themselves strongly in him have done much to mould the Western type of Christian theology. He had great influence on the course of Latin theology, partly through his own writings, but still more through the spell he cast upon Cyprian. At Alexandria, Clement and his great pupil Origen state Christianity in terms of philosophy. Origen's treatise, *De Principiis*, is the first and in some respects the greatest theological system in the whole of Church history. The Catechetical school was primarily meant for instructing adult inquirers into Christianity. But it had attained the rank of a Christian university; and in this treatise Origen does not furnish milk for babes; he writes for himself and for like-minded friends. Wildly conjectural as it may seem, his thinking—though partly Greek and only in part biblical—is completely fused together in his own mind. Nor does it ever suffer from lack of thoroughness. It may be summed up in one word as the theology of free will.

Origen. Unfaltering use is made of that conception as a key to all religious and moral problems. Usually, apologists and divines are hampered by the fact that, beyond a certain limited range, men cannot be regarded as separable moral units. A new world, after death, may be called in to redress the balance of the old; but anomalies remain which faith in a future immortality does not touch. Origen called in a second new world—that of pre-existence. All souls were tried once, with equal privilege; all fell, save one, who steadily clave to the Logos, and thus merited to become in due time the human soul of Jesus Christ. No higher function could be given to free will; unless, by an extravagance, some theologian should teach that the Almighty Himself had merited His sovereignty by the virtuous use of freedom. On the other hand, a shadow is cast upon the future by Origen's fear that incalculable free will may again depart from God. Human birth in a grossly material body is partly due to the pre-temporal fall of souls; here we see in Origen the Greek, the dualist (mind and matter), the ascetic, and to some extent the kinsman of the Gnostics. But he breaks away again when he asserts that God ever wills to do good, and is seeking each lost soul until He find it. Even Satan must repent and live.[3]

It was not possible that this brilliant *tour de force* should become the theology of Christendom. Origen contributed one or two points to the central development of thought; *e.g.* the Son of God is "eternally" begotten in a continuous process. But while to Origen creation also was a continuous process, an unspeculative orthodoxy struck out the latter point as inconsistent with biblical teaching; and we must grant that the eternal generation of the Divine Son adds a more distinctive glory to the Logos when it is no longer balanced by an eternal creation. While the Church thus lived upon fragments of Origen's wisdom, lovers of the great scholar and thinker, who had dominated his age, and reconciled many a heretic to his own version of orthodoxy, must submit to have him branded as a heretic in later days, when all freedom of thought was falling under suspicion.

For a time, freedom in scholarship lingered in the younger rival of Alexandria, the school of Antioch; though speculation was never so strong there. Alexandria, on the other hand, tended to be unduly speculative and allegorizing even in its scholarship. The antagonism of the two schools governs much of the history of doctrine; and behind it we can trace in part the contrast between Church Platonism and what churchmen called Aristotelianism.

Arianism. Arius, a Libyan by birth, of Antioch by training (though earlier than the greatest days of that theological school), and a presbyter of Alexandria, represents the working of Aristotelianism. His chief opponent, Athanasius, is probably the greatest Christian, if Origen is the greatest thinker, among all the Greek fathers. Few will deny that Athanasius stood for the Christian view of the questions at issue, upon the principles held in common by all disputants. Arius represented a shallow if honest intellectualism. He found it necessary to think clearly and define sharply; but Athanasius found it necessary to believe in a divine redemption. According to Harnack, Athanasius simplified the faith of his time by fastening on the essential point—human immortality or "deification" through the Incarnation of true God. Cosmic theories of the work of a Logos subordinate to the Father fell into the background.

Athanasius. Ὁμοούσιος, successfully discredited earlier as a Sabellian formula by Paul of Samosata, was now found to be the one unambiguous term which asserted that Christ was truly God (Council of Nicaea, A.D. 325) and ὑπόστασις (Lat. *persona*) became the technical name for each of the Divine Three. Athanasius himself tried to draw a distinction between affirming the Son ὁμοούσιος, and calling Him μονοούσιος. Yet it seems plain that he considered Sabellianizing reduction of the Divine Persons to phases or modes in the unity a lesser evil than regarding the Logos (with Arius) as a creature, however dignified. This was made plain by the leniency of Athanasius towards Marcellus of Ancyra.

Marcellus. In those days there was no word for "Person" as modern philosophy defines it; perhaps no word would have served the purpose of the Church if precisely so defined. The result is, however, that a critic of doctrine sometimes questions whether Athanasianism offers a definition of the mystery at all, or only

[1] The passages referred to have sometimes, but with no great probability, been regarded as Christian infiltrations.

[2] Adoptionism is one species of Monarchianism. The other species, Modalism, has its most important type historically in Sabellianism. And the name Sabellianism is often loosely applied (*e.g.* to Swedenborgianism) to any modalistic Monarchianism (Christ one phase of God. Not three persons in the Godhead, but a threefold revelation of a God strictly one in person).

[3] Harnack takes a different view of Origen; the certainty of ultimate salvation overbears free will with a sort of physical necessity. He also thinks that in Origen's esoteric doctrine the historical Christ becomes unimportant. That is a severe judgment.

a set of sanctioned phrases, and a longer list of phrases which are proscribed as heretical. The long and dubious conflicts of opinion concern Church history but left few traces on doctrine; Athanasius never flinched through all the reaction against Nicaea, and his faith ultimately conquered the Catholic Church. There is only this to notice, that it conquered under the great Cappadocians (Basil, Gregory Nazianzen, Gregory of Nyssa), who represented a somewhat different type of teaching.[1] The Trinity in Unity stood firm; but, instead of recognizing God as one yet in some sense three, men now began to recognize three Divine beings, somewhat definitely distinguished in rank each from each and yet in some sense one. Athanasius's piety is thus brought into association with the details of Logos speculation. The new type passed on into the West through Augustine, and the so-called Athanasian creed, which states an Augustinian version of Greek dogma. There is indeed one immense change. Subordinationism is blotted out, more even than by Athanasius. On these lines modern popular orthodoxy maintains the doctrine of the Trinity. It seeks to prove its case by asserting first the divinity of Christ, and secondly the personality of the Holy Spirit. The modern idea of personality, though with doubtful fairness, helps the change.

The Cappadocians.

Augustine's Trinitarianism.

The first great supplement of the doctrine of the Logos or Son was the more explicit doctrine of the Holy Spirit. Macedonius, who defended the semi-Arian or Homoiousian position that the Spirit was merely a Divine influence—Origen had held the Spirit to be a creature—was branded as a heretic (Synod of Alexandria, 362; Council of Constantinople, 381); a strong support to Cappadocian or modern Trinitarianism. Then, in the light of the affirmation of Christ's full divinity, the problems of His person necessarily received further attention. Did the Divine Logos take the place of the higher rational soul in the humanity of Jesus? So Apollinaris or Apollinarius of Laodicea taught, but the Council of Constantinople (381) marked the position as heretical. Did the two natures, human and divine, remain so separated in Jesus as to jeopardize the unity of His person? This was the view which Cyril of Alexandria ascribed to Nestorius, who hesitated to call Mary θεοτόκος, and represented the tradition of the Antiochene school. Such views were marked as heretical by the Council of Ephesus (431), the decision resulting in a profound and lasting schism. Did the two natures coalesce in Jesus so as to constitute a single nature? This is the Monophysite or Eutychian view, developed out of the Alexandrian tradition ("Eutychianism is simply Cyrillianism run mad," A. B. Bruce). The Council of Chalcedon (451) rejected the Alexandrian extreme in its turn, guided by Leo of Rome's celebrated letter, and thus put the emphasis on the duality rather than the unity in Christ's person. Another grave and lasting schism was the result. Two great doctrinal traditions had thus been anathematized; the narrow line of orthodoxy sought still to keep the middle track. Was there at least unity of will in Jesus? No, said orthodoxy; He had two independent faculties of will, divine and human. The Maronites of Syria, reconciled to the see of Rome in 1182, probably represent the Monothelete schism. John of Damascus's theory of Enhypostasy (Christ's manhood not impersonal, but made personal only through union with His Godhead) is held by some to be the copingstone of this great dogmatic development.

Doctrine of the Spirit.

Monophysites.

Monotheletes.

Enhypostasy.

In the Trinity the problem is to combine independence and unity; in Christology, to combine duality of nature[2] with the unity of the person. Verbally this is done; is it done substantially? The question, Who is Jesus Christ? has been pushed to the very end, and authoritatively answered in the definitions of Church orthodoxy. With these the Orthodox Greek Churches—and with their divergent decisions the various non-Orthodox Eastern Churches, Coptic, Armenian, &c.—desire to rest satisfied; theology has finished its work, unless in so far as it is to be codified. It is never true while men live that thought is at a standstill; but, as nearly as it may be true, Eastern theology has made it so. In the West the decisions of the great councils have been accepted as a datum. They enter into the basis of theology; results attained by long struggles in the East are simply presuppositions to the West; but, for the most part, no independent interest attaches to them in the Western world. They are taken as involved in redemption from sin—in the Atonement, or in the sacraments. Belief in the Trinity is almost unbroken. Western Christendom wishes to call Christ God; even the Ritschlian school uses the wonted language in the light of its own definitions. For others, the Trinity is the accepted way of making that confession. It becomes of practical importance, according to S. T. Coleridge,[3] in connexion with Redemption. It passes, therefore, as a datum of revelation. In Christology the tradition has been more frequently challenged since the Reformation.

The definitions in East and West.

Harnack criticizes the doctrinal development. He considers that Christianity is best defended on the basis of the doctrine that Christ is a man chosen and equipped for His task by God. But in the Eastern Church the religious interest, as he thinks, points to Monophysitism. Dyophysite orthodoxy has sterilized Eastern Christianity, or thrown it upon inferior forms of piety. Of course this does not mean that Harnack considers monophysitism nearer the historic truth, or nearer the normal type of Christian thought. On the contrary, he would hold that the scholarly tradition of Antioch more nearly reaches the real historical manhood of Jesus. But if it be presupposed that the purpose of Christ's mission was to deify men by bestowing physical immortality, then we must assume, first, Christ's essential Godhead, and, secondly, the fusion of His divine and human natures. Whatever be the truth in the assertion that death rather than sin is the enemy dreaded by Eastern Christianity, and immortality rather than forgiveness the blessing craved, it is difficult to take the talk about deification as anything more than rhetoric. Did they not start from belief in one God? Was not polytheism still a living enemy? It is a more obvious, if perhaps a more vulgar, criticism of the great development to say that it was too simply intellectual—seeking clear-cut definitions and dogmas without measuring the resources at the command of Christians or the urgency of their need for such things. We are sometimes told that the councils simply denied error after error, affirming little or nothing. But the Trinity and the Hypostatic Union are vast speculative constructions reared upon slender biblical data. To complain of the over-subtlety of a theological adversary is a recognized move in the game; it may constantly be played in good faith; it proves little or nothing. The facts appear to be, that the Church embarked confidently on the task of blending philosophy and religion, that the Trinity satisfied most minds in that age as a rational (*i.e.* neo-platonic) construction, but that in Christology the data or the methods proved less tractable. If two natures, divine and human, are added to each other, what can the humanity be except one drop in the ocean of divine power, wisdom, goodness? The biblical authorities plainly set forth "the man Christ Jesus," but theological science failed to explain how Godhead and manhood came together in unity. Fact and theory sprang asunder; for theory had done its utmost, and was baffled. Another admission ought to be made. Western contributions to the prolonged debate constantly tended to take the form of asserting truths of faith rather than theories. Yet what was the whole process but a colossal theory?[4]

One perplexity connected with theology is the question, How far does Christianity succeed in embodying its essential interests in its doctrines? The Orthodox Eastern Church might seem to have succeeded beyond all others. Factions of lay-folk, who quarrelled furiously over shades of opinion never heard of in the West, and scarcely intelligible to Western minds even if expounded, might seem to have placed their sincerity beyond all question. And yet there were at least two other developments which were important in the East and proved still more so in the West—the legal development and the sacramental. The name "Catholic" is one which Protestant Christians may well

Further elements in Catholicism.

[1] Harnack and F. Loofs describe them as belonging to the Homoiousian party—believers in the Son's "likeness of essence" to the Father's, not "identity of essence." Bethune Baker vehemently denies that these great leaders were contented with Homoiousianism. Anyway, we must remember that radical theology had gone to much greater extremes in denial (Anomaeans—the Son unlike the Father). It was not by any means exclusively the "battle of a diphthong."

[2] Spanish Adoptianism breaks up the unity almost without disguise.

[3] Cf. *Aids to Reflection*, Aphorism 2, Comment.

[4] A. M. Fairbairn takes the rather unusual view that Greek Christian theology was the climax of the process of Greek *philosophy*, and so far alien to piety, although he is far from banishing speculation out of theology. *Christ in Modern Theol.*, pp. 81, 90, 183.

hesitate to resign to their rivals. Yet there is convenience and no small significance in connecting the term with a certain characteristic and un-Protestant type of the Christian religion. Catholicism is not dogma only, but dogma *plus* law *plus* sacrament. From very early days Christianity was hailed as the "new law"; and the suppression of the rigorist sects, by definitely giving law supremacy over enthusiasm, aggrandized it, but at the same time aggrandized the sacraments. The Western Christian must needs hold that the Eastern development was incomplete. It laid these things side by side; it did not work them into a unity. The latter task was accomplished with no little power by the Western Church in the period of its independent development.[1] The Greek and the Roman Catholic Churches stand united against Protestantism in the general theory of law and of sacraments; but a Protestant can hardly doubt that, if Catholicism is to be accepted, a Catholic organization, and doctrine are better furnished by the Western Church than by the arrested development of its rival.

Ascetic element.

The theory of asceticism had also to be more fully worked out and better harmonized with Church authority. The priesthood had successive rivals to face. First in the period of "enthusiasm," the prophets; then the martyrs and confessors; finally the ascetics. The last, in regulated forms, are a permanent feature of Catholicism; and the rivalries of these "regular" clergy with their "secular" or parochial brethren continue to make history to-day. That the ascetic life is intrinsically higher, that not every one is called to it, that the call is imperious when it comes, and that asceticism must be developed under Church control—all this may be common to East and West. But, in the utilization of the monks as the best of the Church's forces, the Western Church far surpasses the East, where meditation rather than practical activity is the monastic ideal. In the West, "enthusiasm," in the transformation under which it survives, is not merely bridled but harnessed and set to work.

Augustine's influence.

The new developments of the West could not grow directly out of Eastern or even out of early Western conditions. They grow out of the influence of Ambrose of Milan, but far more of Augustine of Hippo; and behind the latter to no small degree there is the greater influence of St Paul. Intellectual developments do not go straight onward; there are sharp and sudden reactions. Pelagianism, the rival and contradiction of Augustinianism, represents a mode of thought which appeared early in Christianity and which could count upon sympathizers both in East and in West. But, when the Christian world was faced with the clear-cut questions, Was this, then, how it conceived man's relation to God? and Did it mean this by merit? Augustine without much difficulty secured the answer "No." In the East (Council of Ephesus, 431) he was helped by the entanglement of Pelagianism with Nestorianism, just as in the West the ruin of Nestorian prospects was occasioned partly by dislike for the better known system of Pelagianism. In Augustine's own case, reaction against Pelagianism was not needed in order to make his position clear. He may have left a vulnerable frontier in his earlier dealings with the same thorny problem of free will. Certainly his polemic as a Christian against the Manichaeism of his youth constitutes a curious preface to his vehement rejection of Pelagian libertarianism. Once again, a narrow track of orthodoxy midway between the obvious landmarks! But Augustine had a deeply religious nature, and passed through deep personal experiences; these things above all gave him his power. He was also genius and scholar and churchman, transmitting uncriticized the dogmas of Athanasianism and the philosophy of ancient Greece, according to his understanding of them. Without forgetting that Augustine was partly a symptom and only in part a cause—without committing ourselves to the one-sidedness of the great-man method of construing history—we must do justice to his supreme greatness. If earlier times lived upon fragments of Origen, the generations of the West since Augustine have largely lived upon fragments of his thought and experience. On the other hand, not even the authority of Paul and of Augustine has been able to keep alive the belief in unconditional predestination. If in the West Athanasianism is a datum, but unexamined, and not valued for its own sake, Augustinianism is a bold interpretation of the essential piety of the West, but an interpretation which not even piety can long endure—morally burdensome if religiously impressive. The clock is wound up at the great crises of history, but proceeds to run down, and does so even more rapidly in Protestantism than in Catholicism. It may be held by hostile critics that the whole thing is a delusion. More sympathetic judgments will divine unquenchable vitality in a faith whose very paradoxes rise up in new power again and again. Augustine's (erroneous) interpretation of the Millennium (Rev. xx.), as a parable of the Church's historic triumph, stands for the final eradication of primitive "enthusiasm" in the great Church, though of course millenarianism has had many revivals in special circles.

[1] Loofs declares that the very conception of a means of grace is medieval.

Even if the Augustinian stream is the main current of Western piety, there are feeders and also side-currents. Ambrose, Augustine, Jerome, Gregory the Great are known as the four Latin Fathers. Jerome is very great as a scholar, and Pope Gregory as an administrator. As a writer, too, Gregory modifies Augustinian beliefs into forms which make them more available for Church teaching—a process very characteristic of Western Catholicism and carried still further in later centuries (notably by Peter Lombard). Perhaps two side-currents of piety should be named. There is an ethical rationalism which can never be wholly suppressed in the Christian Church by the Pauline or Augustinian soteriology. One thinks one sees traces of it, though held down by other influences, in the whole of medieval theology, and notably in Abelard. It disengages itself in the 17th century as Socinianism and in the 18th as Rationalism or Deism. Secondly there is a strong side-current in the mystical tradition, which we may perhaps treat as the modified form under which the philosophical theology of the Greek Church maintained its life in the medieval West. If so, Mysticism includes in itself a prophecy of modern Christian Platonism or idealism, with its cry of "Back to Alexandria."

Ethical rationalism and mysticism.

A Western echo of the Christological controversies of the East is found in the Adoptianism of Spain 785–818). These Adoptianists do not hold that Christ the person is adopted (He is God by birth), but his *human nature* may be.[2] There might be need of this, indeed, if the Adoptianists' theory of redemption were to stand, according to which Christ had taken to Himself a sinful human nature, and had washed it clean. This extreme assertion of duality as against Christological unity was naturally marked as heretical.

Sacraments.

Great advance is made in organizing Catholic theology by the fuller theory of sacraments. The East had a tentative hesitating doctrine of transubstantiation;[3] the West defines it with absolute precision (cf. Paschasius Radbertus against Ratramnus; the fourth Lateran Council, 1215). But if the medieval Church and modern Catholics regard the Eucharist as the principal sacrament, Protestants can hardly keep from assigning the supreme place, in the medieval system, to the sacrament of penance. If early "enthusiasm" conceived the Christian as almost entirely free from acts of sin, and if Protestant Paulinism conceives the child of God as justified by faith once for all, the full Catholic theory, representing one development of Augustinianism, views the Christian as an invalid, perpetually dependent on the good offices of the Church. The number of sacraments is fixed at seven,[4] first by Peter Lombard, and the essence of the three sacraments which do not allow of repetition—baptism, confirmation, orders—is defined as a "character"[5] imprinted on the soul and never capable of being lost. We must mark the advance in formal completeness. Theology is now not merely the dogma of the Divine nature or of Christ's person; it is also a dogmatic

[2] The term Adoptianism arose at this time. Modern theologians carry it back to much earlier views.

[3] Until indeed, in modern times, Greek theology accepted the Western term and definition.

[4] This, too, has been adopted in modern Greek theology.

[5] Augustine already has this conception (Loofs). A hostile critic might say that the conception affirms the absolute worth of sacraments while absolutely declining to say what they accomplish.

theory of how the Christian salvation is conveyed through sacraments to sinful men. On the other hand, a theology which is mainly sacramental is overtaken pretty soon by dumbness. It is of the essence of a sacrament to be an inscrutable process.

Theories of legal merit, amount of debt, supererogatory goodness, and ascetic claim—representing the aspect of Catholicism as law—are more and more worked out. The occasion of the formal separation of East and West—the Western doctrine of the twofold "procession" of the Holy Spirit, incorporated in the (so-called Nicene) creed itself ("filioque")—is of little or no real theological importance. The schism was due to race rivalries, and to dislike for the ever-growing claims of the see of Rome.

An important contribution to doctrine is contained in the *Cur Deus Homo* of Anselm of Canterbury. The doctrine of Atonement, destined to be the focus of Protestant evangelicalism, has remained undefined in Catholic circles,[1] an implicate or presupposition, but no part of the explicit and authorized creeds. When treated in the early centuries, it was frequently explained by saying that Christ's sufferings bought off the devil's claim to sinful man, and some of the greatest theologians (*e.g.* Gregory of Nyssa) added that the devil was finely outwitted—attracted by the bait of Christ's humanity, but caught by the hidden hook of His divinity. Anselm holds that it was best for the injured honour of God to receive from a substitute what the sinner was personally in no condition to offer. Whatever other elements and suggestions are present, the atmosphere of the medieval world, and its sense of personal claims, are unmistakable. With Anselm Ritschl takes Abelard, who explains the Atonement simply by God's love, and thus is the forerunner of "moral" or "subjective" modern theories as Anselm is of the "objective" or "forensic" theory. It must be admitted, however, that there is less definiteness of outline in Abelard than in Anselm. He does not even deal with the doctrine as a specialist, in a monograph, but only as an exegete.

Anselm on Atonement.

Contemporaneously with the new and vivid intellectual life of an Anselm or an Abelard, the "freezing up" of traditionalism is evidenced by the preparation of volumes of *Sentences* from Scripture and the Fathers. One of the earliest of such collections is that of Isidore (*q.v.*) of Seville (560–636), who, from this and other writings, ranks among the few channels which conveyed ancient learning to the middle ages. His *Sentences* are selected almost (though not quite) exclusively from Augustine and Gregory the Great. Direct influence from the Greek Fathers upon the West is vanishing as the Greek language is forgotten. The great outburst of *Sentences* at a later time has been referred to the consternation produced by Abelard's *Sic et Non.* The modern reader can hardly banish the impression that Abelard writes in a spirit of sheer mischief. Probably it would be truer to say that he riots in the pleasures of discussion, and in setting tasks to other irresponsible and ingenious spirits. He does not fear to contrast authority with authority, upon each point in succession; the harder the task, the greater the achievement when harmony is reached! In regard to Scripture alone does he maintain that seeming error or discrepancy must be due to our misinterpretation. If throughout the middle ages Scripture is treated as the ultimate authority in doctrine, yet Abelard seems to stand alone in definitely *contrasting* Scripture with later authorities. Moderns will question the possibility of asserting Bible infallibility a priori; but it is more really startling and noteworthy that Abelard should preserve a living sense of fallibility outside the Bible.

"Sentences."

There are many great collections of *Sentences*, notably by Hugh of St Victor and Peter Lombard. The last-named—though with more continuity of texture than Isidore—quotes largely from the Bible and the Latin Fathers. If Abelard stands for the intellectual daring of scholasticism, Lombard represents its other pole—interest in piety, *i.e.* in the Church. He is almost timidly cautious. He does not open up difficulties like Abelard, but smoothes them over. This suits the coming age. The great writers of the early centuries were to tell on men's minds not in the breadth of their treatment but in a theological pemmican. And the characteristic task for living theologians was to consist in writing commentaries on the Lombard's *Sentences*; for a time these *Sentences* themselves had been suspected, but they gained immense influence.

[1] Even the Council of Trent defined what Protestants had challenged—nothing else.

Had this been all, Western theology might have sunk into a purely Chinese devotion to ancient classics. But the medieval world had not one authority but two. Thin and turbid, the stream of classical tradition had flowed on through Cassiodorus or Boetius or Isidore; through these, at second-hand, it made itself known and did its work. But before the great outburst of scholasticism, ancient literature found a somewhat less inadequate channel in Arabian and partly even in Jewish scholarship. Aristotle was no longer strained through the meshes of Boetius; and the new light inspired Roscellinus with heresy. True, we must not exaggerate this influence. There was no genuine renaissance of civilization, such as marked the dawn of modern history. The medieval world did not copy the free scientific spirit of Aristotle; it made him, so far as known, a sort of philosophical Bible side by side with the theological Bible. But it was a very great matter to have two authorities rather than one. And if any man was to be put in the preposterous position of a secular Bible, no writer was fitter for it than Aristotle. The middle ages did their best in this grouping; only here and there a rare spirit like Roger Bacon did something more, something altogether superior to his age, in showing that the faculty of independent scientific inquiry was not quite extinct. It is possible to exaggerate the influence of the revived knowledge of Aristotle; but, so far as one can trace causes in the mysterious intellectual life of mankind, that influence gave scholasticism its vigour. (See Arabian Philosophy, Scholasticism.)

Guarantees of progress.

Arabian study of Aristotle.

With the new knowledge and impulse, there came a new method. Alexander of Hales is the first to adopt it, in place of the "rhetorical" method of previous theologians. Everything is now matter of debate and argument. The *Sentences* had resolved theology into a string of headings; with scholasticism each topic dissolves into a string of arguments for and against. These arguments are made up of "rationes" and "auctoritates," philosophical authorities and theological authorities. They are as litigious as a lawsuit—without any summing up; the end comes in a moment with a text of Scripture or an utterance by one of the great Fathers. Once such a dictum has been cited, the rest of the discussion is treated as by-play and goes for nothing. "I am a transmitter," Confucius is reported to have said. The great schoolmen were transmitters—putting in order, stating clearly and consecutively, conclusions reached by wiser and holier men in earlier times. Are the systems self-consistent? Their guarantee is the tireless criticism carried on by rival systems. No parallel display of debating acuteness has ever been seen in the world's history. It is easy to underrate the schoolmen. Indolence in every age escapes difficulties by shirking them, but the schoolmen's activity raised innumerable awkward questions. On the other hand, they possessed to perfection the means of making their speech evasive. If there are hollow places in the doctrinal foundations of the Church, it will be a tacit understanding among the schoolmen that such questions are not to be pressed. Above all, one must not look to a schoolman to speak "a piercing and a reconciling word." There is no revision of the premises in debate from a higher or even from a detached and independent point of view. The premises from which he may select are fixed; many of the conclusions to be reached are also fixed. He speaks, most cleverly, to his brief, but he will not go outside it. He may argue as he likes so long as he respects the Church's decisions and reaches her conclusions.

Scholastic method.

The systems of the leading schoolmen must rank above their commentaries upon the Lombard's *Sentences*, as the greatest of all systems of theology. Especially is that honour due to St Thomas Aquinas's larger *Summa Theologiae.*[2] We may well believe that he represents scholastic divinity at its best. He is not an Augustine, still less perhaps an Aristotle, but he is the Aristotle and the Augustine of his age, the normal thinker of the present and the lawgiver of the future. He teaches the medieval Platonic realism, but he accepts the Aristotelian philosophy of his day, marking off certain truths as proved and understood by the light of nature, and stamping those which are not so proved as not understood nor understandable, *i.e.* as "mysteries,"

Aquinas.

[2] The *Summa contra Gentiles* has a more polemic or apologetic interest than the dogmatic *Summa*, but deals almost equally with the contents of Christian theology as a whole. Books i.–iii. are said to deal with what is later known as natural theology, and Book iv. with what is later known as dogmatic. But Aquinas appeals to the Bible as an authority all through. That is not the procedure of modern natural theology.

in the sense in which the term has come to be used by ages that have inherited Aquinas's thoughts. He has Augustine's Predestinarianism, stiffened (according to Loofs) by Arab philosophical determinism, and he has much of Augustine's doctrine of the grace of God, though it is flanked with doctrines of human merit which might have astonished Augustine. The seven sacraments of course have their place in the body of the system, and are exhaustively studied. When we turn to Duns Scotus, we still find realism, still predestinarianism. And yet these are rivals. An attempt has been made by R. Seeberg to interpret Duns as the forerunner of Luther in his emphasis on the practical. Expert knowledge and judicial insight must decide the point; but, so far as the present writer can judge, it is illusory to imagine that Duns points us beyond the medieval assumptions. As generally understood, Duns makes caprice supreme in God. The arbitrary divine will makes right right and wrong wrong. Here, says Ritschl, the involuntary logic of predestinarianism speaks its last word. Though he may technically be classed as an "extreme realist," Duns is the forerunner of those later Nominalists, like William of Occam, who unsettled every intellectual ground of belief in order that they might resettle belief upon Church authority, not reason but rather scepticism being for them the *ancilla domini*. Later authoritative pronouncements on the part of the Roman Catholic Church favour Thomism and disown the Occamites; though the keen hostile criticism of Harnack affirms that the Church had need of both systems—of Thomism, to champion its cause in the arena of thought, and of the Nominalist theology to aggrandize the Church as the ruling power in practice.

Duns Scotus.

When Protestantism arose, there was urgent need of reform. All sides granted that at the time, and all grant it now. Separation was not contemplated by any one at the first; this again is manifest. Yet it is also matter of plain history that Protestantism is more than a removal of abuses, or even than a removal carried out with reckless disregard of consequences. It is partly an outcome of Luther's personality—of his violence, no doubt, but also of his great qualities. It is due mainly to the dominant tradition in Church doctrine. Augustinianism reacted against attempts to tone it down in theory or neutralize it in practice, until at last it broke loose in the form of Protestantism. But Protestantism is largely due further to the Renaissance. The new knowledge enabled men to read the Bible, like all other ancient books, with a fresh mind. Finally, we have the true central cause in the Pauline doctrine of faith. Evaded by Augustinianism, it came back now, with some at least of its difficulties and paradoxes, but also with its immense attractive and dynamic power. When the Reformers went beyond Augustine to Paul, Protestantism was born.[1] Even the Counter-Reformation, so far as it was a matter of doctrine (Council of Trent, 1545–63), took the form of reaffirming a cautious version of Augustinianism.

Origins of Protestantism.

Whether Protestantism found its adequate doctrinal expression is very doubtful. Luther was no systematic thinker; Melanchthon, the theologian of the Lutheran Church, gave his system the loose form of *Loci communes*, and went back more and more in successive editions to the traditional lines of doctrinal theory—a course which could not be followed without bringing back much of the older substance along with the familiar forms of thought. To find the distinctive technicalities of Lutheranism we have to leave Melanchthon's system (and his great Reformation creed, the *Augsburg Confession*) for the *Formula of Concord* and the lesser men of that later period. In Calvin, indeed, the Reformed[2] theology possessed a master of system. We notice in him resolute Predestinarianism—as in Luther, and at first in Melanchthon too; the vehicle of revived Augustinian piety—and resolute depotentiation of sacraments, with their definite reduction to two (admittedly the two chief sacraments)—baptism and the Lord's Supper.[3] In affirming the "inamissibility" of grace in the *regenerate* (not simply in the unknowable *elect*) Calvin went beyond Augustine, perhaps beyond Paul, certainly beyond the Epistle to the Hebrews, resolutely loyal to the logic of his non-sacramental theory of grace. Yet, in contrast with the doctrine usually ascribed to Ulrich Zwingli, Calvin teaches that grace does come through sacraments; but then, nothing comes beyond the fruits of faith; from which grace all salvation springs necessarily. To use technical language, Calvinism holds that sacraments are needful *ex ratione praecepti*, (merely) "because commanded." In contrast with this, orthodox Lutheranism has to teach baptismal regeneration and consubstantiation, as well as justification by faith. It is hard to see how the positions harmonize. Zwingli and Calvin, developing a hint of Hus, introduce a distinction between the visible and the invisible Church which Melanchthon repudiates but later Lutheranism adopts. The Articles of the Church of England (19, 26) speak of the visible Church, but unless by inference do not assert a Church invisible. Upon most points Anglicanism seeks for a *via media* of its own. Resolutely Protestant in early days and even Calvinistic, it yielded to the suggestions of its episcopal constitution[4] and sacramental liturgies; and now its theologies range from Calvinism at one extreme to outspoken hatred of Protestantism at the other. Historically, great issues have hung upon the dislike by which High Lutheranism and High Anglicanism, those two midway fortresses between Rome and Geneva, have been estranged from each other.

Melanchthon.

Calvin.

[1] Roman Catholic scholars naturally hold that Paul was misconstrued, but they cannot deny that Protestant theology was directly a version and interpretation of Paulinism.

[2] The more radical Protestantism of the non-Lutheran orthodox churches is called in a technical sense "Reformed." German scholarship generally ranks the Church of England with the "Reformed" churches because of its Articles.

[3] Lutheranism seeks to add, in a sense, a third sacrament, Penance (so even Melanchthon).

It is thus plain that the stream of Protestantism was very early split up into separate channels. Did any of these theologies do justice to the great master thought of grace given to faith? Antecedently to their separation from each other the Reformers took over the theology of Greek orthodoxy as a whole. Complaints against that theology may be quoted from early writings of every Reformer, even Calvin. They knew well that the centre of gravity in their own belief lay elsewhere than in the elaborately detailed scheme of relations within the Godhead or in the Theanthropic person. But ultimately they persuaded themselves to accept these definitions as normal and biblical, and as presuppositions of Christ's saving work. The decision had immense results, both for religion and for theology. Nor did the unity of Protestant theology—Lutheran and Calvinist—confine itself to the period before the great divergence. Men of the second or third generation —often called the "Protestant Scholastics"—work together upon two characteristic doctrines which the fathers of Protestantism left vague. The Reformation doctrine of Atonement, while akin to Anselm's, differs in making God the guardian of a system of public law rather than of His private or personal honour. This conception came to be more fully defined. Christ's twofold obedience, (*a*) active and (*b*) passive, produces jointly a twofold result, (1) satisfaction to the broken moral law, (2) merit, securing eternal life to Christ's people.[5] There is no such full and careful theory of Atonement in any Catholic theology, and, according to so unbiassed a judge as A. Ritschl, it represents the last word in doctrine along the lines laid down by the Reformers. Could Catholics adopt it? Hardly; for the Protestant assertion of Christ's merit is shadowed, if any doctrine of merit in the Christian is brought in. Yet the very word reminds us of the legal piety which is characteristic of Western popular religion through all its history. We now find "merit" confined to Christ, and the usual application ruled out, somewhat as St Paul's intenser use of Pharisee conceptions destroyed instead of confirming the idea of righteousness by works. But it is by no means clear that this Protestant doctrine of Atonement is a unity. "Merit" is an intruder in that region of more strict and majestic law; yet Christ's "merit" is the only form under which the positive contents and promises of the Christian Gospel are there represented. Even the most resolute modern orthodoxy usually tries to modify this doctrine. There is a break with the past, which no revival or reaction can quite conceal.

Continued unity in Protestant doctrines.

Again, the Reformation had drawn a line round the canon—sharply in Calvinism, less sharply in Lutheranism (which also gave a *quasi* normative position to its Confessions of Faith). Anglicanism once more resembles Lutheranism with differences;

[4] Few Lutheran churches possess bishops. In Germany the "episcopal system" is a right claimed on behalf of the civil government.

[5] This is not fully formulated even in the Lutheran *Formula of Concord*, nor yet in the Calvinistic canons of Dort and Confession of Westminster, though these and other Protestant creeds have various instalments of the finished doctrine. One might add a still further distinction of the Protestant scholasticism. The Atonement imparts to the believer (*a*) forgiveness, (*b*) positive acceptance. Actual renewal is, of course, something beyond either of these.

it enjoins public reading of certain lessons from the Apocrypha and uses in worship even the "Athanasian" as well as the two more ancient creeds. On the basis of belief in inspiration we find, during the days of Protestant scholasticism, the most reckless and insane assertions of scriptural perfection. Even in our own time, popular Protestant evangelicalism joins with the newer emphasis upon conversion the two great early Protestant appeals—to Atonement and to infallible Scripture. But the Protestant Church is by no means alone in making such assertions. Other Churches make them too, though they overlay and disguise them with appeals to tradition and to the authority of the Church itself or the Fathers. The definite and limited burden had to be more definitely dealt with; hence these Protestant extravagances.

The first great rival to Protestant orthodoxy, apart from its old enemy of Rome, was Socinianism, guided by Laelius Socinus (*q.v.*), but still more by his nephew Faustus. Thoroughly intellectualist, and rational, and supernaturalist, it has no one to champion it to-day, yet its influence is everywhere. Jesus, a teacher who sealed His testimony with His blood, and, raised from the dead, was exalted or adopted to divine glory, thus giving to men for the first time the certainty that God's favour could be won and eternal life enjoyed—such is the scheme. There is no natural theology; the teachings so described are really part, or rather are the essence, of the revelation of Jesus. Atonement is a dream, and an immoral dream. Supernatural sacraments of course drop out. The Lord's Supper is a simple memorial. Baptism were better disused, though Faustus will leave the matter to each Christian man's discretion. There is not in all Church history any statement of doctrine better knit together. Socinus's church is a school—a school of enlightenment. He was also—like Calvin, if on more narrowly common-sense lines—an admirable exegete. Harnack ranks his system with Tridentine and post-Tridentine theology on the one hand, and with Protestantism on the other hand, as the third great outcome of the history of dogma. Nevertheless the judgment of history declares that this brilliant exploit was entirely eccentric, and could only in indirect ways subserve theological study. Those to-day who are nearest the Socini in belief are as far as any from their fashion of approaching and justifying their chosen version of Christian doctrine.

Socinianism.

Even after the loss of the Protestants and the suppression or expulsion of the Jansenists, the doctrinal history of the Church of Rome is described as governed by discussions in regard to Thomist Augustinianism. The Molinists (*i.e.* followers of Louis Molina the Jesuit, not Michael Molinos the mystic) are the leading representatives of a different theology. Harnack, a keenly hostile critic, draws attention to a change in the region of moral theology, not dogmatics. After long controversy, St Alfonso Liguori's doctrine of Probabilism (originated by Molina) definitely triumphed everywhere. Conduct is considered lawful if any good Church authority holds it to be defensible; and "probability" warrants the confessor in taking a lenient view of sins which he himself, and authorities of weight in the Church, may regard as black in the extreme. From Harnack's point of view, the theory destroys Augustinianism, whatever honour may still be paid to that name. Another important change in Roman Catholic theology has been the increasing personal power of the pope. This was significantly foreshadowed when Pius IV. put forward by his own act what is known as the creed of the Council of Trent; and, after the coldness of the 18th century and the evil days of the French Revolution, an Ultramontane revival, relying with enthusiasm on the papacy, grew more and more strong until it became all-powerful under Pius IX. It gained a notable victory when that pope, acting on his own authority, defined (1854) as of faith a doctrine which had been long and hotly discussed—the Immaculate or absolutely sinless Conception (deeper than mere sinlessness in act and life) of the Blessed Virgin. The second and decisive victory followed at the Vatican Council (1870), which, at the cost of a small secession of distinguished men, declared the pope personally infallible (see INFALLIBILITY) and irreformable as often as he rules *ex cathedra* points of faith or morals. This once again seems to be the last word in a long development. Uncertainty as to the authorities determining religious belief—Scripture, tradition, Fathers, Doctors—is now, at least potentially, at an end; the pope can rule every point definitely, if he sees good to do so.

Later history of Roman Catholic doctrine.

The theory of Development (J. A. Möhler, J. H. Newman), which throws so new a light upon the meaning of tradition, is a valuable support of the conception of a sovereign pontiff drawing out dogmas from implicit into explicit life. Still, new and obscure questionings may still arise. When is the pope ruling faith and morals from his throne? When may the Church be assured that the infallible guidance is being given? A startling fresh development is suggested by Harnack, while vehemently dismissed as impossible by another Protestant scholar, H. M. Gwatkin. May a reforming or innovating pope arise? He would find, in theory at least, that he possessed a weapon of matchless power and precision. But hitherto Roman Catholic theology has refused to conceive of any development except by enlargement of the Church's creed. Much may be added to formulated belief; it is not admitted that anything has been or can be withdrawn. Brilliant Modernist scholars like A. Loisy may have successors who will champion theories of evolutionary transformation. But at the present hour a representative writer names as a typical open question in his communion the Assumption of the Virgin. Perhaps, indeed, it is rather a dogma hastening towards definition. Is the theory or tradition correct, that, after death and burial, Mary was bodily received into heaven and her grave left empty? Such problems engage the official theologians of the Church of Rome.

Modern theory of "development."

It is natural that the "variations" with which Bossuet reproached the Protestants should demand more space. The Christological problem seems to require separate treatment. In regard to the Trinity, Protestantism has nothing very new to say, though "Sabellianism" is revived by Swedenborg and Schleiermacher. But in regard to Christology opinion takes fresh forms as early as Luther himself. While this became conspicuous in connexion with his doctrine of consubstantiation in the Eucharist, it appears[1] that he had a genuine speculative interest in the matter. *Communicatio idiomatum* was well known in the schools as an affair of terminology. You might say correctly that God has died (meaning the Godman), or that a man is to be worshipped —Christ Jesus. According to Luther, however, it is not merely in words that the attributes of the Godhead qualify Christ's human nature.[2] That takes place in fact; and so the human glorified body of Christ is, or may become under conditions which please Him, *e.g.* at the Eucharist, ubiquitous. This new quasi-monophysitism disinclined the Lutherans to make much of Christ's humanity, while the Reformed, partly from the scholarly tradition of Calvin, partly from a polemical motive, laid great emphasis on the manhood. A. Ritschl[3] even speaks of the Reformed as teaching Kenosis in the modern sense; but it is to be feared they rather taught alternately the manhood and the Godhead than made a serious effort to show the compatibility of divine and human predicates in one person. Christ as man was one of the Elect (and their head); He needed grace; He depended upon the Holy Spirit. On the other hand, as God, He was the very source of grace. The Lutherans held that the Incarnate One possessed all divine attributes, but either willed to suspend their use—this is the Kenosis doctrine of the Lutheran school of Tübingen in the 17th century—or concealed their working; the latter was the doctrine of the Giessen school.

Protestant history of doctrines.

A theory which flickers through Church history in the train of mystical influence proceeding from the pseudo-Dionysius Areopagita has become more prominent in modern times—that Christ would have become Incarnate even had man not sinned. Rejected by Thomas, it is patronized by Duns—not, one thinks, that he loved rational certainties more, but that he loved redemptive necessities

"Necessity" of Incarnation.

[1] According to I. A. Dorner.

[2] The human predicates are not held to modify the Divine nature, except by modern Kenoticists, who therefore, when they are Lutherans, claim to be completing Luther's theory.

[3] *Rechtfertigung u. Versöhnung*, i. p. 384.

less. In a sense this theory puts the coping-stone upon Christological development. If we are warranted in regarding the Second Person of the Godhead as in very deed "Himself vouchsafing to be made," that great Becoming cannot well be suspended upon a contingency which might or might not arise; and theologians in general regard the sin of man as such a contingent event. Incarnation almost demands to be speculatively interpreted as the necessary last stage in the self-manifestation and self-imparting of God. Yet interest in man's moral necessities threatens to be lost amid this cosmological wisdom. Theology pushed too far may overleap itself. Those who shrink from the old confident assertion, "Christ would not have become incarnate but for man's sin," might claim to say, from reverence and not from evasiveness, *ignoramus*. On the other hand, the type of thought which would perfect Christianity in the form of a philosophy, and subordinates Atonement to Incarnation, is pledged to this doctrine that Incarnation was a rational necessity. Such speculative views are associated with the revival of another traditional piece of mysticism—the Holy Spirit the *Copula* or bond of union in the Godhead. There is no such assertion anywhere in the New Testament.

Modern theories of Kenosis.

For modern German theories of *Kenosis* among Lutheran and Reformed, see A. B. Bruce's *Humiliation of Christ*. Basing on the language of Phil. ii. 7, they teach, in different forms, that the Son of God became a man under human limitations at conception or birth, and resumed divine predicates at His exaltation. It might be put in this way—a really Divine personality, a really human experience. Strong as are the terms of Phil. ii. 7, we can hardly suppose that St Paul had a metaphysical theory of Christ's person in view. In Great Britain and America many have adopted this theory. It is often taught, *e.g.* that Christ's statements on Old Testament literature are to be interpreted in the light of the Kenosis. The enemies of the theory insist that, while it safeguards the unity of Christ's personal experience at any one point, it breaks up by absolute gulfs the continuity of experience and destroys the identity of the person. Indeed, those forms of the theory, which give us a Logos in heaven (John iii. 13) along with the humbled or Incarnate Christ on earth, seem to fail of unifying experience even at the single point. Other suggestions in explanation of the mystery have been:

Other Christological speculations.

a gradual Incarnation, the process not being complete until Christ's exaltation (I. A. Dorner's earlier view); impersonal pre-existence of the Logos, who became personal—compare and contrast Marcellus of Ancyra—at the Incarnation (W. Beyschlag's earlier view, practically adopted by Dorner in his later days); Jesus the man who was absolutely filled with the consciousness of God (Schleiermacher); Jesus not to be defined in terms of "nature," either human or divine, but as the perfect fulfiller of God's absolute purpose (A. Ritschl's view, practically adopted in later days by Beyschlag). The orthodoxy which refuses all new theories may look for help to the pathological dissociation of personality, or at least (*e.g.* J. O. Dykes in *Expository Times*, Jan. 1906; Sanday *Christologies Ancient and Modern*) to the mystery of the subconscious.

We have now to look at Protestant theology in its dealing with questions in which it is more immediately or more fully interested. In the early period known as the Protestant scholasticism there was no desire for progress in doctrine.

Arminianism.

Challenged by Arminianism in Holland, the Calvinistic theology replied in the Confession of Dort; at which Synod English delegates were present. This creed may almost rank with the Lutheran *Formula of Concord* as summing up post-Reformation Protestant orthodoxy. But the direct fate of Arminian teachers or churches was no measure of their influence. One proof of the latter is found in Archbishop Laud and the English High Churchmen of his school, who throw off the Augustinian or Calvinistic yoke in favour of an Arminian theology. Lutheranism had set the example of this change. Later editions of Melanchthon's *Loci Communes*, generously protected by Luther, drop out or tone down Luther's favourite doctrine of predestination. The Augustinian clock was running down, as usual. In the 18th century "Illumination"—an age

The "Illumination."

which piqued itself upon its "enlightenment," and which did a good deal to drive away obscurity, though at the cost of losing depth—Deism outside the churches is matched by a spirit of cool common-sense within them, a spirit which is not confined to professed Rationalists. Civil wars and theological wranglings had wearied men. Supposed universal truths and natural certainties were in fashion. The plainest legacy of the 18th century to later times has been a humaner spirit in theology. Christian teachers during the 19th century grew more reticent in regard to future punishment. The doctrine when taught is frequently softened; sometimes universalism is taught.

Unitarianism.

A movement towards Arianism and then towards Socinianism (Joseph Priestley, Nath. Lardner, W. E. Channing) among English Presbyterians and American Congregationalists left permanent results in the shape of new non-subscribing churches and a diffusion of Unitarian theology (J. Martineau). The 18th century is very differently interpreted in different quarters. Orthodox evangelicalism is tempted to view it as an apostasy or an aberration. On the other hand, not merely agnostics like Leslie Stephen but Christian theologians of the Left like Ernst Troeltsch regard it as the time when supernaturalism began decisively to go to pieces, and the "modern" spirit to assert its authority even over religion. A. Ritschl, again, claims that neglected elements of Christianity were striving for utterance, particularly a serious belief in God as Father and in His providential care. It was not, says Ritschl, a turning away from Christian motives, but a turning towards neglected Christian motives. This view seems logically to involve Ritschl's belief, that it is not the light of reason but the revelation of Christ which warrants the assertion of God's fatherly providential goodness.

Whether temporary or permanent, a great reaction from the 18th-century spirit set in. It was partly on Augustinian lines, partly on the lines of what the Germans call Pietism.

The Evangelical revival.

Under John and Charles Wesley, a system known as Evangelical Arminianism was worked out in 18th-century England, strongly Augustinian in its doctrines of sin and atonement, modern Augustinian in its doctrine of conversion, strongly anti-Augustinian in its rejection of absolute predestination. Within the Anglican Church, however, the new revival was Augustinian and Calvinistic, till it gave place to a Church revival, the echo or the sister of the Ultramontane movement in the Church of Rome.

The Oxford Movement.

The vigorous practical life of the modern school of High Church Anglicanism, initiated by John Keble, W. Hurrell Froude, J. H. Newman, E. B. Pusey, is associated with a theological appeal to the tradition of the early centuries, and with a strongly medieval emphasis upon sacramental grace. In Germany, dislike of the Prussian policy of "Union"

Lutheran opposition to the "Union."

—the legal fusion of the Lutheran and Reformed Churches—gave life to a High Lutheran reaction which has shown some vigour in thought and some asperity in judgment (E. W. Hengstenberg; H. A. C. Haevernick; dogmatic in G. Thomasius and F. A. Philippi; more liberal type in C. F. A. Kahnis; history of doctrine in G. Thomasius). The most distinguished of the theologians classed as "mediating" are C. Ullmann, C. I. Nitzsch and Julius Müller. Later evangelicalism in the English-speaking lands gives up belief in predestination, or at least, with very few exceptions, holds it less strongly. That change is clearly a characteristic feature of 19th-century theology.

Many of the movements just mentioned are, at least in design, pure reactions involving no new thoughts. Apart from apologetics or single doctrines like that of the Atonement,

Proposals to unify theology.

the task of rethinking Christian theology upon the great scale has been left chiefly to German science, philosophical and historical. If the task is to be accomplished, then, whatever merit in detail belongs to wise and learned writers already referred to, it would seem that some one central principle must become dominant. This consideration, as far as an outsider can judge, excludes any formal Roman Catholic co-operation in the suggested task. So long as theological truth is divided into the two compartments of natural or rational theology and incomprehensible revealed mysteries, there is no possibility of carrying through a unity of principle. Again, many Protestants rule themselves out of participation in the search for unified doctrine. It is a modern commonplace—Loofs dates the formula from about 1825—that

Protestantism has two principles: a "formal principle," the authority of Scripture, and a "material principle," the doctrine of justification by faith. We have already indicated that some such pair of principles was prominent when historic Protestantism pulled itself together for defence during its scholastic age. But surely serious thought cannot acquiesce in a dual control. While the double authority continues or is believed to continue in power, there seems no hope of making theology a living unity, which will claim respect from the modern age.

Influence of Hegelianism.

One great attempt at unifying Christian theology came from the side of philosophy. Kant's scheme, which in religious theory as well as in chronology may be regarded as a link between the 18th and 19th centuries, led on to the very different scheme of Hegel; and the latter system began almost at once to influence Church doctrine. D. F. Strauss (*q.v.*) applied it with explosive effect to the study of the life of Jesus. F. C. Baur, assisted by able colleagues, if hardly less revolutionary, was much more in touch with theology than Strauss had been. The Hegelian threefold rhythm was to run through all history, especially for Baur through the history of the Christian Church and of its doctrine. Baur maintained a thorough-going evolutionary optimism. "The real was the rational" from first to last. However biassed, this a priori study had its merits. It unified history with a mighty sweep, and revealed through all the ages one evolving process. But we have still to ask whether the doctrines it made prominent are really those which are vital to the Christian Church. And we have to look into Baur's esoteric interpretation of the doctrinal development. For him, as for Strauss, the unity of God and man is the central truth, of which Christ's atoning death is a sort of pictorial symbol. This implies that the whole of Western theology has been an aberration or an exoteric veiling of the truth.[1] In Dogmatic the school is represented by A. E. Biedermann, and with variations by O. Pfleiderer. A more orthodox reading of Hegel's thought, which brings it into line with some Christological developments already described, is found in J. E. Erdmann and the theologians P. K. Marheineke and Karl Daub. Influences from Hegel are also to be traced in Richard Rothe, I. A. Dorner, A. M. Fairbairn; and through the mediation of British philosophers Hegelianism has widely affected British theology.

Influence in England.

The orthodox wing of idealists take as their watchword Incarnation; Christianity is "the religion of the Incarnation" (sub-title of *Lux Mundi;* see B. F. Westcott, *passim*). The rationalist wing resolve Incarnation and still more Atonement into symbols of philosophical truth. Of the two parties, the latter appears the more successful in accomplishing the task of unifying theology, although at the cost of subordinating both theology and religion to philosophy. The strength of all the idealists consists in their appeal to reason.

Schleiermacher.

Schleiermacher set himself to explain what is *distinctive* in religion. He distinguishes religion from philosophy as feeling in contrast with thought; but when he has done that (*Reden über die Religion*, 1799) he has little to add. Any type of highly wrought feeling may make a man religious, whether it be theistic or pantheistic; indeed, as a child of Romanticism, Schleiermacher puts a peculiarly high estimate upon the pantheistic type. What else can we expect from a thinker who is interested simply in feeling as feeling? When he wrote his *Glaubenslehre* (1821) Schleiermacher had become much more of a Christian churchman. "Christianity is one of the teleological pieties," and has as its peculiarity that "in it everything is referred to the redemption accomplished through Jesus of Nazareth." But it is doubtful whether the elements of his final synthesis really interpenetrate. He tells us (*Kurze Darstellung des theologischen Studiums*, 1811) that the theologian, while himself loyal to his Church, must expound, as a historian, the beliefs actually held in the branch of the Church which he represents. Oil and water do not mix. Do the unchecked individual enthusiasm of the *Reden*, and the loyalty to established beliefs required in the later writings, combine to form a living theology? It is little wonder if Schleiermacher attains a compromise rather than a unity. He has been one of the great ferments in modern Protestant doctrine both of the Right and of the Left. Alex. Schweizer[2] maintained his general positions more nearly than any other. But there is no Schleiermacher school. W. Herrmann, from his own point of view, has quoted J. C. K. Hofmann and F. R. Frank as making important modifications and sometimes corrections of the lines laid down by Schleiermacher, while J. S. Candlish, representing a moderate Scottish Calvinism, was half inclined to welcome the reduced form of Schleiermacher's basis found in H. L. Martensen (a Dane), J. T. Beck, and the Dutchman, J. J. van Oosterzee, *i.e.* Scripture the true source of doctrine, but the religious consciousness its ordering principle.

[1] Hence R. B. Haldane, in the Scottish Church lawsuit of 1904, is found telling the House of Lords that Justin Martyr had a grasp of speculative truth which was impossible to St Augustine.

[2] Or the Dutchman, J. H. Scholten.

Ritschl.

A bolder and more original attempt to restate Protestantism as a systematic unity is found in the work of A. Ritschl, with H. Schultz and W. Herrmann as independent allies and colleagues, and with J. Kaftan, A. Harnack and many others as younger representatives on divergent lines. Reaction against the philosophy of Hegel and the criticism of Baur is common to all the school, though Ritschl went further back than the younger men towards critical tradition and further in some points towards orthodox dogma. Positively, the school build upon foundations laid in ethics by Kant and in philosophy of religion by Schleiermacher; so also R. A. Lipsius, and yet his dogmatic results coincide more nearly with Biedermann's or Pfleiderer's than with the "intermediate though not mediating" position taken up by the Ritschlians. Not even the acceptance of forgiveness as the central religious blessing is exclusively Ritschlian, still, it is a challenge alike to the 18th century, to the Church of Rome and to the modern mind. Ritschl and his friends forfeit that unifying of life and duty which is gained by making the moral or perhaps rather legal point of view supreme. As they deny the natural religion of the 18th century—the religion which works its way into harmony with God by virtue—so, still more emphatically, they refuse to bid the sinner merit forgiveness. Thus they constitute one more revival of Paulinism or Augustinianism, though with qualifications.

Their effort is to expound Christianity, not from the point of view of philosophy like the Hegelians, nor from that of an abstract conception of religion, tempered by regard for historical precedents, like Schleiermacher, but from its own, from the Christian point of view. Ritschl has several dogmatic peculiarities, intenser in him than in his fellow-workers and followers. A notable instance is his doctrine of the Church—the community (*Gemeinde*); the sole object of God's electing love, according to Ritschl's interpretation of St Paul. Hence theology is not to be the utterance of individual Christianity merely, but of the Church's faith, embodied in its classical literature, the New Testament, and (subordinately) in the Old. The finality of the New Testament is partly due to its being the work of minds—including St Paul—who knew the Old Testament from the inside, and did not misconstrue its religious terminology as Greek converts almost inevitably did (cf. Harnack or E. Hatch). Upon the Church, Ritschl, who very much disliked and distrusted mysticism, poured out the same wealth of emotion which the Christian mystic pours out upon his dimly visualized God or Christ. Again, Ritschl divides all theology into two compartments, morality and religion; service of men in the Kingdom of God, direct relation to God in the Church by faith. Though he later declared that "Kingdom of God" was the paramount category of Christian thought, it does not appear that he substantially recast his theology. Here then his strong desire for unity is cut across by his own action. There may well be room for relative distinctions in any system of thought, however coherent; but it looks as if Ritschl's distinction hardened into absolute dualism.

Again Ritschl modifies the doctrine of sin. Like Schleiermacher he substitutes collective guilt for original sin; and he attaches great dogmatic value to the assertion that sin has two stages—ignorance, in which it is pardonable, and obduracy, when it is ripe for final sentence (probably annihilation). Here then Ritschl swerves from Paulinism; it is in other Scriptures[3] that he finds his guarantees for the position just stated. The result is to eliminate everything remedial from the Christian gospel. Yet Ritschl claims that his doctrine of Christ as Head of the Church combines the lines of thought found separately in Anselm and Abelard, while Schleiermacher is said to have been one-sidedly Abelardian. Ritschl denies natural theology[4] as well as natural religion, denies dogma outright in its Greek forms—Trinitarian and Christological; and seeks to transpose the doctrine of Atonement—Christ's Person "or" Works as he puts it—from the legal to the ethical. The Pauline touch shows itself plainly here. Justification by faith is a "synthetic" judgment—the *sinner* is righteous; it is not an "analytic" judgment—the *believer* is righteous. God "justifieth the ungodly." Sacraments are a republication of the "Word" of the Gospel; we have to content ourselves with this rather evasive formula, so often employed by the Reformers.

The highly academic Ritschlian movement has had wide practical influence in many lands. Here English and American thought strikes in sympathetically, offering moral theories of Atonement, though not looking so exclusively towards forgiveness. Horace Bushnell's last theory declared that in forgiving sin God "bore cost," as even a good man must do. John M'Leod Campbell—with a strong desire for unity in thought, "the simplicity that is in Christ"—caught most attention by the suggestion of a vicarious repentance in Jesus Christ. With R. C. Moberly this becomes an assertion that Christ has initiated a redemptive process of self-humiliation, which we can prolong in ourselves by the help of sacraments if we choose; while W. Porcher du Bose (like E. Irving early in the 19th century) holds the Adoptianist theory styled by A. B. Bruce "redemption by sample"—the divine Christ has

[3] Unless 1 Tim. i. 13; but is that epistle Paul's?

[4] The doctrine of "value judgments" which he substitutes for Schleiermacher's appeal to feeling, belongs to philosophy of religion and is thus analogous to natural theology.

assumed a tainted human nature and washed it clean, thus making it a promise and potency of the world's redemption.

Even if we accept the programme of reconstructing theology from a single point of view, we may desire to criticize not merely Ritschl's execution of the scheme, but his selection of the ruling principle. Is it enough to extricate the spirit of Protestantism from the imperfect letter of its early creeds?

Theology and Science. One set of difficulties is raised by the progress of science. No Protestant can deny that it is a duty for Christianity to come to terms with scientific discoveries, and few Catholics will care to deny it. Anxious negotiations thus arise, which colour all modern schemes of theology. But with a certain school they become central and dominant. We distinguish this position from the new emphasis on Christology, whether churchly or radical. Those who find a gospel in philosophy are ready to dictate terms to outsiders; but those who wait upon science for its verdicts supplicate terms of peace. Just as much of Christianity is to survive as science will spare. Often the theologians in question look to psychology as the permanent basis of religion; who is to deny that religion is a psychological fact, and the natural expression of something in man's constitution? This strain may be recognized, mingled with others, in Schleiermacher; it has found interesting expression in the contributions of H. J. Holtzmann and Ernst Troeltsch to the volume dealing with Christianity in *Die Kultur der Gegenwart*. Christ is confessed as the greatest figure of the past, and as one of no small importance still for the present and future. But, with entire decision, Christianity is called to the bar of modern culture. From that tribunal there is to be no appeal, whether to a higher revelation or to a deeper experience. This view stands in connexion with the study of comparative religion. Out of that very Ritschl school, which began by despising all religions except those of the Bible, has developed the *religionsgeschichtlich* movement, which dissolves Christianity in the wider stream. Such a policy is at the opposite pole to Ritschl's; he desired to interpret Christianity in the light of its own central thought. If Christians can find in their faith new resources to meet the new needs, they may hope to command the future. Theology if it is to live must be henceforth at once more Christian and more scientific than it has ever yet been.

A less threatening yet important possibility of modification arises out of the scientific study of the New Testament.

Theology and New Testament scholarship. Augustine, Luther, the evangelical revival, went back to St Paul; can Christianity not dig deeper by going back to Jesus? A Protestant has to view the past history of doctrine very much as a succession of declensions and revivals, the latter more than counteracting the former. He does not claim to have regained the inspiration of a Paul; but he holds that Augustine was more Christian than the sub-apostolic age, and Luther more Christian than Augustine. That is the hopeful feature in the past. The task for the present, with its unequalled scientific resources, is to get nearer than ever to the heart of the Gospel. Must Pauline categories always be supreme? The Ritschl school, and others too, have made an earnest effort to incorporate Christ's words in Dogmatic and no longer shunt them into systems of "Christian Ethics." They have not idolized Paulinism; but have they not idolized Luther? They seem to take for granted that the spirit—though not the letter—of that great man was a definitive statement of the Christian principle. To interpret Christianity out of itself is one thing; to interpret it out of Luther, even out of a distillate of Luther, is possibly a lower thing. The theology of the future may draw more equally from several New Testament types of doctrines. The scheme that includes most may be the successful scheme. Unity may be safeguarded in the confession of Christ, and theology indeed prove "Christocentric."[1] Above all, the social message of Jesus may well prove a gospel to our materially prosperous but inwardly sorrowful age. Any school of thought which despises that hope has small right to call itself Christian.

[1] Thomasius and H. B. Smith are quoted as holding the "Christocentric" ideal. A. M. Fairbairn, mindful of the vast importance of the conception of God, amends the programme. Theology is to be formally Christocentric, materially Theocentric (Fatherhood of God).

Natural and Revealed—the Logos. Casting a backward glance once more over the evolution of Christian theology, we may say very roughly that at first it recognized as natural or rational truth the being of the Logos, and as special fact of revelation the Incarnation of the Word in Jesus Christ. In medieval times the basis was altered. What had been rational truth now claimed acceptance as supernatural mystery. Modern idealists, ill at ease with this inheritance, try to show that Christ's Incarnation no less than His eternal divine being is a natural and rational truth. But, when this programme is carried out, there is no small danger lest the relations traced out between God and men should collapse into dust, the facts of Christ transform themselves into symbols, and the idealistic theology of the right wheel to the left.

The Atonement. Again, Western theology, very roughly summarized, while accepting the earlier doctrinal tradition, has broken new ground for itself, in affirming as rational necessity that God must punish sin (this is at least latent in Aquinas's doctrine of natural law), but as contingent fact of revelation that God has in Christ combined the punishment of sin with the salvation of sinners; this is the Reformation or post-Reformation thought. Here again the desire makes itself felt to impute more to God's nature. Is His mercy not as inherent as His justice? If so, *must* He not redeem? For, if He merely may redeem but must punish, then His greatest deeds on our behalf wear an aspect of caprice, or suggest unknown if not unknowable motives. The doctrine of penal substitution in the Atonement, as usually conceived, seems to point in the same direction as predestinarianism. Behind superficial manifestations of grace there is a dark background, almost like the Greek Fate. The ultimate source of God's actions is something either unintelligible or unrevealed. Christian theology cannot acquiesce in this. In our day especially it must seek to light up every doctrine with the genuine Christian belief in God's Fatherhood. And yet here again incautious advance may seem to overleap itself. If it should come to be held that with so kind a God no redemption at all is necessary, the significance of Christ is immensely curtailed if not blotted out. Even if He should still be taken as the prophet of the divine goodwill, yet the loss of any serious estimate of sin makes good nature on God's part a matter of course. Christianity of such a type is likely to be feeble and precarious. Perhaps we may find a third and better possibility by ceasing to aim at a scientific gnosis of God, either limited or unlimited. Perhaps what concerns the Christian is rather the assured revelation that God is acting in character, like Himself, and yet acting wonderfully by methods which we could not predict but must adore. The free life of personal beings is no more to be mastered by a formula than it is to be assigned to caprice. A God who is love will act neither from wilfulness nor from what is called rational but might more correctly be called physical necessity. He will act in and from character. Always wise, always holy, always unsearchable, the Christian's God is that heavenly Father who has His full image and revelation in Jesus Christ.

Modern divisions of theology. While the greatest of all theological systems, the *Summae* of the middle ages, include everything in the one treatise, it has been the business of post-Reformation learning to effect a formal improvement by distributing theological studies among a definite number of headings. The new theory lived and grew throughout the 18th-century Age of Enlightenment (*e.g.* J. S. Semler), linking Protestant scholasticism with modern thought, and exhibiting the continuity of science in spite of great revolutionary changes and great reactions. The beginning is ascribed to A. Hyperius (Gerhard of Yprès), a professor at Marburg, and, it seems, a conciliatory Lutheran, not, as sometimes said, a Reformed (1511–64). He published *Four Books on the Study of Theology* (1556). Book iv. is said to be the first appearance of Practical Theology—Liturgics, Pastoral Theology, &c. In virtue of another work (*De Formandis Concionibus*, 1553), Hyperius has been further termed the father of Homiletics. L. Danaeus (Daneau), a French Protestant, has the merit of publishing for the first time on *Christian Ethics* (1577). It has been supposed that the Reformed divinity here set itself to remedy the dogmatic dryness of Protestant scholasticism, fifty years before the Lutheran G. Calixtus moved in the matter (*Theol. Moralis*, 1634). Too much has been made of this. Danaeus hardly represents at all what moderns mean by Christian ethics. He does not contrast the Christian outlook upon ethics with all others, but dwells chiefly upon the super-eminence of the Ten Commandments as a summary of duty. Other distinctions are named after an interval of two centuries. J. T. Gabler, for the first time "with clearness" (R. Flint), wrote in 1787 *De Justo Discrimine Theologiae Biblicae et Dogmaticae.* Biblical Theology is a historical statement of the different Bible teachings, not a dogmatic statement of what the writer holds for truth, *qua* truth. Again, P. K. Marheineke is named as the first writer (1810) on Symbolics, the comparative study of creeds and confessions of faith. In 1764 the introductory study of theology as a whole, which Hyperius invented, had been given by S. Mursinna the name it has since usually borne—"Theological Encyclopaedia." Most of such Encyclopaedias have been "material," *i.e.* connected treatises, giving a brief outline of theology as a whole; not, of course, alphabetic indexes or dictionaries. The most famous of all, however—Schleiermacher's *Kurze Darstellung des theologischen Studiums* (1st ed. 1811)—belongs to the class of "formal" encyclopaedias. It states how theology should be divided, but does not profess to give a bird's-eye view of results.

Schleiermacher's treatise is highly individual. Theology is viewed as essentially a branch of church administration. True, in the theologian properly so called the scientific interest is strong; where the religious or practical interest is stronger, you get church rulers or administrators in a narrower sense. Still, even to the theologian the practical interest in church welfare is vital. Theology loses its savour when studied in a spirit of merely scientific curiosity; and it does not concern the lay Christian.

In spite of what may be deemed eccentric in this standpoint, Schleiermacher's summary is full of interest. He divides as follows:—I. Philosophical Theology: A. Apologetics; B. Polemics. II. Historical Theology: A. Exegetical—including the determination of the canon; B. Church History proper; C. The depicting of the present state of the Church; (1) its faith—Dogmatics; the belief of one branch of the Church; (2) its outward condition—Statistics; these should be universal. Symbolics is to be a branch of statistics. Biblical "Dogmatics" also is said to be nearer this than it is to Dogmatics proper. III. Practical Theology: A. the service of the (local) church; Homiletics, Liturgics, &c.; B. the *Government* of the (national or international) Church; questions of relation to the State, &c. The reader will note Schleiermacher's peculiar way of dealing with Dogmatic as the belief of the Church—an unprecedented view, according to A. Ritschl—and his requiring that belief to be reported *qua* historical fact.

It is singular that Schleiermacher on the whole sums up in the *Kurze Darstellung* against the separation of Christian Ethics from Dogmatics. But he grants that much may be said on both sides of that question, and in his own *Glaubenslehre* he follows ordinary usage and as far as possible banishes Ethics to a *Christliche Sittenlehre*, a book which has caused him to be regarded by Protestants as the founder of modern Christian Ethics. There are therefore three parallel studies, on all of which Schleiermacher published—Dogmatic or *Glaubenslehre*, Christian Ethics, Philosophical Ethics.

Curiously enough, it is from Schleiermacher's philosophical ethics that a threefold division—the Chief Good, Virtues, and Duty or the Law—passed into almost all text-books of Christian Ethics, till recently a rebellion rose against it on the ground of redundancy and overlapping. Books on Christian Ethics have also found room for a *quasi* Synoptic doctrine of the Kingdom of God, which Paulinized dogmatic systems were slow to admit. It should also be noted that Schleiermacher's place for Apologetics is by no means undisputed. Many dislike the subject; some would thrust it into practical theology. Again, the new study of the religions of the world is seeking its place in the curriculum of Christian theology, just as it is seeking—in some way—to modify Christian thought. The recognized place, the assured results, have not yet been attained

Further details must be sought in text-books. But it may be affirmed that Dogmatic must remain the vital centre; and so far we may soften Flint's censure of the British thoughtlessness which has called that study by the name "systematic theology." Systems of ethics and apologetics are welcome to the theologian; "encyclopaedia" is a new and broader-based "systematic theology" in itself; but none of these is central as Dogmatic is. One may also venture to declare that Dogmatic rests upon philosophical and historical studies, and exists for practical uses. Thus a triple or fourfold division of theological sciences seems natural. Lastly, it must be confessed that at the beginning of the 20th century there is more life or health in history than in philosophy, and much more in either than in dogmatic theology.

Some conclusions.

Sub-divisions of Dogmatic, whether well chosen or ill, throw light upon theology as developed in the past. The six usual Protestant headings are as follows: Theology proper, Anthropology, Christology (C. Hodge here inserts Hamartiology), Soteriology, Ecclesiology (omitted by C. Hodge), Eschatology. The Lombard's *Sentences* deal in bk. i. with God; bk. ii. the creatures; bk. iii. Incarnation, Redemption, Virtues; bk. iv. Sacraments and Last Things. Aquinas's *Summa* has no such clear lines of division.

The Church carried forward from the middle ages a tradition of "Moral Theology"[1] answering to Christian Ethics, alongside of Dogmatics or of all-inclusive *Summae.* Casuistry (with parallels in early Protestantism like Jeremy Taylor's *Ductor Dubitantium*), growing out of the Confessional, is characteristic of this Roman Catholic Ethic; yet the study is not restricted to the technical equipment of confessors. The Roman Catholic contributors to the volume on Christianity in *Die Kultur der Gegenwart* write on:—I. Dogmatic: A. Apologetic or General Dogmatic; B. Special Dogmatic or Dogmatic proper. II. Moral Theology. III. Practical Theology. The Protestant contributors, representing somewhat varied standpoints in German religion, follow much the same plan. Apologetic has no separate place with them; but the *system* of theology (in a sense midway between the dogmatists and the encyclopedists), is allotted between Dogmatics, Christian Ethics and Practical Theology.

LITERATURE.—A bibliography of theology cannot name every important book. The effort is made here (1) to mention writers of great originality and distinction, (2) writers of special importance to some one Christian confession, (3) without needless repetition of what has already been said, (4) dogmatic treatises being preferred but not to the exclusion of everything else.

Origen is great in scholarship as well as in system. Athanasius's *On the Incarnation of the Eternal Word* represents his central thoughts not less interestingly because it is earlier than the Arian controversy. Cyril of Jerusalem's *Catechetical Lectures* are a statement of doctrine for popular use, but arranged as a complete system. Gregory of Nyssa's *Great Catechesis* is an instruction to catechists how they should proceed—though of course stating the writer's theology and apologetic, with his belief in universal salvation. Theodoret has an outline of theology in the last book (v.) of his treatise *Against Heresies.* Theodore of Mopsuestia is a more suspected representative of the same scholarship—that of Antioch; John Chrysostom is the orator of the school. Cyril of Alexandria represents the later Alexandrian theology. With John of Damascus the progress of Greek divinity ends. A good modern statement is in Chr. Androntsos's Δογματική. In the West, Augustine is the chief agent in breaking new ground for theology. The *Enchiridion ad Laurentium* is a slight but interesting sketch of a system, while the *De Doctrina Christiana* is another lesson in the imparting of Christian instruction, as is also, naturally, the *De Catechizandis Rudibus.* The *City of God* and the *Confessions* are of unmatched importance in their several ways; and nothing of Augustine's was without influence. Gregory the Great's *Magna Moralia* should also be named.

In the middle ages Isidore (at its gateway), then Peter Lombard, then Aquinas (and his rivals), are pre-eminent for system, Anselm and Abelard for originality, Bernard of Clairvaux as the theologian who represents medieval piety at its purest and in its most characteristic forms, while Thomas à Kempis's devotional masterpiece, *On the Imitation of Christ*, with Tauler's *Sermons* and the *Theologia Germanica*, belong to the world's classics. All the Protestant reformers are of theological importance—Luther, Melanchthon and

[1] "Mystical Theology" is described in Addis and Arnold's *Catholic Dictionary* as a "branch" of Moral Theology.

Calvin, then Zwingli, then John Knox and others. The reply to Protestantism is represented by Cardinal Bellarmine, Petavius (less directly), Moehler.

Speculative theology was represented in the Roman Catholic Church of the 19th century by the Italian writers A. Rosmini, V. Gioberti, T. Mamiani della Rovere. Roman Catholic learning has always taken a high place (the Bollandists; the Benedictines; the huge collections of Migne). Of the Church's ample devotional literature St Francis of Sales and F. W. Faber are favourable specimens. A modern *Dogmatic* is by Syl. T. Hunter, S.J.

Anglican theology is little inclined to dogmatics. We have such unsystematic systems as Bishop Pearson's *Exposition* of the Apostles' Creed—a book of the golden age of great writers—or we have average 19th-century Church orthodoxy in Bishop H. Browne, *On the XXXIX. Articles*. Anglicanism prefers to philosophize institutions (R. Hooker, *Laws of Ecclesiastical Polity*), or states ancient learning (R. Cudworth; the Cambridge Platonists), or else polemical learning—Bishop Bull (against Petavius's innovating views of history), D. Waterland (against S. Clarke), S. Horsley (against J. Priestley), J. B. Lightfoot (very strong as an apologist in scholarship; not strong in pure thinking); the polemic becomes altogether conciliatory in those other glories of 19th-century Cambridge, B. F. Westcott and F. J. A. Hort. Or Anglican theology deals with historical points of detail, such as fill the *Journal of Theol. Studies*. In devotional literature Anglicanism has always been rich (*e.g.* Jeremy Taylor, Archbishop R. Leighton, L. Andrewes, W. Law, J. H. Newman). Bishop Butler stands by himself in lonely greatness.

English Puritanism lives in the affections of modern readers more than the Protestant schoolmen of the Continent do—Richard Baxter, John Owen, John Howe, Thos. Goodwin, John Goodwin (an early Arminian); for learning, John Lightfoot; for genius, John Milton; for literary and devotional power, John Bunyan—always admirable except when he talks Puritan dogma. Essential Puritanism is prolonged in the 19th century by R. W. Dale (*The Atonement; Christian Doctrine*). The Scottish leader, T. Chalmers (*Lectures on Divinity*), is more important as an orator or as a man than as a thinker. The somewhat earlier lectures of G. Hill are dry.

Arminianism is less fully worked out by Arminius than by later Dutch divines, of whom the "conciliatory" Limborch is sometimes used as a Methodist text-book. The theologian of English Methodism, apart from John Wesley himself, is Richard Watson. W. B. Pope's *Compendium* is a somewhat more modern version.

Jonathan Edwards, a very stern Calvinist, is one of the few first-rate geniuses America has to boast in theology. C. Hodge, A. A. Hodge, W. G. T. Shedd, published Calvinistic systems. Horace Bushnell had great influence.

While the production of systems of Dogmatic (and of Christian Ethics) never ceases in Germany, A. Ritschl was content to rely on his treatise upon *Justification and Reconciliation* (vol. i. History of the Doctrine; ii. Biblical material; iii. Positive construction—but much intermingled with history; good English translations of i. and iii.). His *Unterricht in der Christlichen Religion* is poor as a school-book but useful for reference. Something is to be learned regarding Ritschl himself from his very hostile *Hist. of Pietism*. The earlier *Entstehung der altkatholischen Kirche* (2nd ed. 1857) is a landmark in Apologetics and Church history. J. Kaftan's *Dogmatic* should be named, also the *Modern Positive Theology* of Th. Kaftan and others.

H. L. Martensen's *Dogmatics* restates substantial orthodoxy with fine literary taste. His *Christian Ethics*, though diffuse, is perhaps the finest piece of Protestant theology under that title. His friend, I. A. Dorner, had a powerful mind but an inferior gift of style.

The student of theology will do well to seek in the best histories of doctrine more detached treatment than Dogmatic can give. F. Loofs mentions W. Münscher, J. A. W. Neander, F. C. Baur, G. Thomasius, F. Nitzsch, A. Harnack, as showing steady advance. Add Loofs himself and R. Seeberg. Works in English by W. G. T. Shedd, G. P. Fisher, J. F. Bethune Baker. Church formularies in Winer (*Confessions of Christendom*), Schaff (*Creeds of Christendom*), F. Loofs (*Symbolik*). The *Symbolik* of J. A. Moehler is a very able anti-Protestant polemic.

A German reviewer has associated as English contributions to Dogmatics, A. M. Fairbairn's *Christ in Modern Theology*, A. B. Bruce's *Apologetics*, and the present writer's *Essay towards a New Theology*. Two American books represent modern evangelicalism—W. N. Clarke's very successful *Outline of Theology*, and W. A. Brown's *Christian Theology in Outline*. The High Church position is given in the *Manual* of T. B. Strong, Evangelical Anglicanism in H. G. C. Moule's *Outline*.

Encyclopaedia may be studied in J. F. Räbiger, translated with additions by J. Macpherson. J. Drummond (Unitarian) and A. Cave (Congregationalist) have written *Introductions to Theology*; Cave's bibliographies are not free from errors. American contributions in P. Schaff's *Propaedeutic* and J. F. Hurst's *Literature of Theology; a Classified Bibliography*. Recent German work by C. F. G. Heinrici; for older treatment see C. R. Hagenbach.

(R. Ma.)

THEON, AELIUS, Alexandrian sophist of uncertain date, author of a collection of preliminary exercises (*pro-gymnasmata*) for the training of orators. The work (extant, though incomplete), which probably formed an appendix to a manual of rhetoric, shows learning and taste, and contains valuable notices on the style and speeches of the masters of Attic oratory. Theon also wrote commentaries on Xenophon, Isocrates and Demosthenes, and treatises on style. He is to be distinguished from the Stoic Theon, who lived in the time of Augustus and also wrote on rhetoric (Quintilian, *Inst. Orat.* ix. 3, 77).

THEON, of Samos, Greek painter of the age of Alexander the Great, is mentioned by Quintilian as a good artist of the second rank. If we may trust the somewhat flimsy stories told about him, his forte consisted in a lifelike, or perhaps, as Brunn (*Künstlergeschichte*, ii. 253) puts it, a theatrical representation of action. His figures were said to start out of the picture. He chose such congenial subjects as the madness of Orestes, and a soldier rushing to battle. Another painter, Theorus, is mentioned, whom Brunn regards as identical with Theon.

THEOPHANES, surnamed "the Confessor" (*c.* A.D. 758–817), Greek ascetic, chronicler and saint, belonged to a noble and wealthy family, and held several offices under Constantine V. Copronymus (741–775). He subsequently retired from the world and founded a monastery (τοῦ Μεγάλου Ἀγροῦ) near Sigriane.[1] He was a strong supporter of the worship of images, and in 815 was summoned to Constantinople by Leo the Armenian, who formally ordered him to renounce his principles. Theophanes refused, and, after two years' imprisonment, was banished to the island of Samothrace, where he died. He subsequently received the honours of canonization. At the request of his dying friend, George the Syncellus (*q.v.*), Theophanes undertook to continue his *Chronicle*, which he carried on from the accession of Diocletian to the downfall of Michael I. Rhangabes (284–813). The work, although wanting in critical insight and chronological accuracy, is of great value as supplying the accounts of lost authorities. The language occupies a place midway between the stiff ecclesiastical and the vulgar Greek. In chronology, in addition to reckoning by the years of the world and the Christian era, Theophanes introduces in tabular form the regnal years of the Roman emperors, of the Persian kings and Arab caliphs, and of the five oecumenical patriarchs, a system which leads to considerable confusion. The *Chronicle* was much used by succeeding chroniclers, and in 873–875 a compilation in barbarous Latin (in vol. ii. of De Boor's edition) was made by the papal librarian Anastasius from Nicephorus, George the Syncellus, and Theophanes for the use of a deacon named Johannes. The translation (or rather paraphrase) of Theophanes really begins with the reign of Justin II. (565), the excerpts from the earlier portion being scanty. At that time there were very few good Greek scholars in the West, and Anastasius shows himself no exception.

There is also extant a further continuation, in six books, of the *Chronicle* down to the year 961 by a number of mostly anonymous writers (called Οἱ μετὰ Θεοφάνην, Scriptores post Theophanem), who undertook the work by the instructions of Constantine Porphyrogenitus.

Editions of the *Chronicle:—Editio princeps*, J. Goar (1655); J. P. Migne, *Patrologia Graeca*, cviii.; J. Classen in Bonn *Corpus Scriptorum Hist. Byzantinae* (1839–41); and C. de Boor (1883–85), with an exhaustive treatise on the MS. and an elaborate index; see also the monograph by J. Pargoire, "Saint Théophane le Chronographe et ses rapports avec saint Théodore studite," in Βυζαντινὰ Χρονικά, ix. (St Petersburg, 1902).

Editions of the *Continuation* in J. P. Migne, *Patr. Gr.*, cix., and by I. Bekker, Bonn *Corpus Scriptorum Hist. Byz.* (1838); on both works and Theophanes generally, see C. Krumbacher, *Geschichte der byzantinischen Litteratur* (1897); *Ein Dithyrambus auf Theophanes Confessor* (a panegyric on Theophanes by a certain *protoasecretis*, or chief secretary, under Constantine Porphyrogenitus) and *Eine neue Vita des Theophanes Confessor* (anonymous), both edited by the same writer in *Sitzungsberichte der philos.-philol. und*

[1] Near the village of Kurshunla, on the Sea of Marmora, between the site of the ancient Cyzicus and the mouth of the Rhyndacus, ruins of the monastery may still be seen; on the whole question see J. Pargoire's monograph, section 6 (see Bibliography).

der hist. Cl. der k. bayer. Akad. der Wissenschaften (1896, pp. 583–625; and 1897, pp. 371–399); Gibbon's *Decline and Fall* (ed. Bury), v. p. 500.

THEOPHANO (*c.* 956–991), wife of the Roman emperor Otto II., was a daughter of the Eastern emperor Romanus II., and passed her early years amid the tragic and changing fortunes which beset the court of Constantinople. Otto the Great having procured her betrothal to his son Otto II., she was married to him and crowned empress at Rome by Pope John XIII. on the 14th of April 972. In return for costly gifts brought by her to her husband, she was granted extensive estates in all parts of the empire. She appears to have been a woman of great beauty and considerable intelligence, and after the death of Otto the Great in 973 gradually superseded his widow Adelaide as the chief adviser of the new emperor, whom she accompanied on several military expeditions. She introduced many Byzantine customs into the German court. After the death of Otto in December 983 she returned to Germany, which she governed with conspicuous success in the name of her son, Otto III. In 989 she visited Rome, where she exercised as *imperatrix* the imperial prerogatives, and probably compelled the Romans to swear to acknowledge her son. Theophano died at Nimwegen on the 15th of June 991, and was buried in the church of St Pantaléon at Cologne.

See J. Moltmann, *Theophano, die Gemahlin Ottos II. in ihrer Bedeutung für die Politik Ottos I. und Ottos II.* (Göttingen, 1878).

THÉOPHILE, the name by which Théophile de Viau (or Viaud), French poet (1591–1626), is more commonly called. He was born in 1591, at Clairac, near Agen, and spent his early years at Boussères de Mazères, his father's property. He was educated at the Protestant college of Saumur, and he went to Paris in his twentieth year. In 1612 he met Balzac, with whom he made an expedition to the Netherlands, which ended in a serious quarrel. On his return he seems to have been for two years a regular playwright to the actors at the Hôtel de Bourgogne. In 1615 he attached himself to the ill-fated Henry, duke of Montmorency (1595–1632), under whose protection he produced with success the tragedy of *Pyrame et Thisbé*, acted probably about 1617 and printed in 1623, although placed later by some critics. This piece, written in the extravagant Spanish-Italian manner, which was fashionable in the interval between the Pléiade model and the innovations of Corneille, was ridiculed by Boileau (Preface to his *Œuvres*, 1701). Théophile was the acknowledged leader of a set of Parisian libertines, whose excesses seem to have been chiefly dictated by a general hatred of restraint. He himself was not only a Huguenot, but a free-thinker, and had made unsparing use of his sharp wit in epigrams on the Church and on the government. In 1619 he was accused of blasphemous and indecent writings, and was banished from Paris. He took refuge in the south of France, where he found protection with many friends. He was allowed to return in the next year, and effected a partial reconciliation with one of his most powerful enemies, the duc de Luynes. He served in that year in the campaign against the Huguenots, but in the autumn was again in exile, this time in England. He was recalled in 1621, and began to be instructed in the Roman Catholic religion, though his abjuration of Protestantism was deferred until the end of 1622. There is nothing to show that this conversion was purely political; in any case it did little to mollify his enemies. In 1622 he had contributed four pieces to the *Nouveau Parnasse Satirique*, a miscellany of verse by many hands. In the next year a new edition appeared, with the addition of some licentious verse, and the inscription *par le sieur Théophile* on the title-page. Contemporary opinion justified Théophile's denial of this ascription, but the Jesuit father, François Garasse, published a tract against him entitled *La Doctrine curieuse* (1623). Théophile was again prosecuted. This time he fled from Paris, to the court of Montmorency, and was condemned in his absence (19th of August 1623) to death. On his flight to the border he was arrested, and imprisoned in the Conciergerie in Paris. He defended himself in an *Apologie au roi* (1625), and was liberated in September, his sentence being commuted to banishment for life. Under Montmorency's protection he was able to hide in Paris for some time, and he subsequently accompanied his friend and patron to the south. He died in Paris on the 25th of September 1626.

The great interest aroused by the prosecution and defence of Théophile is shown by the number of pamphlets on the subject, forty-two of which, written between the dates 1622 and 1626, are preserved in the Bibliothèque Nationale in Paris.

Les Œuvres du Sieur Théophile were printed in Paris in 1621, and other collections followed during his lifetime. Six years after his death Georges de Scudéry edited his work with a *Tombeau* (copy of obituary verses), and a challenge in the preface to any one who might be offended by the editor's eulogy of the poet. A tragedy entitled *Pasiphae*, published in 1631, is probably not Théophile's, and is not included in his works, the standard modern edition of which is that of Alleaume in the *Bibliothèque Elzévirienne* (2 vols. 1856). Besides *Pyrame et Thisbé*, his works include a paraphrase, half verse, half prose, of the *Phaedo*. There are numerous French and Latin letters, his *Apologie*, a promising fragment of comic prose narrative, and a large collection of occasional verses, odes, elegies, stanzas, &c.

In addition to Alleaume's edition, a delightful article in Théophile Gautier's *Grotesques* should be consulted respecting him. A full account of the extensive literature dealing with Théophile is given by Dr K. Schirmacher in a study on *Théophile de Viau* (Leipzig and Paris, 1897). In the *Page disgracié* of Tristan l'Hermite, the page makes the acquaintance of a dramatic author, and his description may be accepted as a contemporary portrait of Théophile's vigorous personality.

THEOPHILUS, East Roman emperor (829–842), the second of the "Phrygian" dynasty. Unlike his father Michael II., he declared himself a pronounced iconoclast. In 832 he issued an edict strictly forbidding the worship of images; but the stories of his cruel treatment of recalcitrants are probably exaggerated. At the time of his accession, the Sicilians were still engaged in hostilities with the Saracens, but Theophilus was obliged to devote all his energies to the war against the caliphs of Bagdad (see CALIPHATE, especially sect. C., § 8). This war was caused by Theophilus, who afforded an asylum to a number of Persian refugees, one of whom, called Theophobus after his conversion to Christianity, married the emperor's sister Helena, and became one of his generals. The Roman arms were at first successful; in 837 Samosata and Zapetra (Zibatra, Sozopetra), the birthplace of Motasim, were taken and destroyed. Eager for revenge, Motasim assembled a vast army, one division of which defeated Theophilus, who commanded in person, at Dasymon, while the other advanced against Amorium, the cradle of the Phrygian dynasty. After a brave resistance of fifty-five days, the city fell into Motasim's hands through treachery (23rd of September 838). Thirty thousand of the inhabitants were slain, the rest sold as slaves, and the city razed to the ground. Theophilus never recovered from the blow, his health gradually failed, and he died at the beginning of 842. His character has been the subject of considerable discussion, some regarding him as one of the ablest of the Byzantine emperors, others as an ordinary oriental despot, an overrated and insignificant ruler. There is no doubt that he did his best to check corruption and oppression on the part of his officials, and administered justice with strict impartiality, although his punishments did not always fit the crime. In spite of the drain of the war in Asia and the large sums spent by Theophilus on building, commerce, industry, and the finances of the empire were in a most flourishing condition, the credit of which was in great measure due to the highly efficient administration of the department. Theophilus, who had received an excellent education from John Hylilas, the grammarian, was a great admirer of music and a lover of art, although his taste was not of the highest. He strengthened the walls of Constantinople, and built a hospital, which continued in existence till the latest times of the Byzantine Empire.

See Zonaras, xv. 25–29; Cedrenus, pp. 513–533; Theophanes continuatus, iii.; Gibbon, *Decline and Fall*, chaps. 48 and 52; F. G. Schlosser, *Geschichte der bilderstürmenden Kaiser* (1812); G. Finlay, *History of Greece*, ii. (1877) p. 142; G. F. Hertzberg, *Geschichte der Byzantiner und des osmanischen Reiches*, bk. i. (Berlin, 1883); H. Gelzer, "Abriss der byzantinischen Kaisergeschichte" in C. Krumbacher's *Geschichte der byzantinischen Litteratur* (2nd ed.

1897); and authorities under ROMAN EMPIRE, LATER. On the early campaigns against the Arabs see J. B. Bury, in *Journ. Hell. Stud.* xxix., 1909, pt. i.

THEOPHRASTUS, the successor of Aristotle in the Peripatetic school, a native of Eresus in Lesbos, was born *c.* 372 B.C. His original name was Tyrtamus, but he later became known by the nickname "Theophrastus," given to him, it is said, by Aristotle to indicate the grace of his conversation. After receiving his first introduction to philosophy in Lesbos from one Leucippus or Alcippus, he proceeded to Athens, and became a member of the Platonic circle. After Plato's death he attached himself to Aristotle, and in all probability accompanied him to Stagira. The intimate friendship of Theophrastus with Callisthenes, the fellow-pupil of Alexander the Great, the mention made in his will of an estate belonging to him at Stagira, and the repeated notices of the town and its museum in the *History of Plants*, are facts which point to this conclusion. Aristotle in his will made him guardian of his children, bequeathed to him his library and the originals of his works, and designated him as his successor at the Lyceum on his own removal to Chalcis. Eudemus of Rhodes also had some claims to this position, and Aristoxenus is said to have resented Aristotle's choice. Theophrastus presided over the Peripatetic school for thirty-five years, and died in 287 B.C. Under his guidance the school flourished greatly—there were at one period more than 2000 students—and at his death he bequeathed to it his garden with house and colonnades as a permanent seat of instruction. Menander was among his pupils. His popularity was shown in the regard paid to him by Philip, Cassander and Ptolemy, and by the complete failure of a charge of impiety brought against him. He was honoured with a public funeral, and "the whole population of Athens, honouring him greatly, followed him to the grave" (Diog. Laërt.).

From the lists of the ancients it appears that the activity of Theophrastus extended over the whole field of contemporary knowledge. His writing probably differed little from the Aristotelian treatment of the same themes, though supplementary in details (see PERIPATETICS). He served his age mainly as a great popularizer of science. The most important of his books are two large botanical treatises, *On the History of Plants*, in nine books (originally ten), and *On the Causes of Plants*, in six books (originally eight), which constitute the most important contribution to botanical science during antiquity and the middle ages. We also possess in fragments a *History of Physics*, a treatise *On Stones*, and a work *On Sensation*, and certain metaphysical Ἀπορίαι, which probably once formed part of a systematic treatise. Various smaller scientific fragments have been collected in the editions of J. G. Schneider (1818–21) and F. Wimmer (1842–62) and in Usener's *Analecta Theophrastea*.

The *Ethical Characters* (Ἠθικοὶ χαρακτῆρες) deserves a separate mention. The work consists of brief, vigorous and trenchant delineations of moral types, which contain a most valuable picture of the life of his time. They form the first recorded attempt at systematic character writing. The book has been regarded by some as an independent work; others incline to the view that the sketches were written from time to time by Theophrastus, and collected and edited after his death; others, again, regard the *Characters* as part of a larger systematic work, but the style of the book is against this. Theophrastus has found many imitators in this kind of writing, notably Hall (1608), Sir Thomas Overbury (1614–16), Bishop Earle (1628) and La Bruyère (1688), who also translated the *Characters*.

BIBLIOGRAPHY.—A good account of Theophrastus is found in Zeller, *Aristotle and the Earlier Peripatetics* (Eng. trans. by B. F. C. Costelloe and J. H. Muirhead, vol. ii., chap. 18, 1897). For his astronomical work see ASTRONOMY (Historical Section), and for the botanical works, see Dr J. Berendes, *Die Pharmacie bei den alten Culturvölken* (vol. i., 1891). The *Ethical Characters* was edited by Casaubon in 1592 and translated by La Bruyère (1688–89); the best modern translation (with introduction and notes) is that of Sir R. C. Jebb (1870; new ed. J. E. Sandys, 1909); recent editions are that of J. M. Edmonds and G. E. V. Austen (1904), containing text, notes and illustrations (intended for schools), and that of C. E. Bennett and W. A. Hammond (1902), a translation, with an introduction. The work has been translated into nearly all European languages (see Baldwin's *Dict. of Philos. and Psych.*, vol. iii. pt. i.). (E. WH.)

THEOPHYLACT (d. *c.* 1110), biblical commentator, was born most probably at Euripus, in Euboea, about the middle of the 11th century. He became a deacon at Constantinople, attained a high reputation as a scholar, and became the tutor of Constantine Porphyrogenitus, son of the Emperor Michael VII., for whom he wrote *The Education of Princes* (Παιδεία βασιλική). About 1078 he went into Bulgaria as archbishop of Achrida. In his letters he complains much of the rude manners of the Bulgarians, and he sought to be relieved of his office, but apparently without success. His death took place after 1107.

His commentaries on the Gospels, Acts, the Pauline epistles and the Minor Prophets are founded on those of Chrysostom, but deserve the considerable place they hold in exegetical literature for their appositeness, sobriety, accuracy and judiciousness. His other extant works include 130 letters and various homilies and orations and other minor pieces. A careful edition of nearly all his writings, in Greek and Latin, with a preliminary dissertation, was published in 1754–63 by J. F. B. M. de Rossi (4 vols. fol., Venice).

See Krumbacher, *Byzantinische Litteraturgeschichte* (2nd ed. 1897), pp. 132, 463.

THEOPOMPUS (b. *c.* 380), Greek historian and rhetorician, was born at Chios about 380 B.C. In early youth he seems to have spent some time at Athens, along with his father, who had been exiled on accouut of his Laconian sympathies. Here he became a pupil of Isocrates, and rapidly made great progress in rhetoric; we are told that Isocrates used to say that Ephorus required the spur but Theopompus the bit (Cicero, *Brutus*, 204). At first he appears to have composed epideictic speeches, in which he attained to such proficiency that in 352–351 he gained the prize of oratory given by Artemisia (*q.v.*) in honour of her husband, although Isocrates was himself among the competitors. It is said to have been the advice of his teacher that finally determined his career as an historian—a career for which he was peculiarly qualified owing to his abundant patrimony and his wide knowledge of men and places. Through the influence of Alexander, he was restored to Chios about 333, and figured for some time as one of the leaders of the aristocratic party in his native town. After Alexander's death he was again expelled, and took refuge with Ptolemy in Egypt, where he appears to have met with a somewhat cold reception. The date of his death is unknown.

The works of Theopompus were chiefly historical, and are much quoted by later writers. They included an *Epitome of Herodotus's History* (the genuineness of which is doubted), the *Hellenics* (Ἑλληνικά, Ἑλληνικαὶ ἱστορίαι), the *History of Philip* (Φιλιππικά), and several panegyrics and hortatory addresses, the chief of which was the *Letter to Alexander*. The *Hellenics* treated of the history of Greece, in twelve books, from 411 (where Thucydides breaks off) to 394—the date of the battle of Cnidus (cf. Diod. Sic., xiii. 42, with xiv. 84). Of this work only a few fragments were known up till 1907. The papyrus fragment of a Greek historian of the 4th century B.C., discovered by B. P. Grenfell and A. S. Hunt, and published by them in *Oxyrhynchus Papyri*, vol. v. (1908), has been recognized by Ed. Meyer, U. von Wilamowitz-Moellendorff and G. Busolt as a portion of the *Hellenics*. This identification has been disputed, however, by F. Blass, J. B. Bury, E. M. Walker and others, most of whom attribute the fragment, which deals with the events of the year 395 B.C. and is of considerable extent, to Cratippus (*q.v.*). A far more elaborate work was the Φιλιππικά in 58 books. In this Theopompus narrated the history of Philip's reign (360–336), with digressions on the names and customs of the various races and countries of which he had occasion to speak, which were so numerous that Philip V. of Macedon reduced the bulk of the history from 58 to 16 books by cutting out those parts which had no connexion with Macedonia. It was from this history that Trogus Pompeius (of whose *Historiae Philippicae* we possess the epitome by Justin) derived much of his material. Fifty-three books were extant in the time of Photius (9th century), who read them, and has left us an epitome of the 12th book. Several fragments, chiefly anecdotes and strictures of various kinds upon the character of nations and individuals, are preserved by Athenaeus, Plutarch and others. Of the *Letter to Alexander* we possess one or two fragments cited by Athenaeus, animadverting severely upon the immorality and dissipations of Harpalus. The *Attack upon Plato*, and the treatise *On Piety*, which are sometimes referred to as separate works, were perhaps only two of the many digressions in the history of Philip; some writers have doubted their authenticity. The libellous attack (Τρικάρανος, the "three-headed") on the three cities—Athens, Sparta and Thebes—was published under the name of Theopompus by his enemy Anaximenes of Lampsacus. The nature of the extant fragments fully bears out the divergent criticisms of antiquity upon Theopompus. Their style is clear and pure, full of choice and pointed expressions, but lacking in weight and dignity. The artistic unity of his work suffered severely from the frequent and lengthy digressions already referred to. The most important was that *On the Athenian Demagogues* in the 10th book of the *Philippica*, containing a bitter attack on many of the chief Athenian statesmen, and generally recognized as having been freely used by Plutarch in several of the *Lives*. Another fault of Theopompus was his excessive fondness for romantic and incredible stories; a collection of some of these (Θαυμάσια) was afterwards made and published under his name. He was also severely blamed in antiquity for his censoriousness, and throughout his fragments no feature is more striking than this. On the whole, however, he appears to have been fairly impartial. Philip himself he censures severely for drunkenness and immorality, while Demosthenes receives his warm praise.

Bibliography.—Fragments in C. Müller, *Frag. Hist. Graec.*, i.; monograph by A. J. Pflugk (1827), and a good account in W. Mure, *Language and Literature of Ancient Greece*, v. pp. 509–529. See also Greece: *Ancient History*, § Authorities. A complete edition of the fragments of Theopompus and of Cratippus has been published by the Clarendon Press, Oxford (1909), containing the fragment of the new historian. For a discussion of the authorship of this fragment see *Oxyrhynchus Papyri* (1908), vol. v. pp. 110–242; G. Busolt, *Hermes* (1908), pp. 255–285 (*Der Neue Historiker und Xenophon*); E. M. Walker, *Klio* (1908) ("Cratippus or Theopompus"); W. A. Goligher, *English Historical Review*, vol. xxiii. pp. 277–282 ("The New Greek Historical Fragment"); A. von Mess, *Rheinisches Museum* (1908), pp. 370–391 ("Die Hellenica von Oxyrhynchos"). (E. M. W.)

THEORBO [Fr. *théorbe*, Ger. *Theorba*, Ital. *theorba*, Barbitone], the large double-necked bass lute much used during the 16th and 17th centuries as general bass in the orchestra. The body of the theorbo was constructed on the same principles as that of the lute but larger, and the same scheme of decoration was followed. The neck, instead of being bent back at an angle to form the head, was straight, having sufficient pegs set in the sides of the head for from 12 to 16 strings tuned in pairs of unisons; on the fingerboards were marked 8 or more frets for semitones. Above this neck was another without frets, curving forwards and slightly to one side to enable the long bass strings, stretched not over but at the side of the neck, to escape the pegs of the shorter strings. These free strings, known as diapason strings (Ger. *Begleitseiten*) were plucked *à vide* like those of the lyre, each giving but one note; the number of these strings varied from 8 to 11.

The theorbo was made in two sizes, the ordinary instrument measuring about 3 ft. 6 in., and the Paduan, also known as archlute, about 5 ft. The chitarrone, or Roman theorbo, was the largest of all, a contrabass lute in fact, and frequently stood over 6 ft. high. It differed slightly from the theorbo; the body was a little smaller than in the Paduan variety, the whole of the extra length being in the second neck. The strings over the fingerboard were of steel or brass, and the diapason strings of spun wire.

For the history of the theorbo, see Barbiton and Lute.

THEOSOPHY (from Gr. θεός, god, and σοφία, wisdom), a term used to denote those forms of philosophic and religious thought which claim a special insight into the Divine nature and its constitutive moments or processes. Sometimes this insight is claimed as the result of the operation of some higher faculty or some supernatural revelation to the individual; in other instances the theosophical theory is not based upon any special illumination, but is simply put forward as the deepest speculative wisdom of its author. But in any case it is characteristic of theosophy that it starts with an explication of the Divine essence, and endeavours to deduce the phenomenal universe from the play of forces within the Divine nature itself.

General Theory.—Theosophy is thus differentiated at once from all philosophic systems which attempt to rise from an analysis of phenomena to a knowledge, more or less adequate, of the existence and nature of God. In all such systems, God is the *terminus ad quem*, a direct knowledge of whom is not claimed, but who is, as it were, the hypothesis adopted, with varying degrees of certainty in different thinkers, for the explanation of the facts before them. The theosophist, on the other hand, is most at his ease when moving within the circle of the Divine essence, into which he seems to claim absolute insight. This, however, would be insufficient to distinguish theosophy from those systems of philosophy which are sometimes called "speculative" and "absolute," and which also in many cases proceed deductively from the idea of God.

In a wide sense, the system of Hegel or the system of Spinoza may be cited as examples of what is meant. Both thinkers claim to exhibit the universe as the evolution of the Divine nature. They must believe, therefore, that they have grasped the inmost principles of that nature: so much is involved, indeed, in the construction of an absolute system. But it is to be noted that, though there is much talk of God in such systems, the known universe—the world that now is—is nowhere transcended; God is really no more than the principle of unity immanent in the whole. Hence, while the accusation of pantheism is frequently brought against these thinkers, the term theosophical is never used in their regard. A theosophical system may also be pantheistic, in tendency if not in intention; but the transcendent character of its Godhead definitely distinguishes it from the speculative philosophies which might otherwise seem to fall under the same definition. God is regarded as the transcendent source of being and purity, from which the individual in his natural state is alienated and afar off. An historical survey shows, indeed, that theosophy generally arises in connexion with religious needs, and is the expression of religious convictions or aspirations. Accepting the testimony of religion that the present world lies in wickedness and imperfection, theosophy faces the problem of speculatively accounting for this state of things from the nature of the Godhead itself. It is thus in some sort a mystical philosophy of the existence of evil; or at least it assumes this form in some of its most typical representatives.

The term Mysticism (*q.v.*) has properly a practical rather than a speculative reference; but it is currently applied so as to include the systems of thought on which practical mysticism was based. Thus, to take only one prominent example, the profound speculations of Meister Eckhart (*q.v.*) are always treated under the head of Mysticism, but they might with equal right appear under the rubric Theosophy. In other words, while an emotional and practical mysticism may exist without attempting philosophically to explain itself, speculative mysticism is almost another name for theosophy. There is still a certain difference observable, however, in so far as the speculative mystic remains primarily concerned with the theory of the soul's relation to God, while the theosophist gives his thoughts a wider scope, and frequently devotes himself to the elaboration of a fantastic philosophy of nature.

In the above acceptation of the term, the Neoplatonic doctrine of emanations from the supra-essential One, the fanciful emanation-doctrine of some of the Gnostics (the aeons of the Valentinian system might be mentioned), and the elaborate esoteric system of the Kabbalah, to which the two former in all probability largely contributed, are generally included under the head of theosophy. In the two latter instances there may be noted the allegorical interpretation of traditional doctrines and sacred writings which is a common characteristic of theosophical writers. Still more typical examples of theosophy are furnished by the mystical system of Meister Eckhart and the doctrine of Jacob Boehme (*q.v.*), who is known as "the theosophist" *par excellence*. Eckhart's doctrine asserts behind God a predicateless Godhead, which, though unknowable not only to man but also to itself, is, as it were, the essence or potentiality of all things. From it proceed, and in it, as their nature, exist, the three persons of the Trinity, conceived as stadia of an eternal self-revealing process. The eternal generation of the Son is equivalent to the eternal creation of the world. But the sensuous and phenomenal, as such, so far as they seem to imply independence of God, are mere privation and nothingness; things exist only through the presence of God in them, and the goal of creation, like its outset, is the repose of the Godhead. The soul of man, which as a microcosmos resumes the nature of things, strives by self-abnegation or self-annihilation to attain this unspeakable reunion (which Eckhart calls being buried in God). Regarding evil simply as privation, Eckhart does not make it the pivot of his thought, as was afterwards done by Boehme; but his notion of the Godhead as a dark and formless essence is a favourite thesis of theosophy.

Besides mystical theology, Boehme was indebted to the writings of Paracelsus. This circumstance is not accidental, but points to an affinity in thought. The nature-philosophers of the Renaissance, such as Nicolaus Cusanus, Paracelsus, Cardan and others, curiously blend scientific ideas with speculative notions derived from scholastic theology, from Neoplatonism and even from the Kabbalah. Hence it is customary to speak of their theories as a mixture of theosophy and physics, or theosophy and chemistry, as the case may be. Boehme offers us a natural philosophy of the same sort. As Boehme is the typical theosophist, and as modern theosophy has nourished itself almost in every case upon the study of his works, his dominating conceptions supply us with the best illustration of the general trend of this mode of thought. His speculation turns, as has been said, upon the necessity of reconciling the existence and the might of evil with the existence of an all-embracing and all-powerful God, without falling into Manichaeanism on the one hand, or, on the other, into a naturalistic pantheism that denies the reality of the distinction between good and evil. He faces the difficulty boldly, and the eternal conflict between the two may be said to furnish him with the principle of his philosophy. It is in this connexion that he insists on the necessity of the Nay to the Yea, of the negative to the positive. Eckhart's Godhead appears in Boehme as the abyss, the eternal nothing, the essenceless quiet ("Ungrund" and "Stille ohne Wesen" are two of Boehme's phrases). But, if this were all, the Divine Being would remain an abyss dark even to itself. In God, however, as the condition of His manifestation, lies, according to Boehme, the "eternal nature" or the *mysterium magnum*, which is as anger to love, as darkness to light, and, in general, as the negative to the positive. This principle (which Boehme often calls the evil in God) illuminates both sides of the antithesis, and thus contains the possibility of their real existence. By the "Qual" or torture, as it were, of this diremption, the universe has qualitative existence, and is knowable. Even the three persons of the Trinity, though existing *idealiter* beforehand, attain reality only through this principle of nature in God, which is hence spoken of as their *matrix*. It forms also the matter, as it were, out of which the world is created; without the dark and fiery principle, we are told, there would be no creature. Hence God is sometimes spoken of as the father, and the eternal nature as the mother, of things. Creation (which is conceived as an eternal process) begins with the creation of the angels. The subsequent fall of Lucifer is explained as his surrender of himself to the principle of nature, instead of dwelling in the heart of God. He sought to make anger predominate over love; and he had his will, becoming prince of hell, the kingdom of God's anger, which still remains, however, an integral part of the Divine universe. It is useless to follow Boehme further, for his cosmogony is disfigured by a wild Paracelsian symbolism, and his constructive efforts in general are full of the uncouth straining of an untrained writer. In spite of these defects, his speculations have exercised a remarkable influence.

Schelling's *Philosophical Inquiries into the Nature of Human Freedom* (1809) is almost entirely a reproduction of Boehme's ideas, and forms, along with Baader's writings, the best modern example of theosophical speculation. In his philosophy of identity Schelling (*q.v.*) had already defined the Absolute as pure indifference, or the identity of subject and object, but without advancing further into theogony. He now proceeded to distinguish three moments in God, the first of which is the pure indifference which, in a sense, precedes all existence—the primal basis or abyss, as he calls it, in agreement with Boehme. But, as there is nothing before or besides God, God must have the ground or cause of His existence in Himself. This is the second moment, called nature in God, distinguishable from God, but inseparable from Him. It is that in God which is not God Himself, it is the yearning of the eternal One to give birth to itself. This yearning is a dumb unintelligent longing, which moves like a heaving sea in obedience to some dark and indefinite law, and is powerless to fashion anything in permanence. But in correspondence to the first stirring of the Divine existence there awakes in God Himself an inner reflective perception, by means of which—since no object is possible for it but God—God beholds Himself in His own image. In this, God is for the first time as it were realized, although as yet only within Himself. This perception combines, as understanding, with the primal yearning, which becomes thereby free creative will, and works formatively in the originally lawless nature or ground. In this wise is created the world as we know it. In every natural existence there are, therefore, two principles to be distinguished—first, the dark principle, through which this is separated from God, and exists, as it were, in the mere ground; and, secondly, the Divine principle of understanding. The first is the particular will of the creature, the second is the universal will. In irrational creatures the particular will or greed of the individual is controlled by external forces, and thus used as an instrument of the universal. But in man the two principles are consciously present together, not, however, in inseparable union, as they are in God, but with the possibility of separation. This possibility of separation is the possibility of good and evil. In Boehme's spirit, Schelling defended his idea of God as the only way of vindicating for God the consciousness which naturalism denies, and which ordinary theism emptily asserts. This theosophical transformation of Schelling's doctrine was largely due to the influence of his contemporary Baader (*q.v.*). Baader distinguishes, in a manner which may be paralleled from Boehme, between an immanent or esoteric process of self-production in God, through which He issues from His unrevealed state, and the emanent, exoteric or real process, in which God overcomes and takes up into Himself the eternal "nature" or the principle of selfhood, and appears as a Trinity of persons. The creation of the world is still further to be distinguished from these two processes as an act of freedom or will; it cannot, therefore, be speculatively constructed, but must be historically accepted. Baader, who combined his theosophy with the doctrines of Roman Catholicism, has had many followers. Among thinkers on the same lines, but more or less independent, Molitor is perhaps the most important. Swedenborg (*q.v.*) is usually reckoned among the theosophists, and some parts of his theory justify this inclusion; but his system as a whole has little in common with those speculative constructions of the Divine nature which form the essence of theosophy, as strictly understood.

Besides the books mentioned under MYSTICISM, and those referred to under individual authors, Baur's *Die christliche Gnosis in ihrer geschichtlichen Entwicklung* (1835) and Hamberger, *Stimmen aus dem Heiligthum der christlichen Mystik und Theosophie* (1857), may be mentioned. (A. S. P.-P.)

ORIENTAL THEOSOPHY

The term "theosophy" has in recent years obtained a somewhat wide currency in a restricted signification as denominating the beliefs and teachings of the Theosophical Society. This society was founded in the United States of America in the year 1875 by Madame H. P. Blavatsky (*q.v.*), in connexion with Colonel H. S. Olcott (d. 1906) and others. The main objects of the society were thus set out: (1) To establish a nucleus of the universal brotherhood of humanity; (2) to promote the study of comparative religion and philosophy; (3) to make a systematic investigation into the mystic potencies of life and matter, or what is usually termed "occultism." As regards the first object the mere fact of joining the society and becoming an "initiated fellow" was supposed to involve a certain kind of intellectual and social brotherhood, though not implying anything in the nature of an economic union. This latter aspect of the fraternity was to be satisfied by the contribution from each fellow of five dollars by way of initiation fee. The society's theory of universal brotherhood was, however, of far wider scope, being based upon a mystical conception of "the One Life"—an idea derived from and common to various forms of Eastern thought, Vedic and Buddhist. It implies the necessary interdependence of all that is—that ultimate *Oneness* which underlies and sustains all phenomenal diversity, whether inwardly or outwardly, whether individual or universal. The theosophical conception of brotherhood is thus rather transcendental than materialistic, and is not therefore to be regarded as the exact equivalent of the socialistic doctrine of the solidarity of the human race.

The second object of the society, the study of comparative religion and philosophy, soon crystallized into an exposition of a more or less definite system of dogmatic teaching. The leading thesis seems to have been that all the great religions of the world originated from the same supreme source, and that they were all to be regarded as so many divers expressions of one and the same fundamental truth, or "Wisdom Religion," in such form and dress as was best adapted to suit the times and the people for whose spiritual growth and development religious instruction was required. Now, in order to discern this underlying truth in the various and apparently conflicting world creeds, appeal was made to a "Secret Doctrine," and "Esoteric Teaching," which Madame Blavatsky proclaimed had been held for ages as a sacred possession and trust by certain mysterious adepts in occultism, or "Mahâtmâs," with whom she said she was in *psychical* as well as in direct physical communication. It is here that the theosophical movement showed its most serious shortcomings. From time to time Madame Blavatsky's numerous friends and associates were allowed to witness the manifestations of "occult phenomena," which she averred were the outcome of her connexion with these "Mahâtmâs." The fraudulent character of the "phenomena" was on several occasions exposed by numerous painstaking investigators (see *Proceedings of the Society for Psychical Research*, vols. iii. and ix., and *A Modern Priestess of Isis*, by Solovyoff). There are, moreover, numerous passages in the sacred books of the East, especially those of the Buddhists, which warn the student against the assumption that "magical" performances of any kind are to be regarded as proving the truth of the performer's teaching; and indeed it must be owned in justice to the theosophists that similar warnings are to be found scattered throughout their writings; while even Madame Blavatsky herself was wont to expatiate on the folly of accepting her "phenomena" as the mark of spiritual truth. Yet at the same time it cannot well be denied that she was in the habit of pointing to the said marvels as evidence of her Mahâtmâ's existence.

If theosophy were to be judged solely by the published revelations of this "Secret Doctrine" it would hardly be deserving of serious consideration; for, as suggested in the separate article on Madame Blavatsky, the revelations themselves appear to have been no more than a crude compilation of vague, contradictory and garbled extracts from various periodicals, books and translations. It was an article of faith with her disciples that the outward and visible Helena Petrovna Blavatsky was on certain occasions the vehicle of psychic powers of transcendent spiritual import. Although there is not much to justify such a proposition, it may perhaps be conceded that she was in many respects abnormal and that some of her work is characteristic of a process known to modern psychologists as "automatism," or in other words that it is the result of a spasmodic uprush to the surface of sub-conscious mental activities. Apart, however, from these pseudo-revelations the Theosophical Society has given rise to an extensive literature, some of which displays a high degree of argumentative and expository ability; and moreover the movement has from time to time attracted the attention and secured the co-operation of many earnest seekers, of some few of whom it can be truly said that they possessed undoubted spiritual power, insight and knowledge.

Soon after the death of Madame Blavatsky a split in the society was brought about by Mr Wm. Q. Judge (d. 1896) of New York, who claimed the leadership; and there came into existence two if not three separate theosophical societies (following Judge and later Mrs Katherine Tingley in America, Olcott and Mrs Annie Besant in America and India, with a more or less independent organization in England), each one contending that the original afflatus of the founder had descended upon it exclusively. The fortunes of the societies are, however of less importance than their leading doctrine.

It will be surmised from what has been said that any concise statement of orthodox theosophy is hardly to be expected; though from the materials available a fairly definite outline of its leading tenets can be deciphered. We will try to give a cursory review of three of the most important of these, viz.: the constitution and development of the personality or ego; the doctrine of "Karma"; and the Way or Path towards enlightenment and emancipation. Human personality, we learn, is the temporary manifestation of a complex organization consisting of "seven principles," which are united and interdependent, yet divided into certain groups, each capable of maintaining temporarily a spurious kind of personality of its own and sometimes capable of acting, so to speak, as a distinct vehicle of our conscious individual life. Each "principle" is composed of its own form of matter, determined and conditioned by its own laws of time, space and motion, and is, as it were, the repository of our various memories and volitions. These seven "principles," starting from the most gross—the physical body, or "Rûpa"—become more and more subtle and attenuated until we reach the Universal Self "Âtmâ," the centre as also the matrix of the whole, both individual and universal. Now that which binds together these elements of our nature and maintains their interrelation in their respective spheres of activity—that which determines an individual's powers, his tastes, his opportunities, advantages and drawbacks, in a word, the character—is his "Karma." Broadly speaking, it is the sum of an individual's bodily, mental and spiritual *growth*; having its roots, as it were, spread over many lives, past and future. The two sentences, "as a man soweth, so must he reap," and "as he reaps so also he must have sown," give comprehensive expression to the idea of Karmic activity.

The doctrine of Karma is with modification common to both Buddhism and Brahminism, and in their expositions theosophists have apparently drawn from both sources.

The theosophic "Path" to the final goal of emancipation or Nîrvâna, is in a great measure derived from the Buddhist literature, available to the English-speaking peoples through numerous excellent translations, more especially those of Professor T. W. Rhys Davids, and also from the many translations in all the European languages of the Bhagavad Gîtâ and Upanishads. Theosophic teachings on this subject are not, however, exclusively Oriental, for following their contention that they are the exponents of the universal and unchangeable "Wisdom Religion" of all the ages, theosophists have selected from various sources—Vedic, Buddhist, Greek and Cabalistic—certain passages for the purpose of exposition and illustration. To the uninitiated it would appear that this selection has been made, generally speaking, at random; it is at any rate lacking in the wise discrimination one would expect from the supposed source of its inspiration. Nevertheless theosophists by their investigations and expositions have undoubtedly been brought in touch with some of the most profound thought in both ancient and modern worlds; and this fact in itself has assuredly had an inspiring and ennobling influence upon their lives and work. The histories of all the great religious and philosophic movements show them as developments of an evolutionary process, arriving at their accepted dogmas through long periods of contention between numerous tendencies and cross-currents, resulting in some compromises and not a little confusion of thought. So it is in the main with theosophy. It has followed Buddhism in deprecating any reliance upon ritual. Ceremonial and sacrificial observances of all kinds are held to be useless in themselves, but operative for good or ill indirectly by their effect upon the mental attitude of those who practise them. Theosophists insist, however, that all religious observances had their origin in some mystical process, the true meaning of which has in most instances been lost. The Path is represented as the great work whereby the inner nature of the individual is consciously transformed and developed. The views of life held by the ordinary mortal as well as his aims and motives must be radically altered; and simultaneously a change must take place in his modes of speech, conduct and thought. The Path is said to be long and difficult, and with most individuals must extend over many lives. It is divided into four stages, each one representing the degree of spiritual growth and karmic development at which the "chela" or disciple has arrived. But even the entrance upon the very first stage implies something more than, and something fundamentally different from, the life of an ordinary layman, however morally excellent this life may be. Morality, important though it be as preparatory to the "higher life," does not alone lend itself to that awakening of the spiritual faculties without which progress along the Path is not possible. In good citizenship morality is practised out of regard to certain preconceived notions of the needs, the health and happiness of ourselves, our fellows and the community at large. According to theosophy, it would appear that these notions are for the most part mistaken, or at any rate they are quite insignificant in comparison with the interests with which the traveller along the Path soon finds himself absorbed. It is not that human needs are to be disregarded, but that the pabulum which he now sees that humanity really requires is of an incomparably higher order than that which is generally so considered. The physical methods and spiritual exercises recommended by theosophists are those inculcated in the systems known in Hindu philosophy as Râja Yoga in contradistinction to the Hatha Yoga system, which is most commonly to be met with in India, and in which the material aspects are given greater prominence. The Path has an active and a passive side. Fresh knowledge, new forces and faculties, have to be acquired by positive and strenuous efforts, while, on the other hand, delusions and superstitions are to be abandoned by an attitude of conscious neglect; or to use the phraseology of the Hindus, *Avidyâ*, nescience—the mental state of the unenlightened—through which the individual energies are scattered and dissipated in futile effort, is gradually replaced by *Vidyâ*, the higher wisdom which dispels the darkness of the mind, awakens our latent faculties and concentrates our efforts in the direction of that harmonious union, which ultimately results in Nîrvâna. Although the way of the disciple or "chela" is always represented as long and difficult, it is said that as he proceeds, the transcendental faculties which arise to help him enable him to pursue the right course with ever increasing confidence and security. These powers of the mind, or "siddhi," should never be sought for their own sake, or be used for selfish purposes. The attempt to develop and use them without regard to the higher purpose is spoken of as practising the arts of "black magic," the exercise of which invariably leads to disaster. It is proclaimed that were the "chela" to attempt to make an improper use of his powers—that is to say, were he to yield to the promptings of selfishness, lust or antagonism—such a lapse would at once set in action counteracting forces, which not only retard his upward growth, but which would, were such evil courses persisted in, lead ultimately to the obliteration of all his newly acquired psychic possessions.

The Path may also be described in terms of the "seven principles." It may be said to be a process of *unification*, whereby the centres of volition, consciousness and active memory are systematically shifted upwards from the lower to the higher "principles" until they have become firmly established in the "Buddhi," or "sixth principle." As this last stage is approached the "chela" becomes less and less dependent on the guidance of traditions and scriptures. The truth becomes revealed to him by the opening of his inner vision, and he learns to see Dharma, the Eternal Law, as it were, face to face. Thus theosophists may be said to accept in their own sense the saying: "He who does the Will shall know the doctrine."

Along the Path are ranged ten great obstacles, or fetters, the Buddhist Sanyojanas, which have to be successively overcome before the final goal is reached. As these sanyojanas give a very good idea of what has been termed the negative aspect of the Path, we may enumerate them as follows:—

1. The delusion of personality—the belief in a permanent and unchangeable egoentity.
2. Doubt as to the use of the higher efforts, or as to the possibility of solving the great mysteries of life.
3. The reliance upon ritual—seeking salvation through outward acts.
4. Lust.
5. Ill-will, or antagonism.
6. Love of this life and its possessions—"The care of the world and the deceitfulness of riches."
7. The egoistic longing for a future life.
8. Pride.
9. Self-righteousness.
10. Nescience.

A few words should be added as to the theosophic hell, or "Avichi." This is described as a long drawn-out dream of bitter memories—a vivid consciousness of failure without volition, or the power of initiative—a dream of lost opportunities and futile regrets, of ambitions thwarted and hopes denied, of neglected duties, abused powers and impotent hate; a dream ending ultimately in the oblivion of utter annihilation.

There is no doubt much of valuable suggestion to be found in the philosophic system, or rather the conglomerate of systems, which pass to-day under the name of theosophy; and probably much has been done by means of its propaganda to popularize Eastern thought in the West, and in the East to reawaken a truer appreciation of its own philosophic treasures; but however that may be, the serious student would be well advised to seek his information and his inspiration from the fountain-heads of the theosophists' doctrines, which are all easily accessible in translations; and to avoid the confusions and errors of writers who in most cases have but a superficial if any knowledge of the original languages and systems from which their doctrine has been arbitrarily culled. (St G. L. F.-P.)

THÉOT, CATHERINE (d. 1794), French visionary, was born at Barenton (Manche). From her youth a victim of hallucinations, a long course of religious asceticism in the convent of the Miramiones in Paris unhinged her mind, and she was placed under restraint. Liberated in 1782, her early delusions concerning a Messiah became accentuated; that she was destined to be the mother of the new Messiah, she was now assured; she pictured to her followers the fantastic features of the coming Paradise on earth; and was hailed as the "Mother of God." From the idea of the advent of a Messiah to its realization was but a step; in Robespierre the Théotists saw the redeemer of mankind; and preparations for his initiation were put in train. The enemies of Robespierre, resenting his theocratic aims, seized upon his relations with the Théotists as an engine of revenge; Catherine, with Gerle (*q.v.*) and others, was arrested and imprisoned, and a letter to Robespierre discovered in her house. In the Convention M. G. A. Vadier trumped up the conspiracy of Théot, asserting that Catherine was a tool of Pitt, that the mummeries of the Théotists were but a cloak for clerical and reactionary intrigue, and hinting that Robespierre favoured their designs. The case was adjourned to the Revolutionary Tribunal, and figured in the proceedings of the 9th Thermidor. The accused were ultimately acquitted, Catherine herself having died in prison on the 1st of September 1794.

THERA, the southernmost island of the Sporades, now called Santorin (*q.v.*). It was known as Thera until after the Fourth Crusade, when it became part of the duchy of the Archipelago.

THERALITE (Gk. θηρᾶν, to pursue), in petrology, a group of plutonic holocrystalline rocks consisting of nepheline, basic plagioclase, augite and olivine, and so called because it is of rare occurrence, and its discovery was looked forward to with interest as completing the series of basic rocks containing nepheline as an essential constituent. The felspars are mostly of basic character and are often zonal; the nepheline is of later crystallization, rarely idiomorphic and often decomposed. Pyroxene in these rocks may be of green colour or purplish-brown and rich in titanium; olivine is usually abundant. Among the accessories may be mentioned apatite and iron oxides, biotite and dark brown hornblende, the latter often surrounding the purple augite. The rocks have rarely ophitic structure, but their minerals tend to have good crystalline form, except in the case of nepheline and orthoclase (if that be present). By decomposition the nepheline yields zeolites such as natrolite and analcite. The theralites are rarely cross-grained and have much resemblance to dolerites in hand specimens. Among localities for these rocks are Duppau in central Bohemia, Pridazzo (W. Alps), Umptek (on the White Sea), Madagascar and the Crazy Mountains in Montana. A variety of theralite occurs also at Montreal in Canada, and rocks from Crawford John in Lanarkshire and from Paisley in Renfrewshire have recently been ascribed to this group.

Very close to the theralites is a series of rock types known as the teschenites (from Teschen in Moravia). Instead of nepheline these rocks usually contain analcite, and from their microscopic characters it is by no means likely that the analcite is secondary after nepheline in this case; it appears, in fact, to be either primary or of pneumatolytic origin. Nepheline, however, has been found in teschenites from Portugal and from Moravia, so that the distinction between the two series practically vanishes. In central Scotland, around Edinburgh and Glasgow, teschenites are abundant, forming thick sills intrusive into the Carboniferous rocks, and some are also known from Leicestershire (Whitwick) and from Arran. These teschenites are sometimes ophitic and present transitions to olivine-diabases on the one hand and to picrites on the other. They are the deep-seated representatives of the basaltic lavas which were emitted in great numbers in the early part of the Carboniferous period. Other localities for teschenite are the Caucasus and the coast of California (Cuyama Valley, &c.).

The essexites are an allied series containing a larger amount of alkali felspar. Nepheline also occurs by no means uncommonly; the augite is sometimes green, but in other specimens is of a rich purple colour with well-marked zonal structure. Olivine is by no means uncommon, and brown hornblende and biotite occur rather frequently. The type rock is from Essex (Massachusetts) and other examples have been described from Rongstock on the Elbe, from Mount Royal (Montreal), from S. Norway, near Christiania, and from St Vincent in the Cape Verde Islands. A few essexites have been found in Britain, accompanying the Carboniferous teschenites near Edinburgh and in the Campsie Hills of Stirlingshire. As they contain both orthoclase and plagioclase felspar they have a certain affinity to the olivine-monzonites and kentallenites.

The shonkinites are dark grey rocks consisting of olivine, green augite, dark brown biotite, nepheline and orthoclase, which are found at Shonkin Sag in the Highwood Mountains of Montana. They are basic variations of sodalite-syenite and have some resemblance to theralites, especially in the association of nepheline with large amounts of augite and olivine. They are of exceedingly rare occurrence. (J. S. F.)

THERAMENES (d. 403 B.C.), Athenian statesman, was the adopted son of Hagnon, a prominent conservative who in 430 impeached Pericles, and after the Sicilian expedition became one of the ten *probuli* (*πρόβουλοι*, commissioners) appointed to devise economies in the administration. As a pupil of the sophist Prodicus he acquired facility in public speaking. Under his father's patronage he joined in the conservative reaction which came to a head in 411, when hopes of a Persian alliance or peace with Sparta strengthened the existing dissatisfaction with the democratic rule. Theramenes specially studied the constitutional side of this movement and formulated a new party-cry, "the constitution of our fathers." It was no doubt largely due to his advocacy that the *probuli*, strengthened by further members, were commissioned to draft new measures on behalf of the public safety and to examine Cleisthenes' "ancestral code." In their report the following measures were recommended: (i.) annulment of the act against promulgating illegal measures; (ii.) abolition of pay, save for the troops in the field and the archons; (iii.) restriction of the franchise to 5000 able to serve "with person and purse"; (iv.) the appointment of a special board to choose the 5000. When these proposals were passed (apparently in a packed assembly outside the walls), a Constituent Assembly of 100 was elected, nominally by the 5000, who as yet were a mere phantom body, in point of fact by the leading conspirators. The new constitution provided for a boulē whose members were to be recruited by lot from all citizens above thirty; the functions of this body to be exercised by four sections succeeding one another by yearly rotation and serving without pay; all high officials to be chosen by it out of its own members. This scheme embodied the chief reforms desired by Theramenes, and marks the triumph of his policy. But before it could be carried into effect it was superseded by a "provisional constitution," which gave unlimited power to a boulē of 400 (chosen by a roundabout system which favoured intrigue) and its nominees, the ten "absolute" generals. This extreme reaction displeased Theramenes, who in return began to agitate for the calling of the 5000 into real existence. Furthermore he warned Athens against the treason of the extreme oligarchs, and induced the troops to raze a mole erected to facilitate a Spartan descent on Peiraeus.

After the disaster of Eretria (see PELOPONNESIAN WAR), which caused the fall of the extremists and the institution of a government of "5000" (*i.e.* all citizens who could afford a suit of armour), Theramenes stood in high esteem. After assisting in the prosecution of his former colleagues he received the command of a squadron with which he helped to win the great victory at Cyzicus (410) and to recover the Bosporus. After the triumph of the radical democrats which followed upon these successes he lost his high command. At Arginusae (406) he fought as a simple ship's captain, but after the battle was commissioned by the generals to rescue some drowning crews, an order which, with his ill-trained and exhausted troops, in a heavy storm, he was unable to carry out. For this failure the generals were severely criticized at Athens; an inquiry by the boulē led to their arrest, and before the ecclesia they aggravated their case by pleading (i.) that the storm made a rescue impossible, (ii.) that Theramenes was to blame. Theramenes in reply brought out the implied contradiction in these statements, and in consequence the assembly condemned the accused to death and subsequently returned Theramenes general.

Late in 405 Theramenes went as plenipotentiary to Lysander (*q.v.*) to obtain peace terms; after long negotiations he proceeded to Sparta and arranged a settlement which the Athenians ratified (April 404). In spite of this peace the disorder in Athens did not abate. The restored fugitives selected five "ephors," including Critias, to organize a revolution, while the radicals opposed that return to the "ancestral constitution" for which Theramenes had stipulated. Hereupon Lysander returned to Athens and had a Constituent Committee elected, of whom ten members were nominees of each section. In this body Theramenes at first assumed the chief part, and the new measures rescinding the laws against the Areopagus and suppressing sycophancy were well received. But, exactly as in 411, a more violent party under Critias, forgetting its real duties, appointed an autocratic boulē of its own creatures, and proceeded by judicial murders and confiscations to earn for the new government the name of "the Thirty Tyrants." Theramenes protested, and managed to get a citizen-body of 3000 admitted to a share of the government. Critias, however, fearing a renewal of the collapse of 411, disarmed the people and decided to remove Theramenes before he could create a new democratic party. The latter successfully repelled Critias' denunciation of treason, but was led away by violence and forced to take poison. His well-known gibe, "Here's to the noble Critias," attests his strength of mind at the hour of death.[1]

Theramenes demonstrably had a definite policy throughout his career. His ideal was a return to a 6th century constitution, which his contemporaries could equally regard as a moderate oligarchy or a restricted democracy. The main features of his programme were: (1) property qualification for franchise; (ii.) abolition of pay; (iii.) transference of some judicial powers from the popular courts to a restored Areopagus. At times he seemed likely to succeed, but amid the violent oscillations of party he could not definitely join any one faction, and so earned the nickname *Κόθορνος* (a stage-boot fitting either foot). Aristotle, however, discerned Theramenes' real policy, and, like Cicero and Caesar, in later years ranked him among the greatest Athenian statesmen.

SOURCES.—The *Constitution of Athens* with its numerous documents affords much valuable knowledge, but does not give the inner history of 411. Thucydides viii. supplies this, but his

[1] The attempted rescue by Isocrates (Pseudo-Plutarch, *Vitae X. Oratorum*) is improbable; but Theramenes may have taught Isocrates in oratory.

knowledge of the constitutional side of the revolution and of Theramenes' activity is somewhat fragmentary. Xenophon (*Hellenica*, i., ii.) was an eye-witness in 406–403, but is clearly inaccurate in his details and prejudiced throughout. Lysias (*c. Eratosth.* and *c. Agorat.*) gives an avowedly hostile account of Theramenes. Diodorus xiii., xiv., goes too far in making Theramenes a pure democrat. See also Plutarch, *Cicero*, chap. 59; Cicero, *de Oratore*, iii. 16, 59; Wilamowitz-Möellendorff, *Aristoteles und Athen* (Berlin and Leipzig, 1893), ii. p. 113 sqq.; E. Meyer, *Forschungen zur alten Geschichte* (Halle, 1899), ii. pp. 406 sqq.; B. Perrin in *American Historical Review*, ix. (1904), pp. 649–69. (M. O. B. C.)

THERAPEUTAE (Gr. θεραπευταί, literally "attendants" or "physicians," hence "worshippers of God"), a monastic order among the Jews of Egypt, similar to the Essenes. Our sole authority for their existence is Philo in his treatise *De Vita Contemplativa*. He takes them as the type of the contemplative, in contrast with the Essenes, who represented rather the practical life. While the Essenes were confined to Palestine or its near neighbourhood, the Therapeutae, we are told, existed in many parts of the world, but especially in Egypt. Their headquarters there were on Lake Mareotis, which at that time debouched into the sea. This establishment near Alexandria was, as it were, the Grande Chartreuse of their order. Philo himself was uncertain as to the meaning of the name, whether it was given to them because they were "physicians" of souls or because they were "servants" of the One God. Their mode of life he in one place (ii. 473, line 14) calls θεραπεία, and his use of words generally accords better with the latter meaning. That the origin of the name of these ascetics was unknown in Philo's time goes to prove their antiquity.

A man on joining the order died to the world, and so voluntarily resigned his property to his heirs. How the order itself was supported does not appear. So far as we are informed, prayer and study were the sole occupations of the Therapeutae. The community at Alexandria lived in mean and scattered houses, near enough to afford protection, without depriving the members of the solitude which they prized. Each of these houses contained a chamber called σεμνεῖον or μοναστήριον (cf. Matt. vi. 6), which was devoted to prayer and study, and into which the inmate brought nothing but the Law and the Prophets, together with the Psalms and other works which tended to the promotion of piety. At sunrise the Therapeutae prayed and again at sunset. The whole interval was devoted to a study of the internal sense of the Scriptures. In addition to the Old Testament the Therapeutae had books by the founders of their sect on the allegorical method of interpreting Scripture. They also contributed to sacred literature themselves in the composition of new psalms. Attendance to the ordinary needs of nature was entirely relegated to the hours of darkness. Some of these recluses only ate every second day, while others succeeded in confining the necessity to a single week-day. But the Sabbath was a feast on which, after attending to their souls, they indulged their bodies, like yoke animals let out to graze. But their indulgence even then is not mentioned to have gone beyond the coarse bread, flavoured with salt and sometimes hyssop, while their drink was water from the spring. Thus during the six days of the week the Therapeutae "philosophized," each in his own cell, but on the Sabbath they met in a common assembly, where women also had places screened off from the men, and listened to a discourse from one who was the eldest and most skilled in their doctrines.

In contrast with the drunken revels of the Greeks, Philo describes the sober enjoyment by the Therapeutae of the feast of Pentecost, or rather of the eve of that festival. They assembled together with glad faces and in white garments, and the proceedings were begun with prayers, in which they stood and stretched their eyes and hands to heaven. Then they took their seats in the order of their admission, the men on the right and the women on the left. Slavery being against their principles, the younger members of the society waited on the elder. No flesh was served at table, and for drink only water either hot or cold. But first came "the feast of reason and the flow of soul." All listened devoutly to a discourse delivered with an emphatic slowness and penetrating beneath the letter of the Law to the spiritual truth that lay hidden within. When the president's address had been duly applauded, there followed the singing of hymns ancient and modern. Then came the meal of the simple kind already described. And after this a *pervigilium*, celebrated with antiphonal and joint singing on the part of men and women and with choral dancing in imitation of Moses and Miriam at the Red Sea. At sunrise, turning to the east, they prayed that the light of truth might illumine their minds, and then returned to their studies.

Such is the account of the Therapeutae given by Philo. It seems to have formed part of the Apology for the Jews (Eus *Pr. Ev.* viii. 10, § 12)—hence its highly rhetorical character—from which Eusebius gives the extract about the Essenes; while this in its turn may have constituted the fourth book of a large work entitled ("sarcastically," says Eusebius, *H.E.* ii. 18) περὶ Ἀρετῶν, of which the *Legatio ad Gaium* formed the first. The *De Vita Contemplativa* thus owes its place next to the *Quod Omnis Probus Liber*, a place which it already occupied in the copy of Philo's works possessed by Eusebius (*H.E.* ii. 18), merely to the mention of the Essenes at the beginning of it.

To the modern reader the importance of the Therapeutae, as of the Essenes, lies in the evidence they afford of the existence of the monastic system long before the Christian era. We have no clue to the origin of the Therapeutae, but it is plain that they were already ancient when Philo described them. Eusebius was so much struck by the likeness of the Therapeutae to the Christian monks of his own day as to claim that they were Christians converted by the preaching of St Mark. He goes so far as to say that "the writings of ancient men, who were the founders of the sect" referred to by Philo, may very well have been the Gospels and Epistles (which were not yet written). This is a strong instance of how the wish may be father to the thought even in a fairly critical mind. Eusebius having gone wrong on this point, others of the Fathers followed suit, so that Philo is reckoned by Jerome among the ecclesiastical writers of the Christians.

Nothing is more likely than that Christianity gained adherents among the Therapeutae, and that their institutions were adapted to the new religion, just as they seem to have been borrowed by the Jews from the Egyptians. Strabo (xi. 29, p. 806) tells us how he saw at Heliopolis large buildings belonging to the priests, which had once been tenanted by men skilled in philosophy and astronomy, who had been consulted by Plato and Eudoxus, but that the σύστημα and ἄσκησις (the very words used by Philo in speaking of the Therapeutae) had then fallen into decay. The system, however, was not even then extinct, for it was described by Chaeremon the Stoic, a contemporary of Strabo's. Chaeremon's account has been preserved by Porphyry (*De Abstinentia*, iv. 6), and has curious resemblances to Philo's description of the Therapeutae, even down to such details as their posture and gait and the eating of hyssop with their bread.

After 1879 a theory became current in Germany (first stated in P. E. Lucius, *Die Therapeuten und ihre Stellung*), and accepted in England, to the effect that the *De Vita Contemplativa* is not a work of Philo's at all, but a forgery put forward about the end of the 3rd century and intended to procure the authority of Philo's name for the then rising monasticism of the Church. But this theory was signally refuted by F. C. Conybeare in his *Philo about the Contemplative Life* (Oxford, 1895).

See also works quoted by Conybeare (pp. 391–399); Bousset, *Religion des Judenthums im neutestamentlichen Zeitalter* (1903); A. Harnack, *s.v.* "Therapeuten" in Herzog-Hauck, *Realencyk.*, xix. 677 (1907). (St G. S.)

THERAPEUTICS (Gr. θεραπευτική, *sc.* τέχνη, from θεραπεύειν, to serve), the name given to that branch of medicine which deals specifically with the means employed to cure disease if possible, or to control and lessen its evil results when a cure is impossible.

The cure which is sought for may either be *symptomatic* or *radical*. Various morbid conditions of the body generally may give rise to different symptoms. Thus a gouty condition may manifest itself in one man as eczema of the skin, giving rise to redness and intense itching; in another as neuralgia, causing most severe pain; in a third as bronchitis, producing a distressing cough; in a fourth as dyspepsia, giving rise to flatulence and intestinal disturbance; and in a fifth as inflammation of the great toe, accompanied by redness, swelling and pain. The therapeutic measures employed in these different cases may be directed towards alleviating the symptoms, such as itching, pain, cough and swelling, in which case the treatment will be merely *symptomatic*; or they may be directed towards removing the root of the disease, viz. the gouty condition underlying them all, and thus effecting a *radical* cure. It very frequently happens that we do not know what the underlying condition is, and we are forced simply to relieve as best we can the most prominent and most distressing symptoms. In symptomatic treatment we are frequently obliged to use remedies simply because we know they have done good before in similar cases, and we expect them to do so again without having the least idea of how they act. Thus in acute gout the most common and most trusted remedy for removing the pain is colchicum, but at present we do not know what action it has upon the system, or why it gives so much ease in the pain of gout while it has comparatively little effect upon pain due to other causes. This plan of treatment is termed *empirical*. It is a useful method, and is often very satisfactory, but it has the disadvantage that it admits of but little progress, and when a trusted empirical remedy fails we do not know precisely in what direction to look for a substitute. In contradistinction to empirical we have *rational* therapeutics, by which we mean the application of a remedy, whose mode of action we know more or less perfectly, in diseased conditions, the nature of which we also understand more or less fully. As an example may be taken the use of nitrite of amyl in angina pectoris. It has been found that in many cases of this disease the pressure of blood within the arteries becomes increased, probably from spasmodic contraction of the arteries themselves. Nitrite of amyl has the power of dilating the arteries; it has consequently been employed with much success in lowering the blood pressure and removing the pain in angina pectoris. But such rational knowledge as this not only enables us to remove pain at the time, but helps us to prevent its recurrence. For on the one hand knowledge of the fact that nitrite of amyl lessens blood pressure has led to the successful employment of other nitrites and bodies having a similar action, and on the other the knowledge that increased blood pressure tends to cause anginal pain leads to the prohibition of any strain, any food, any exposure to cold, and also of any medicines which would unduly raise the blood pressure. Here we notice one of the greatest advantages of rational over empirical therapeutics. In cases of angina, while the resistance opposed to the action of the heart by spasm in the vessels may be great, the heart itself may be feeble, and it may therefore be necessary to give some remedy which will increase the power of the heart. But if such a remedy were given alone it might, and probably would, act on the arteries as well as the heart, and by causing the contraction of the vessels do more harm than good. But if we know what remedies will increase the power of the heart and what will lessen resistance in the vessels, we may combine them and thus obtain the objects we desired, viz. removal of the pain, better action of the heart, and more perfect circulation.

The testing of ideas by observation and experiment which was begun in anatomy by Vesalius. and by Harvey in physiology, was applied by Morgagni to alterations in the organs produced by disease, by Bichat to the tissues, and by Virchow to the cell. The study of disease in the living body may be said to have been begun by John Hunter, developed by Magendie, Claude Bernard, Brown-Séquard and others. Of late years enormous impulse has been given to our knowledge of the causation of disease by microbes, through the works of Gaspard, who injected putrid matter into the veins of a living animal; by Villemin, who discovered that tuberculosis is infective; by Davaine; and especially by Pasteur, Koch and others too numerous to mention, who have worked, and are still working, at the microbic causation of disease with marvellous success.

The natural end of life is that all the organs should become old and gradually decay at the same time, so that at the last the individual should become less and less active, weaker and weaker, and finally die without any definite disease, without pain and without struggle. But this is exceptional, and generally one part gives way before another, either on account of one part being naturally weaker or of one part having been overtaxed or more severely attacked by some injurious external influence, or by some undue preponderance of another part of the body itself. For health consists in a due proportion between the action of all the different parts of the body, and if one part be unnaturally strong it may lead to injury or death. Thus a very strong heart, although it may be useful to its possessor for many years, driving the blood rapidly through the vessels, and supplying all his tissues with such abundant nutriment as to enable him to endure great exertion, mental or bodily, may in the end cause death by bursting a vessel in the brain, which might have resisted the pressure of a feebler circulation for years longer. On the other hand, a heart that is too feeble may cause its owner's death by its inability to carry on the circulation against increased resistance. This may occur suddenly, as when the resistance is increased in the arterial system by a sudden exertion or strain, and more slowly when the resistance is increased in the pulmonary circulation by inflammation of the respiratory passages. The thyroid gland, which is situated in front of the neck, yields a secretion which passes into the blood and there tends to maintain a state of moderate dilatation in the blood-vessels and of oxidization in the tissues, so that the circulation remains good and the body-heat and muscular activity remain well maintained. When this gland becomes enlarged, and its secretion consequently increases, the vessels dilate, the heart beats more rapidly, the skin becomes too hot, the nervous system becomes irritable, and tremors occur in the limbs. On the other hand, when it becomes atrophied the circulation becomes feeble, the face heavy and dull, the patient suffers from cold, the features grow lumpish, mental processes become sluggish, and bodily vigour diminishes.

Disease by feebleness or excessive action of one part of the body.

Disease of the whole body may thus be produced by over-action or under-action of some part of it, but such causes of disease are slight as compared with the effect of external noxious influences, and more especially the effect of microbes. These enter the body through various channels, and once they have effected a lodgment they grow, multiply and give rise to various poisons which attack and injure or destroy different tissues or organs in the body. Various safeguards are provided by nature to prevent their entrance. On the skin we have a thick epidermis through which microbes cannot pass, although if an entrance is obtained for them by a prick or cut they may readily grow in the tissues below and spread from them throughout the whole body. They pass more readily through mucous membranes, but almost every one of these is provided not only with a coating of mucus, which obstructs their passage, but with some reflex mechanism which tends to remove them. Thus irritation of the eye causes winking and secretion of tears, by which the irritant is removed; irritation of the nose causes sneezing; of the air-passages, coughing; of the stomach, vomiting; and of the intestines, diarrhoea. Even when they have passed through an abrasion in the skin or through the mucous membranes and enter the blood they are met, in some instances, by a toxic action of the blood itself upon them; and in others they are attacked by the white corpuscles, which destroy them, eat them up, and digest them, the process being known as *phagocytosis*. The greater the number of leucocytes that can reach the spot where the invading microbes enter the more quickly can the microbes be destroyed and general infection prevented. The microbes appear in many cases to attract the leucocytes (positive chemiotaxis), but when very virulent they usually repel the leucocytes (negative chemiotaxis)

Microbes.

and excrete toxins which kill the leucocytes. The irritation caused by the microbes generally is followed by dilatation of the vessels of that part and thus more leucocytes are brought up to the fight. This dilatation may be increased by local warmth, and poultices or fomentations are commonly applied to inflamed parts; recently suction apparatus has been used for the same purpose or ligature so as to cause venous stasis (Bier's treatment). Blisters also cause local dilatation of vessels, but are usually applied to the skin for inflammation in deep-seated parts, such as the lungs, though they also relieve pain in the joints in acute rheumatism. Bier increases the blood in a part by compressing the veins and thus producing passive instead of active congestion. The toxins produced by microbes, if too weak to destroy the leucocytes, induce them to secrete anti-toxins, which not only act as antidotes to the toxins and are injurious to the microbes, but also increase the phagocytic power of the leucocytes (opsonius of Wright). By inoculation with increasing doses of these the resistance of the organism is greatly increased and the invading microbes destroyed. The vaccine is usually made by sterilizing a virulent culture and the proper dose is ascertained by noting the extent to which the power of the leucocytes to envelop and digest the microbes is increased.

Moreover, the products of microbic secretion tend to produce *fever*. The high temperature characteristic of this condition is no doubt injurious to the body itself, but it is frequently more so to the microbe which has invaded the organism; and thus fever, instead of now being regarded as a morbid condition to be suppressed by every means in our power, is considered to be a reaction of the organism tending to protect it by destroying the infection. But it must be kept within limits, lest it should of itself cause death, and here again we see the difference between empirical and rational medicine. Fever is not to be looked upon as an unmitigated evil, to be removed if possible, but rather as a defensive mechanism by which the organism may prevent invasion from noxicus microbes. Nevertheless, as in a campaign the general's plan may be spoiled by too hasty or too eager action on the part of some of his troops, so the defensive arrangement carried to excess may prove injurious or fatal to the organism. Thus too great a rise of temperature in fever may kill the patient; and the aim of therapeutics is to restrain the temperature within proper limits, neither allowing it to rise too high nor to fall too low. The old plan of lowering it by means of cold baths was known to Musa, the physician of Augustus, and by it he saved the emperor's life; but the same treatment killed the emperor's nephew. The introduction of the clinical thermometer, which allows us to ascertain exactly the amount to which the temperature rises in fever or to which it is reduced by antipyretic measures, is to the physician like the compass to the sailor, and allows him to steer safely between two extremes.

After the struggle between the organism and the microbes is over, even when it has ended victoriously for the former, injuries are left behind which require repair. Every one has noticed after prolonged fever how thin and weak the patient is, and both the muscular and nervous power throughout the whole body are sadly in want of repair. Where there has been local mischief due to inflammation the dead leucocytes must be removed, and this is done either by their being converted into pus in one mass, and making their way through the tissues to the nearest surface, whether of skin or mucous membrane, from which it can be discharged, or they may undergo a process of fatty degeneration and absorption, leaving behind in some cases cheesy matter, in others hard connective tissue.

Poisons formed by microbes are partly eliminated by the kidneys, partly by the mucous membrane of the stomach and intestines, and possibly also by the skin. In old days free elimination by these channels was looked upon as a sign of returning health, and was termed a "critical" diuresis, diarrhoea or sweating, according to the channel through which the eliminative act had occurred.

By therapeutic measures we strive to limit as far as possible the entry of injurious microbes into the organism, to expel or destroy them and their harmful products, and to maintain the strength of the organism itself. One of the influences which is most injurious to the body, and favours most the invasion of microbes, is *chill*. So much is this the case that some diseases which are now known to be due to infection were formerly attributed entirely to the effect of cold. Thus pneumonia is now known to be due to the diplococcus pneumoniae, and yet its invasion occurs so frequently after a chill that it is almost impossible not to look upon chill and pneumonia as cause and effect. The reason of this appears to be that the diplococcus is frequently present in the mouth or air-passages without giving rise to any symptoms; but when the patient is exposed to chill, and the tissues of the respiratory passages are thereby weakened, the diplococcus grows, multiplies and gives rise to inflammation of the lungs. Even what are known as common colds are probably due chiefly to microbic infection aided by a chill, just as in the case of pneumonia. Therapeutic measures which are commonly adopted in the treatment of a cold have for their object to destroy the microbes before they penetrate fairly into the organism, and to restore the balance of the circulation and increase the strength of the invaded parts. Thus carbolic acid or carbolized ammonia are sniffed into the nose to destroy the microbes there, or the nose is washed out by an antiseptic solution as a nasal douche; bismuth or morphine are insufflated, or zinc ointment is applied, to cover the mucous membrane, and protect it from further irritation; and various antiseptic gargles, paints and powders applied to the pharynx in order to prevent the microbic inflammation from extending to the pharynx and down the trachea and bronchi, for many a severe bronchitis begins first by sneezing and nasal irritation. Sometimes the patient is put to bed and the circulation is encouraged, especially on the surface of the body, by the use of hot spirits and water, or opium and ipecacuanha, while the outside of the nose is protected to a certain extent from loss of heat, and consequent irritation, by smearing it with a tallow candle or rubbing some ointment over the skin. At the same time, if the throat has begun to show signs of being involved, a hot poultice or wet pack is applied to the neck.

Both inflammation and fever are protective processes calculated to defend the organism against the attacks of microbes. But protective processes misdirected or carried to excess may become injurious or even dangerous to the organism. As an instance of misdirection, we may take the irritation which remains in the eye after a particle of dust has been removed, or the itching of the skin which occurs in eczema. The irritation of the conjunctiva caused by dust leads to winking of the eyelids, lachrymation and rubbing, which tend to remove it; but after the dust has been removed violent rubbing tends rather to keep up the irritation; and sometimes, if the particle of dust remains under the eyelid and is sharp and angular, the process of rubbing may cause it to injure the conjunctiva much more than if it were left alone. In the same way itching is often caused by the presence of insects or other irritants upon the skin, and it tends reflexly to cause rubbing, which is useful by removing the irritant. But when the irritation is situated in the skin itself, as in eczema, the scratching tends to increase inflammation, and makes the irritation worse. In the same way, the reflex act of coughing is useful in removing either foreign bodies or excessive secretion from the air passages; but when the mucous membrane of the respiratory tract is irritated and inflamed, it produces a feeling of tickling and a desire to cough sometimes very violently; yet the coughing simply tends to exhaust the patient, because there is really little or nothing to bring up. The same is the case in inflammation of the lung substance itself. As an example of excessive action we may take sneezing, which is calculated to remove irritants from the nose, but when too powerful may cause the patient to burst a blood-vessel. In phthisis also, although there may be some expectoration to bring up, yet a good deal of the irritation is in the lung substance, and the efforts of coughing are far greater and more continuous than are required for the removal of expectoration, and they simply exhaust the patient. In inflammation of the stomach also such continuous vomiting occasionally occurs that the patient's life is in danger by his inability to retain food; and similar danger also occurs from inflammation of the intestines and consequent diarrhoea.

We will next take the various parts of the body, and consider more in detail the therapeutic measures most commonly employed in the treatment of their diseases. The defensive powers of the body against microbes, when actually on or in it, may be classed as means (1) of passive defence, (2) of active defence, and (3) of repair. Besides these, however, we must consider the protection of the whole body from injury caused by (*a*) inaction, or (*b*) overaction, or (*c*) weakness of any one of its parts. The means of passive and active defence are sometimes so closely associated that it is difficult to distinguish between them. Thus if a little diphtheritic sputum were coughed into a person's eye, or some blood containing anthrax bacilli were to touch a raw spot upon the hand, the removal of microbes in either case by washing with simple water might be regarded as a means of passive defence, whilst washing them away with an antiseptic lotion might be regarded as active defence, because the antiseptic would tend not only to remove but to destroy the microbes. In the same way, washing the skin with spirit would tend to harden the epidermis and thus prevent the entrance of microbes; and the application of an ointment to an abrasion would have a similar action. But by the addition of some antiseptic to the ointment its defensive action would be converted from passive to active, and its power to prevent infection would become greater; and if inflammation had already set up in the skin, the addition of opium, belladonna, or cocaine would lessen local pain; and an astringent, either metallic or organic, would restrain inflammation and accelerate repair. The thickening of the epidermis in the hands and feet, which occurs from constant use, is nature's provision for meeting the extra wear to which these parts are subjected by much use; but pressure is apt to cause the defensive process to be carried too far, and to lead to corns, which give rise to much pain and annoyance. To remove these salicylic acid dissolved in flexible collodion is now generally employed. When this is painted upon the part the corn usually peels off in a day or two, and the patient is cured.

Defensive measures.

But the object of therapeutics is not merely to cure. It is, in the words of the old formula, *Curare, cito, tuto, et jucunde*, to cure quickly, safely, and pleasantly. There are therefore in most prescriptions (1) a basis or chief ingredient intended to cure (*curare*), (2) an adjuvant to assist its action and make it cure quickly (*cito*), (3) a corrective to prevent or lessen any undesirable effect (*tuto*), and (4) a vehicle or excipient to make it suitable for administration and pleasant to the patient (*jucunde*). In the remedy just mentioned the salicylic acid forms the basis; but sometimes chloride of zinc or lactic acid is added to it to make it act more quickly, and these are the adjuvants. Extract of belladonna is added to lessen the pain which might occur during the removal of the corn, and this acts as a corrective, while the flexible collodion forms a means of applying it conveniently, and constitutes the vehicle.

Principles of cure.

The surface of the skin may be invaded by parasitic organisms and may exhibit spots, which are removed by something which will destroy the parasite, such as ointments containing mercurial salts. In psoriasis the epidermis separates in flakes at various spots which have not been subjected to pressure, and to cure it ointment containing tar or other products of the dry distillation of wood is employed. When the true skin is inflamed various appearances may arise, according to the intensity and extent of the inflammation, and the eruption may be papular, vesicular, pustular, tubercular, bulbous or ulcerative. To lessen irritation the skin is protected by dusting powders, such as oxide of zinc, starch, fuller's earth, &c., or by ointments. Irritation is lessened by lotions containing substances that will diminish irritability of the nerve-endings and skin, such as carbolic acid, hydrocyanic acid, morphine or opium, cocaine, belladonna or atropine. Where the surface is ulcerated it may be protected from external violence and placed under favourable conditions for healing by covering it with lint moistened with water and with oil-silk over it to prevent evaporation. If the granulations tend to become too abundant, some astringent, such as sulphate of copper or sulphate of zinc, is added to the water. On the other hand, when the ulceration is old and the circulation through it poor, the aim of the therapeutist is to reawaken the normal reparative process, to bring about increased circulation and increased tissue change, and thereby insure healing. For this reason a blister is placed upon the callous ulcer, which heals with the fresh inflammation thus excited.

Inflammation.

The treatment of inflammation of mucous membrane is based upon the same principles as inflammation of the skin, and there too we usually associate means (1) for removing microbes, (2) for destroying them, (3) for lessening the irritation they produce, and (4) for repairing any mischief they have done. Thus in the eye and ear, lotions containing an antiseptic, a sedative and an astringent are very generally used. For inflammation of the mouth a similar combination is used as a mouth wash, in the throat as a gargle, and in the nose as a wash and sometimes as an ointment or spray, the ointment possessing the advantage of protecting the delicate nasal mucous membrane from irritation by stopping the entrance of irritant dust into the nasal cavities. In the stomach we aid the vomiting by which microbes or the products of decomposition of food are usually eliminated by giving to the patient repeated draughts of hot water so as to wash the stomach clean. Frequently this is sufficient; but if the stomach refuses to eject its objectionable contents, we may either give an emetic or wash it out by means of a stomach-pump or siphon. Similar procedures are used for the intestine, and one of the best methods of treating the diarrhoea consequent upon the presence of irritating substances in the intestinal canal is to give a dose of castor-oil together with a few drops of laudanum. By means of the castor-oil the irritating substances are removed, and the laudanum which is mixed with the purgative soothes the intestine. Even in cases of very acute intestinal diseases similar treatment is now pursued, and instead of treating dysentery simply by sedatives or astringents, an eliminative treatment by means of sulphate of magnesia is largely employed. After the irritant has been removed either from the stomach or intestine, a feeling of irritation of the mucous membrane may remain, and sickness, diarrhoea or pain may continue in the stomach and intestine although the irritant is no longer present within them, just as the flow of tears and desire to rub may remain in the eye after the piece of grit which has occasioned it may have been removed. The condition which remains after the irritant has been removed is one of inflammation more or less intense. The process of inflammation is a defensive one, but if carried too far may prove injurious.

For the purpose of checking the inflammatory processes and lessening discharge from mucous membranes astringents are employed. Some of these are of mineral and some of vegetable origin, but they almost all possess one chemical property in common, namely, they precipitate albumin. This power is possessed alike by a glass of brandy, by solution of lime, soluble salts of zinc, copper, or silver, by tannic and gallic acids, as well as vegetable juices and extracts which contain them. The strength of the astringent application and the mode of its administration are varied according to the delicacy and position of the mucous membrane affected. Thus to the eye we may use a solution of sulphate of zinc of half a grain to the ounce, while to the ear, urethra or vagina a solution of four to eight grains or even more may be applied. For the stomach and intestines we employ the same drug in the form of a pill; and when it is desired to act especially upon the intestines, the pills are made of a harder consistence or less soluble preparation, or are covered with keratin, so that they may not act much, if at all, upon the stomach while passing through it before reaching the intestines. The heat which occurs in inflamed parts is chiefly due to the larger amount of blood circulating in the part on account of the dilatation of the vessels. The pain is due to stretching of the nerve fibrils or compression of them by the turgid vessels in the swollen tissues. This latter cause is chiefly observed when the tissues are of a very unyielding character; for example, when the inflammation occurs in a bone or under a thick fibrous and unyielding membrane. The swelling, heat and pain may sometimes be relieved by mere change of position altering the flow of blood to the inflamed part. Thus when inflammation occurs in the finger, as in a whitlow, the pain is not only constantly severe, but it is increased by every pulsation of the heart, and thus has a throbbing character. By raising the hand nearly to a level with the head both the constant pain and the severity of the throbs may be relieved, as the blood is not sent with such great force into the arteries and returns more readily through the veins. In other parts of the body the same relief may be obtained by raising the inflamed part as high as possible. Relief is frequently given also by both heat and cold, and at first sight it seems strange that agents having such an opposite action should each produce a similar effect. The reason probably is that the application of cold causes contraction of the arteries leading to the inflamed part, while heat by dilating the vessels around forms a side channel through which the blood passes, the tension in the seat of inflammation being thus lessened in both cases. When the inflammation occurs in soft parts where the surrounding vessels can be readily dilated, heat often affords more relief to the pain than cold, but when the inflammation is in a bone or in unyielding fibrous tissues, cold generally gives more relief. For example, the pain of a gum-boil is generally relieved more by warmth, because the yielding tissues of the gum, mouth and cheek can be readily relaxed by heat and their vessels dilated; but when the pain is dependent upon inflammation in the hard unyielding socket of a tooth, cold generally gives greater relief. The removal of blood, either by incision or by the application of leeches, sometimes gives considerable relief to the pain and tension of inflamed parts. Blisters applied at some distance from inflamed parts are also sometimes useful; and probably they produce this good effect by causing a reflex contraction of the arteries in the inflamed part, and thus acting like a cold application. Certain drugs have the power of relieving inflammation by slowing the heart and rendering its impulse more feeble. Amongst those are to be classed small doses of aconite and colchicum; the former especially tends to lessen the process of inflammation generally, when it is not too severe. There can be little doubt that the intensity of inflammation frequently depends very much on the condition of the blood, and that by altering the blood inflammation may be lessened. Thus free purgation, and especially purgation by cholagogues and salines, has long been recognized as a useful means of reducing the inflammatory process. For example, a mercurial pill at night, followed by salts and senna in the morning, will often relieve the pain in toothache or gum-boil, and lessen inflammation not only in the mouth, but other parts of the body as well. Such remedies are termed *antiphlogistic*. Venesection (blood-letting) at one time was highly esteemed as an antiphlogistic measure, and while it is possible that it has now fallen too much into disuse, there can be no doubt that at one time it was very greatly abused, and was carried to such an excess as to kill many patients who would have recovered perfectly had they been let alone. Although the high temperature in an inflamed part is chiefly due to the increased circulation of blood in it, yet the presence of inflammation appears to cause increased formation of heat either in the inflamed part itself or in the body generally, because we rarely find inflammation exist to any extent without the temperature of the body being raised and a febrile condition produced.

Two very old remedies for fever are acetate of ammonia and nitrous ether. These were formerly given empirically, simply because they had been found to do good. Now we can see the reason for their administration, because the nitrous ether, consisting chiefly of ethyl nitrite, dilates the superficial vessels and thus allows greater escape of heat from the surface; while acetate of ammonia, by acting as a diaphoretic and stimulating the secretion of sweat, increases the loss of heat by evaporation. When a patient is covered with several blankets, loss of heat from the surface both by radiation and evaporation is to a great extent prevented, but if a cradle be placed over him, so as to raise the bedclothes and allow of free circulation of air around his body, both radiation and evaporation will be increased and the temperature consequently lowered. If his body be left uncovered except by the sheet or blanket thrown over the cradle, the loss of heat is still greater, and it may be much increased by sponging the surface with either hot or cold water so as to leave it slightly moist and increase evaporation. The temperature may be still further reduced by placing vessels filled with ice inside the cradle. When the patient is very restless, so that cradling is impossible, a wet pack may be employed, a sheet wrung out of cold water being wrapped round him, and over this a blanket. The pack has the double effect of restraining his movements and thus lessening the production of heat, while at the same time it dilates the vessels of the skin and produces loss of heat. The restraint which it imposes and the equal distribution of heat over the surface frequently cause sleep quickly in patients who have previously been wildly delirious and entirely sleepless. When the temperature continues to rise in spite of wet sponging and cradling, recourse must be had to the cold bath. The bath should be brought to the bedside and the patient, wrapped in a sheet, should be lifted into it by two attendants. The water should be at the temperature of 90° and gradually reduced by the removal of hot water and displacement by cold, until the temperature of the patient as taken in the mouth is reduced to about 99½° or 99°. After this the patient should be taken out and again put into bed. It is inadvisable to lower the temperature quite to the normal while the patient is in the bath, as frequently it falls after his removal, and may fall so far as to induce collapse. In cases where no bath is available a large mackintosh sheet may be spread upon the bed under the patient, the sides and top may be raised by pillows, and cold water may be applied to the surface of the body with large sponges. The mackintosh sheet forms a shallow bath, and the water may afterwards be run off from it at the lower end of the bed. Another way of applying cold is to dip an ordinary sheet into cold water, apply it for three or four minutes to the surface of the body, then remove it and replace it by another sheet while the first one is being dipped in water. By the alternate use of the two sheets, or by the use of one quickly wrung out of cold water as soon as it becomes warm, the patient's temperature may be rapidly reduced.

Fever.

There are a number of drugs which have a very powerful action in lowering temperature. Most of these belong to the aromatic group of bodies, although one of them, antipyrin, belongs rather to the furfurol group. Carbolic acid has an antipyretic action, but on account of its poisonous properties it cannot be employed as an antipyretic. Salicylic acid has a strong antipyretic action, and is most commonly used in the form of its sodium salt, which is much more soluble than the acid itself. Amongst other antipyretics, the most important are quinine, phenacetin and antifebrin. These probably lessen fever by their action upon the nerve centres which regulate the temperature of the body, and partly by their peripheral action in causing the secretion of sweat. Very high fever in itself will cause death, the fatal temperature in rabbits being 114·6°. Before death occurs the pulse and respiration become exceedingly rapid and weak, and complete unconsciousness sets in. That these symptoms are simply due to heat is shown by the fact that if the temperature be quickly reduced by the application of cold the symptoms at once subside. But the delirium which is common in fever, although it may be partly due to rise of temperature, is very often due to poisons in the blood, for in some cases it occurs with quite a low temperature, 101° or 102°, whereas in others the temperature rises to 104° and 105° with no delirium whatever. The presence of toxins in the blood not only affects the brain, causing delirium, but also other organs, the heart and lung, and may cause fatal syncope or respiratory failure.

Anti-toxins and anti-serums. Many years ago Dr S. L. Mitchill (1764–1831) pointed out in America the resemblance which exists between symptoms of poisoning by snake venom and infective fevers.[1] S. Weir Mitchell and others have shown that serpent venom consists chiefly of albumoses, and the toxins formed by infective bacilli have a somewhat similar chemical nature. Calmette and Fraser found that when small doses of snake venom, insufficient to cause death, are injected into an animal, temporary disturbance is produced; but after a few days the animal recovers, and a larger dose is then required to produce any symptoms. By gradually increasing the dose the animal becomes more and more resistant, until at last a dose fifty times as great as that which would at first have produced immediate death can be injected without doing the animal any harm. If a horse be chosen for the experiment, a considerable quantity of blood may be withdrawn without injuring the animal. When this is clotted the serum is found to act as an anti-venin, so that when mixed with the venom of a snake it renders it harmless. Although this result is best obtained when the venom and serum are mixed in a glass before injection, yet if they be injected at the same time in different parts of the body the animal will still be protected and the poison will not produce its usual deadly results. What occurs with snake venom takes place also when the toxins are formed by microbes, and a new method of treatment by anti-toxic serums has been introduced of late years with great success. This is most commonly and successfully used in the treatment of diphtheria. This disease depends upon the presence of a bacillus which grows rapidly at the back of the throat and in the air-passages specially of children, causing the formation of a membrane which, by plugging the windpipe, causes suffocation and death. At the same time it produces a poison which causes inflammation of the nerves, leading to paralysis, which sometimes proves fatal. By growing this bacillus in broth a toxin is formed which remains in solution and can be separated from the bacilli themselves by filtration. This toxin-containing broth is injected into a horse in increasing doses, just as in the case of the serpent venom, and after the resistance of the horse has been much increased it is bled into sterilized vessels and the blood is allowed to coagulate. The serum is then removed and its anti-toxic power tested by ascertaining the amount necessary to counteract a given amount of active toxin in a guinea-pig of a certain size, the standard weight being three hundred grammes. The serum, the strength of which has thus been ascertained, is distributed in bottles and injected in the proper quantity under the skin of children suffering from diphtheria. If used at an early stage of the disease, and in sufficient quantity, the results are wonderful. The same method of serum therapeutics has been used in other infective diseases, but not with the same success.

Inoculation. Another therapeutic method which is historically much older than that of serum therapeutics is that of inoculation. The virulence of infective diseases varies in different epidemics, and at different times in the same epidemic. It had been noted that many infective diseases did not attack an individual a second time, the first attack appearing to protect from subsequent ones. The idea of inoculation, therefore, was to infect an individual with a mild form of the disease, so that he should escape infection by a more virulent one. This was tried largely in the case of smallpox, and once at least by Dr Erasmus Darwin in the case of scarlet fever. The worst of this method was that the disease thus inoculated did not always prove of a mild character, and in the case of Dr Erasmus Darwin's son the scarlet fever was exceedingly severe and very nearly proved fatal. To Edward Jenner we owe the discovery that vaccination protects against smallpox, and it is now generally acknowledged that smallpox and vaccine are probably the same disease, the virus of which is modified and its virulence lessened by passing through the body of the cow. Pasteur found that the germs of anthrax could be cultivated outside the body and their virulence weakened either by growing them at too high a temperature or in an unsuitable medium. By inoculating first with a weak virus and then with others which were stronger and stronger, he was able completely to protect oxen either from the effects of inoculation with the strongest virus or from infection through contact with other animals suffering from the disorder. On the other hand, he found the weakened virus could be again strengthened by inoculating a feeble animal such as a guinea-pig a day or two old with it, and then inoculating stronger and stronger animals: an increase in strength was gained with each inoculation, until at last the virus could attack the strongest. A similar increase in virulence appears to occur in plague, where animals, especially rats and mice, seem to be affected before human beings, and not only increase the virulence of the microbes, but convey the infection. Two methods of protective inoculation have been used. In one, Haffkine employs the toxins obtained by growing plague bacilli in broth for five or six weeks, and then heating the whole to 65° or 70° C. so as to destroy the bacilli. This preparation is prophylactic, but does not seem to be curative. Yersin has prepared a serum from horses in the same way as diphtheria anti-toxin, and this is said to have a curative action during the attack. In the same way sterilized cultures of typhoid bacilli have been used to protect against attacks of typhoid fever, and an anti-typhoid serum has been employed with intent to cure. Protection does seem to be afforded, but the curative action of the serum is still somewhat doubtful. Although the anti-toxins which are used in the cure of infective diseases are not dangerous to life, yet they sometimes cause unpleasant consequences, more especially an urticarial eruption almost exactly like that which follows eating mussels or other shell-fish. Sometimes the swelling of the skin is much more general, so that the whole body may be so swollen and puffy as exactly to resemble that of a person suffering from advanced kidney disease. These disagreeable results, however, are not to be compared with the benefits obtained by the injection of anti-toxic serum, and this method of treatment is likely to maintain its place in therapeutics.

Organo-therapeutics. For many years pepsine has been used as a remedy in dyspepsia to supplement the deficiency of digestive juice in the stomach, and it has been used popularly in dyspepsia for a still longer period. From time immemorial savages have been accustomed to eat the hearts of lions and other wild animals, under the belief that they will thereby obtain courage and strength like that of the animal from which the heart had been taken, but in 1889 Brown-Séquard proposed to use testicular juice as a general tonic and stimulant. Observations were made on the connexion between thyroid gland and myxoedema, which appeared to show that this disease was dependent upon atrophy of the gland. Accordingly the liquid extracts of the gland, or the gland substance itself compressed into tablets, have become largely used in the treatment of the disorder. The success which has been achieved has led to the use of many other organs in a raw or compressed form, or as extracts, in other diseases; *e.g.* of suprarenal capsule in Addison's disease, of bone marrow in pernicious anaemia, of thymus and suprarenal capsule in exophthalmic goître, of kidney in renal disease, and of pituitary body in acromegaly. To this method of treatment the name of organo-therapeutics or opo-therapy has been given. The first scientific attempt to employ portions of raw organs in the treatment of disease was made by Lauder Brunton in diabetes in 1873, sixteen years before Brown-Séquard's paper on the effect of testicular juice. From considering the nature of diabetes, he had come to the conclusion that many cases were due to imperfect oxidation of sugar in the body; that this oxidation was normally carried out by a ferment in the muscles, and that probably the disease was in some cases dependent upon absence of the ferment. He tried to supply this by giving raw

[1] Quoted by Weir Mitchell, "Researches on the Venom of the Rattlesnake," *Smithsonian Contributions* (1860), p. 97.

meat and glycerine extract of meat, but although he seemed to get some benefit from the treatment, it was not sufficiently marked to attract general attention. His attempts to isolate a glycolytic ferment from flesh were also only partially successful. One of the great difficulties in the way of applying this treatment is that in all probability many of the ferments or enzymes are altered during the process of absorption in the same way as the normal ferments of digestion, and unless the tissue enzymes can be isolated and injected subcutaneously the desired results will not be obtained. The most striking of all the results of organo-therapy are those obtained in myxoedema. In this disease the face is heavy, puffy and expressionless, the lips thick, the speech slow, the hands shapeless and spade-like, the patient apathetic, the circulation slow and the extremities cold. Under the influence of thyroid gland these symptoms all disappear, and the patient is frequently restored to a normal condition. When the thyroid gland is absent in children, not only is the expression of the face dull and heavy as in the adult, but the growth both of body and mind is arrested, and the child remains a stunted idiot. The effect of thyroid gland in such cases is marvellous, the child growing in body and becoming healthy and intelligent. In the case of the thyroid the function of the gland appears to be to prepare a secretion which is poured out into the blood and alters tissue-change. When the thyroid tablets or extract of thyroid are given in too large quantities to patients suffering from myxoedema, the symptoms of myxoedema disappear, but in their place appear others indicative of increased metabolism and accelerated circulation. The pulse-rate becomes very rapid, the extremities become warm, so that the patient is obliged to wear few clothes, the temper becomes irritable, the patient nervous, and a fine tremor is observed in the hands. On stopping the administration of thyroid these symptoms again disappear. When the thyroid is hypertrophied, as in Graves's disease, the same symptoms are observed, and these are probably due to increased secretion from the thyroid. At the same time other symptoms, such as exophthalmos, may appear, which have an independent origin and are not due to the secretion of the gland. The whole of the secretion here is poured into the blood and not at all on to a mucous surface, and herein the thyroid gland differs largely from such glands as the pancreas or peptic and intestinal glands. But it seems now probable that all glands which have what may be termed an external secretion like the pancreas, stomach, intestine, skin and kidneys have also an internal secretion, so that while they are pouring out one secretion from the ducts into the intestine or external air, they are also pouring into the lymphatics, and thus into the blood, an internal secretion. In fact, a splitting appears to take place in the process of secretion somewhat resembling that which takes place in the formation of a toxin and anti-toxin. The secretion of some digestive glands would prove poisonous if absorbed unchanged. For example, the trypsin of the pancreas (see NUTRITION) digests albuminous bodies in neutral or alcoholic solution, and if the whole of that which is secreted in the pancreas for the digestion of meat in the intestine were absorbed unchanged into the circulation, it would digest the body itself and quickly cause death. The secretion of trypsin by the pancreas may therefore be looked upon as the formation of a toxin. We do not know at present if any corresponding anti-toxin or anti-trypsin, as we may term it, is returned into the lymphatics or blood from the gland, but the pancreas, which in addition to secreting trypsin secretes a diastatic ferment forming sugar from starch, pours this into the intestine and secretes at the same time a glycolytic ferment which breaks up sugar, and this latter passes into the blood by way of the lymphatics. Thus the gland not only breaks up starch into sugar in the intestine, but breaks up the sugar thus formed after it has been absorbed into the blood. It is known that several, perhaps very many, if not all glands have also the power of secreting substances to which Starling has given the name of "hormones." These pass into the blood and cause other glands to secrete. Thus an acid in the duodenum causes it to secrete a hormone to which the name of "secretin" has been given. This passes to the pancreas and causes increased secretion from that gland. It is probable that the pancreas in its turn also secretes something which activates a ferment in the muscles. It is evident therefore that the connexion between the different glands of the body is a very complicated one and that the effects of a drug which acts upon any one of them may be of a very far-reaching character. It is by no means improbable that all glands have a double or even triple function, and that sometimes the external may be even less important than the internal secretion. On this point, however, we have but little definite knowledge, and a great field is open for future research. At the same time, there are many indications of the importance of an internal secretion in popular treatment. For example, there are many people who feel very much better after profuse perspiration, and as sweat appears to contain little but water and a few salts, it is not improbable that the improvement in their condition is due rather to the internal secretion from the skin than to the elimination effected by the sweat. It is probable that the kidneys also have an internal secretion, and that the great oedema sometimes found in kidney disease is rather due to the action of some proteid body resembling in its effects the streptococcus anti-toxin, than to accumulation of water due to imperfect action of the kidney. Similarly the beneficial effects of purgation may be due not only to the elimination which takes place through the bowel, but also to the internal secretion from the intestinal glands.

The health of the body depends upon the proper kind and supply of food, upon its proper digestion and absorption, on the proper metabolism or tissue-change in the body, and the proper excretion of waste. We have considered how these may be disturbed by microbes from without and from within. We have also considered in a general way the treatment of local diseases by passive protection, active protection and repair of waste; but both maintenance of health and repair of waste depend very largely upon the condition of the blood. When this is healthy the attacks of microbes are resisted, wounds heal readily, and patients recover from serious diseases which in persons of debilitated constitution would prove fatal. In order to keep the blood in a satisfactory condition it must be well supplied with fresh nutriment, and the products of waste freely eliminated. The food required for the body may be divided into five kinds—carbohydrates, such as starches and sugars; fats; proteids, such as meat and eggs; salts; and last, but not least, water.

Nutrition and elimination.

Water forms almost three-fifths of the weight of the body, so that it amounts to more than all the other constituents put together. Without it life would be impossible, and it is well recognized that death from thirst is more awful than death from hunger. The healthy organism can adapt itself to great varieties both in regard to the quality and quantity of food; but when health begins to fail much care may be required, and many ailments arise from dyspepsia. Imperfect digestion is very often caused by defective teeth or by undue haste in eating, so that the food is bolted instead of being sufficiently masticated and insalivated. The food thus reaches the stomach in large lumps which cannot be readily digested, and either remain there till they decompose and give rise to irritation in the stomach itself, or pass on to the intestine, where digestion is likewise incomplete, and the food is ejected without the proper amount of nourishment having been extracted from it; while at the same time the products of its decomposition may have been absorbed and acted as poisons, giving rise to lassitude, discomfort, headache, or perhaps even to irritability and sleeplessness. Much dyspepsia would be avoided by attention to the condition of the teeth, by artificial teeth when the natural ones are defective, and by obedience to one or two simple rules: (1) to eat slowly; (2) to masticate thoroughly; (3) to take no liquid with meals excepting breakfast, but sip half a pint of hot water on rising in the morning, on going to bed at night, and again about an hour before luncheon and dinner. The object of taking no liquid with meals is that it ensures mastication being more complete, because persons cannot wash the unmasticated food down by drinking, and it prevents the gastric juice from being greatly diluted, and so allows it to digest more rapidly. Should these rules be insufficient, then (4) proteid and farinaceous food should be taken in separate meals—farinaceous food at breakfast, proteid alone at lunch; farinaceous in the afternoon, and proteid again in the evening. The reason for this is that farinaceous foods are digested in the intestine and not in the stomach, where they may undergo fermentation, whereas proteid foods are to a great extent digested in the stomach. When the secretion of gastric juice is deficient it may be excited by gastric tonics, such as ten grains of bicarbonate of soda and a drachm of compound tincture of gentian in water shortly before meals, and may be supplemented by the administration of pepsin and hydrochloric acid after meals. When the nervous system is below par, and both secretion and movements are deficient in the stomach, nervine tonics, such as nux vomica or strychnine, are most useful.

Sleeplessness. High tension in the arteries is often associated with sleeplessness, the pressure of blood being such that the circulation in the brain is constantly maintained at a high rate of speed and the brain is unable to obtain rest. The means of producing sleep may be divided into two classes: those (1) which lessen the circulation, and which (2) diminish the excitability of the brain cells. The circulation in the brain may be lessened by warmth to the feet, cold to the head, warm food in the stomach, warm poultices or compresses to the abdomen, antipyretics, which reduce the temperature and consequently slow the beats of the heart in fever, and cardiac or vascular tonics, which slow the heart and tend to restore tone to the blood-vessels, so that the circulation in the brain may be more efficiently regulated. Amongst those which lessen excitability of the brain-cells are opium, morphine, hyoscyamus, chloral, sulphonal, trional, paraldehyde, chloralamide, chloralose, hop and many others. A combination of the two kinds of remedy is sometimes useful, and chloral sometimes succeeds when other things fail, because it depresses the circulation as well as lessens the activity of the brain-cells.

Pain. Irritation of sensory nerves tends to cause contraction of the vessels and to raise the blood pressure, and where pain is present opium or morphine is the most efficient sedative. The sensation of pain is felt in the brain, and the cause of it may be in the sensory centres of the brain alone, as in cases of hysterical pain, with no lesion to cause it. Ordinarily, however, it is due to some peripheral irritation which is conducted by sensory nerves to the spinal cord and thence up to the sensory centre in the brain. Pain may be stopped by removing the cause of irritation, as, for example, by the extraction of a carious tooth or by rendering the nerve-endings insensitive to irritation, as by the application of cocaine; by preventing its transmission along the spinal cord by antipyrin, phenacetin, acetanilide, cocaine, &c.; or by dulling the perceptive centre in the brain by means of opium or its alkaloids, by anaesthetics, and probably also, to a certain extent, by antipyrin and its congeners.

High tension. Both sleeplessness and pain are sometimes due to the action of toxins absorbed from the intestine, and both of them may sometimes be relieved more efficiently by thorough purgation than by narcotics. Another condition which is probably due to toxins is high pressure within the arteries. When this continues for a length of time it tends by itself to cause deterioration of the blood-vessels and leads to death either by cerebral apoplexy or by cardiac failure. It is therefore very important to discover high tension at an early period. It may be diminished or its increase prevented by a diet from which red meat and meat extracts are excluded, by the use of the lactic acid bacillus, by the administration of laxatives and cholagogues to regulate the bowels, and by the use of iodides and nitrites. By such régime and medicines life may sometimes be prolonged for many years.

Deficient nervous action also leads to defective secretion and movement in the intestine, sometimes with flatulent accumulation and sometimes with constipation. In such cases nux vomica or strychnine is useful. *Flatulence.* Flatulent distension in the stomach or bowels is partly due to air which has been swallowed and partly to gas which has been formed by the decomposition of food. The stomach may become distended with gas on account of acid fermentation leading to the frequent swallowing of saliva, and both this form of flatulence and that caused by the actual formation of gas are much diminished by such drugs as tend to prevent fermentation. Amongst the best of these are carbolic acid in doses of one or two grains, creosote in one or two drops, and sulpho-carbolate of soda in doses of ten grains. Others which may be mentioned are salicylate of bismuth, salol, β-naphthol and naphthalene. By preventing fermentation in the intestine these also tend to prevent or check diarrhoea, and they may do good after the irritant has been removed by castor oil. After the irritant has been removed and fermentation stopped, the irritation still remaining in the intestinal wall may be soothed by chalk mixture and bismuth, to which if necessary small quantities of opium may be added. In cases where diarrhoea is very obstinate and lasts for weeks, sulphuric acid is sometimes more efficacious than alkalis; and in chronic colics it may be necessary to treat the mucous membrane by local application of astringent solutions. For this purpose solutions of sulphate of copper or of nitrate of silver may be gently introduced into the bowel in quantities of a quart at a time. It is essential that a large quantity should be used, as otherwise the seat of irritation may not be reached by the astringent. Flatulence and diarrhoea as well as many general disorders are often due to intestinal depression caused by microbes. To these injurious microbes Metchnikoff has given the name of "wild," and he proposes to restore health by giving "tame" microbes, such as lactic acid bacilli. This treatment on the principle of "setting a thief to catch a thief" is frequently very useful. The lactic acid bacilli are given either in the form of tablets or milk soured by them, or cheese made from the sour milk. The most efficient form is soured milk, which acts as a food as well as medicine.

Constipation. Constipation is so common that it may be almost looked upon as the normal condition in civilized countries. Two of its chief causes probably are (1) improvement in cookery, whereby the harder and more irritating parts of the food are softened or removed; and (2) improvement in grinding machinery, whereby the harder and more stimulating parts of the grain are separated from the finer flour which is used for bread. In consequence of the absence of mechanical stimulant the bowels act more slowly, and constipation is the result. It may be considerably diminished by a return to a more natural system of feeding, as by using brown bread instead of white, by taking oatmeal porridge, and by eating raw or cooked fruits, such as apples, oranges, prunes and figs, or preserves made of fruit, such as raspberry and strawberry jam, marmalade, &c., by vegetables or by dried and powdered seaweed. Should these means fail, aperients may be used. The commonest are senna in the form of compound liquorice powder, sulphur in the form of lozenges, cascara sagrada, either in tablets or in the form of liquid or dry extract, rhubarb, colocynth and especially aloes. The last acts chiefly upon the lower bowel, and forms a constituent of nearly every purgative pill. The medicines above mentioned may be taken either in a moderate dose at bedtime or in the form of a dinner pill, or they may be taken in small doses three times a day just before or after meals. Some sufferers from constipation find that they get greater relief from salts dissolved in water, or from natural aperient water taken on rising in the morning, and others again find that the best way of opening the bowels is to inject one or two drachms of glycerine into the rectum, or use it as a suppository. If these means fail, exercise, massage and electricity may help a cure.

The most common diseases of malassimilation (or "metabolic" diseases) are gout, rheumatism and diabetes. In health most of the nitrogenous waste in the body is eliminated as urea, but in gout uric acid is either formed in too great quantity or too little is eliminated, so that it tends to be deposited as urate of soda in the joints and other tissues. Two means of treating it by diet have been proposed. One is to put the patient on an almost complete vegetarian diet, so as to limit both the amount of uric acid introduced into the body as well as its formation in the body. The other plan is to use an exclusively meat diet, combined with the ingestion of a large quantity of hot water, so as to cause free elimination. Where neither method is strictly pursued it is usual to forbid to gouty patients sugar, pastry and pickles, and to forbid heavy wines, especially Burgundy and port. During an attack of acute gout nothing relieves so much as colchicum, but during the intervals potash or lithia salts taken in water are advisable, as tending to prevent the deposits of urate of soda. In true diabetes, which probably originates in the central nervous system, or in disease of the pancreas, as well as in the glycosuria common in gouty patients, sugar in every form should be entirely forbidden, and starchy food restricted to within narrow limits. The remedy most trusted to in this disease is opium and its alkaloids, morphine and codeine. In acute attacks of rheumatism the remedy *par excellence* is salicylate of soda, which reduces the temperature, relieves the pain, and removes the swellings from the joints. Rest in bed should be insisted upon for a longer time than appears actually required, because acute rheumatism tends to bring on cardiac changes, and is more likely to do this when the heart is excited than when the patient is kept at rest. In chronic rheumatism the chief remedies are salicylate of soda, and its allies iodide of potassium, guaiacum and sulphur, while massage, liniments and baths are beneficial as local applications.

Diseases of mal-assimilation.

Elimination of waste-products is one of the most important points in regard to health, and when this is interfered with by disease of the kidneys, the life of the patient is rendered more or less uncertain and the health frequently seriously impaired. In some cases of chronic inflammation of the kidneys, where the disease is not extensive, the patient may continue in fair health for a number of years, provided attention be paid to the following rules:—(1) The body must be kept warm, and chills must be scrupulously avoided; (2) the digestion must be attended to carefully, so that no excess of poisonous bodies is formed in the intestine or absorbed from it; (3) eliminating channels such as the skin and bowel must be kept active. It is usual to reduce the quantity of proteid food to a minimum, in order to lessen the amount of nitrogenous waste to be excreted by the kidneys. Sometimes an entirely milk diet is useful, but in others it does not agree, and a more liberal diet is essential. Alcohol should be avoided as much as possible. The small contracted kidney, which is so common in elderly gouty people, is usually associated with a very large secretion of urine containing only a minute trace of albumin. The tension within the blood-vessels is generally high, and the patients run a risk of anginal attacks or of apoplexy. A nearly vegetarian diet and a complete abstinence from alcoholic stimulants is the ideal in such cases, but it must be modified to suit individuals, as sometimes very strict limitations prove injurious. The daily use of potash, and especially nitrate of potash, tends to reduce the tension and increase the patient's safety, but if pushed too far may sometimes render him very weak and depressed.

Diets and "cures."

It has already been mentioned that water is absolutely necessary for the body: by taking it hot it does not lie like a weight on the stomach, and by taking it an hour before meals it washes out the remnants of the previous meal; and being absorbed into the blood, it probably renders the secretion of gastric juice freer and accelerates digestion, instead of diluting it and interfering with the digestive processes. Where the stomach and bowels are irritable, all food likely to cause mechanical irritation should be avoided, such as skins, bones, fibres and seeds. In some cases of diarrhoea an entirely milk diet has to be prescribed, and in the diarrhoea of children it is sometimes necessary to alternate a diet of barley water with one of beef juice or white of egg and water, or to give whey instead of milk. The drinking of large quantities of whey is used as a means of cure for dyspepsia in adults, and also in cases of chronic bronchitis. The whey is drunk warm, and for this cure it is usual to go to some Alpine resort where pasturage is abundant and fresh milk can be had at all times of the day. The cure is greatly helped by the fresh air and sunshine of such places, among which are Interlaken, Rigi-Scheideck and Weggis in Switzerland; Ischl and Meran in Austria; Harzburg, Reichenhall and Sanct Blasien in Germany. Another therapeutic method is the so-called "grape cure," in which, along with a regulated diet, five or six pounds of grapes are eaten daily. As the grapes contain a quantity of water and of salts, they tend to lessen the amount of food taken, to increase the action of the bowels, and to stimulate the kidneys. The "grape cure" is used both in chronic disease of the stomach and intestines with or without constipation, and also in cases of gout or ailments depending upon a gouty constitution. The chief places where it is carried on are in the neighbourhood of the Rhine, on the Lake of Geneva and in Tirol. Amongst places in the Rhine and its vicinity may be mentioned Kreuznach, Neustadt, Rüdesheim and St Goar; on the Lake of Geneva are Montreux and Vevey; and in Tirol Gries and Meran. The so-called "Salisbury" cure consists of living entirely upon minced beef and hot water. It sometimes answers very well in persons troubled with flatulence, since meat does not give rise to the same amount of gas in the intestines as carbohydrates. During its continuance fat is absorbed from the subcutaneous tissue, and patients become very much thinner, so that it not only lessens flatulence, but reduces obesity. It is, in fact, very much the same system as that proposed a number of years ago by Banting (see CORPULENCE). It is very important for those who are trying this diet to bear in mind the necessity of abundance of water, because sometimes they may be tempted to lessen the water on account of the inconvenience produced either by frequent micturition or too profuse sweats. If the meat diet be continued with too small a proportion of water, a gouty condition may be brought on. This diet has been recommended in gout, and no doubt the essential part of it is the hot water, but there can be little doubt that in fat gouty people it is often useful. An entirely opposite dietary is that in which butcher's meat is completely excluded and proteids reduced to a minimum, as advocated by Dr Haig. This dietary also is very useful in gout, but it answers better in thin gouty people than in fat ones.

The dietaries already mentioned, the whey cure, the grape cure, the meat cure and the vegetarian cure, are all more or less systems of starvation, one or other article of ordinary diet being either reduced to a minimum or omitted altogether. In three of them at least—the whey cure, the grape cure and the meat cure—a diminution in one or other of the solid constituents of food is associated with the ingestion of an unusually large quantity of water. In visiting the most famous watering-places, it is curious to note how one finds, in the various waters, here some chloride, there some sulphate, here some potash, there some magnesium, but in all of them we find water. In watching the troops of patients who go to the wells we notice that most of them do more early rising, take more regular exercise, and drink more water in the course of a month at the well than they would do in the rest of the year at home. The watering-places divide themselves, according to the temperature of the waters, into cold and thermal, and according to the composition of the waters, into purgative saline, indifferent saline, sulphur and iron. Amongst the most celebrated saline waters are those of Carlsbad, which contain sulphate of soda and bicarbonate of soda. These salts crystallize out when the water is partially evaporated and may be used with hot water at home, the best imitation of the Carlsbad water being obtained by mixing with hot water the powdered Carlsbad salts (*pulverförmig*), which contain all the constituents of the natural water. Where it is impossible for the patient to visit Carlsbad, half a teaspoonful or a teaspoonful of salt may be taken in a large tumbler of hot water on rising every morning; but when taken at home the treatment is not so effective as at Carlsbad, because at the wells sipping water is associated with early rising, considerable exercise and a very carefully regulated diet. It is, indeed, the care with which the diet of patients is regulated and the difficulty that patients find in obtaining forbidden foods at hotels and restaurants, that make Carlsbad better for the liver than any other watering-place. Amongst other places having a similar action are Marienbad, Franzensbad and Tarasp. The waters just mentioned contain free alkali as well as sulphates, and are employed more especially in cases of hepatic disorder, such as congestion of the liver, jaundice, gall-stone and diabetes. A number of other waters containing sulphides and chlorides are powerfully purgative, and are more often drunk at home than at the springs. Amongst these are the Hungarian waters, Aesculap, Apenta, Franz Josef and Hunyadi Janos; and the Rubinat and Condal waters of Spain. Waters which have a similar composition are drunk at the springs of Leamington and Cheltenham in England, Brides Salins and St Gervais in France, for chronic constipation, dyspepsia, gout and hepatic disorders of a milder character than those usually treated at Carlsbad. The waters in which chlorides form the purgative principle are those of Homburg, Kissingen, Wiesbaden and Baden Baden in Germany, and Bridge of Allan in Scotland. Similar waters, but much weaker, are found at Innerleithen and Pitkeithly. Sulphur waters are chiefly used for painful and stiff joints, chronic skin disease, and chronic catarrhal affections. The most important are Aix-les-Bains, and a number of springs in the Pyrenees in France, Aachen in Germany, Harrogate in England, Strathpeffer and Moffat in Scotland. Iron waters are used in anaemia and the affections which are frequently associated with it. The most important are Spa in Belgium, Schwalbach in Germany, St Moritz and Tarasp in Switzerland. Iron waters are, however, common, and are generally found at all those places which have sulphur waters. Simple alkaline waters containing carbonates, chiefly of sodium along with some magnesium and calcium, are drunk for their utility in gastric and intestinal disorders as well as in rheumatism and gout. They are also employed locally as sprays and douches to the nose, throat, vagina and rectum, for catarrhal conditions of the mucous membranes. The most important are Vichy and Vals in France and Neuenahr in Germany. Alkaline waters containing a little common salt are perhaps even more important than the pure alkaline, as the salt lessens the depressing effect of the alkali. They are therefore used largely in chronic gout, rheumatism and in calculous affections of the kidney. Amongst the most important are Ems and Wildungen in Germany, Contrexéville and Royat in France.

Simple thermal waters are those which contain only a very small quantity of solids, and owe their efficacy chiefly to their temperature. They are used partly for drinking, but even more so for baths. Bath, Buxton and Matlock in England; Mallow in Ireland; Wildbad, Schlangenbad and Badenweiler in Germany; Gastein and Teplitz in Austria; Ragatz in Switzerland; Plombières and Dax in France; and Bormio in Italy are amongst the best known. When water is dashed against the body with more or less violence, its effects are more powerful than when the body is simply immersed in it. Thus the stimulating effect of sea-bathing is more marked than simple salt-water baths, for in addition to the effect upon the skin produced by the salt and by the temperature of the water, we have the quicker removal of heat by the continual renewal of the water as the waves dash over the body, and mechanical stimulus from its weight and impetus. Somewhat similar effects are produced by so-called wave-baths, and at Nauheim, although the fresh movement of the water against the surface of the body is much less than in the sea, yet its stimulating effect is greatly increased by the presence of carbonic acid in it. Douches have a still more powerful action than waves. They are generally given in the air, but at Plombières very simple douches are given under water. These form a more powerful wave-bath, and in combination with intestinal irrigation, are used very successfully for the treatment of abdominal disorders. Douches to the spine are much employed for nervous debility, and good effects are also obtained in such cases from the so-called needle-bath, where small streams of water at high pressure are driven against the whole surface of the body. In the treatment of stiffened joints, massage under water is very serviceable, and in the so-called Aix douche a nozzle from which water continuously streams is fastened to the wrist of the masseur, so that a current of water is constantly playing upon the joint which he is rubbing. While water containing much saline matter, and more especially water containing free carbonic acid, has a very stimulating action upon the skin, mud has a sedative effect, so that in a mud-bath one feels a pleasant soothing sensation as if bathing in cream. These mud-baths are chiefly employed at Marienbad, Franzensbad and Homburg. Sulphur-baths and sulphur waters are chiefly used in combination for rheumatism and gout, and massage, especially under water, is frequently combined most advantageously with baths and drinking water to effect a cure.

Baths.

Exercises, passive and active, are also used in diseases of the joints, as well as massage and baths, but exercises and training are even more important in cases of cardiac disease. In very bad cases of heart disease, where the patient is unable to go about, the best plan of treatment usually is to make him stay absolutely quiet in bed and have massage, which aids the circulation, tends to remove waste, and increases the appetite. To this is added gentle exercise, beginning with the fingers at first. At Meran walks have been arranged according to Oertel's system, and at Llangammarch in Wales both Oertel's and Schott's systems are employed, and baths according to the Nauheim system are also to be found in London, Sidmouth, Leamington, Buxton, Strathpeffer, &c. Many people who have sedentary employments are unable to get as much exercise as they require because they have not either the time or the opportunity. Such persons may sometimes get a good deal of exercise in a short time by the use of dumb-bells, of elastic cords, or of cords running over pulleys and weighted at one end. The whole system of methodical exercises was started by Ling in Sweden, but it has been developed to a large extent for the purpose of increasing muscular strength by the professional athlete Sandow. A punching ball or rowing machine is even better as being less monotonous. Fencing, boxing or wrestling may also be resorted to. Walking on the flat is of comparatively little use as a mode of exercise, and has become supplanted to a considerable extent by bicycling. Ascending mountains, however, is very different, because in walking up a steep ascent all the muscles of the body are thrown into action, and not only those of the legs. In addition the purer and rarefied air of the Swiss mountains seems to produce a sense of exhilaration which is not felt nearer the sea-level. For those who suffer from nervous depression, exercise in the Swiss mountains is useful, and even living at a height of about 6000 ft. above the sea-level seems to have an exhilarating influence. The nature of this is not very easy to analyse, but as mental depression is closely associated with irritation of the vagus nerve and weakening of the circulation, it seems not at all unlikely that mountain air acts by accelerating the pulse and quickening the circulation, and thus creating a sense of well-being. Indeed, many patients liken its effect to that of drinking champagne. In some persons rarefied air is too stimulating, so that they find difficulty in sleeping, and for those who suffer from insomnia a warm moist air nearer the sea-level is preferable.

Exercise.

It sometimes happens, however, that people cannot sleep at the seaside itself, although they do so perfectly well a mile or two inland. Where the nervous system is exhausted, such warm and moist climates as Malaga, Madeira, Tenerife and Grand Canary are suitable. In these places not only is the air moist, but the temperature is particularly equable, and they are therefore suitable places also for persons suffering from kidney disease. Many such persons also do well in dry, warm places, such as the higher reaches of the Nile, Egypt, Mentone, St Raphaël and other sheltered places on the Riviera. The places mentioned are all suitable for persons suffering from chronic bronchitis, who should avoid any irritation

Health resorts.

of the larynx, trachea or bronchi by air which is too dry or which is liable to great changes of temperature. Some cases of phthisis, therefore, do better in warmer and moist climates, and especially those where the larynx has become affected by the disease. Such patients are apt to suffer much from cough and laryngeal irritation in the cold, dry air of the Alps, whereas they live in comparative comfort on the Riviera, in the Canary Islands, Madeira or at Capri. But warm, moist climates rather favour sedentary habits and tend to lessen appetite, so that the nutrition of the patient is apt to suffer; and although phthisical patients may live in comparative comfort in such climates, their tendency to recovery in them is small. At the Swiss health resorts, on the contrary, during the winter the air is very pure, and has just sufficient coldness to make exercise agreeable to patients. They are thus induced to be out the whole day, and to take food with an appetite which greatly improves their nutrition and aids their restoration to health. The best-known Alpine health resorts are St Moritz and Davos, to which lately Grindelwald has been added. St Moritz is, upon the whole, better for less advanced cases, while Davos is more sheltered and better for cases which are severe. It is a mistake, however, to send those in whom the disease is very far advanced away from home and friends, because when there is no hope of cure it is better for them to die in comfort at home. At the health resorts just mentioned the amount of food taken is regulated by the appetite of the patient himself, but a system of cure has been inaugurated by Dr Brehmer at Görbersdorf, by Dr Dettweiler at Falkenstein, and by Dr Walther at Nordrach, in the Black Forest. The most important point in this treatment consists in forced feeding, the want of appetite which is so prominent in many cases of phthisis being regarded as an abnormal sensation not to be regarded; and under the forced feeding, combined with open-air life, many marvellous recoveries are recorded. Numerous other institutions have been started in Great Britain in imitation of Dr Walther's with a considerable amount of success. Even when patients are unable to stay long at a sanatorium they learn there the advantages of open air and can continue the treatment at home to their great advantage.

In the well-known "rest" cure, which we owe to Weir Mitchell, forced feeding takes a prominent part. The essence of this cure is to give to the patient rest, bodily and mental, by confinement to bed and isolation from the outside world. While this treamcnt by itself would aid recovery from nervous exhaustion, it would lessen appetite and thus interfere with nervous repair; but the want of exertion is supplied by means of massage, which stimulates the circulation and increases the appetite, so that the patient gets all the benefit of exercise without any exhaustion. Where nervous exhaustion is less marked and the Weir Mitchell treatment is not appropriate—for example, in men who are simply overworked or broken down by anxiety or sorrow—a sea voyage is often a satisfactory form of "rest" cure. The lack of posts and telegrams prevents much of the excitement which they would have upon shore, the space for exercise is limited, food is abundant and appetite is supplied by the stimulus of constant exposure in the open air. In order that the voyage should be satisfactory, however, it must be sufficiently long, and the weather must be sufficiently warm to allow the patient to stay in the open air the whole day long. During the heat of summer voyages to the North Cape are suitable, and during the spring and autumn to the Mediterranean, but in the colder months of the year the West Indies, India, Cape Town, Australia or New Zealand forms the best objective.

(T. L. B.)

THERESA, ST (1515–1582), or Teresa de Cepeda, Spanish nun, was born at Avila, in Old Castile, on the 28th of March 1515, and was educated in an Augustinian convent in the town. As a child she was interested in the stories of martyrs, and at the age of eighteen left home one morning, and applied for admission at the Carmelite convent of the Incarnation. She was disappointed at first at the slackness of discipline, but she appears afterwards to have accommodated herself with tolerable success to the worldliness of her environment, though not without intervals of religious misgiving. It was in the year 1554, when she was nearly forty, that the event known as her conversion took place, and the second part of her life began. The death of her father roused her to serious reflection, and one day, as she entered the oratory, she was struck by the image of the wounded Christ, placed there for an approaching festival. She fell in tears at the feet of the figure, and felt every worldly emotion die within her. The shock threw her into a trance, and these trances, accompanied by visions, recurred frequently in the subsequent part of her life. They have since been adduced as Divine attestations of her saintship, but the sisterhood in the convent set them down to possession by a devil; her new departure was due in their eyes to no worthier motive than the desire to be peculiar and to be reputed better than other people. Teresa herself was very humble, and thought their explanation might be true; she took her case to her confessor and to the provincial-general of the Jesuits, who put her under a course of discipline. One day, while thus occupied, her trance came upon her, and she heard a voice say, "Though shalt have no more converse with men, but with angels." After this the trance or fit always returned when she was at prayers, and she felt that Christ was close to her. Presently she was able to see Him, "exactly as He was painted rising from the sepulchre." Her confessor directed her to exorcise the figure, and she obeyed with pain, but, it is needless to say, in vain. The visions grew more and more vivid. The cross of her rosary was snatched from her hand one day, and when returned it was made of jewels more brilliant than diamonds, visible, however, to her alone. She had often an acute pain in her side, and fancied that an angel came to her with a lance tipped with fire, which he struck into her heart. The 27th of August is kept sacred in Spain to this mystery, which has also formed a favourite subject of Spanish painters. She had also visions of another description: she was shown hell with its horrors, and the devil would sit upon her breviary, belabour her with blows, and fill her cell with imps. For several years these experiences continued, and the verdict as to their source still remained far from unanimous. Meanwhile, the spread of the Refcrmation became the subject of much searching of hearts to pious Catholics. Teresa reflected like the rest, and her experience led her to find the real cause of the catastrophe in the relaxation of discipline within the religious orders. She formed the project of founding a house in which all the original rules of the Carmelite order would be observed. In spite of great opposition from the authorities of the order, and in particular from the prioress and sisters of the Incarnation, she persevered with her scheme, being encouraged to appeal to the pope by certain priests who saw the benefit which would accrue to the Church from her zeal. A private house in Avila was secretly got ready to serve as a small convent, and, when the bull arrived from Rome, Teresa went out on leave from the Incarnation and installed four poor women in the new house dedicated to her patron St Joseph. It was on the 24th of August 1562 that mass was said in the little chapel and the new order constituted. It was to be an order of Descalzos or Barefoots, in opposition to the relaxed parent body, the Calzados. The sisters were not to be literally shoeless, but to wear sandals of rope; they were to sleep on straw, to eat no meat, to be strictly confined to the cloister, and to live on alms without regular endowment. After lodging her four sisters, Teresa returned to the Incarnation; but, when the secret was discovered, Carmelites and townspeople were alike furious. Violence, however, was prevented, and the matter was referred to the council of state at Madrid. Philip II. referred it again to the pope, and after six months a fresh bull arrived from Pius V. The provincial of her order now gave her leave to remove and take charge of her sisterhood. The number of thirteen, to which on grounds of discipline she had limited the foundation, was soon filled up, and Teresa spent here the five happiest years of her life. Her visions continued, and, by command of her ecclesiastical superiors, she wrote her autobiography containing a full account of these experiences, though she was far from basing any claim to holiness upon them. The general of the order visited her at Avila, and gave her powers to found other houses of Descalzos, for men as well as women. The last fifteen years of her life were spent mainly in hard journeys with this end and in the continually growing labour of organization. Convents were founded at Medina, Malaga, Valladolid, Toledo, Segovia and Salamanca, and two at Alva under the patronage of the famous duke. Then she had three years of rest, as prioress of her old convent of the Incarnation. She next went to Seville to found a house, thus overstepping for the first time the boundaries of the Castiles, to which her authorization limited her. The latent hostility of the old order was aroused; the general ordered the immediate suppression of the house at Seville, and procured a bull from Gregory XIII. prohibiting the further extension of the reformed houses (1575). But the movement against her came from Italy, and was resented by Philip and the Spanish authorities as undue interference; and after a fierce struggle, during which Teresa was two years under arrest at Toledo, the Carmelites were divided into two bodies in 1580, and the Descalzos obtained the right to elect their own provincial-generals (see CARMELITES). The few remaining years of Teresa's life were spent in the old way, organizing the order she had founded, and travelling about to open new convents. Sixteen convents and fourteen monasteries were founded by her efforts; she wrote a history of her foundations, which forms a supplement to her autobiography. Her last journey of inspection was cut short at Alva, where she died on the 29th of September 1582. A violet odour and a fragrant oil were said to distil from her tomb; and when it was opened nine months afterwards the flesh was found uncorrupted. A hand cut off by a fervent brother was found to work miracles, and the order became convinced that their founder had been a saint. It was resolved in 1585 to remove her remains to Avila, where she was born, the sisters at Alva being consoled by permission to retain the mutilated arm. But the family of the duke of Alva procured an order from the pope enjoining that the body should be restored to Alva, and she was accordingly laid there once more in a splendid tomb. But even then she was not allowed to rest: she was again disentombed, to be laid in a more magnificent coffin, and the greed of reverential relic-seekers made unseemly havoc of her bones.

Teresa was canonized by Gregory XV. in 1622. The honour was doubtless largely due to her asceticism and mystic visions. She called herself Teresa de Jesus, to signify the closeness of her relation to the heavenly Bridegroom, who directed all her actions. Though she deprecated excess of ascetic severity in others, she scourged herself habitually, and wore a peculiarly painful hair-cloth. But her life shows her to have been, besides, a woman of strong practicality and good sense, full of natural shrewdness, and with unusual powers of organization. "You deceived me in saying she was a woman," writes one of her confessors; "she is a bearded man." She was brave in the face of difficulties and dangers, pure in her motives, and her utterances, some of which have been quoted, have the true ethical ring about them. Her MSS. were collected by Philip II. and placed in a rich case in the Escorial, the key of which the king carried about with him. Besides her autobiography and the history of her foundations, her works (all written in Spanish) contain a great number of letters and various treatises of mystical religion, the chief of which are *The Way of Perfection* and *The Castle of the Soul.* Both describe the progress of the soul towards perfect union with God.

Her works, edited by two Dominicans were first published in 1587, and have since appeared in various editions. They were soon afterwards translated into Italian, French (4 vols., Paris, 1840–46) and Latin; an English translation of the *Life* and works (except the letters) by A. Woodhead appeared in 1669. Other translations of the *Life* are those by John Dalton (1851), who also translated *The Way of Perfection* and the *Letters* (1902), and by David Lewis (1870), who in 1871 also translated the *Foundations.* A. R. Waller reprinted Woodhead's translation of *The Way of Perfection* in "The Cloister Library" (1901). Biographies appeared soon after her death by the Jesuit Ribera, who had been her confessor (1602), and by Diego de Yepez, confessor to Philip II. (1599). Details are also given in Ribadeneyra's *Flos Sanctorum* and in Alban Butler's *Lives of the Saints.* A separate biography, with preface by Cardinal Manning, appeared in 1865; a full and critical edition of the *Life* is that by Mrs G. C. Graham, 2 vols. (1894). See also H. Prinz v. Oettingen-Spielberg, *Geschichte d. heil. Theresia* (Regensburg, 1899); A. Whyte, *Santa Teresa, an appreciation, with some of the best passages of the writings* (1897); E. Hello, *Studies in Saintship* (1903).

THEREZINA, a city of Brazil, capital of the state of Piauhy, on the left bank of the Parnahyba river, about 220 m. from its mouth. Pop. (1890) 21,620; for the commune or municipio, 31,523; (1906, estimated), 25,000. It is prettily situated on an open plain and is laid out regularly with broad straight streets with seven large squares. Among its public buildings are the government palace, the legislative and municipal hall, the "Quatro de Setembro" theatre, Misericordia hospital, public market, sanitation and public works, building, courts, police headquarters, barracks, &c. The town is characteristically Portuguese in appearance, its buildings being one or two stories in height, plastered and frequently coloured outside, with large rooms, thick walls, and tile roofs to ensure coolness. There is one lyceum, or high school, with about 400 students, in addition to its primary schools. Its manufacturing industries include a cotton mill, foundry, and soap-works. A steamboat service, with three small boats, maintains regular communication with Parnahyba, near the mouth of the river, besides which there are a number of independent freight-carrying boats. Therezina was founded in 1852, its site being originally called Chapada de Corisco, and was named in honour of the empress, Dona Thereza Christina. It was made the capital of Piauhy in succession to Oeiras.

THERMIDOR (from Gr. θέρμη, heat, and δῶρον, gift), the name given during the French Revolution to the eleventh month of the year in the Republican Calendar. The month fell in the hottest season of the year, beginning on the 19th or 20th of July and ending on the 18th or 19th of August, according to the year. As in all the other months of the Republican Calendar, each of the days of Thermidor was, in accordance with the suggestion of Fabre d'Églantine, consecrated to some useful object. Thus 1 Thermidor was consecrated to spelt, 10 Thermidor to the watering-pot, 15 Thermidor to sheep, and 27 Thermidor to lentils. The most important event that took place in this month was the revolution of 9 Thermidor year II. (27th of July 1794), which resulted in the fall of Robespierre and the collapse of the Terror. The name Thermidorian (Thermidorien) was given to the authors of this revolution and to the supporters of the reactionary movement of which it was the signal.

See C. d'Héricault, *La Révolution de Thermidor* (2nd ed., Paris, 1878); E. B. Courtois, *Rapport fait au nom de la commission chargée de l'examen des papiers trouvés chez Robespierre et ses complices* (1795); D. A. Martin, *Papiers inédits . . . supprimés ou omis par Courtois* (3 vols., 1828); also bibliography in M. Tourneux, *Bibliog. de la ville de Paris . . .* (1890), vol. i., nos. 4265–4309.

THERMOCHEMISTRY, a branch of Energetics, treating of the thermal phenomena which are associated with chemical change.

§ 1. That vigorous chemical action is accompanied by a brisk evolution of heat is evident from such familiar examples as the combustion of fuel or the explosion of gunpowder. The heat attendant on these actions, and on the vital processes of the animal organism, naturally first attracted attention. Robert Boyle, A. Crawford, A. L. Lavoisier and P. S. Laplace, P. L. Dulong, H. Davy, Count Rumford, all concerned themselves with thermochemical investigations of such processes. Their quantitative experiments were, however, too rough to permit of accurate generalization; and although Lavoisier and Laplace stated the principle that the same amount of heat must be supplied to decompose a compound as would be produced on its formation, the statement was not based on exact experiment, and only received experimental confirmation much later.

The beginnings of modern thermochemistry, though made independently of the doctrine of the conservation of energy, are practically contemporaneous with the recognition of that law, and without it the science could scarcely have reached the degree of development which it rapidly attained. Thomas Andrews and, especially, G. H. Hess (1840) were the first who systematically investigated thermochemical effects in solution, and arrived at conclusions from their experimental data which still possess validity. Andrews, for example, found that when a series of acids were under similar conditions used to neutralize a given amount of a base, the quantity of heat evolved on the neutralization was the same in all cases. Hess, from his work, arrived at the converse conclusion, that when a series of bases were used to neutralize a given amount of an acid, the heat of neutralization was always the same. Both of these statements are correct when the powerful mineral acid and bases are considered, exceptions only arising when weak acids and bases are employed. Again, Andrews discovered that when one metal displaces another from solution of its salts (*e.g.* zinc with solutions of copper salts), the thermal effect is practically independent of the nature of the acid radical in the salt employed. Andrews likewise found that when the heat evolved on the displacement from its salts of a metal M′ by a metal M is added to the heat of displacement of another metal M″ by M′, the sum is equal to the heat which is evolved on the direct displacement of M″ from its salts by M. This affords an example of a principle which had been stated by Hess in a very general form under the name of the *Law of Constant Heat Sums*—namely, that the thermal effect of a given chemical action is the same, independently of the character and number of the stages in which it takes place. Thus, in the above example, it is immaterial whether M displaces M″ from its salt directly, or whether M first displaces M′, which is then used to displace M″. This important principle is a direct consequence of the law of the conservation of energy, but was discovered independently by Hess from accurate experiment.

Hess employed this principle to determine indirectly the *heat of formation* of compounds from their elements, when this magnitude, as is generally the case, was inaccessible to direct measurement. Thus the heat of formation of anhydrous zinc sulphate, $ZnSO_4$, which cannot be determined directly, may be arrived at by summation (in Hess's units) as follows:—

Oxidation of Zn to ZnO	5291	units
,, S to SO_3	6384	,,
Dissolution of SO_3 in much water	2566	,,
,, ZnO in the resulting aqueous H_2SO_4	1609	,,
	15850	,,
Deduct heat of dissolution of anhydrous $ZnSO_4$	1193	,,
Heat of formation of $ZnSO_4$ from Zn, S, and 4O =	14657	,,

Heats of formation are still determined for the most part in a precisely similar manner.

Hess also stated another principle on empirical grounds, which, although admitting of many exceptions, is of considerable utility and significance. It had been known long before his time that when solutions of neutral salts were mixed, and no precipitate resulted, the mixed solution was also neutral. Hess now observed that in the process of mixing such neutral solutions no thermal effect was produced—that is, neutral salts in aqueous solution could apparently interchange their radicals without evolution or absorption of heat. These experimental results were generalized by him under the title of the *Law of Thermoneutrality*.

After the investigations of Hess and Andrews, a great deal of excellent experimental work was performed by P. A. Favre and J. T. Silbermann, whose chief theoretical achievement was the recognition that the heat of neutralization of acids and bases was additively composed of two constants, one determined by the acid and the other by the base. This deduction harmonized the observations of Andrews and of Hess previously alluded to, and also accounted satisfactorily for the Law of Thermoneutrality.

Julius Thomsen was the first investigator who deliberately adopted the principle of the conservation of energy as the basis of a thermochemical system. His thermochemical work was begun in 1853, but most of his experiments were performed in the years 1869–82, the whole being published collectively, under the title *Thermochemische Untersuchungen*, in four volumes. Somewhat later than Thomsen, Marcellin P. E. Berthelot began (in 1873) a long series of thermochemical determinations. It is to these two investigators and their pupils that most of our exact thermochemical data are due.

Thomsen and Berthelot independently enunciated a generalization (commonly known as Berthelot's *Third Principle*, or *Principle of Maximum Work*), which may be stated in brief as follows:—Every pure chemical reaction is accompanied by *evolution* of heat. Whilst this principle is undoubtedly applicable to the great majority of chemical actions under ordinary conditions, it is subject to numerous exceptions, and cannot therefore be taken (as its authors originally intended) as a secure basis for theoretical reasoning on the connexion between thermal effect and chemical affinity. The existence of reactions which are reversible on slight alteration of conditions at once invalidates the principle, for if the action proceeding in one direction evolves heat, it must absorb heat when proceeding in the reverse direction. As the principle was abandoned even by its authors, it is now only of historical importance, although for many years it exerted considerable influence on thermochemical research.

§2. From the standpoint of the law of conservation of energy, the relation between chemical and thermochemical action bears the following aspect:—A given amount of any substance under given conditions possesses a perfectly definite amount of intrinsic energy, and, no matter what chemical and physical transformations the substance may undergo, it will, when it returns to its original state, possess the original amount of intrinsic energy. If we consider now the transformation of one system of chemical substances into another system under specified conditions, we shall find that in general the intrinsic energy of the second system is different from the intrinsic energy of the first. Let us assume, as is commonly the case, that the intrinsic energy of the initial system is greater than that of the final system. When the first system then is transformed into the second, the excess of energy which the former possesses must appear in the shape of heat, light, electrical energy, mechanical energy, &c. It is for the most part a simple matter to obtain the excess of energy entirely in the form of heat, the amount of which is easily susceptible of measurement, and thus the existence of thermochemistry as a practical science is rendered possible. Since the intrinsic energies of the two systems under given conditions are invariable, the difference between them is constant, so that the heat evolved when the first system is converted into the second is equal to that absorbed when the second system is re-transformed into the first (cf. Lavoisier and Laplace, *ante*, § 1). The total thermal effect, too, which is associated with the transformation, must be the same, whether the transformation is conducted directly or indirectly (Hess's *Law of Constant Heat Sums*), since the thermal effect depends only on the intrinsic energies of the initial and final systems.

Since the intrinsic energy of a substance varies with the conditions under which the substance exists, it is necessary, before proceeding to the practical application of any of the laws mentioned above, accurately to specify the conditions of the initial and final systems, or at least to secure that they shall not vary in the operations considered. It is also a necessary condition for the application of the preceding laws that no form of energy except heat and the intrinsic energy of the substances should be ultimately involved. For example, when metallic zinc is dissolved in dilute sulphuric acid with production of zinc sulphate (in solution) and hydrogen gas, a definite quantity of heat is produced for a given amount of zinc dissolved, provided that the excess of energy in the initial system appears entirely as heat. This provision may not always be fulfilled, since by placing the zinc in electrical contact with a piece of platinum, likewise immersed in the sulphuric acid, we can generate a current of electricity through the solution and the metallic part of the circuit. The reaction as before is completely expressed by the chemical equation $Zn+H_2SO_4 = ZnSO_4H+_2$, the initial and final systems being exactly the same as in the first case; yet the amount of heat generated by the action is much smaller, a quantity of the intrinsic energy having been converted into electrical energy. This electrical energy, however, is equivalent to the heat which has disappeared, for it has been shown experimentally that if it is converted into heat and added to the heat actually evolved, the total quantity of heat obtained is exactly equal to that produced by the direct dissolution of the zinc in the absence of platinum.

§ 3. The following conditions have to be considered as affecting in a greater or less degree the intrinsic energy of the initial and final systems:—

(1) Dilution of solutions.
(2) Physical state.
(3) Change of volume.
(4) Allotropic modifications.
(5) Temperature.

(1) Generally speaking, there is a considerable thermal effect when a substance is dissolved in water, and this effect varies in magnitude according to the amount of water employed. It is only, however, when we deal with comparatively concentrated solutions that the heat-effect of diluting the solutions is at all great, the heat-change on diluting an already dilute solution being for most practical purposes negligible. In dealing, therefore, with dilute solutions, it is only necessary to state that the solutions are dilute, the exact degree of dilution being unimportant. It occasionally happens that a change in dilution affects the chemical action that occurs. Thus if concentrated instead of dilute sulphuric acid acts upon zinc, the action takes place to a great extent not according to the equation given above, but according to the equation

$$Zn+2H_2SO_4 = ZnSO_4+SO_2+2H_2O,$$

sulphur dioxide and water being produced instead of hydrogen. Here we have a different final system with a different amount of intrinsic energy, so that the thermal effect of the action is altogether different.

(2) The physical state of the reacting substances must be considered, since comparatively large amounts of heat are absorbed on fusion and on vaporization. Thus the heat of fusion of ice (for $H_2O=18$ g) is 1440 cal., and the heat of vaporization of water at 100°, for the same quantity, 9670 cal.

(3) The effect of change of volume against external pressure (due to production or consumption of mechanical energy) may be neglected in the case of solids, liquids or solutions, but must usually be taken into account when gases are dealt with. Each gramme-molecule of a gas which appears under constant pressure during a chemical action (*e.g.* hydrogen during the action of zinc on dilute sulphuric acid) performs work equivalent to 580 cal. at the ordinary temperature, which must be allowed for in the thermochemical calculation. A similar correction, of opposite sign, must be made when a gramme-molecule of gas disappears during the chemical action.

(4) When a substance—*e.g.* carbon, phosphorus, sulphur—exists in allotropic forms, the particular variety employed should always be stated, as the conversion of one modification into another is frequently attended by a considerable thermal effect. Thus the conversion of yellow into red phosphorus evolves about one-sixth of the heat of combustion of the latter in oxygen, and so the knowledge of which variety of phosphorus has been employed is of essential importance in the thermochemistry of that element.

(5) The influence of temperature on the thermal effect of a chemical action is sometimes considerable, but since the initial and final temperatures, which alone determine the variation in the thermal effect, are in almost all cases within the ordinary laboratory range of a few degrees, this influence may in general be neglected without serious error.

§ 4. *Methods.*—In order to estimate the thermal effect of any chemical process, use is made of the ordinary methods of calorimetry, the particular method being selected according to the nature of the chemical action involved. In almost every case the method of mixture (see CALORIMETRY) is employed, the method of fusion with Bunsen's ice-calorimeter being only used in special and rarely occurring circumstances.

As a very great number of important chemical actions take place on mixing solutions, the method for such cases has been thoroughly studied. When the solutions employed are dilute, no water is placed in the calorimeter, the temperature-change of the solutions themselves being used to estimate the thermal effect brought about by mixing them. Known quantities of the solutions are taken, and the temperature of each is accurately measured before mixing, the solutions having been allowed as far as possible to adjust themselves to the same temperature. The change of temperature of the solutions after the mixing has taken place is then observed with the usual precautions. It is of course in such a case necessary to know the specific heat of the liquid in the calorimeter. Thomsen by direct experiment found that the heat-capacity of a dilute aqueous solution diverged in general less than 1 per cent. from the heat-capacity of the water contained in it, the divergence being sometimes in one sense, sometimes in the other. He therefore abstained from determining for each case the specific heats of the solutions he employed, and contented himself with the above approximation. Berthelot, on the other hand, assumed that the heat-capacity of an aqueous solution is equal to that of an equal volume of water, and calculated his results on this assumption, which involves much the same uncertainty as that of Thomsen. Since thermochemical measurements of this type may be frequently performed with an error due to other causes of much less than 1 per cent., the error introduced by either of these assumptions is the chief cause of uncertainty in the method.

The calorimeter used for solutions is usually cylindrical, and made of glass or a metal which is not attacked by the reacting substances. The total quantity of liquid employed need not in general exceed half a litre if a sufficiently delicate thermometer is available. The same type of calorimeter is used in determining the heat of solution of a solid or liquid in water.

Combustion calorimeters are employed for observing the heat generated by the brisk interaction of substances, one of which at least is gaseous. They are of two kinds. In the older type the combustion chamber (of metal or glass) is sunk in the calorimeter proper, tubes being provided for the entrance and exit of the gaseous substances involved in the action. These tubes are generally in the form of worms immersed in the water of the calorimeter. In the newer type (which was first proposed by Andrews for the combustion of gases) the chemical action takes place in a completely closed combustion chamber of sufficient strength to resist the pressure generated by the sudden action, which is often of explosive violence. The steel combustion chamber is of about 250 c.c. capacity, and is wholly immersed in the calorimeter. To withstand the chemical action of the gases, the "calorimetric bomb" is lined either with platinum, as in Berthelot's apparatus, or with porcelain, as in Mahler's. For ordinary combustions compressed oxygen is used, so that the combustible substance burns almost instantaneously, the action being induced by means of some electrical device which can be controlled from without the calorimeter. The accuracy of heats of combustion determined in the closed calorimeter is in favourable cases about one-half per cent. of the quantity estimated.

§ 5. *Units and Notation.*—The heat-units employed in thermochemistry have varied from time to time. The following are those which have been in most general use:—

Small calorie or gramme calorie	cal.
Large or kilogramme calorie	Cal.
Centuple or "rational" calorie	K.

The centuple calorie is the amount of heat required to raise 1 g. of water from 0° C. to 100° C., and is approximately equal to 100 cal. The large calorie is equal to 1000 cal. In view of the not very great accuracy of thermochemical measurements, the precise definition of the heat-unit employed is not a matter of special importance. It has been proposed to adopt the *joule*, with the symbol j, as thermochemical unit for small quantities of heat, large amounts being expressed in terms of the *kilojoule*, Kj = 1000 j. (For the exact relation between these heat-units, see CALORIMETRY.) For ordinary thermochemical work we may adopt the relation 1 cal. = 4·18 j, or 1 Cal. = 4·18 Kj.

Except for technological purposes, thermochemical data are not referred to unit quantity of matter, but to chemical quantities —*i.e.* to the gramme-equivalents or gramme-molecules of the reacting substances, or to some multiples of them. The notation which Julius Thomsen employed to express his thermochemical measurements is still extensively used, and is as follows:—The chemical symbols of the reacting substances are written in juxtaposition and separated by commas; the whole is then enclosed in brackets and connected by the sign of equality to the number expressing the thermal effect of the action. The chemical symbols stand for quantities measured in grammes, and heat-evolution is reckoned as positive, heat-absorption as negative. Thus

$$[S, 2O] = 71100 \text{ cal.}$$

indicates that 71100 calories are evolved when 32 grammes of sulphur react with 2×16 grammes of free oxygen to form sulphur dioxide. It is of course necessary in accurate work to state the conditions of the reaction. In the above instance the sulphur is supposed to be in the solid rhombic modification, the oxygen and sulphur dioxide being in the gaseous state, and the initial and final systems being at the ordinary temperature. Again, the equation

$$[2N, O] = -18500 \text{ cal.}$$

indicates that if 28 grammes of nitrogen could be made to unite directly with 16 grammes of oxygen to form nitrous oxide, the union would cause the absorption of 18500 calories. When substances in solution are dealt with, Thomsen indicates their state by affixing Aq to their symbols. Thus

$$[NaOH\ Aq, HNO_3\ Aq] = 13680 \text{ cal.}$$

represents the heat of neutralization of one gramme-equivalent of caustic soda with nitric acid, each in dilute aqueous solution before being brought into contact. One drawback of Thomsen's notation is that the nature of the final system is not indicated, although this defect in general causes no ambiguity.

Berthelot's notation defines both initial and final systems by giving the chemical equation for the reaction considered, the thermal effect being appended, and the state of the various substances being affixed to their formulae after brackets. W. Ostwald has proposed a modification of Berthelot's method which has many advantages, and is now commonly in use. Like Berthelot, he writes the chemical equation of the reaction, but in addition he considers the chemical formula of each substance to express not only its material composition, but also the (unknown) value of its intrinsic energy. To the right-hand member of the equation he then adds the number expressing the thermal effect of the reaction, heat-evolution being as before counted positive, and heat-absorption negative. The mass-equation then becomes an energy-equation. He thus writes

$$S + O_2 = SO_2 + 71100 \text{ cal.},$$

which expresses the fact that the intrinsic energy of the quantities of sulphur and oxygen considered exceeds that of the sulphur dioxide derived from them by 71100 cal. when thermal units are employed. The equation

$$H_2 + I_2 = 2HI - 12200 \text{ cal.}$$

expresses that under certain conditions the intrinsic energy of hydriodic acid is greater than the intrinsic energy of its component elements by 12200 cal., *i.e.* that hydriodic acid is formed from its elements with absorption of this amount of heat. Energy-equations, such as the above, may be operated with precisely as if they were algebraic equations, a property which is of great advantage in calculation. Thus by transposition we may write the last equation as follows:—

$$2HI = H_2 + I_2 + 12200 \text{ cal.},$$

and thus express that hydriodic acid when decomposed into its elements evolves 12200 cal. for the quantity indicated by the equation.

Ostwald has made the further proposal that the formulae of solids should be printed in heavy type (or within square brackets), of liquids (solutions, &c.) in ordinary type, and of gases in italics (or within curved brackets), so that the physical state of the substances might be indicated by the equation itself. Thus the equation

$$\mathit{Cl_2} + 2KI, Aq = 2KCl, Aq + \mathbf{I_2} + 52400 \text{ cal.},$$

or

$$(Cl_2) + 2KI, Aq = 2KCl, Aq + [I_2] + 52400 \text{ cal.},$$

would express that when gaseous chlorine acts on a solution of potassium iodide, with separation of solid iodine, 52400 calories are evolved.

§ 6. *Heat of Formation.*—For thermochemical calculations it is of great importance to know the heat of formation of compounds from their elements, even when the combination cannot be brought about directly. As an example of the use of Ostwald's energy-equations for the indirect determination we may take the case of carbon monoxide.

The following equations give the result of direct experiment:—

$$C + 2O = CO_2 + 94300 \text{ cal.}$$
$$CO + O = CO_2 + 68000 \text{ cal.}$$

If now it is required to find the heat of formation of the compound CO, which cannot be directly ascertained, we have merely to subtract the second equation from the first, each symbol representing constant intrinsic energy, and thus we obtain

$$C + O - CO = 26300 \text{ cal.},$$

or

$$C + O = CO + 26300 \text{ cal.},$$

that is, the heat of formation of a gramme-molecule of carbon monoxide is 26300 cal.

As has already been stated, the heat of formation of a compound is the amount (expressed in thermal units) by which its intrinsic energy exceeds or falls short of that of the elements which enter into its composition. Now of the absolute values of intrinsic energy we know nothing; we can only estimate differences of intrinsic energy when one system is compared with another into which it may be directly or indirectly converted. But since the elements cannot be converted one into the other, we are absolutely without knowledge of the relative values of their intrinsic energy. This being the case, we are at liberty to make the assumption that the intrinsic energy of each element (under specified conditions) is zero, without thereby introducing any risk of self-contradiction in thermochemical calculations. This assumption has the great advantage, that the intrinsic energy of a compound relatively to its elements now appears as the heat of formation of the compound with its sign reversed. Thus if we consider the energy-equation

$$C + O_2 = CO_2 + 94300 \text{ cal.},$$

and replace the symbols by the values of the intrinsic energy, viz. zero for carbon and oxygen, and x for carbon dioxide, we obtain the equation

$$0 + 0 = x + 94300 \text{ cal.}$$

or

$$x = -94300 \text{ cal.}$$

With knowledge then of the heats of formation of the substances involved in any chemical action, we can at once calculate the thermal effect of the action, by placing for each compound in the energy-equation its heat of formation with the sign reversed, *i.e.* its heat of decomposition into its elements. Thus if we wish to ascertain the thermal effect of the action

$$Mg + CaO = MgO + Ca,$$

we may write, knowing the heats of formation of CaO and MgO to be 131000 and 146000 respectively,

$$0 - 131000 = 0 - 146000 + x$$
$$x = 15000 \text{ cal.}$$

Since heats of formation afford such convenient data for calculation on the above method, they have been ascertained for as many compounds as possible.

Substances with positive heats of formation are termed ***exothermic;*** those with negative heats of formation are termed ***endothermic.*** The latter, which are not very numerous, give out heat on decomposition into their elements, and are more or less unstable. Amongst endothermic compounds may be noted hydriodic acid, HI, acetylene, C_2H_2, nitrous oxide, N_2O, nitric oxide, NO, azoimide, N_3H, nitrogen trichloride, NCl_3. Some of these pass into their elements with explosive violence, owing to the heat generated by their decomposition and the gaseous nature of the products.

§ 7. *Heat of Combustion.*—The thermochemical magnitude which is universally determined for organic compounds is the heat of combustion, usually by means of the calorimetric bomb. The relation between the heat of combustion of a hydrocarbon and its heat of formation may be readily seen from the following example. The hydrocarbon methane, CH_4, when completely burned to carbon dioxide and water, generates 213800 cal. We may therefore write

$$CH_4 + 4O = CO_2 + 2H_2O + 213800.$$

Now we know the heats of formation of carbon dioxide (from diamond) and of liquid water to be 94300 cal. and 68300 cal. respectively. The above equation may consequently be written, if x is the heat of formation of methane,

$$-x + 0 = -94300 - (2\times68300) + 213800$$
$$x = 17000 \text{ cal.}$$

This heat of formation, like that of most hydrocarbons, is comparatively small: the heat of formation of saturated hydrocarbons is always positive, but the heat of formation of unsaturated hydrocarbons is frequently negative. For example, ethylene, C_2H_4, is formed with absorption of 16200 cal., acetylene, C_2H_2, with absorption of 59100 cal., and liquid benzene, C_6H_6, with absorption of 9100 cal. Since the heat of combustion of a hydrocarbon is equal to the heat of combustion of the carbon and hydrogen it contains minus its heat of formation, those hydrocarbons with positive heat of formation generate less heat on burning than the elements from which they were formed, whilst those with a negative heat of formation generate more. Thus the heat generated by the combustion of acetylene, C_2H_2, is 316000 cal., whereas the heat of combustion of the carbon and hydrogen composing it is only 256900 cal., the difference being equal to the negative heat of formation of the acetylene.

For substances consisting of carbon, hydrogen and oxygen, a rule was early devised for the purpose of roughly calculating their heat of combustion (J. J. Welter's rule). The oxygen contained in the compound was deducted, together with the equivalent amount of hydrogen, and the heat of combustion of the compound was then taken to be equal to the heats of combustion of the elements in the residue. That the rule is not very accurate may be seen from the following example. Cane-sugar has the formula $C_{12}H_{22}O_{11}$. According to Welter's rule, we deduct 11 O with the equivalent amount of hydrogen, namely, 22 H, and are left with the residue 12 C, the heat of combustion of which is 1131600 cal. The observed heat of combustion of sugar is, however, 1354000, so that the error of the rule is here 20 per cent. A much better approximation to the heat of combustion of such substances is obtained by deducting the oxygen together with the amount of carbon necessary to form CO_2, and then ascertaining the amount of heat produced by the residual carbon and hydrogen. In the above case we should deduct with 11 O the equivalent amount of carbon 5·5 C, thus obtaining the residue 6·5 C and 22 H. These when burnt would yield $(6{\cdot}5\times94300)+(11\times68300)=1364250$ cal., an amount which is less than 1 per cent. different from the observed heat of combustion of sugar. Neither of the above rules can be applied to carbon compounds containing nitrogen.

§ 8. *Heat of Neutralization.*—It has already been stated that the heats of neutralization of acids and bases in aqueous solution are additively composed of two terms, one being constant for a given base, the other constant for a given acid. In addition to this, the further regularity has been observed that when the powerful monobasic acids are neutralized by the powerful monacid bases, the heat of neutralization is in all cases the same. The following table gives the heats of neutralization of the commoner strong monobasic acids with soda:—

Hydrochloric acid	HCl	137400 cal.
Hydrobromic acid	HBr	137500 „
Hydriodic acid	HI	136800 „
Nitric acid	HNO_3	136800 „
Chloric acid	$HClO_3$	137600 „
Bromic acid	$HBrO_3$	137800 „

Within the error of experiment these numbers are identical.

It was at one time thought that the greater the heat of neutralization of an acid with a given base, the greater was the strength of the acid. It is now known, however, that when weak acids or bases are used, the heat of neutralization may be either greater or less than the normal value for powerful acids and bases, so that there is no proportionality, or even parallelism, between the strengths of acids and their heats of neutralization (see SOLUTIONS).

§ 9. *Heat of Solution.*—When substances readily combine with water to form hydrates, the heat of solution in water is usually positive; when, on the other hand, they do not readily form hydrates, or when they are already hydrated, the heat of solution is usually negative. The following examples show the effect of hydration on heat of solution in a large quantity of water:—

	Heat of Solution.	Heat of Hydration.
I. Sodium carbonate—		
Na_2CO_3	+5640 cal.	
Na_2CO_3, H_2O	+2250 „	+3390 cal.
Na_2CO_3, $2H_2O$	+20 „	+5620 „
Na_2CO_3, $10H_2O$	−16160 „	+21800 „
II. Sodium sulphate—		
Na_2SO_4	+460 cal.	
Na_2SO_4, H_2O	−1900 „	+2360 cal.
Na_2SO_4, $10H_2O$	−18760 „	+19200 „

§ 10. *Application of the Second Law of Thermodynamics to Thermochemistry.*—What is commonly understood by thermochemistry is based entirely on the first law of thermodynamics, but of recent years great progress has been made in the study of chemical equilibrium by the application of the second law. For an account of work in this direction see CHEMICAL ACTION.

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THERMODYNAMICS (from Gr. θερμός, hot, δύναμις, force). 1. The name thermodynamics is given to that branch of the general science of Energetics which deals with the relations between thermal and mechanical energy, and the transformations of heat into work, and vice versa. Other transformations of heat are often included under the same title (see ENERGETICS). An historical account of the development of thermodynamics is given in the article HEAT. The object of the present article is to illustrate the practical application of the two general principles— (1) Joule's law of the equivalence of heat and work, and (2) Carnot's principle, that the efficiency of a reversible engine depends only on the temperatures between which it works; these principles are commonly known as the first and second laws of thermodynamics. The application will necessarily be confined to simple cases such as are commonly met with in practice, or are required for reference in cognate subjects.

2. *Application of the First Law.*—The complete transformation of mechanical energy into heat by friction, or some analogous process of degradation, is always possible, and is made the basis of experiments for the determination of the mechanical equivalent of the heat unit (see CALORIMETRY). The converse process of the transformation of heat into mechanical work or other forms of energy is subject to limitations.

When a quantity of heat, H, is supplied to a body, part is expended in raising the temperature of the body, or in expanding the volume against molecular forces, and is represented by an increase in the total quantity of energy contained in the body, which is generally called its *Intrinsic Energy*, and will be denoted by the symbol E. The remainder is equivalent to the external work, W, done *by* the body in expanding or otherwise, which can be utilized for mechanical purposes, and ceases to exist as heat in the body. The application of the first law leads immediately to the equation,

$$H=E-E_0+W, \qquad (1)$$

in which E_0 represents the quantity of energy originally present in the body, and all the quantities are supposed, as usual, to be expressed in mechanical units. This equation is generally true for any series of transformations, provided that we regard H and W as representing the *algebraic sums* of all the quantities of heat supplied to, and of work done *by* the body, heat taken *from* the body or work done *on* the body being reckoned negative in the summation. $E-E_0$, then, represents the total increase of the intrinsic energy of the body in its final state, which may be determined by measuring H and W. If after any series or cycle of transformations the body is restored to its initial state, we must have $E=E_0$, whence it follows that $H=W$. But this simple relation is only true of the net balances of heat and work in a complete cyclical process, which must be adopted for theoretical purposes if we wish to eliminate the unknown changes of intrinsic energy. The balance of work obtainable in such a cycle depends on the limits of temperature in a manner which forms the subject of the second law.

3. *Indicator or p.v. Diagram.*—The significance of relation (1) is best appreciated by considering the graphic representation of quantities of heat and energy on a work-diagram.

On the familiar indicator diagram the state of the working substance is represented by the position of a point called the "state-point," defined by the values of the pressure p and volume v of *unit mass*, as ordinate and abscissa respectively (fig. 1). Any line ("path" or "graph") on the diagram, such as BCD, represents an "operation" or "process" *i.e.* a continuous series of states through which the substance may be made to pass in any transformation. It is tacitly assumed that the motion is relatively so slow that the pressure and temperature of the substance are practically uniform throughout its mass at any stage of the process. Otherwise the transformation could not be fully represented on the diagram, and would not be reversible. The area BCD*db* under the path represents the external work done *by* the substance in expanding from B to D, which is analytically represented by the integral of pdv taken along the given path. Any closed path or figure, such as ABCD, represents a complete cycle or series of operations, in the course of which the substance is restored to its original state with respect to temperature, intrinsic energy and other properties. The area DABbd under the return path (v diminishing) represents work done *on* the substance, or against the back-pressure, and is negative. The area of the cycle, viz., that enclosed by the path BCDA, represents the balance of external work done by the substance in one cycle, and is positive if the cycle is described clockwise as indicated by the arrows. The simplest types of process or operation are:—(1), heating or cooling *at constant volume*, represented by vertical lines such as Bb, called *Isometrics*, in which the pressure varies, but no external work is done. (2) Heating or cooling *at constant pressure*, represented by horizontal lines such as NA, called *Isopiestics*, in which the external work done is the product of the pressure p and the expansion $v''-v'$. (3) Expansion or compression *at constant temperature*, represented by curves called *Isothermals*, such as BC, AD, the form of which depends on the nature of the working substance. The isothermals are approximately equilateral hyperbolas (pv=constant), with the axes of p and v for asymptotes, for a gas or unsaturated vapour, but coincide with the isopiestics for a saturated vapour in presence of its liquid. (4) Expansion or compression under the condition of *heat-insulation*, represented by curves called *Adiabatics*, such as BAZ or CDZ′, which are necessarily steeper than the isothermals.

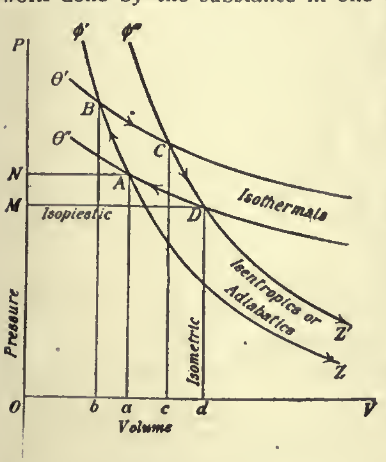

FIG. 1.

A cycle such as ABCD enclosed by parts of two isothermals, BC, AD, and two adiabatics, AB, CD, is the simplest form of cycle for theoretical purposes, since all the heat absorbed, H', is taken in during the process represented by one isothermal at the temperature θ', and all the heat rejected, H'', is given out during the process represented by the other at the temperature θ''. This is the cycle employed by Carnot for the establishment of his fundamental principle of reversibility as the criterion of perfect efficiency in a heat engine. The area ABCD, representing the work, W, per cycle, is the difference $(H'-H'')$ of the quantities of heat absorbed and rejected at the temperatures θ' and θ''. As the temperature θ'' is lowered, the area of the cycle increases, but since W can never exceed H', there must be a zero limit of temperature at which the pressure would vanish and the area of the cycle become equal to the whole heat absorbed at the higher temperature. Taking this ideal limit as a theoretical or absolute zero, the value of H' may be represented on the diagram by the whole area included between the two adiabatics BAZ, CDZ′ down to the points where they intersect the isothermal of absolute zero, or the zero isopiestic OV asymptotically at infinity.

If the substance in any state such as B were allowed to expand adiabatically ($dH=0$) down to the absolute zero, at which point it contains no heat and exerts no pressure, the whole of its available heat energy might theoretically be recovered in the form of external work, represented on the diagram by the whole area BAZcb under the adiabatic through the state-point B, bounded by the isometric Bb and the zero isopiestic bV. The change of the intrinsic energy in passing from one state to another, as from B to C is represented by the addition of the heat-area H=BCZZ′, and the subtraction of the work-area W=BCcb. It follows from the first law that the intrinsic energy of a substance in a given state must always be the same, or that the change of E in any transformation must depend only on the initial and final states, and not on the path or process. It will be observed that the areas representing H and W both depend on the form of the path BC, but that the difference of the areas representing the change of intrinsic energy dE is independent of BC, which is a boundary common to both H and W. This is mathematically expressed by the statement that dE is an exact differential of a function of the co-ordinates defining the state of the body, which can be integrated between limits without reference to the relation representing the path along which the variations are taken.

4. *Application of Carnot's Principle.*—Carnot adopted as the analytical expression of his principle the statement that the efficiency W/H, or the work obtainable per unit of heat by means of a perfect engine taking in heat at a temperature $t°$ C. and rejecting heat at 0° C., must be some function $F(t)$ of the temperature t, the lower limit 0° C. being supposed constant. He was unable to apply the principle directly in this form, as it would require an exact knowledge of the properties of substances through a wide range of temperature. He therefore employed the corresponding expression for a cycle of infinitesimal range dt at the temperature t in which the work dW obtainable from a quantity of heat H would be represented by the equation

$$dW=HF'(t)dt,$$

where $F'(t)$ is the derived function of $F(t)$, or $dF(t)/dt$, and represents the work obtainable per unit of heat per degree fall of temperature at a temperature t. The principle in this form is readily applicable to all cases, and is independent of any view with regard to the nature of the heat. It simply asserts that the efficiency function $F'(t)$, which is known as Carnot's function, is the same for all substances at the same temperature. Carnot verified this by calculating the values of $F'(t)$ at various temperatures from the known properties of vapours and gases, and showed that the efficiency function diminished with rise of temperature, as measured on the scale of the mercury or gas thermometer, from about 1·40 kilogrammetres per kilo-calorie per degree C. at 0° C. to about 1·11 at 100° C., according to the imperfect data available in his time. Applying the above equation to a gas obeying the law $pv=RT$, for which the work done in isothermal expansion from a volume 1 to a volume r is $W=RT\log_e r$, whence $dW=R\log_e r dt$, he deduced the expression for the heat absorbed by a gas in isothermal expansion

$$H=R\log_e r/F'(t).$$

He also showed that the difference of the specific heats at constant pressure and volume, $S-s$, must be the same for equal volumes of all gases at the same temperature and pressure, being represented by the expression $R/TF'(t)$. He remarks that "the law according to which the motive power of heat varies at different points of the thermometric scale is intimately connected with that of the variations of the specific heats of gases at different temperatures—a law which experiment has not yet made known to us with sufficient exactness." If he had ventured to assume the difference of the specific heats constant, it would have followed that $F'(t)$ must vary inversely as T. The same result follows if the work $W=RT\log_e r$ done by a gas in isothermal expansion is assumed to be equivalent or proportional to the heat absorbed, $H=R\log_e r/F'(t)$. Mayer (1842) made this assumption in calculating the mechanical equivalent of heat. Joule (1845) was the first to prove it approximately by direct experiment, but did not see his way to reconcile Carnot's principle, as stated by Clapeyron, with the mechanical theory. Holtzmann (1845) by the same assumption deduced the value J/T for the function $F'(t)$, but obtained erroneous results by combining this assumption with the caloric theory. Clausius (1850), applying the same assumption, deduced the same value of $F'(t)$, and showed that it was consistent with the mechanical theory and Joule's experiments, but required that a vapour like steam should deviate more considerably from the gaseous laws than was at that time generally admitted. The values of $F'(t)$ calculated previously by Sir W. Thomson (Lord Kelvin) from Regnault's tables of the properties of steam, assuming the gaseous laws, did not vary exactly as J/T. Joule's experiments on the equivalence of W and H were not sufficiently precise to decide the question. This most fundamental point was finally settled by a more delicate test, devised by Lord Kelvin, and carried out in conjunction with Joule (1854), which showed that the fundamental assumption $W=H$ in isothermal expansion was very nearly true for permanent gases, and that $F'(t)$ must therefore vary very nearly as J/T. Kelvin had previously proposed to define an absolute scale of temperature independent of the properties of any particular substance in terms of Carnot's function by making $F'(t)$ constant. He now proposed to define absolute temperature as proportional to the reciprocal of Carnot's function, so as to agree as closely as possible with the scale of the gas thermometer. With this definition of temperature θ, if the heat H is measured in work units, the expression of Carnot's principle for an infinitesimal cycle of range $d\theta$ reduces to the simple form $dW/d\theta=H/\theta$. Combining this with the first law, for a Carnot cycle of finite range, if H' is the heat taken in at θ', and H'' is the heat rejected at θ'', the work W done in the cycle is equal to the difference $H'-H''$, and we have the simple relations,

$$W/(\theta'-\theta'')=H'/\theta'=H''\theta'' \quad . \quad . \quad . \quad (2)$$

5. *Thermodynamical Relations.*—The most important and most useful of the relations between the thermodynamical properties of a substance may be very simply deduced from a consideration of the indicator diagram by a geometrical method, which is in many respects more instructive than the analytical method generally employed. Referring to fig. 2, let BC be a small portion of any isothermal corresponding to the temperature θ', and AD a neighbouring isothermal θ''. Let BE be an isometric through B meeting AD in E, and EC an isopiestic through E meeting BC in C. Let BA, CD be adiabatics through B and C meeting the isothermal θ'' in A and D. Then by relations (2) the heat, H, absorbed in the isothermal change BC, is to the work, W, done in the cycle ABCD in the ratio of θ' to $(\theta'-\theta'')$. If the difference

of temperature $(\theta'-\theta'')$ is small, the figure ABCD may be regarded as a parallelogram, and its area W as equal to the rectangle BE×EC. This is accurately true in the limit when $(\theta'-\theta'')$ is infinitesimal, but in practice it is necessary to measure specific heats, &c., over finite ranges of temperature, and the error involved is generally negligible if the range does not exceed a few degrees. BE is the increase of pressure $(p'-p'')$ produced by the rise of temperature $(\theta'-\theta'')$ if the volume is kept constant. EC is the expansion $(v''-v')$ produced by the same rise of temperature if the pressure is kept constant. Substituting these symbols in the expression for the area, the relation becomes

$$H=\theta(p'-p'')(v''-v')/(\theta'-\theta'') \quad . \quad . \quad . \quad (3)$$

This relation may be interpreted in two ways, according as we require the heat absorbed in terms of the change of pressure or volume. (1) The heat, H, absorbed in isothermal expansion (latent heat of expansion) from p' to p'' is equal to the diminution of pressure $(p'-p'')$ multiplied by the absolute temperature and by the expansion per degree $(v''-v')/(\theta'-\theta'')$ at constant pressure. (2) The heat, H, absorbed in isothermal expansion from v' to v'' is equal to the increase of volume $(v''-v')$ multiplied by the absolute temperature, and by the increase of pressure per degree $(p'-p'')/(\theta'-\theta'')$, at constant volume. In the notation of the calculus the relations become

$$\left.\begin{aligned} -dH/dp\ (\theta \text{ const}) &= \theta dv/d\theta\ (p \text{ const}) \\ dH/dv\ (\theta \text{ const}) &= \theta dp/d\theta\ (v \text{ const}) \end{aligned}\right\} \quad . \quad . \quad . \quad (4)$$

The negative sign is prefixed to dH/dp because absorption of heat $+dH$ corresponds to diminution of pressure $-dp$. The utility of these relations results from the circumstance that the pressure and expansion coefficients are familiar and easily measured, whereas the latent heat of expansion is difficult to determine.

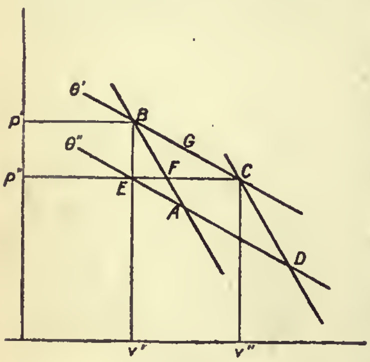

FIG. 2.

The most instructive example of the application of relations (1) and (2) is afforded by the change of state of a substance at constant temperature and pressure. Starting with unit mass of the substance in the first state (*e.g.* liquid) possessing volume v' at a temperature θ'' and pressure p'' represented by the point A in fig. 3, the heat absorbed in raising the temperature to θ' and the pressure to p' without change of state may be written $s'(\theta'-\theta'')$, where s' is the specific heat of the substance in the first state at saturation pressure. If now the substance in the state B is entirely converted at constant temperature and pressure into the second state (*e.g.* saturated vapour), in which it occupies a volume v'', the line BC represents the change of volume $(v''-v')$. The heat absorbed in this change is called the latent heat of change of state, and may be represented by the symbol L'. The substance is then cooled to the lower temperature θ'' along the path CD, keeping it in the saturated state. The heat evolved in this process may be represented by $s''(\theta'-\theta'')$, where s'' is the specific heat of the substance in the second state at saturation pressure. Finally, the substance is reconverted into the first state at the temperature θ'', completing the cycle by the abstraction of a quantity of heat L''. By the application of the first law, the difference of the quantities of heat absorbed and evolved in the cycle must be equal to the work represented by the area of the cycle, which is equal to $(p'-p'')(v''-v')$ in the limit when the difference of pressure is small. By the application of the second law, relations (2), the same work area is equal to $(\theta'-\theta'')L'/\theta'$. Dividing by $(\theta'-\theta'')$, and writing $dp/d\theta$ and $dL/d\theta$ for the limiting values of the ratios $(p'-p'')/(\theta'-\theta'')$ and $(L'-L'')/(\theta'-\theta'')$, we obtain the important relations

$$s'-s''+dL/d\theta=(v''-v')dp/d\theta=L/\theta, \quad . \quad . \quad . \quad (5)$$

in which $dp/d\theta$ is the rate of change of pressure with temperature when the two states are in equilibrium. It is not necessary in this example that AB, CD should be adiabatics, because the change of volume BC is finite. The same equations apply to the case of fusion of a solid, if L is the latest heat of fusion, and v', s', v'', s'' the specific volumes and specific heats of the solid and liquid respectively.

6. *Ratio and Difference of Specific Heats.*—If we take unit mass of the substance at B, fig. 2, and cool it at constant volume to E, through an interval of temperature $(\theta'-\theta'')$, the amount of heat abstracted may be written $h=s(\theta'-\theta'')$, where s is the specific heat *at constant volume.* If, starting from E, *the same* amount of heat h is restored *at constant pressure*, we should arrive at the point F on the adiabatic through B, since the substance has been transformed from B to F by a reversible path without loss or gain of heat on the whole. In order to restore the substance to its original temperature θ' *at constant pressure*, it would be necessary to supply a further quantity of heat, H, represented by the area between the two adiabatics from FC down to the absolute zero. This quantity of heat is the same as that already found in equation (3), but for the small area BFC, which is negligibly small in the limit compared with H. The whole quantity of heat required to raise the temperature from θ'' to θ' at constant pressure along the path EC is $H+h$, which is equal to $S(\theta'-\theta'')$, where S is the specific heat at constant pressure. Since $h=s(\theta'-\theta'')$, the difference $S-s$ between the specific heats at constant pressure and volume is evidently $H/(\theta'-\theta'')$. Substituting for H its value from (3), and employing the notation of the calculus, we obtain the relation

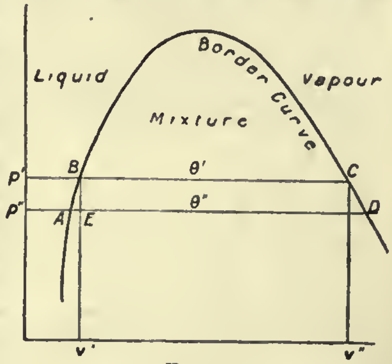

FIG. 3.

$$S-s=\theta(dp/d\theta)(dv/d\theta), \quad . \quad . \quad . \quad . \quad (6)$$

in which the partial differential coefficients have the same meaning as in (4).

Since the amounts of heat supplied at constant pressure from E to F and from E to C are in the limit proportional to the expansions EF and EC which they produce, the ratio S/s is equal to the ratio EC/EF. EF is the change of volume corresponding to a change of pressure BE when no heat is allowed to escape and the path is the adiabatic BF. EC is the change of volume for *the same* change of pressure BE when the path is the isothermal BC. These changes of volume are directly as the compressibilities, or inversely as the elasticities. If we write K for the adiabatic elasticity, and k for the isothermal elasticity, we obtain

$$S/s=\text{EC/EF}=K/k \quad . \quad . \quad . \quad . \quad (7)$$

The value of the specific heat S at constant pressure can always be determined by experiment, and in practice is one of the most important thermodynamical properties of a substance. The value of the specific heat s at constant volume can also be measured in a few cases, but it is generally necessary to deduce it from that at constant pressure by means of relation (6). It is often impossible to observe the pressure-coefficient $dp/d\theta$ directly, but it may be deduced from the isothermal compressibility by means of the geometrically obvious relation, BE=(BE/EC)×EC. The ratio BE/EC of the diminution of pressure to the increase of volume at constant temperature, or $-dp/dv$, is readily observed.

The amount of heat absorbed in any small change of state, as from E to G in fig. 2, may be found by adding to the heat required for the change of temperature at constant volume, $sd\theta$, or at constant pressure, $Sd\theta$, the heat absorbed in isothermal expansion as given by relations (4). We thus obtain the expressions

$$dH=sd\theta+\theta(dp/d\theta)dv=Sd\theta-\theta(dv/d\theta)dp \quad . \quad . \quad . \quad (8)$$

The first is equivalent to measuring the heat along the path EBG, the second along the path ECG. The two differ by the area BEC, which can be neglected if the change is small. For a finite change it is necessary to represent the path by a series of small steps, which is the graphic equivalent of integration along the path represented by the given relation between v and θ, or p and θ. If we put $dH=0$ in equations (8), we obtain the relations between dv and $d\theta$, or dp and $d\theta$, under the condition of no heat-supply, *i.e.* along the adiabatic, which can be integrated, giving the equations to the adiabatics, provided that the values of the specific heats and expansion-coefficients are known.

6. *Intrinsic Energy.*—The change of intrinsic energy E along any path is found by subtracting the work pdv from either of the expressions for dH. Since the change of energy is independent of the path, the finite change between any two given states may be found by integration along *any* convenient path. It is generally convenient to divide the path into two steps, isothermal and isometric, or isothermal and isopiestic, and to integrate along each separately. The change of energy at constant volume is simply $sd\theta$, the change at constant temperature is $(\theta dp/d\theta-p)dv$, which may be written

$$dE/d\theta\ (v \text{ const})=s,\ dE/dv\ (\theta \text{ const})=\theta dp/d\theta-p \quad . \quad (9)$$

These must be expressed as functions of v and θ, which is theoretically possible if the values of s, p, and $dp/d\theta$ are known. Since the two expressions (9) are the partial differential-coefficients of a single function E of the independent variables v and θ, we shall obtain the same result, namely $d^2E/d\theta dv$, if we differentiate the first with respect to v and the second with respect to θ. We thus obtain the relation

$$ds/dv(\theta \text{ const})=\theta d^2p/d\theta^2\ (v \text{ const}), \quad . \quad . \quad . \quad (10)$$

which is useful for calculating the variation of the specific heat s with variation of density at constant temperature. A similar expression for the variation of the specific heat S at constant pressure is obtained from the second expression in (8), by taking p and θ as independent variables; but it follows more directly from a consideration of the variation of the function $(E+pv)$.

7. *Total Heat.*—The function $F=(E+pv)$, like E itself, has a value depending only on the state of the body. It may conveniently be called the *Total Heat*, by a slight extension of the meaning of a term which has been for a long time in use as applied to vapours (see VAPORIZATION). Since $dE=dH-pdv$, we have evidently for the variation of the total heat from the second expression (8),

$$dF=d(E+pv)=dH+vdp=Sd\theta-(\theta dv/d\theta-v)dp \quad . \quad (11)$$

This expression shows that the rate of variation of the total heat with temperature at constant pressure is equal to the specific heat at constant pressure. To find the total heat of a substance in any given state defined by the values of p and θ, starting from any convenient zero of temperature, it is sufficient to measure the total heat required to raise the substance to the final temperature under a constant pressure equal to p. For instance, in the boiler of a steam engine the feed water is pumped into the boiler against the final pressure of the steam, and is heated under this constant pressure up to the temperature of the steam. The total heat with which we are actually concerned in the working of a steam engine is the total heat as here defined, and not the total heat as defined by Regnault, which, however, differs from $(E+pv)$ only by a quantity which is inappreciable in ordinary practice.

Observing that F is a function of the co-ordinates expressing the state of the substance, we obtain for the variation of S with pressure at constant temperature,

$$dS/dp\ (\theta \text{ const})=d^2F/d\theta dp=-\theta d^2v/d\theta^2\ (p \text{ const}) \quad . \quad (12)$$

If the heat supplied to a substance which is expanding reversibly and doing external work, pdv, is equal to the external work done, the intrinsic energy, E, remains constant. The lines of constant energy on the diagram are called *Isenergics*. The equation to these lines in terms of v and θ is obtained by integrating

$$dE=sd\theta+(\theta dp/d\theta-p)dv=0 \quad . \quad . \quad . \quad (13)$$

If, on the other hand, the heat supplied is equal to $-vdp$, we see from (11) that F remains constant. The equation to the lines of constant total heat is found in terms of p and θ by putting $dF=0$ and integrating (11).

8. *Ideal Gases.*—An ideal gas is a substance possessing very simple thermodynamic properties to which actual gases and vapours appear to approximate indefinitely at low pressures and high temperatures. It has the characteristic equation $pv=R\theta$, and obeys Boyle's law at all temperatures. The coefficient of expansion at constant pressure is equal to the coefficient of increase of pressure at constant volume. The difference of the specific heats by equation (6) is constant and equal to R. The isothermal elasticity $-v(dp/dv)$ is equal to the pressure p. The adiabatic elasticity is equal to γp, where γ is the ratio S/s of the specific heats. The heat absorbed in isothermal expansion from v_0 to v at a temperature θ is equal to the work done by equation (8) (since $d\theta=0$, and $\theta(dp/d\theta)dv=pdv$), and both are given by the expression $R\theta \log_e(v/v_0)$. The energy E and the total heat F are functions of the temperature only, by equations (9) and (11), and their variations take the form $dE=sd\theta$, $dF=Sd\theta$. The specific heats are independent of the pressure or density by equations (10) and (12). If we also assume that they are constant with respect to temperature (which does not necessarily follow from the characteristic equation, but is generally assumed, and appears from Regnault's experiments to be approximately the case for simple gases), the expressions for the change of energy or total heat from θ_0 to θ may be written $E-E_0=s(\theta-\theta_0)$, $F-F_0=S(\theta-\theta_0)$. In this case the ratio of the specific heats is constant as well as the difference, and the adiabatic equation takes the simple form, $pv^\gamma=$ constant, which is at once obtained by integrating the equation for the adiabatic elasticity, $-v(dp/dv)=\gamma p$.

The specific heats may be any function of the temperature consistently with the characteristic equation provided that their difference is constant. If we assume that s is a linear function of θ, $s=s_0(1+a\theta)$, the adiabatic equation takes the form,

$$s_0 \log^e(\theta/\theta_0)+as_0(\theta-\theta_0)+R\log_e(v/v_0)=0 \quad . \quad . \quad . \quad (14)$$

where (θ_0,v), (θ_0,v_0) are any two points on the adiabatic. The corresponding expressions for the change of energy or total heat are obtained by adding the term $\frac{1}{2}as_0(\theta^2-\theta_0^2)$ to those already given, thus:

$$E-E_0=s_0(\theta-\theta_0)+\tfrac{1}{2}as_0(\theta^2-\theta_0^2),$$
$$F-F_0=S_0(\theta-\theta_0)+\tfrac{1}{2}as_0(\theta^2-\theta_0^2),$$

where $S_0=s_0+R$.

9. *Deviations of Actual Gases from the Ideal State.*—Since no gas is ideally perfect, it is most important for practical purposes to discuss the deviations of actual gases from the ideal state, and to consider how their properties may be thermodynamically explained and defined. The most natural method of procedure is to observe the deviations from Boyle's law by measuring the changes of pv at various constant temperatures. It is found by experiment that the change of pv with pressure at moderate pressures is nearly proportional to the change of p, in other words that the coefficient $d(pv)/dp$ is to a first approximation a function of the temperature only. This coefficient is sometimes called the "angular coefficient," and may be regarded as a measure of the deviations from Boyle's law, which may be most simply expressed at moderate pressures by formulating the variation of the angular coefficient with temperature. But this procedure in itself is not sufficient, because, although it would be highly probable that a gas obeying Boyle's law at all temperatures was practically an ideal gas, it is evident that Boyle's law would be satisfied by any substance having the characteristic equation $pv=f(\theta)$, where $f(\theta)$ is any arbitrary function of θ, and that the scale of temperatures given by such a substance would not necessarily coincide with the absolute scale. A sufficient test, in addition to Boyle's law, is the condition $dE/dv=0$ at constant temperature. This gives by equation (9) the condition $\theta dp/d\theta=p$, which is satisfied by any substance possessing the characteristic equation $p/\theta=f(v)$, where $f(v)$ is any arbitrary function of v. This test was applied by Joule in the well-known experiment in which he allowed a gas to expand from one vessel to another in a calorimeter without doing external work. Under this condition the increase of intrinsic energy would be equal to the heat absorbed, and would be indicated by fall of temperature of the calorimeter. Joule failed to observe any change of temperature in his apparatus, and was therefore justified in assuming that the increase of intrinsic energy of a gas in isothermal expansion was very small, and that the absorption of heat observed in a similar experiment in which the gas was allowed to do external work by expanding against the atmospheric pressure was equivalent to the external work done. But owing to the large thermal capacity of his calorimeter, the test, though sufficient for his immediate purpose, was not delicate enough to detect and measure the small deviations which actually exist.

10. *Method of Joule and Thomson.*—William Thomson (Lord Kelvin), who was the first to realize the importance of the absolute scale in thermodynamics, and the inadequacy of the test afforded by Boyle's law or by experiments on the constancy of the specific heat of gases, devised a more delicate and practical test, which he carried out successfully in conjunction with Joule. A continuous stream of gas, supplied at a constant pressure and temperature, is forced through a porous plug, from which it issues at a lower pressure through an orifice carefully surrounded with non-conducting material, where its temperature is measured. If we consider any short length of the stream bounded by two imaginary cross-sections A and B on either side of the plug, unit mass of the fluid in passing A has work, $p'v'$, done on it by the fluid behind and carries its energy, $E'+U'$, with it into the space AB, where U' is the kinetic energy of flow. In passing B it does work, $p''v''$, on the fluid in front, and carries its energy, $E''+U''$, with it out of the space AB. If there is no external loss or gain of heat through the walls of the pipe, and if the flow is steady, so that energy is not accumulating in the space AB, we must evidently have the condition $E'+U'+p'v'=E''+U''+p''v''$ at any two cross-sections of the stream. It is easy to arrange the experiment so that U is small and nearly constant. In this case the condition of flow is simply that of constant total heat, or in symbols, $d(E+pv)=0$. We have therefore, by equation, (11),

$$Sd\theta=(\theta dv/d\theta-v)dp, \quad . \quad . \quad . \quad . \quad (15)$$

where $d\theta$ is the fall of temperature of the fluid corresponding to a diminution of pressure dp. If there is no fall of temperature in passing the plug, $d\theta=0$, and we have the condition $\theta dv/d\theta=v$. The characteristic equation of the fluid must then be of the form $v/\theta=f(p)$, where $f(p)$ is any arbitrary function of p. If the fluid is a gas also obeying Boyle's law, $pv=f(\theta)$, then it must be an ideal gas. As the result of their experiments on actual gases (air, hydrogen, and CO_2), Joule and Thomson (*Phil. Trans.*, 1854, 1862) found that the cooling effect, $d\theta$, was of the same order of magnitude as the deviations from Boyle's law in each case, and that it was proportional to the difference of pressure, dp, so that $d\theta/dp$ was nearly constant for each gas over a range of pressure of five or six atmospheres. By experiments at different temperatures between 0° and 100° C., they found that the cooling effect per atmosphere of pressure varied inversely as the square of the absolute temperature for air and CO_2. Putting $d\theta/dp=A/\theta^2$ in equation (15), and integrating on the assumption that the small variations of S could be neglected over the range of the experiment, they found a solution of the type, $v/\theta=f(p)-SA/3\theta^3$, in which $f(p)$ is an arbitrary function of p. Assuming that the gas should approximate indefinitely to the ideal state $pv=R\theta$ at high temperatures, they put $f(p)=R/p$, which gives a characteristic equation of the form

$$v=R\theta/p-SA/3\theta^2 \quad . \quad . \quad . \quad . \quad . \quad (16)$$

An equation of a similar form had previously been employed by Rankine (*Trans. Roy. Soc. Ed.*, 1854) to represent Regnault's experiments on the deviations of CO_2 from Boyle's law. This equation is practically identical for moderate pressures with that devised by Clausius (*Phil. Mag.*, 1880) to represent the behaviour of CO_2 up to the critical point. Experiments by Natanson on CO_2 at 17° C. confirm those of Joule and Thomson, but show a slight increase of the ratio $d\theta/dp$ at higher pressures, which is otherwise rendered probable by the form of the isothermals as determined by Andrews and Amagat. More recent experiments by J. H. Grindley (*Proc. Roy. Soc.*, 1900, 66, p. 79) and Callendar (*Proc. Roy. Soc.*, 1900) on steam confirm this type of equation, but give much larger values of the cooling effect than for CO_2, and a more rapid rate of variation with temperature.

11. *Modified Joule-Thomson Equation.*—G. A. Hirn (*Théorie Mec. de la Chaleur*, ii. p. 211, Paris, 1869) proposed an equation of the form $(p+p_0)(v-b)=R\theta$, in which the effect of the size of the molecules is represented by subtracting a quantity b, the "co-volume," from the volume occupied by the gas, and the effect of the mutual attractions of the molecules is represented by adding a quantity p_0, the internal pressure, to the external pressure, p. This type of equation, was more fully worked out by van der Waals, who identified the internal pressure, p_0, with the capillary pressure of Laplace, and assumed that it varied directly as the square of the density, and could be written a/v^2. This assumption represents qualitatively the theoretical isothermal of James Thomson (see VAPORIZATION) and the phenomena of the critical state (see CONDENSATION OF GASES); but the numerical results to which it leads differ so widely from experiment that it is necessary to suppose the constant, a, to be a function of the temperature. Many complicated expressions have been suggested by subsequent writers in the attempt to represent the continuity of the gaseous and liquid states in a single formula, but these are of a highly empirical nature, and beyond the scope of the present inquiry. The simplest assumption which suffices to express the small deviations of gases and vapours from the ideal state *at moderate pressures* is that the coefficient a in the expression for the capillary pressure varies inversely as some power of the absolute temperature. Neglecting small terms of the second order, the equation may then be written in the form

$$v-b=R\theta/p-c_0(\theta_0/\theta)^n=V-c, \quad . \quad . \quad . \quad (17)$$

in which c is a small quantity (expressing the defect from the ideal volume $V=R\theta/p$ due to co-aggregation of the molecules) which varies inversely as the nth power of θ, but is independent of p to a first approximation at moderate pressures. The constant c_0 is the value of c at some standard temperature θ_0. The value of the index, n, appears to be different for different types of molecule. For CO_2 at ordinary temperatures $n=2$, as in the Joule-Thomson equation. For steam between 100° and 150° C. it approaches the value 3·5. It is probably less than 2 for air and the more perfect gases. The introduction of the covolume, b, into the equation is required in order to enable it to represent the behaviour of hydrogen and other gases at high temperatures and pressures according to the experiments of Amagat. It is generally taken as constant, but its value at moderate pressures is difficult to determine. According to van der Waals, assuming spherical molecules, it should be four times; according to O. E. Meyer, on slightly different assumptions, it should be $4\sqrt{2}$ times, the actual volume of the molecules. It appears to be a quantity of the same order as the volume of the liquid, or as the limiting volume of the gas at very high pressures. The value of the co-aggregation volume, c, at any temperature, assuming equation (17), may be found by observing the deviations from Boyle's law and by experiments on the Joule-Thomson effect. The value of the angular coefficient $d(pv)/dp$ is evidently $(b-c)$, which expresses the defect of the actual volume v from the ideal volume $R\theta/p$. Differentiating equation (17) at constant pressure to find $dv/d\theta$, and observing that $dc/d\theta=-nc/\theta$, we find by substitution in (15) the following simple expression for the cooling effect $d\theta/dp$ in terms of c and b,

$$S d\theta/dp=(n+1)c-b \quad . \quad . \quad . \quad . \quad (18)$$

Experiments at two temperatures suffice to determine both c and n if we assume that b is equal to the volume of the liquid. But it is better to apply the Boyle's law test in addition, provided that errors due to surface condensation can be avoided. The advantage of this type of equation is that c is a function of the temperature only. Other favourite types of equation for approximate work are (1) $p=R\theta/v+f(v)$, which makes p a linear function of θ at constant volume, as in van der Waal's equation; (2) $v=R\theta/p+f(p)$, which makes v a linear function of θ at constant pressure. These have often been employed as empirical formulae (*e.g.* Zeuner's formula for steam), but they cannot be made to represent with sufficient approximation the deviations from the ideal state at moderate pressures and generally lead to erroneous results. In the modified Joule-Thomson equation (17), both c and n have simple theoretical interpretations, and it is possible to express the thermodynamical properties of the substance in terms of them by means of reasonably simple formulae.

12. *Application of the Modified Equation.*—We may take equation (17) as a practical example of the thermodynamical principles already given. The values of the partial differential coefficients in terms of n and c are as follows:—

$$dv/d\theta\ (p\ \text{const})=(R/p)(1+nc/V) \quad . \quad . \quad . \quad . \quad . \quad (19)$$
$$d^2v/d\theta^2\ \ ,, \quad = -n(n+1)c/\theta^2 \quad . \quad . \quad . \quad . \quad . \quad (20)$$
$$dp/d\theta\ (v\ \text{const})=(R/V)(1+nc/V) \quad . \quad . \quad . \quad . \quad (21)$$
$$d^2p/d\theta^2\ \ ,, \quad =Rnc(1-n+2nc/V)/\theta V^2 \quad . \quad . \quad . \quad (22)$$
$$d(pv)/dp(\theta\ \text{const})=b-c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Substituting these values in equations already given, we find,

from (6) $\quad S-s=R(1+nc/V)^2 \quad . \quad . \quad . \quad . \quad . \quad (24)$

,, (9) $dE/dv\ (\theta\ \text{const})=ncp/V \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$

,, (11) $dF/dp \quad ,, \quad =(n+1)c-b \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$

,, (10) $ds/dv \quad ,, \quad =(1-n+2nc/V)Rnc/V^2 \quad . \quad . \quad . \quad (27)$

,, (12) $dS/dp \quad ,, \quad =n(n+1)c/\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$

In order to deduce the complete variation of the specific heats from these equations, it is necessary to make some assumption with regard to the variation of the specific heats with temperature. The assumption usually made is that the total kinetic energy of the molecules, including possible energy of rotation or vibration if the molecules consist of more than one atom, is proportional to the energy of translation in the case of an ideal gas. In the case of imperfect gases, all the available experimental evidence shows that the specific volume tends towards its ideal value, $V=R\theta/p$, in the limit, when the pressure is indefinitely reduced and the molecules are widely separated so as to eliminate the effects of their mutual actions. We may therefore reasonably assume that the *limiting* values of the specific heats at zero pressure do not vary with the temperature, provided that the molecule is stable and there is no dissociation. Denoting by S_0, s_0, these constant limiting values at $p=0$, we may obtain the values at any pressure by integrating the expressions (27) and (28) from ∞ to v and from 0 to p respectively. We thus obtain

$$S=S_0+n(n+1)pc/\theta \quad . \quad . \quad . \quad . \quad . \quad (29)$$
$$s=s_0+(n-1-nc/V)ncp/\theta \quad . \quad . \quad . \quad . \quad (30)$$

In working to a first approximation, the small term nc/V may be omitted in the expression for s.

The expression for the change of intrinsic energy E between any given limits $p_0\theta_0$ to $p\theta$ is readily found by substituting these values of the specific heats in equations (11) or (13), and integrating between the given limits. We thus obtain

$$E-E_0=s_0(\theta-\theta_0)-n(pc-p_0c_0) \quad . \quad . \quad . \quad (31)$$

We have similarly for the total heat $F=E+pv$,

$$F-F_0=S_0(\theta-\theta_0)-(n+1)(cp-c_0p_0)+b(p-p_0).$$

The energy is less than that of an ideal gas by the term npc. If we imagine that the defect of volume c is due to the formation of molecular aggregates consisting of two or more single molecules, and if the kinetic energy of translation of any one of these aggregates is equal to that of one of the single molecules, it is clear that some energy must be lost in co-aggregating, but that the proportion lost will be different for different types of molecules and also for different types of co-aggregation. If two monatomic molecules, having energy of translation only, equivalent to 3 degrees of freedom, combined to form a diatomic molecule with 5 degrees of freedom, the energy lost would be $pc/2$ for co-aggregation, c, per unit mass. In this case $n=1/2$. If two diatomic molecules, having each 5 degrees of freedom, combine to form a molecule with 6 degrees of freedom, we should have $n=2$, or the energy lost would be $2pc$ per unit mass. If the molecules and molecular aggregates were more complicated, and the number of degrees of freedom of the aggregates were limited to 6, or were the same as for single molecules, we should have $n=s_0/R$. The loss of energy could not be greater than this on the simple kinetic theory, unless there were some evolution of latent heat of co-aggregation, due to the work done by the mutual attractions of the co-aggregating molecules.

It is not necessary to suppose that the co-aggregated molecules are permanently associated. They are continually changing partners, the ratio c/V representing approximately the ratio of the time during which any one molecule is paired to the time during which it is free. At higher densities it is probable that more complex aggregates would be formed, so that as the effect of the collisions became more important c would cease to be a function of the temperature only; experiment, indeed, shows this to be the case.

13. *Entropy.*—It follows from the definition of the absolute scale of temperature, as given in relations (2), that in passing at constant temperature θ from one adiabatic ϕ' (Fig. 1) to any other adiabatic ϕ'', the quotient H/θ of the heat absorbed by the temperature at which it is absorbed is the same for the same two adiabatics whatever the temperature of the isothermal path. This quotient is called the change of entropy, and may be denoted by $(\phi''-\phi')$. In passing along an adiabatic there is no change of entropy, since no heat is absorbed. The adiabatics are lines of constant entropy, and are also called *Isentropics*. In virtue of relations (2), the change of entropy of a substance between any two states depends only on the initial and final states, and may be reckoned along any reversible path, not necessarily isothermal, by dividing each small increment of heat, dH, by the temperature, θ, at which it is acquired, and taking the sum or integral of the quotients, dH/θ, so obtained.

The expression for the change of entropy between any two states is found by dividing either of the expressions for dH in (8) by θ and integrating between the given limits, since dH/θ is a perfect differential. In the case of a solid or a liquid, the latent heat of isothermal expansion may often be neglected, and if the specific heat, s, be also taken as constant, we have simply $\phi-\phi_0=s\log_e\theta/\theta_0$. If the substance at the temperature θ undergoes a change of state, absorbing latent heat, L, we have merely to add the term L/θ to the above expression. In the case of an ideal gas, $dp/d\theta$ at constant volume $=R/v$, and $dv/d\theta$ at constant pressure $=R/p$; thus we obtain the expressions for the change of entropy $\phi-\phi_0$ from the state $p_0\theta_0v_0$ to the state $p\theta v$,

$$\begin{aligned}\phi-\phi_0&=s\log_e\theta/\theta_0+R\log_e v/v_0\\&=S\log_e\theta/\theta_0-R\log_e p/p_0 \quad . \quad . \quad . \quad (32)\end{aligned}$$

In the case of an imperfect gas or vapour, the above expressions are frequently employed, but a more accurate result may be obtained by employing equation (17) with the value of the specific heat, S, from (29), which gives the expression

$$\phi-\phi_0=S_0\log_e\theta/\theta_0-R\log_e p/p_0-n(cp/\theta-c_0p_0/\theta_0) \quad . \quad . \quad (33)$$

The state of a substance may be defined by means of the temperature and entropy as co-ordinates, instead of employing the pressure and volume as in the indicator diagram. This method of representation is applicable to certain kinds of problems, and has been developed by Macfarlane Gray and other writers in its application to the steam engine. (See STEAM ENGINE.) Areas on the temperature-entropy or θ, ϕ diagram represent quantities of heat in the same way as areas on the indicator diagram represent quantities of work. The θ, ϕ diagram is useful in the study of heat waste and condensation, but from other points of view the utility of the conception of entropy as a "factor of heat" is limited by the fact that it does not correspond to any directly measurable physical property, but is merely a mathematical function arising from the form of the definition of absolute temperature. Changes of entropy must be calculated in terms of quantities of heat, and must be interpreted in a similar manner. The majority of thermodynamical problems may be treated without any reference to entropy, but it affords a convenient method of expression in abstract thermodynamics, especially in the consideration of irreversible processes and in reference to the conditions of equilibrium of heterogeneous systems.

14. *Irreversible Processes.*—In order that a process may be strictly reversible, it is necessary that the state of the working substance should be one of equilibrium at uniform pressure and temperature throughout. If heat passes "of itself" from a higher to a lower temperature by conduction, convection or radiation, the transfer cannot be reversed without an expenditure of work. If mechanical work or kinetic energy is directly converted into heat by friction, reversal of the motion does not restore the energy so converted. In all such cases there is necessarily, by Carnot's principle, a loss of efficiency or available energy, accompanied by an increase of entropy, which serves as a convenient measure or criterion of the loss. A common illustration of an irreversible process is the expansion of a gas into a vacuum or against a pressure less than its own. In this case the work of expansion, pdv, is expended in the first instance in producing kinetic energy of motion of parts of the gas. If this could be co-ordinated and utilized without dissipation, the gas might conceivably be restored to its initial state; but in practice violent local differences of pressure and temperature are produced, the kinetic energy is rapidly converted into heat by viscous eddy friction, and residual differences of temperature are equalized by diffusion throughout the mass. Even if the expansion is adiabatic, in the sense that it takes place inside a non-conducting enclosure and no heat is supplied from external sources, it will not be isentropic, since the heat supplied by internal friction must be included in reckoning the change of entropy. Assuming that no heat is supplied from external sources and no external work is done, the intrinsic energy remains constant by the first law. The final state of the substance, when equilibrium has been restored, may be deduced from this condition, if the energy can be expressed in terms of the co-ordinates. But the line of constant energy on the diagram does not represent the path of the transformation, unless it be supposed to be effected in a series of infinitesimal steps between each of which the substance is restored to an equilibrium state. An irreversible process which permits a more complete experimental investigation is the steady flow of a fluid in a tube already referred to in section 10. If the tube is a perfect non-conductor, and if there are no eddies or frictional dissipation, the state of the substance at any point of the tube as to E, p, and v, is represented by the adiabatic or isentropic path, $dE=-pdv$. As the section of the tube varies, the change of kinetic energy of flow, dU, is represented by $-vdp$. The flow in this case is reversible, and the state of the fluid is the same at points where the section of the tube is the same. In practice, however, there is always some frictional dissipation, accompanied by an increase of entropy and by a fall of pressure. In the limiting case of a long fine tube, the bore of which varies in such a manner that U is constant, the state of the substance along a line of flow may be represented by the line of constant total heat, $d(E+pv)=0$; but in the case of a porous plug or small throttling aperture, the steps of the process cannot be followed, though the final state is the same.

In any small reversible change in which the substance absorbs heat, dH, from external sources, the increase of entropy, $d\phi$, must be equal to dH/θ. If the change is not reversible, but the final state is the same, the change of entropy, $d\phi$, is the same, but it is no longer equal to dH/θ. By Carnot's principle, in all irreversible processes, dH/θ must be algebraically less than $d\phi$, otherwise it would be possible to devise a cycle more efficient than a reversible cycle. This affords a useful criterion (see ENERGETICS) between transformations which are impossible and those which are possible but irreversible. In the special case of a substance isolated from external heat supply, $dH=0$, the change of entropy is zero in a reversible process, but must be positive if the process is not reversible. The entropy cannot diminish. Any change involving decrease of entropy is impossible. The entropy tends to a maximum, and the state is one of stable equilibrium when the value of the entropy is the maximum value consistent with the conditions of the problem.

15. *Heterogeneous Equilibrium.*—In a *system*, as distinguished from a homogeneous substance, consisting of two or more states or phases, a similar condition of equilibrium applies. In any spontaneous irreversible change, if the system is heat-isolated, there must be an increase of entropy. The total entropy of the system is found by multiplying the entropy per unit mass of the substance in each state by the mass existing in that state, and adding the products so obtained. The simplest case to consider is that of equilibrium between solid and liquid, or liquid and vapour. The more general case is discussed in the article ENERGETICS, and in the original memoirs of Willard Gibbs and others. Since the condition of heat-isolation is impracticable, the condition of maximum entropy cannot, as a rule, be directly applied, and it is necessary to find a more convenient method of expression. If dW is the external work done, dH the heat absorbed from external sources, and dE the increase of intrinsic energy, we have in all cases by the first law, $dH-dE=dW$. Since $\theta d\phi$ cannot be less than dH, the difference $(\theta d\phi-dE)$ cannot be less than dW. This inequality holds in all cases, but cannot in general be applied to an irreversible change, because $\theta d\phi$ is not a perfect differential, and cannot be evaluated without a knowledge of the path or process of transformation. In the special case, however, in which the transformation is conducted in an isothermal enclosure, a common condition easily realized in practice, the temperature at the end of the transformation is reduced to its initial value throughout the substance. The value of $\theta d\phi$ is then the same as $d(\theta\phi)$, which is a perfect differential, so that the condition may be written $d(\phi\theta-E)=dW$. The condition in this form can be readily applied provided that the external work dW can be measured. There are two special cases of importance:—(*a*) If the volume is constant, or $dW=0$, the value of the function $(\theta\phi-E)$ cannot diminish, or $(E-\theta\phi)$ cannot increase, if the temperature is kept constant. This function may be represented, for each state or phase of the system considered, by an area on the indicator diagram similar to that representing the intrinsic energy, E. The product $\theta\phi$ may be represented at any point such as D in Fig. 1 by the whole area θ''DZ′VO under the isothermal θ''D and the adiabatic DZ′, bounded by the axes of pressure and volume. The intrinsic energy, E, is similarly represented by the area DZ′V*d* under the adiabatic to the right of the isometric D*d*. The difference $\theta\phi-E$ is represented by the area θ''D*d*O to the left of the isometric D*d* under the isothermal θ''D. The increment of this area (or the decrement of the negative area $E-\theta\phi$) at constant temperature represents the external work obtainable from the substance in isothermal expansion, in the same way that the decrement of the intrinsic energy represents the work done in adiabatic expansion. The function $J=E-\theta\phi$, has been called the "free energy" of the substance by Helmholtz, and $\theta\phi$ the "bound energy." These functions do not, however, represent energy existing in the substance, like the intrinsic energy; but the increment of $\theta\phi$ represents heat supplied to, and the decrement of $(E-\theta\phi)$ represents work obtainable from, the substance when the temperature is kept constant. The condition of stable equilibrium of a system at constant temperature and volume is that the total J should be a minimum. This function is also called the "thermodynamic potential at constant volume" from the analogy with the condition of minimum potential energy as the criterion of stable equilibrium in statics.

As an example, we may apply this condition to the case of change of state. If J', J'' represent the values of the function for unit mass of the substance of specific volumes v' and v'' in the two states at temperature θ and pressure p, and if a mass m is in the state v', and $1-m$ in the state v'', the value of J for unit mass of the mixture is $mJ'+(1-m)J''$. This must be a minimum in the state of equilibrium at constant temperature. Since the volume is constant, we have the condition $mv'+(1-m)v''=$constant. Since $dJ=-\phi d\theta-pdv$, we have also the relations $dJ'/dv'=-p=dJ''/dv''$, at constant temperature. Putting $dJ/dm=0$ at constant volume, we obtain as the condition of equilibrium of the two states $J'+p'v'=J''+p''v''$. This may be interpreted as the equation of the border curve giving the relation between p and θ, but is more easily obtained by considering the equilibrium at constant pressure instead of constant volume.

(*b*) The second case, which is of greater practical utility, is that in which the external pressure, p, is kept constant. In this case $dW=pdv=d(pv)$, a perfect differential, so that the external work done is known from the initial and final states. In any possible transformation $d(\theta\phi-E)$ cannot be less than $d(pv)$, or the function $(E-\theta\phi+pv)=G$ cannot increase. The condition of stable equilibrium is that G should be a minimum, for which reason it has been called the "thermodynamic potential at constant pressure." The product pv for any state such as D in fig. 1 is represented by the rectangle MDdO, bounded by the isopiestic and the isometric through D. The function G is represented by the negative area θ''DM under the isothermal, bounded by the isopiestic DM and the axis of pressure. The increment of $\theta\phi$ is always greater than that of the total heat $F=E+pv$, except in the special case of an equilibrium change at constant temperature and pressure, in which case both are equal to the heat absorbed in the change, and the function G remains constant. This is geometrically obvious from the form of the area representing the function on the indicator diagram, and also follows directly from the first law. The simplest application of the thermodynamic potential is to questions of change of state. If ϕ', E', v'; and ϕ'', E'', v'', refer to unit mass of the substance in the first and second states respectively in equilibrium at a temperature θ and pressure p, the heat absorbed, L, per unit mass in a change from the first to the second state is, by definition of the entropy, equal to $\theta(\phi''-\phi')$, and this by the first law is equal to the change of intrinsic energy, $E''-E'$, plus the external work done, $p(v''-v')$, *i.e.* to the change of total heat, $F''-F$. If G' and G'' are the values of the function G for the two states in equilibrium at the same pressure and temperature, we must have $G'=G''$. Assuming the function G to be expressed in terms of p and θ, this condition represents the relation between p and θ corresponding to equilibrium between the two states, which is the solution of the relation $(v''-v')dp/d\theta=L/\theta$, (5). The direct integration of this equation requires that L and $v''-v'$ should be known as functions of p and θ, and cannot generally be performed. As an example of one of the few cases where a complete solution is possible, we may take the comparatively simple case equation (17), already considered, which is approximately true for the majority of vapours at moderate pressures.

Writing formulae (31) and (33) for the energy and entropy with indeterminate constants A and B, instead of taking them between limits, we obtain the following expressions for the thermodynamic functions in the case of the vapour:—

$$\phi''=S_0\log_e\theta-R\log_e p-ncp/\theta+A'' \quad (34)$$
$$E''=s_0\theta-ncp+B'' \quad (35)$$
$$F''=S_0\theta-(n+1)cp+bp+B'' \quad (36)$$
$$G''=S_0\theta(1-\log_e\theta)+R\theta\log_e p-(c-b)p-A''\theta+B'' \quad (37)$$
$$J''=s_0\theta-S_0\theta\log_e\theta+R\theta\log_e p-A''\theta+B'' \quad (38)$$

The function J'' may be expressed in terms of θ and v by writing for p its value, namely, $R\theta/(v+c-b)$. We have also in any case the relations

$$dG''/d\theta\ (p\ \text{const})=\phi''=dJ''/d\theta\ (v\ \text{const}) \quad (39)$$
$$dG''/dp\ (\theta\ \text{const})=v,\ dJ''/dv\ (\theta\ \text{const})=p \quad (40)$$

And all the properties of the substance may be expressed in terms of G or J and their partial differential coefficients. The values of the corresponding functions for the liquid or solid cannot be accurately expressed, as the theoretical variation of the specific heat is unknown, but if we take the specific heat at constant pressure s' to be approximately constant, and observe the small residual variation dh of the total heat, we may write

$$F'=s'\theta+dh+B' \quad (41)$$
$$\phi'=s'\log_e\theta+d\phi+A' \quad (42)$$
$$G'=s'\theta(1-\log_e\theta)+(dh-\theta d\phi)-A'\theta+B' \quad (43)$$

where $d\phi$ is the corresponding residual variation of ϕ', and is easily calculated from a table of values of h.

To find the border curve of equilibrium between the two states, giving the saturation pressure as a function of the temperature, we have merely to equate the values of G' and G''. Rearranging the terms, and dividing throughout by θ, we obtain an equation of the form

$$R\ \log_e p=A-B/\theta-(s'-S_0)\log_e\theta+(c-b)p/\theta+(dh/\theta-d\phi) \quad (44)$$

in which $B=B''-B'$, and $A=A''-A'+s'-S_0$. The value of A is determined by observing the value of θ_0 at some known pressure p_0, *e.g.* at the boiling-point. The value of B is determined by observing the latent heat, $L_0=F''_0-F'_0$, which gives

$$B=B''-B'=L_0+(s'-S_0)\theta_0+(n+1)c_0p_0-bp_0+dh_0 \quad (45)$$

This constant may be called the absolute latent heat, as it expresses the thermal value of the change of state in a manner independent of temperature.

The term $(dh/\theta-d\phi)$ depending on the variation of the specific heat of the liquid may be made very small in the case of water by a proper choice of the constant s'. It is of the same order as the probable errors of observation, and may be neglected in practice. (See VAPORIZATION, § 16.) The expression for $R\log p$ for an imperfect gas of this type differs from that for a perfect gas only by the addition of the term $(c-b)p/\theta$. This simple result is generally true, and the corresponding expressions for G'' and J'' are valid, provided that $c-b$ in formula (17) is a function of the temperature only. It is not necessary to suppose that c varies inversely as the nth power of the temperature, and that b is constant, as assumed in deducing the expressions for ϕ, E, and F.

Although the value of G in any case cannot be found without that of ϕ, and although the consideration of the properties of the thermodynamic potential cannot in any case lead to results which are not directly deducible from the two fundamental laws, it affords a convenient method of formal expression in abstract thermodynamics for the condition of equilibrium between different phases, or the criterion of the possibility of a transformation. For such purely abstract purposes, the possibility of numerical evaluation of the function is of secondary importance, and it is often possible to make qualitative deductions with regard to the general nature of a transformation without any knowledge of the actual form of the function. A more common method of procedure, however, is to infer the general relations of the thermodynamic potential from a consideration of the phenomena of equilibrium.

As it would be impossible within the limits of this article to illustrate or explain adequately the applications which have been made of the principles of thermodynamics, it has been necessary to select such illustrations only as are required for other reasons, or could not be found elsewhere. For fuller details and explanations of the elements of the subject, the reader must be referred to general treatises such as Baynes's *Thermodynamics* (Oxford), Tait's *Thermodynamics* (Edinburgh), Maxwell's *Theory of Heat* (London), Parker's *Thermodynamics* (Cambridge), Clausius's *Mechanical Theory of Heat* (translated by Browne, London), and Preston's *Theory of Heat* (London). One or two chapters on the subject are also generally included in treatises on the steam engine, or other heat engines, such as those of Rankine, Perry or Ewing. Of greater interest, particularly from a historical point of view, are the original papers of Joule, Thomson and Rankine, some of which have been reprinted in a collected form. A more complete and more elaborate treatment of the subject will be found in foreign treatises, such as those of Clausius, Zeuner, Duhem, Bertrand, Planck and others.

Alphabetical Index of Symbols Employed.

θ, Thermodynamic or absolute temperature.
ϕ, Entropy. Section 13.
b, Covolume of molecules of gas. Equation (17).
c, c_0, Co-aggregation volume per unit mass. Equation (17).
e, Base of Napierian logarithms.
E, Intrinsic energy per unit mass. Section 2.
$F=E+pv$, Total heat. Section 7.
G, J, Thermodynamic potential functions. Section 15.
H, Quantity of heat (in mechanical units). Section 2.
K, k, Adiabatic and isothermal elasticities. Equation (7).
L, Latent heat of fusion or vaporization. Equation (5).
M, Molecular weight. Section 8.
m, Mass of substance or molecule.
n, Index in expression for c. Equation (17).
p, Pressure of fluid. p_0, Initial pressure.
$R=S_0-s_0$, Constant in gas-equation (17).
S, Specific heat of gas at constant pressure.
S_0, Limiting value of S when $p=0$. Section 12.
s, Specific heat of gas at constant volume.
s_0, Limiting value of s when $p=0$. Section 12.
s', s'', Specific heat under other conditions. Equation (5).
U, Kinetic energy of flow of fluid. Section 10.
u, Mean velocity of gaseous molecules. Section 8.
$V=R\theta/p$, Ideal volume of gas per unit mass. Equation (17).
v, Specific volume of fluid, reciprocal of density.
W, External work done by fluid. (H. L. C.)

THERMOELECTRICITY. 1. *Fundamental Phenomena.*—Alessandro Volta (1801) showed that although a separation of the two electricities was produced by the contact of two different metals (*Volta Effect*), which could be detected by a sensitive electrometer, a continuous current of corresponding magnitude could not be produced in a purely metallic circuit without the interposition of a liquid, because the electromotive force at one junction was exactly balanced by an equal and opposite force at the other. T. J. Seebeck (1822), employing a galvanometer then recently invented, which was more suited for the detection of small electromotive forces, found that a current was produced if the junctions of the two metals were at different temperatures. He explained this effect by supposing that the Volta contact electromotive force varied with the temperature, so that the exact balance was destroyed by unequal heating. The intensity of the current, C, for any given pair of metals, was found to vary directly as the difference of temperature, $t-t'$, between the hot and cold junctions, and inversely as the resistance, R, of the circuit. We conclude by applying Ohm's law that the electromotive force, E, of the thermocouple may be approximately represented for small differences of temperature by the formula

$$E=CR=p(t-t') \quad . \quad . \quad . \quad . \quad . \quad (1)$$

2. *Thermoelectric Power, Series, Inversion.*—The limiting value, dE/dt, of the coefficient, p, for an infinitesimal difference, dt, between the junctions is called the *Thermoelectric Power* of the couple. One metal (A) is said to be thermoelectrically positive to another (B), if positive electricity flows from A to B across the cold junction when the circuit is completed. The opposite convention is sometimes adopted, but the above is the most convenient in practice, as the circuit is generally broken at or near the cold junction for the insertion of the galvanometer. Seebeck found that the metals could be arranged in a *Thermoelectric Series*, in the order of their power when combined with any one metal, such that the power of any thermocouple p, composed of the metals A and B, was equal to the algebraic difference $(p'-p'')$ of their powers when combined with the standard metal C. The order of the metals in this series was found to be different from that in the corresponding Volta series, and to be considerably affected by variations in purity, hardness and other physical conditions. J. Cumming shortly afterwards discovered the phenomenon of *Thermoelectric Inversion*, or the change of the order of the metals in the thermoelectric series at different temperatures. Copper, for instance, is negative to iron at ordinary temperatures, but is positive to it at 300° C. or above. The E.M.F. of a copper-iron thermocouple reaches a maximum when the temperature of the hot junction is raised to 270° C., at which temperature the thermoelectric power vanishes and the metals are said to be *neutral* to one another. Beyond this point the E.M.F. diminishes, vanishing and changing sign when the temperature of the hot junction is nearly as much above the neutral point as the temperature of the cold junction is below it. Similar phenomena occur in the case of many other couples, and it is found that the thermoelectric power p is not in general a constant, and that the simple linear formula (1) is applicable only for small differences of temperature. More accurately it may be stated that the thermoelectromotive force in any given circuit containing a series of different metals is a function of the temperatures of the junctions only, and is independent of the distribution of the temperature at any intermediate points, provided that each of the metals in the series is of uniform quality. This statement admits of the simple mathematical expression

$$E=\int_{t_0}^{t'} p'dt+\int_{t'}^{t''} p''dt + \&c. \quad . \quad . \quad . \quad (2)$$

where p', p, &c., are the thermoelectric powers of the metals, and t_0, t', t'', &c., the temperatures of the junctions. There are some special cases of sufficient practical importance to be separately stated.

3. *Homogeneous Circuit. Strain Hysteresis.*—In a circuit consisting of a single metal, no current can be produced by variations of temperature, provided that the metal is not thereby strained or altered. This was particularly demonstrated by the experiments of H. G. Magnus. The effects produced by abrupt changes of temperature or section, or by pressing together pieces of the same metal at different temperatures, are probably to be explained as effects of strain. A number of interesting effects of this nature have been investigated by Thomson, F. P. Le Roux, P. G. Tait and others, but the theory has not as yet been fully developed. An interesting example is furnished by an experiment due to F. T. Trouton (*Proc. R. S. Dub.*, 1886). A piece of iron or steel wire in the circuit of a galvanometer is heated in a flame to bright redness at any point. No effect is noticed so long as the flame is stationary, but if the flame be moved slowly in one direction a current is observed, which changes its direction with the direction of motion of the flame. The explanation of this phenomenon is that the metal is transformed at a red heat into another modification, as is proved by simultaneous changes in its magnetic and electrical properties. The change from one state to the other takes place at a higher temperature on heating than on cooling. The junctions of the magnetic and the non-magnetic steel are therefore at different temperatures if the flame is moved, and a current is produced just as if a piece of different metal with junctions at different temperatures had been introduced into the circuit. Other effects of "hysteresis" occur in alloys of iron, which have been studied by W. F. Barrett (*Trans. R. S. Dub.*, January 1900).

4. *Law of Successive Temperatures.*—The E.M.F. of a given couple between any temperatures t' and t'' is the algebraic sum of the E.M.F. between t' and any other temperature t and the E.M.F. between t' and t''. A useful result of this law is that it is sufficient to keep one junction always at some convenient standard temperature, such as 0° C., and to tabulate only the values of the E.M.F. in the circuit corresponding to different temperatures of the other junction.

5. *Law of Intermediate Metals.*—A thermoelectric circuit may be cut at any point and a wire of some other metal introduced without altering the E.M.F. in the circuit, provided that the two junctions with the metal introduced are kept at the same temperature. This law is commonly applied in connecting a thermocouple to a galvanometer with coils of copper wire, the junctions of the copper wires with the other metals being placed side by side in a vessel of water or otherwise kept at the same temperature. Another way of stating this law, which, though apparently quite different, is really equivalent in effect, is the following. The E.M.F. of any couple, AB, for any given limits of temperature is the algebraic sum of the E.M.F.s between the same limits of temperature of the couples BC and CA formed with any other metal C. It is for this reason unnecessary to tabulate the E.M.F.s of all possible combinations of metals, since the E.M.F. of any couple can be at once deduced by addition from the values given by its components with a single standard metal. Different observers have chosen different metals as the standard of reference. Tait and J. A. Fleming select lead on account of the smallness of the Thomson effect in it, as observed by Le Roux. Noll adopts mercury because it is easily purified, and its physical condition in the liquid state is determinate; there is, however, a discontinuity involved in passing from the liquid to the solid state at a temperature of −40° C., and it cannot be used at all with some metals, such as lead, on account of the rapidity with which it dissolves them. Both lead and mercury have the disadvantage that they cannot be employed for temperatures much above 300° C. Of all metals, copper is the most generally convenient, as it is always employed in electrical connexions and is easily obtained in the annealed state of uniform purity. For high temperature work it is necessary to employ platinum, which would be an ideal standard for all purposes on account of its constancy and infusibility, did not the thermoelectric properties of different specimens differ considerably.

6. *Thermoelectric Formulae.*—On the basis of the principles stated above, the most obvious method of tabulating the observations would be to give the values E_t of the E.M.F. between 0° C. and t for each metal against the standard. This involves no assumptions as to the law of variation of E.M.F. with temperature, but is somewhat cumbrous. In the majority of cases it is found that the observations can be represented within the limits of experimental error by a fairly simple empirical formula, at least for moderate ranges of temperatures. The following formulae are some of those employed for this purpose by different observers:—

$E_t=bt+ct^2$	(Avenarius, 1863.)
$E_t=at+bt^2+ct^3$	(General type.)
$\log E=a+b/T+c \log T$ . . .	(Becquerel, 1863.)
$E_{(t-t')}=c(t-t')\,(2t^\circ-(t+t'))$ . .	(Tait, 1870)
$E_t+E_{t^\circ}=10^{a+bt}+10^{a'+b't^\circ}$ . . .	(Barus, 1889.)
$t=aE+bE^2+cE^3$	(Holborn and Wien, 1892.)
$E_{(t-t')}=b(t-t')^{4/3}$	(Paschen, 1893.)
$E_{(t-t')}=a(t-t')+b(t-t')^2$ . . .	(Steele, 1894.)
$E_{(T-T^\circ)}=mT^n-mT^{\circ n}$, $E_t=mt^n$ . .	(Holman, 1896.)
$E_t=bt+c \log T/273$, $(c=Ts.)$ . .	(Stanfield, 1898.)
$E_t=-a+bt+ct^2$	(Holborn and Day, 1899.)

$E_t=at+ct^2+s^\circ(T \log_e T-273 \log_e 273)$.
(Where $s=s^\circ+2cT$, and c is small. See sec. 15.)

For moderate ranges of temperature the binomial formula of M. P. Avenarius is generally sufficient, and has been employed by many observers. It is figured by Avenarius (*Pogg. Ann.*, 119, p. 406) as a semi-circle, but it is really a parabola with its axis parallel to the axis of E, and its vertex at the point $t=-b/2c$, which gives the neutral temperature. We have also the relations $dE/dt=b+2ct$ and $d^2E/dt^2=2c$. The first relation gives the thermoelectric power p at any temperature, and is probably the most convenient method of stating results in all cases in which this formula is applicable. A discussion of some of the exponential formulae is given by S. W. Holman (*Phil. Mag.*, 41, p. 465, June 1896).

7. *Experimental Results.*—In the following comparative table of the results of different observers the values are referred to lead. Before the time of Tait's researches such data were of little interest or value, on account of insufficient care in securing the purity of the materials tested; but increased facilities in this respect, combined with great improvements in electrical measurements, have put the question on a different footing. The comparison of independent results shows in many cases a remarkable concordance, and the data are becoming of great value for the testing of various theories of the relations between heat and electricity.

TABLE I.—THERMOELECTRIC POWER, $p=dE/dt$, IN MICROVOLTS AT 50° C. OF PURE METALS WITH RESPECT TO LEAD. (The mean change, $2c=d^2E/dt^2$, of the thermoelectric power per degree C. over the range covered by the experiments, is added in each case.)

Metal.	Tait (0° to 300°).		Steele (0° to 100°).		Noll (0° to 200°).		Dewar and Fleming (+100° to −200°).	
	p.	*2c.*	*p.*	*2c.*	*p.*	*2c.*	*p.*	*2c.*
Aluminium	−0·56	+·0039	−0·42	+·0021	−0·41	+·00174	−0·394	+·00398
Antimony	..	..	+42·83	+·1450*	..	..	+3·210	+·02817
Bismuth	..	..	..	..	..	..	−76·870	−·08480
Cadmium	+4·75	+·0429	+4·79	+·0389	+4·71	+·0339	+4·792	+·02365
Carbon	..	..	..	..	..	..	+12·795	+·03251
Copper	+1·81*	+·0095	+3·37	+·0122	+3·22	+·0080	+3·156	+·00683
Cobalt	..	..	..	..	−19·252	−·0734	..	..
Gold	+3·30	+·0102	+3·19	+·0131	+3·10	+·0063	+1·161	+·00315
Iron	+14·74	−·0487	..	..	+11·835	−·0306	+14·522	−·01330
Steel (piano)	+9·75	−·0328	..	..	..	..	+9·600	−·01092
Steel (Mn 12%)	..	..	..	..	..	..	−5·73	−·00445
Magnesium	+1·75*	−·0095	..	..	−0·113	+·0019	−0·126	+·00353
Mercury	..	..	..	..	−4·03	−·0086	..	..
Nickel	−24·23*	−·0512	..	..	−20·58	−·0302	−18·87	−·05639
Palladium	−8·04	−·0359	..	..	..	..	−9·100	−·04714
Platinum	−1·15*	−·0110	..	..	−4·09	−·0211	−4·347	−·03708
Silver	+2·86	+·0150	+3·07	+·0115	+2·68	+·0076	+3·317	+·00714
Thallium	..	..	+1·76	−·0077	..	..	..	..
Tin	−0·16	+·0055	−0·091	+·0004	−0·067	+·0019	+0·057	+·00021
Zinc	+3·51	+·0240	+1·77*	+·0195	+3·318	+·0172	+3·233	+·01040

Explanation of Table.—The figures marked with an asterisk (*) represent discrepancies which are probably caused by impurities in the specimens. At the time of Tait's work in 1873 it was difficult, if not impossible, in many cases to secure pure materials. The work of the other three observers dates from 1894–95. The value of the thermoelectric power dE/dt at 50° C. is taken as the mean value between 0° and 100° C., over which range it can be most accurately determined. The values of d^2E/dt^2 agree as well as can be expected, considering the difference of the ranges of temperature and the great variety in the methods of observation adopted; they are calculated assuming the parabolic formula, which is certainly in many cases inadequate. Noll's values apply to the temperature of +100° C., Dewar and Fleming's to that of −100° C., approximately.

In using the above table to find the value of E or dE/dt at any temperature or between any limits, denoting by p the value of dE/dt at 50° C., and by $2c$ the constant value of the second coefficient, we have the following equations:—

$$dE/dt=p+2c(t-50), \text{ at any temperature } t, \text{ Cent.} \quad (3)$$

$$E_{(t-t')}=(t-t')(p+c(t+t'-100)) \quad (4)$$

for the E.M.F. between any temperature t and t'.

8. *Methods of Observation.*—In Tait's observations the E.M.F. was measured by the deflection of a mirror galvanometer, and the temperature by means of a mercury thermometer or an auxiliary thermocouple. He states that the deviations from the formula were "quite within the limits of error introduced by the alteration of the resistance of the circuit with rise of temperature, the deviations of the mercury thermometers from the absolute scale, and the non-correction of the indications of the thermometer for the long column of mercury not immersed in the hot oil round the junctions." The latter correction may amount to about 10° C. at 350°. Later observers have generally employed a balance method (some modification of the potentiometer or Poggendorf balance) for measuring the E.M.F. The range of Steele's observations was too small to show any certain deviation from the formula, but he notes capricious changes attributed to change of condition of the wires. Noll employed mercury thermometers, but as he worked over a small range with vapour baths, it is probable that he did not experience any trouble from immersion corrections. He does not record any systematic deviations from the formula. Dewar and Fleming, working at very low temperatures, were compelled to use the platinum thermometer, and expressed their results in terms of the platinum scale. Their observations were probably free from immersion errors, but they record some deviations from the formula which they consider to be beyond the possible limits of error of their work. The writer has reduced their results to the scale of the gas thermometer, assuming the boiling-point of oxygen to be −182·5° C.

9. *Peltier Effect.*—The discovery by J. C. A. Peltier (1834) that heat is absorbed at the junction of two metals by passing a current through it in the same direction as the current produced by heating it, was recognized by Joule as affording a clue to the source of the energy of the current by the application of the principles of thermodynamics. Unlike the frictional generation of heat due to the resistance of the conductor, which Joule (1841) proved to be proportional to the square of the current, the Peltier effect is reversible with the current, and being directly proportional to the first power of the current, changes sign when the current is reversed. The effect is most easily shown by connecting a voltaic cell to a thermopile for a short interval, then quickly (by means of a suitable key, such as a Pohl commutator with the cross connectors removed) disconnecting the pile from the cell and connecting it to a galvanometer, which will indicate a current in the reverse direction through the pile, and approximately proportional to the original current in intensity, provided that the other conditions of the experiment are constant. It was by an experiment of this kind that Quintus Icilius (1853) verified the proportionality of the heat absorbed or generated to the first power of the current. It had been observed by Peltier and A. E. Becquerel that the intensity of the effect depended on the thermoelectric power of the junction and was independent of its form or dimensions. The order of the metals in respect of the Peltier effect was found to be the same as the thermoelectric series. But on account of the difficulty of the measurements involved, the verification of the accurate relation between the Peltier effect and thermoelectric power was left to more recent times. If C is the intensity of the current through a simple thermocouple, the junctions of which are at temperatures t and t', a quantity of heat, $P\times C$, is absorbed by the passage of the current per second at the hot junction, t, and a quantity, $P'\times C$, is evolved at the cold junction, t'. The coefficients, P and P', are called coefficients of the Peltier effect, and may be stated in calories or joules per ampere-second. The Peltier coefficient may also be expressed in volts or microvolts, and may be regarded as the measure of an E.M.F. located

at the junction, and transforming heat into electrical energy or vice versa. If R is the whole resistance of the circuit, and E the E.M.F. of the couple, and if the flow of the current does not produce any other thermal effects in the circuit besides the Joule and Peltier effects, we should find by applying the principle of the conservation of energy, *i.e.* by equating the balance of the heat absorbed by the Peltier effects to the heat generated in the circuit by the Joule effect,

$$(P-P')C=C^2R=EC, \text{ whence } E=P-P' \quad . \quad . \quad (5)$$

If we might also regard the couple as a reversible thermodynamic engine for converting heat into work, and might neglect irreversible effects, such as conduction, which are independent of the current, we should expect to find the ratio of the heat absorbed at the hot junction to the heat evolved at the cold junction, namely, P/P', to be the same as the ratio T/T' of the absolute temperatures of the junctions. This would lead to the conclusion given by R. J. E. Clausius (1853) that the Peltier effect varied directly as the absolute temperature, and that the E.M.F. of the couple should be directly proportional to the difference of temperature between the junctions.

10. *Thomson Effect.*—Thomson (Lord Kelvin) had already pointed out (*Proc. R.S. Edin.*, 1851) that this conclusion was inconsistent with the known facts of thermoelectric inversion. (1) The E.M.F. was not a linear function of the temperature difference. (2) If the Peltier effect was proportional to the thermoelectric power and changed sign with it, as all experiments appeared to indicate, there would be no absorption of heat in the circuit due to the Peltier effect, and therefore no thermal source to account for the energy of the current, in the case in which the hot junction was at or above the neutral temperature. He therefore predicted that there must be a reversible absorption of heat in some other part of the circuit due to the flow of the current through the unequally heated conductors. He succeeded a few years afterwards in verifying this remarkable prediction by the experimental demonstration that a current of positive electricity flowing from hot to cold in iron produced an absorption of heat, as though it possessed *negative* specific heat in the metal iron. He also succeeded in showing that a current from hot to cold evolved heat in copper, but the effect was smaller and more difficult to observe than in iron.

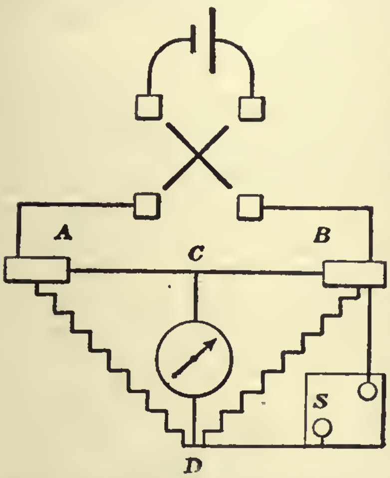

Fig. 1.—Diagram of Apparatus for Demonstrating the Thomson Effect.

The Thomson effect may be readily demonstrated as a lecture experiment by the following method (fig. 1). A piece of wire (No. 28) about 4 cm. long is soldered at either end A, B to thick wires (No. 12), and is heated 100° to 150° C. by a steady current from a storage cell adjusted by a suitable rheostat. The experimental wire AB is connected in parallel with about 2 metres of thicker wire (No. 22), which is not appreciably heated. A low-resistance galvanometer is connected by a very fine wire (2 to 3 mils) to the centre C of the experimental wire AB, and also to the middle point D of the parallel wire so as to form a Wheatstone bridge. The balance is adjusted by shunting either AD or BD with a box, S, containing 20 to 100 ohms. All the wires in the quadrilateral must be of the same metal as AB, to avoid accidental thermoelectric effects which would obscure the result. If the current flows from A to B there will be heat absorbed in AC and evolved in CB by the Thomson effect, if the specific heat of electricity in AB is positive as in copper. When the current is reversed, the temperature of AC will be raised and that of CB lowered by the reversal of the effect. This will disturb the resistance balance by an amount which can be measured by the deflection of the galvanometer, or by the change of the shunt-box, S, required to restore the balance. Owing to the small size of the experimental wire, the method is very quick and sensitive, and the apparatus can be set up in a few minutes when once the experimental quadrilaterals have been made. It works very well with platinum, iron and copper. It was applied with elaborate modifications by the writer in 1886 to determine the value of the Thomson effect in platinum in absolute measure, and has recently been applied with further improvements by R. O. King to measure the effect in copper.

11. *Thomson's Theory.*—Taking account of the Thomson effect, the thermodynamical theory of the couple was satisfactorily completed by Thomson (*Trans. R. S. Edin.*, 1854). If the quantity of heat absorbed and converted into electrical energy, when unit quantity of electricity (one ampere-second) flows from cold to hot through a difference of temperature, dt, be represented by sdt, the coefficient s is called the specific heat of electricity in the metal, or simply the coefficient of the Thomson effect. Like the Peltier coefficient, it may be measured in joules or calories per ampere-second per degree, or more conveniently and simply in microvolts per degree.

Consider an elementary couple of two metals A and B for which s has the values s' and s'' respectively, with junctions at the temperature T and $T+dT$ (absolute), at which the coefficients of the Peltier effect are P and $P+dP$. Equating the quantity of heat absorbed to the quantity of electrical energy generated, we have by the first law of thermodynamics the relation

$$dE/dT=dP/dT+(s'-s'') \quad . \quad . \quad . \quad (6)$$

If we apply the second law, regarding the couple as a reversible engine, and considering only the reversible effects, we obtain

$$(s'-s'')/T=-d(P/T)/dT \quad . \quad . \quad . \quad (7)$$

Eliminating $(s'-s'')$ we find for the Peltier effect

$$P=TdE/dT=Tp \quad . \quad . \quad . \quad . \quad (8)$$

Whence we obtain for the difference of the specific heats

$$(s'-s'')=-Td^2E/dT^2=-Tdp/dT \quad . \quad . \quad (9)$$

From these relations we observe that the Peltier effect P, and the difference of the Thomson effects $(s'-s'')$, for any two metals are easily deduced from the tabulated values of dE/dt and d^2E/dt^2 respectively. The signs in the above equations are chosen on the assumption that positive electricity flows from cold to hot in the metal s'. The signs of the Peltier and Thomson effects will be the same as the signs of the coefficients given in Table I., if we suppose the metal s' to be lead, and assume that the value of s' may be taken as zero at all temperatures.

12. *Experimental Verification of Thomson's Theory.*—In order to justify the assumption involved in the application of the second law of thermodynamics to the theory of the thermocouple in the manner above specified, it would be necessary and sufficient, as Thomson pointed out (*Phil. Mag.*, December 1852), to make experiments to verify quantitatively the relation $P/T=dE/dT$ between the Peltier effect and the thermoelectric power. A qualitative relation was known at that time to exist, but no absolute measurements of sufficient accuracy had been made. The most accurate measurements of the heat absorption due to the Peltier effect at present available are probably those of H. M. Jahn (*Wied. Ann.*, 34, p. 755, 1888). He enclosed various metallic junctions in a Bunsen ice calorimeter, and observed the evolution of heat per hour with a current of about 1·6 amperes in either direction. The Peltier effect was only a small fraction of the total effect, but could be separated from the Joule effect owing to the reversal of the current. The values of dE/dT for *the same specimens* of metal at 0° C. were determined by experiments between +20° C. and −20° C. The results of his observations are contained in the following table, heat absorbed being reckoned positive as in Table I.:—

Table II.

Thermo-couple.	dE/dT Microvolts per deg.	$P=Td\,E/dT$ Microvolts at 0° C.	Heat calc. Calories per hour.	Heat observed Calories per hour.
Cu-Ag	+2·12	+579	+0·495	+0·413
Cu-Fe	+11·28	+3079	+2·640	+3·163
Cu-Pt	−1·40	−382	−0·327	−0·320
Cu-Zn	+1·51	+412	+0·353	+0·585
Cu-Cd	+2·64	+721	+0·617	+0·616
Cu-Ni	−20·03	−5468	−4·680	−4·362

The agreement between the observed and calculated values in the last two columns is as good as can be expected considering the great difficulty of measuring such small quantities of heat. The analogous reversible heat effects which occur at the junction of a metal and an electrolyte were also investigated by Jahn, but he did not succeed in obtaining so complete an agreement with theory in this case.

13. *Tait's Hypothesis.*—From general considerations concerning minimum dissipation of energy (*Proc. R. S. Edin.*, 1867–68), Tait was led to the conclusion that "the thermal and electric conductivities of metals varied inversely as the absolute temperature, and that the specific heat of electricity was directly proportional to the same." Subsequent experiments led him to doubt this conclusion as regards conductivity, but his thermoelectric experiments (*Proc. R. S. Edin.*, December 1870) appeared to be in good agreement with it. If we adopt this hypothesis, and substitute $s=2cT$, where c is a constant, in the fundamental equation (9), we obtain at once $d^2E/dT^2=-2\ (c'-c'')$, which is immediately integrable, and gives

$$dE/dt=p=2(t_o-t)\ (c'-c'') \quad . \quad . \quad . \quad . \quad (10)$$
$$E_{t-t'}=(t-t')\ (c'-c'')\ \{2t_o-(t+t')\} \quad . \quad . \quad . \quad . \quad (11)$$

where t_o is the temperature of the neutral point at which $dE/dt=0$. This is the equation to a parabola, and is equivalent to the empirical formula of Avenarius, with this difference, that in Tait's formula the constants have all a simple and direct interpretation in relation to the theory. Tait's theory and formula were subsequently assimilated by Avenarius (*Pogg. Ann.*, 149, p. 372, 1873), and are now generally attributed to Avenarius in foreign periodicals.

In accordance with this hypothesis, the curves representing the variations of thermoelectric power, dE/dt, with temperature

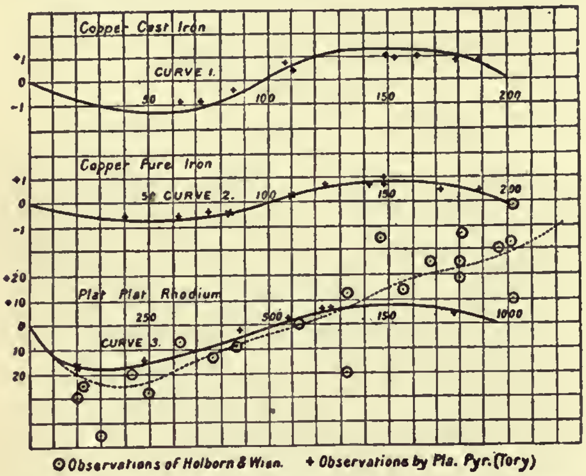

FIG. 2.—Temperature by Thermocouple. Difference from Tait's Formula.

are straight lines, the slope of which for any couple is equal to the difference of the constants $2(c'-c'')$. The diagram constructed by Tait on this principle is fully explained and illustrated in many text-books, and has been generally adopted as embodying in a simple form the fundamental phenomena of thermoelectricity.

14. *Experimental Verification.*—Tait's verification of this hypothesis consisted in showing that the experimental curves of E.M.F. were parabolas in most cases within the limits of error of his observations. He records, however, certain notable divergencies, particularly in the case of iron and nickel, and many others have since come to light from other observations. It should also be remarked that even if the curves were not parabolas, it would always be possible to draw parabolas to agree closely with the observations over a restricted range of temperature. When the question is tested more carefully, either by taking more accurate measurements of temperature, or by extending the observations over a wider range, it is found that there are systematic deviations from the parabola in the majority of cases, which cannot be explained by errors of experiment. A more accurate verification of these relations, both at high and low extremes of temperature, has become possible of late years owing to the development of the theory and application of the platinum resistance thermometer. (See THERMOMETRY.) The curves in fig. 2 illustrate the differences from the parabolic formula, measured in degrees of temperature, as observed by H. M. Tory (*B.A. Report*, 1897). The deviations for the copper-iron couple, and for the copper cast-iron couple over the range 0° to 200° C., appear to be of the order of 1° C., and were carefully verified by repeated and independent series of observations. The deviations of the platinum and platinum-rhodium 10 per cent. couple over the range 0° to 1000° C. are shown on a smaller scale, and are seen to be of a similar nature, but rather greater in proportion. It should be observed that these deviations are continuous, and differ in character from the abrupt changes observed by Tait in special cases. A number of similar deviations at temperatures below 0° C. were found by the writer in reducing the curves representing the observations of Dewar and Fleming (*Phil. Mag.*, July 1895) to the normal scale of temperature from the platinum scale in which they are recorded. In many cases the deviations do not appear to favour any simple hypothesis as to the mode of variation of s with temperature, but as a rule the indication is that s is nearly constant, or even diminishes with rise of temperature. It may be interesting therefore to consider the effect of one or two other simple hypotheses with regard to the mode of variation of s with T.

15. *Other Assumptions.*—If we take the analogy of a perfect gas and assume $s=$constant, we have

$$dE^2/dT^2=-s/T,\ dE/dT=s\log_e T_0/T \quad . \quad . \quad (12)$$
$$E_{(T-T')}=sT\log_e T_0/T-sT''\log_e T_0/T \quad . \quad . \quad (13)$$

where T and T' are the temperatures of the junctions, and T_0 is the neutral temperature. These formulae are not so simple and convenient as Tait's, though apparently founded on a more simple assumption, but they frequently represent the observations more closely. If we suppose that s is not quite constant, but increases or diminishes slightly with change of temperature according to a linear formula $s=s_0+2cT$ (in which s_0 represents the constant part of s, and c may have either sign), we obtain a more general formula which is evidently the sum of the two previous solutions and may be made to cover a greater variety of cases. Another simple and possible assumption is that made by A. Stansfield (*Phil. Mag.*, July 1898), that the value of s varies inversely as the absolute temperature. Putting $s=c/T$, we obtain

$$E_{(T-T')}=c\log_e T/T'-c(T-T')/T_0 \quad . \quad . \quad . \quad (14)$$

which is equivalent to the form given by Stansfield, but with the neutral temperature T_0 explicitly included. According to this formula, the Peltier effect is a linear function of the temperature. It may appear at first sight astonishing that it should be possible to apply so many different assumptions to the solution of one and the same problem. In many cases a formula of the last type would be quite inapplicable, as Stansfield remarks, but the difference between the three is often much less than might be supposed. For instance, in the case of 10 per cent. Rh. Pt.—Pt. couple, if we calculate three formulae of the above types to satisfy the same pair of observations at 0°—445° and 0°—1000° C., we shall find that the formula $s=$constant lies midway between that of Tait and that of Stansfield, but the difference between the formulae is of the same order as that between different observers. In this particular case the parabolic formula appears to be undoubtedly inadequate. The writer's observations agree more nearly with the assumption $s=$constant, those of Stansfield with $s=c/T$. Many other formulae have been suggested. L. F. C. Holborn and A. Day (*Berl. Akad.*, 1899) have gone back to Tait's method at high temperatures, employing arcs of parabolas for limited ranges. But since the parabolic formula is certainly erroneous at low temperatures, it can hardly be trusted for extrapolation above 1000° C.

16. *Absolute Measurement of Thomson Effect.*—Another method of verifying Tait's hypothesis, of greater difficulty but of considerable interest, is to measure the absolute value of the heat absorbed by the Thomson effect, and to observe whether or not it varies with the temperature. Le Roux (*Ann. Chim. Phys.*, x. p. 201, 1867) made a number of relative measurements of the effect in different metals, which agreed qualitatively with observations of the thermoelectric power, and showed that the effect was proportional to the current for a given temperature gradient. Batelli has applied the same method (*Accad. Sci. Turin*, 1886) to the absolute measurement. He observed with a thermocouple the difference of temperature (about ·01° C.) produced by the Thomson effect in twenty minutes between two mercury calorimeters, B_1 and B_2, surrounding the central portions of a pair of rods arranged as in Le Roux's method (see fig. 3). The value of the Thomson

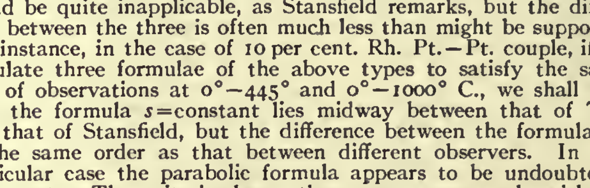

FIG. 3.—Thomson Effect. Batelli (Le Roux's Method).

effect was calculated by multiplying this difference of temperature by the thermal capacity of either calorimeter, and dividing by the current, by the number of seconds in twenty minutes, and by twice the difference of temperature (about 20°) between the ends a and b of either calorimeter. The method appears to be open to the objection that the difference of temperature reached in so long an interval would be more or less independent of the thermal capacities of the calorimeters, and would also be difficult to measure accurately with a thermocouple under the conditions described. The general results of the work appeared to support Tait's hypothesis that the effect was proportional to the absolute temperature, but direct thermoelectric tests do not appear to have been made on the specimens employed, which would have afforded a valuable confirmation by the comparison of the values of d^2E/dT^2, as in Jahn's experiments.

17. *King's Experiments.*—The method employed by the writer, to which allusion has already been made, consisted in observing the change of distribution of temperature in terms of the resistance along a wire heated by an electric current, when the heating current was reversed. It has been fully described by King (*Proc. Amer. Acad.*, June 1898), who applied it most successfully to the case of copper. Although the effect in copper is so small, he succeeded in obtaining changes of temperature due to the Thomson effect of the order of 1° C., which could be measured with satisfactory accuracy. He also determined the effect of change of temperature distribution on the rate of generation of heat by the current; and on the external loss of heat by radiation, convection and conduction. It is necessary to take all these conditions carefully into account in calculating the balance due to the Thomson effect. According to King's experiments, the value of the effect

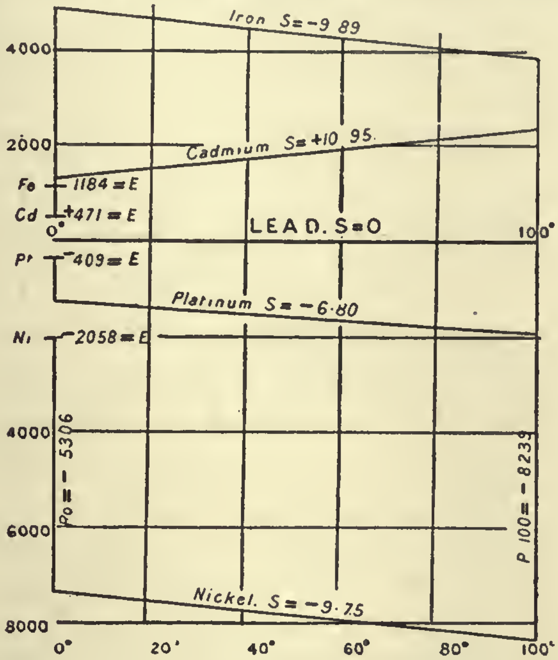

Fig. 4.—Potential Diagrams of Thermocouple on the Contact Theory.

appears to diminish with rise of temperature to a slight extent in copper, but the diminution is so small that he does not regard it as established with certainty. The value found at a temperature of 150° C. was +2·5 microjoules per ampere-second per degree, or +2·5 microvolts per degree in the case of copper, which agrees very fairly with the value deduced from thermoelectric tests. The value found by Batelli for iron was −5·0 microvolts per degree at 108° C., which appears too small in comparison. These measurements, though subject to some uncertainty on account of the great experimental difficulties, are a very valuable confirmation of the accuracy of Thomson's theory, because they show that the magnitude of the effect is of the required order, but they cannot be said to be strongly in support of Tait's hypothesis. A comparison of the results of different observers would also suggest that the law of variation may be different in different metals, although the differences in the values of d^2E/dT^2 may be due in part to differences of purity or errors of observation. It would appear, for instance, according to the observations of Dewar and Fleming, that the value of s for iron is positive below −150° C., at which point it vanishes. At ordinary temperatures the value is negative, increasing rapidly in the negative direction as the temperature rises. This might be appropriately represented, as already suggested, by a linear formula $s=s_0-cT$.

18. *Potential Diagrams on the Contact Theory.*—It is instructive to consider the distribution of potential in a thermoelectric circuit, and its relation to the resultant E.M.F. and to the seat of the E.M.F. In fig. 4, which is given as an illustration, the cold junctions are supposed to be at 0° C. and the hot junctions at 100° C. Noll's values (Table I.) are taken for the E.M.F., and it is supposed that the coefficient of the Thomson effect is zero in lead, *i.e.* that there is no E.M.F. and that the potential is uniform throughout the length of the lead wire. Taking the lead-iron couple as an example, the value of dE/dt at the hot junction 100° C. is 10·305 microvolts per degree, and the value of the Peltier coefficient $P=TdE/dT$ is +3844 microvolts. In other words, we may suppose that there is an E.M.F. of that magnitude situated at the junction which causes positive electricity to flow from the lead to the iron. If the circuit is open, as represented in the diagram, the flow will cease as soon as it has raised the potential of the iron 3844 microvolts above that of the lead. In the substance of the iron itself there is an E.M.F. due to the Thomson effect of about 10 microvolts per degree tending to drive positive electricity from hot to cold, and raising the cold end of the iron 989 microvolts in potential above the hot end on open circuit. At the cold junction the iron is supposed to be connected to a piece of lead at 0° C., and there is a sudden drop of potential due to the Peltier effect of 3648 microvolts. If the circuit is cut at this point, there remains a difference of potential $E=1184$ microvolts, the resultant E.M.F. of the circuit, tending to drive positive electricity from the iron to the lead across the cold junction. If the circuit is closed, there will be a current $C=E/R$, where $R=R'+R''$, the sum of the resistances of the lead and iron. The flow of the current will produce a fall of potential ER'/R in the lead from cold to hot, and ER''/R in the iron from hot to cold, but the potential difference due to the Peltier effect at either junction will not be affected. For simplicity in the diagram the temperature gradient has been taken as uniform, and the specific heat s=constant, but the total P.D. would be the same whatever the gradient.

Similar diagrams are given in fig. 4 for cadmium in which both the specific heat and the Peltier effect are positive, and also for platinum and nickel in which both coefficients are negative. The metals are supposed to be all joined together at the hot junction, and the circuit cut in the lead near the cold junction. The diagram will serve for any selected couple, such as iron-nickel, and is not restricted to combinations with lead. The following table shows the component parts of the E.M.F. in each case:—

Table III.

Thermocouple.	P_{100} —	$-P_0$ —	$-100\times s_{50}$ =	$E_{0\text{-}100}$
Iron-lead .	+3844 −	+3648 −	−988 =	+1184
Cadmium-lead.	+2389 −	+823 −	+1095 =	+471
Platinum-lead .	−1919 −	−828 −	−682 =	−409
Nickel-lead .	−8239 −	−5206 −	−975 =	−2058

The components for any other combination of two are found by taking the algebraic difference of the values with respect to lead.

19. *Relation to the Volta Effect.*—It is now generally conceded that the relatively large differences of potential observable with an electrometer between metals on open circuit, as discovered by Volta, are due to the *chemical* affinities of the metals, and have no direct relation to thermoelectric phenomena or to the Peltier effect. The order of the metals in respect of the two effects is quite different. The potential difference, due to the Volta effect in air, has been shown by Thomson (Lord Kelvin) and his pupils to be of the same order of magnitude, if not absolutely the same, as that produced in a dilute electrolyte in which two metallically connected plates (*e.g.* zinc and copper) are immersed. (On this hypothesis, it may be explained by regarding the air as an electrolyte of infinite specific resistance.) It is also profoundly modified by the state of the exposed surfaces, a coating of oxide on the copper greatly increasing the effect, as it would in a voltaic cell. The Peltier effect and the thermo-E.M.F., on the other hand, do not depend on the state of the surfaces, but only on the state of the substance. An attempt has been made to explain the Volta effect as due to the affinity of the metals *for each other*, but that would not account for the variation of the effect with the state of the surface, except as affecting the actual surface of contact. It is equally evident that chemical affinity between the metals cannot be the explanation of the Peltier E.M.F. This would necessitate chemical action at the junction when a current passed through it, as in an electrolytic cell, whereas the action appears to be purely thermal, and leads to a consistent theory on that hypothesis. The chemical action between metals in the solid state must be infinitesimal, and could only suffice to produce small charges analogous to those of frictional electricity; it could not maintain a permanent difference of potential at a metallic junction through which a current was passing. Although it is possible that differences of potential larger than the Peltier effect might exist between two metals in contact on open circuit, it is certain that the only effective E.M.F. in practice is the

Peltier effect, and that the difference of potential in the substance of the metals when the circuit is complete cannot be greater than the coefficient P. The Peltier effect, it may be objected, measures that part only of the potential difference which depends upon temperature, and can therefore give no information about the absolute potential difference. But the reason for concluding that there is no other effective source of potential difference at the junction besides the Peltier effect, is simply that no other appreciable action takes place at the junction when a current passes except the Peltier generation or absorption of heat.

20. *Convection Theory.*—The idea of convection of heat by an electric current, and the phrase "specific heat of electricity" were introduced by Thomson as a convenient mode of expressing the phenomena of the Thomson effect. He did not intend to imply that electricity really possessed a positive or negative specific heat, but merely that a quantity of heat was absorbed in a metal when unit quantity of electricity flowed from cold to hot through a difference of temperature of 1°. The absorption of heat was considered as representing an equivalent conversion of heat energy into electrical energy in the element. The element might thus be regarded as the seat of an E.M.F., $dE=sdT$, where dT is the difference of temperature between its ends. The potential diagrams already given have been drawn on this assumption, that the Thomson effect is not really due to convection of heat by the current, but is the measure of an E.M.F. located in the substance of the conductor. This view with regard to the seat of the E.M.F. has been generally taken by the majority of writers on the subject. It is not, however, necessarily implied in the reasoning or in the equations given by Thomson, which are not founded on any assumptions with regard to the seat of the E.M.F., but only on the balance of heat absorbed and evolved in all the different parts of the circuit. In fact, the equations themselves are open to an entirely different interpretation in this respect from that which is generally given.

Returning again to the equations already given in § 11 for an elementary thermocouple, we have the following equivalent expressions for the E.M.F. dE, namely,

$$dE=dP+(s'-s'')dT=(P/T)dT=pdT=(p''-p')dT,$$

in which the coefficient, P, of the Peltier effect, and the thermoelectric power, p, of the couple, may be expressed in terms of the difference of the thermoelectric powers, p' and p'', of the separate metals with respect to a neutral standard. So far as these equations are concerned, we might evidently regard the seat of the E.M.F. as located entirely in the conductors themselves, and not at all at the junctions, if p or $(p''-p')$ is the difference of the E.M.F.s per degree in corresponding elements of the two metals. In this case, however, in order to account for the phenomenon of the Peltier effect at the junctions, it is necessary to suppose that there is a *real convection of heat* by an electric current, and that the coefficient P or pT is the difference of the quantities of heat carried by unit quantity of electricity in the two metals. On this hypothesis, if we confine our attention to one of the two metals, say p'', in which the current is supposed to flow from hot to cold, we observe that $p''dT$ expresses the quantity of heat converted into electrical energy per unit of electricity by an E.M.F. p'' per 1° located in the element dT. It happens that the absolute magnitude of p'' cannot be experimentally determined, but this is immaterial, as we are only concerned with differences. The quantity of heat liberated by convection as the current flows from hot to cold is represented in the equation by $dP=d(pT)$. Since $d(p''T)=p''dT+Tdp''$, it is clear that the balance of heat liberated in the element is only $Tdp''=s''dT$, namely, the Thomson effect, and is *not* the equivalent of the E.M.F. $p''dT$, because on this theory the absorption of heat is masked by the convection. If p is constant there is no Thomson effect, but it does not follow that there is no E.M.F. located in the element. The Peltier effect, on the other hand, may be ascribed entirely to convection. The quantity of heat $p''T$ is brought up to one side of the junction per unit of electricity, and the quantity of heat $p'T$ taken away on the other. The balance $(p''-p')T$ is evolved at the junction. If, therefore, we are prepared to admit that an electric current can carry heat, the existence of the Peltier effect is no proof that a corresponding E.M.F. is located at the junction, or, in other words, that the conversion of heat into electrical energy occurs at this point of the circuit, or is due to the contact of dissimilar metals. On the contact theory, as generally adopted, the E.M.F. is due entirely to change of substance $(dP-Tdp)$; on the convection theory, it is due entirely to change of temperature (pdT). But the two expressions are equivalent, and give the same results.

21. *Potential Diagrams on Convection Theory.*—The difference between the two theories is most readily appreciated by drawing the potential diagrams corresponding to the supposed locations of the E.M.F. in each case. The contact theory has been already illustrated in fig. 4. Corresponding diagrams for the same metals on the convection theory are given in fig. 5. In this diagram the metals are supposed to be all joined together and to be at the same time potential at the cold junction at 0° C. The ordinate of the curve at any temperature is the difference of potential between any point in the metal and a point in lead at the same temperature. Since there is no contact E.M.F. on this theory, the ordinates also represent the E.M.F. of a thermocouple metal-

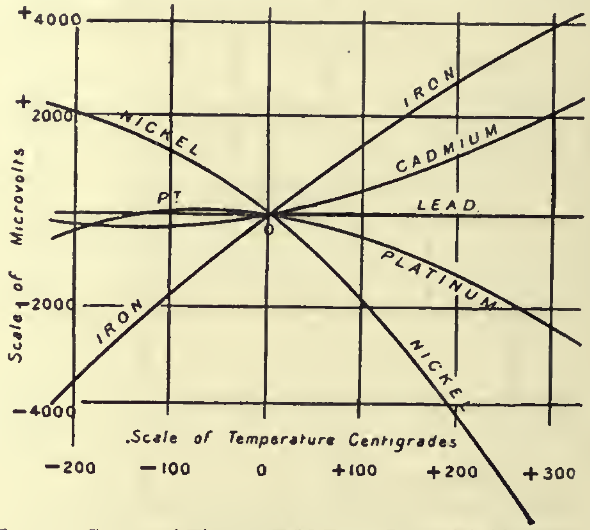

FIG. 5.—Curves of Thermo-E.M.F., or Potential Diagrams, on the Convection Theory.

lead, in which one junction is at 0° C. and the other at t° C. For this reason the potential diagrams on the convection theory are more simple and useful than those on the contact theory. The curves of E.M.F. are in fact the most natural and most convenient method of recording the numerical data, more particularly in cases where they do not admit of being adequately represented by a formula. The line of lead is taken to be horizontal in the diagram, because the thermoelectric power, p, may be reckoned from any convenient zero. It is not intended to imply that there is no E.M.F. in the metal-lead with change of temperature, but that the value of p in this metal is nearly constant, as the Thomson effect is very small. It is very probable that the absolute values of p in different metals are of the same sign and of the same order of magnitude, being large compared with the differences observed. It would be theoretically possible to measure the absolute value in some metal by observing with an electrometer the P.D. between parts of the same metal at different temperatures, but the difference would probably be of the order of only one-hundredth of a volt for a difference of 100° C. It would be sufficiently difficult to detect so small a difference under the best conditions. The difficulty would be greatly increased, if not rendered practically insuperable, by the large difference of temperature.

22. *Conduction Theory.*—In Thomson's theory it is expressly assumed that the reversible thermal effects may be considered separately without reference to conduction. In the conduction theory of F. W. G. Kohlrausch (*Pogg. Ann.*, 1875, vol. 156, p. 601), the fundamental postulate is that the thermo-E.M.F. is due to the conduction of heat in the metal, which is contrary to Thomson's theory. It is assumed that a flow of heat Q, due to conduction, tends to carry with it a proportional electric current $C=aQ$. This is interpreted to mean that there is an E.M.F. $dE=-akr\ dT=-\theta dT$, in each element, where k is the thermal conductivity and

r the specific resistance. The "thermoelectric constant," θ, of Kohlrausch, is evidently the same as the thermoelectric power, p, in Thomson's theory. In order to explain the Peltier effect, Kohlrausch further assumes that an electric current, C, carries a heat-flow, $Q=A\theta C$, with it, where "A is a constant which can be made equal to unity by a proper choice of units." If A and θ are constant, the Peltier effects at the hot and cold junctions are equal and opposite, and may therefore be neglected. The combination of the two postulates leads to a complication. By the second postulate the flow of the current increases the heat-flow, and this by the first postulate increases the E.M.F., or the resistance, which therefore depends on the current. It is difficult to see how this complication can be avoided, unless the first postulate is abandoned, and the heat-flow due to conduction is assumed to be independent of the thermoelectric phenomena. By applying the first law of thermodynamics, Kohlrausch deduces that a quantity of heat, $C\theta dT$, is absorbed in the element dT per second by the current C. He wrongly identifies this with the Thomson effect, by omitting to allow for the heat carried. He does not make any application of the second law to the theory. If we apply Thomson's condition $P=TdE/dT=Tp$, we have $A=T$. If we also assume the ratio of the current to the heat-flow to be the same in both postulates, we have $a=1/T\theta$, whence $\theta^2=kr/T$. This condition was applied in 1899 by C. H. J. B. Liebenow (*Wied. Ann.*, 68, p. 316). It simplifies the theory, and gives a possible relation between the constants, but it does not appear to remove the complication above referred to, which seems to be inseparable from any conduction theory.

L. Boltzmann (*Sitz. Wien. Akad.*, 1887, vol. 96, p. 1258) gives a theoretical discussion of all possible forms of expression for thermoelectric phenomena. Neglecting conduction, all the expressions which he gives are equivalent to the equations of Thomson. Taking conduction into account in the application of the second law of thermodynamics, he proposes to substitute the inequality, $Td/dET-P\leq 2\sqrt{T}(\sqrt{k'r'}+\sqrt{k''r''})$, instead of the equation given by Thomson, namely, $P=TdE/dT$. Since, however, Thomson's equation has been so closely verified by Jahn, it is probable that Boltzmann would now consider that the reversible effects might be treated independently of conduction.

23. *Thermoelectric Relations.*—A number of suggestions have been made as to the possible relations between heat and electricity, and the mechanism by which an electric current might also be a carrier of heat. The simplest is probably that of W. E. Weber (*Wied. Ann.*, 1875), who regarded electricity as consisting of atoms much smaller than those of matter, and supposed that heat was the kinetic energy of these electric atoms. If we suppose that an electric current in a metal is a flow of negative electric atoms in one direction, the positive electricity associated with the far heavier material atoms remaining practically stationary, and if the atomic heat of electricity is of the same order as that of an equivalent quantity of hydrogen or any other element, the heat carried per ampere-second at 0° C., namely P, would be of the order of ·030 of a joule, which would be ample to account for all the observed effects on the convection theory. Others have considered conduction in a metal to be analogous to electrolytic conduction, and the observed effects to be due to "migration of the ions." The majority of these theories are too vague to be profitably discussed in an article like the present, but there can be little doubt that the study of thermoelectricity affords one of the most promising roads to the discovery of the true relations between heat and electricity.

Alphabetical Index of Symbols.

a, b, c = Numerical constants in formulae.
C = Electric Current.
E = E.M.F. = Electromotive Force.
k = Thermal Conductivity.
P = Coefficient of Peltier Effect.
$p = dE/dt$ = Thermoelectric Power.
Q = Heat-flow due to Conduction.
R = Electrical Resistance; r, Specific Resistance.
s = Specific Heat, or Coefficient of Thomson Effect.
t = Temperature on the Centigrade Scale.
T = Temperature on the Absolute Scale.

(H. L. C.)

THERMOMETRY (Gr. θερμός, warm; μέτρον, a measure), the art of measuring temperature or degree of heat. The instruments used for this purpose are known as thermometers, or sometimes, when the temperatures to be measured are high, as pyrometers.

1. A brief sketch of the evolution of the thermometer is included in the article HEAT, §§ 2 and 3. The object of the present article is to discuss the general principles on which the accurate measurement of temperature depends, and to describe the application of these principles to the construction and use of the most important types of thermometer. Special attention will be devoted to more recent advances in scientific methods of testing thermometers and to the application of electrical and optical methods to the difficult problem of measuring high temperatures. In the article PYROMETER an account will be found of some of the thermoscopic methods employed in the arts for determining high temperatures.

2. *Zero: Fundamental Interval.*—In all systems of measuring temperature it is necessary (1) to choose a zero or starting-point from which to reckon, (2) to determine the size of the degree by subdividing the interval between two selected fixed points of the scale (called the "fundamental interval") into a given number of equal parts. The fundamental interval selected is that between the temperature of melting ice and the temperature of condensing steam, under standard atmospheric pressure. On the Centigrade system the fundamental interval is divided into 100 parts, and the melting-point of ice is taken as the zero of the scale. We shall denote temperature reckoned on this system by the letter t, or by affixing the letter C. It is often convenient to reckon temperature, not from the melting-point of ice, but from a theoretical or absolute zero representing the lowest conceivable temperature. We shall denote temperature reckoned in this manner by the letter T, or θ, or by affixing the letters *Abs*. In practice, since the absolute zero is unattainable, the absolute temperature is deduced from the Centigrade temperature by adding a constant quantity, T_0, representing the interval between the absolute zero and the melting-point of ice; thus $T=t+T_0$.

3. *Arbitrary Scales.*—An arbitrary scale can be constructed by selecting any physical property of a substance which varies regularly with the temperature, such as the volume of a liquid, or the pressure or density of a gas, or the electrical resistance of a metal. Thus if V denote the volume of a given mass at the temperature t, and if V_0, V_1 represent the volumes of the same mass at the temperatures 0° and 100° C., the size of 1° C. on the scale of this arbitrary thermometer is one hundredth part of the fundamental interval, namely $(V_1-V_0)/100$, and the temperature t at volume V is the number of these degrees contained in the expansion $V-V_0$ between 0° and t° C. We thus arrive at the formula

$$t=100\ (V-V_0)/(V_1-V_0) \quad . \quad . \quad . \quad (1),$$

which is the general expression for the temperature Centigrade on any such arbitrary scale, provided that we substitute for V the particular physical property selected as the basis of the scale. If we prefer to reckon temperature from an arbitrary zero defined by the vanishing of V, which may conveniently be called the *fundamental zero* of the scale considered, we have, putting V = 0 in equation (1), the numerical values of the fundamental zero T_0, and of the temperature T reckoned from this zero

$$T_0=100V_0/(V_1-V_0), \text{ and } T=T_0V/V_0=t+T_0 \quad . \quad . \quad . \quad (2).$$

It is frequently convenient to measure temperature in this manner when dealing with gases, or electrical resistance thermometers.

4. *Absolute Scale.*—It is necessary for theoretical purposes to reduce all experimental results as far as possible to the absolute scale, defined as explained in HEAT, § 21, on the basis of Carnot's principle, which is independent of the properties of any particular substance. Temperature on this scale measured from the absolute zero will be denoted by the letter θ. This scale can be most nearly realized in practice by observing the temperature T on the scale of a gas-thermometer, and making special experiments on the gas to determine how far its scale deviates from that of the thermodynamical engine. In the case of the gases hydrogen and helium, which can exist in the liquid state only at very low temperatures, the deviations from the absolute scale at ordinary temperatures are so small that

they cannot be certainly determined. Thermometers containing these gases are generally taken as the ultimate standards of reference in practical thermometry.

Mercurial Thermometry

5. The most familiar type of thermometer depends on the apparent expansion of a liquid hermetically sealed in a glass bulb attached to a graduated stem of fine bore. Of all liquid-in-glass thermometers those containing mercury are almost invariably selected for scientific purposes, although at first sight mercury would appear to be the least suitable liquid, on account of its small coefficient of expansion. The smallness of the expansion necessitates an extremely fine bore for the stem, which introduces errors in consequence of the high surface tension of mercury. The considerable density of the liquid also tends to exaggerate the effects of change of position due to variation of the pressure exerted on the interior of the bulb by the liquid column. These errors are small and fairly regular, and can be corrected within certain limits. A much more serious source of trouble, especially at high temperatures, is the imperfect elasticity of the glass, which causes more or less irregular changes in the volume of the bulb. The effect of these changes on the readings of the thermometer is enhanced by the smallness of the expansion of mercury, and might be reduced by employing a more expansible liquid. It is more likely, however, that the defect will be remedied by the construction of thermometers of fused quartz, which is the most perfectly elastic solid hitherto discovered. For work at low temperatures the range of a mercury thermometer is limited by its freezing-point (−39° C.).

These are the serious disadvantages attending the use of mercury, but in other respects it possesses so many advantages over alcohol or other substitutes, that it will in all probability continue to be used almost exclusively in thermometers of this type for scientific work. Among its chief advantages may be reckoned its high boiling-point (357° C.), and the absence of evaporation from the top of the thread, which is so serious a source of error with the alcohol thermometer. With mercury the evaporation is almost inappreciable at 100° C., and can in all cases be avoided by exposing the upper parts of the emergent thread to the temperature of the air. Although an evacuated mercury thermometer cannot be safely used at temperatures over 300° C., owing to the breaking up of the thread of liquid in the stem, it has been found possible, by filling the upper part of the stem with nitrogen or carbon dioxide under high pressure, to extend the range to 550° C. A more important advantage for accurate work is the fact that mercury does not wet glass, and avoids any possible errors due to adherent films of liquid on the walls of the tube. This greatly facilitates observations, and also renders it possible to calibrate the thermometer *after* construction, which cannot be satisfactorily accomplished with other liquids. The process of construction and calibration is further facilitated by the fact that mercury does not dissolve air to any appreciable extent. In consequence of the regularity of expansion of mercury at ordinary temperatures, the scale of the mercury thermometer agrees very closely with that of the gas thermometer. The liquid is very easily obtained in a high state of purity by distillation, and has practically no chemical action on glass. In this respect it is superior to the liquid alloy of potassium and sodium, which has been employed in some high-temperature thermometers, but which rapidly reduces silica at high temperatures. The high conductivity and low specific heat of mercury as compared with most other liquids tend to render the thermometer quick and sensitive in action. Its opacity considerably facilitates accurate reading, and even the smallness of its expansion has one great countervailing advantage, in that the correction for stem-exposure is proportionately reduced. This correction, which (even in the case of mercury) may amount to as much as 40° C. at 550° C., is far the most uncertain in its application, and is the most serious objection to the use of the liquid-in-glass thermometer at high temperatures.

6. *Construction.*—The construction of the most accurate type of mercury thermometer has undergone some changes of detail in recent years. The range of the most accurate standards is generally restricted to the fundamental interval. The length of a degree on the stem can be increased to any extent by enlarging the bulb or diminishing the bore of the stem, but it is found in practice that there is no advantage in making the scale more open than one centimetre to the degree C. in standard instruments, or in increasing the number of divisions beyond ten or at most twenty to the degree. Enlarging the bulb makes the instrument sluggish, and exaggerates the errors due to imperfect elasticity. Diminishing the bore of the tube increases the errors due to capillary friction. Even one centimetre to the degree is an impracticable scale for thermometers graduated continuously from 0° to 100° C., owing to the excessive length of the stem. In order to secure so open a scale, it is necessary to limit the range to 35°, or at most 50°. The fixed points 0° and 100° may still be retained, for purposes of testing and reference, by the device, now commonly employed, of blowing auxiliary bulbs or *ampoules* on the stem, the volume of which is carefully adjusted to correspond with the number of degrees that it is desired to suppress.

In the best instruments for work of precision the bulb is not blown on the capillary tube itself, but is formed of a separate piece of tube fused on the stem. It is possible in this manner to secure greater uniformity of strength and regularity of dimensions. The thickness of the glass is generally between half a millimetre and one millimetre. The advantage in point of quickness gained by making the glass thin is more than counterbalanced by increased fragility and liability to distortion. The best form of bulb is cylindrical, of the same external diameter as the stem. The bore of the stem should also be cylindrical, and not oval or flattened, in order to diminish errors due to capillarity, and to secure the greatest possible uniformity of section. The glass should be clear, and not backed with opal, both to admit of reading from either side, and to minimize risk of bending or distortion. In the commoner sorts of thermometers, which are intended for rough purposes and to be read without the application of minute corrections, it is not unusual to divide the tube into divisions of equal volume by a preliminary calibration. In the most accurate instruments it is preferable to divide the tube into divisions of equal length, as this can be more accurately effected. The corrections to be applied to the readings to allow for inequalities of bore can be most satisfactorily determined in the case of mercury thermometers by calibrating the tube after the instrument is completed (see Calibration). This correction is known as the "calibration correction." Instead of being separately determined it may be included in the scale correction by comparison with a standard instrument, such as a platinum-resistance thermometer.

7. *Corrections.*—The corrections to be applied to the readings of a mercury thermometer, in addition to the calibration correction, may be summarized under the following heads: (i.), Zero. (ii.) Fundamental Interval. (iii.) Internal and External Pressure. (iv.) Stem Exposure. (v.) Scale Correction, including Poggendorff's correction.

(1) The *changes of zero* are of two kinds. (*a*) *Secular rise* of zero due to gradual recovery from changes or strains acquired by the bulb during the process of manufacture. This process may be hastened and subsequent changes practically eliminated by annealing the bulb after manufacture, and before final adjustment, at a high temperature, such as that of boiling sulphur (about 450° C.). A thermometer which has not been so treated may show a rise of zero amounting to as much as 20° or 30° when exposed for some time to a temperature of 350° C. (*b*) *Temporary depression* of zero after each exposure to a high temperature, followed by a slow recovery which may last for days or weeks. The best thermometers of hard glass show a depression of zero amounting to about one-tenth of 1° C. after exposure to 100° C. In softer glass the depression is usually greater and more persistent, and may amount to half a degree after 100° C. At higher temperatures the depression generally increases roughly as the square of the temperature above 0° C. It may amount to 2° or 3° at 300° C. The effect cannot be calculated or predicted in any series of observations,

because it depends in so complicated a manner on the past history and on the time. It is a most serious difficulty in accurate mercurial thermometry, especially at high temperatures. The most satisfactory method of correction appears to be to observe the zero *immediately after each reading*, and to reckon the temperature from the variable zero thus observed. The rationale of this procedure is that the depression is produced at the high temperature much more rapidly than the subsequent recovery at the low temperature. The thermometer is taken from the bath and allowed to cool rapidly by free exposure to the air. As soon as it reaches 40° or 50° C., it is plunged in the melting ice, and the lowest point reached is taken as the temporary zero.

The following formulae have been proposed by various observers to represent the depression of zero for different kinds of glass:—

$$\left.\begin{array}{l}\text{Pernet, French } \textit{cristal},\ dz=0{\cdot}0040(t/100)^2 \\ \text{Guillaume, } \textit{Verre dur},\ 0-100^\circ\text{ C.},\ dz=(8886t+10{\cdot}84t^2)\,10^{-7} \\ \text{Bottcher, } \textit{Cristal dur},\ 0-190^\circ\text{ C.},\ dz=(7970t+329t^2)10^{-7} \\ \quad\text{,, Jena, 16, iii., } dz=(7100t-8t^2)\,10^{-7}\end{array}\right\} \quad (4)$$

The symbol dz in these formulae stands for the depression of zero produced by an exposure to a temperature t. The depression is about three times as large in French crystal as in English flint glass, and varies roughly as the square of t. *Verre dur* and Jena, 16, iii., are varieties of hard glass chosen as standards in France and Germany respectively, on account of the comparatively small depression of zero to which they are liable. At low temperatures, up to 50° C., the depression is very nearly proportional to t, but at temperatures above 100° C. it is necessary to adopt another formula in which the term depending upon t^2 is more important. These formulae are useful as giving an idea of the probable size of the correction in any case, but they cannot be employed in practice except in the simplest cases and at low temperatures. On account of these temporary changes of zero, a mercury thermometer intended for the most accurate work at ordinary temperatures (as in calorimetry) should preferably never be heated above 40° or 50° C., and certainly never above 100° C. Above 100° C. the changes of zero become more irregular and more variable, depending on the rate of cooling and on the sequence of previous observations, so that even if the method of observing the zero after each reading is adopted, the order of precision attainable rapidly diminishes.

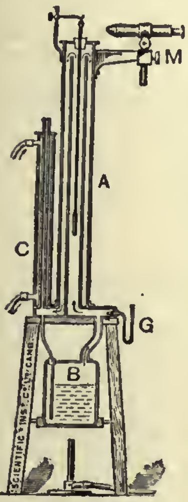

FIG. 1.—Hypsometer.

(II) *Fundamental Interval.*—The thermometer to be tested is exposed to steam condensing at atmospheric pressure in an apparatus which is often called a "hypsometer," constructed with double walls to protect the inner tube containing the thermometer from any cooling by radiation. The standard atmospheric pressure at which the temperature of the steam is by definition equal to 100° C. is equivalent to that produced by a column of mercury at 0° C. and 760 millimetres high, the force of gravitation being equal to that at sea-level in latitude 45°. The atmospheric pressure at the time of observation is reduced to these units by applying the usual corrections for temperature and gravitation. If the pressure is near 760 mm., the temperature of the steam may be deduced by assuming that it increases at the rate of 1° C. for 27·2 mm. of pressure. If the pressure is not near 760 mm., the application of the correction is less certain, but is generally taken from Regnault's tables, from which the following data are extracted. Thermometers cannot be satisfactorily tested at an elevated station where the height of the barometer H is less than 700 mm., as the steam point is too uncertain.

A convenient type of hypsometer is shown in fig. 1. The boiler B is separate from the steam-jacket A surrounding the thermometer. A gauge G is provided for indicating the steam pressure (difference from atmospheric) and a condenser C for returning the condensed steam to the boiler. The thermometer is observed by the microscope M.

steam point. If n be the interval in degrees of the scale between the two observations, and if t_1 be the temperature of the steam, the fundamental interval of the thermometer may be taken as $100\ n/t_1$, provided that t_1 is nearly 100° C. Since all the readings of a thermometer have to be corrected for the error of the fundamental interval, by dividing by the fundamental interval thus observed and multiplying by 100, it is a matter of some convenience in practice to have the instrument graduated so that the difference between the readings in ice and at 100° C. is very nearly 100° of the stem. The correction can then be applied as a small percentage independently of the other corrections. The method of determining the fundamental interval above described applies to all other kinds of thermometers, except that it is not generally necessary to observe the zero *after* the steam point. The temperature of the steam t_1 should be expressed in the scale of the thermometer tested, if the scale differs appreciably from that of Regnault.

(III) *Pressure Correction.*—The corrections for variations of internal and external pressure on the bulb are of some importance in accurate thermometry, but can be applied with considerable certainty at moderate temperatures. The correction for external pressure is assumed to be proportional to the change of pressure, and to be independent of the temperature. It is generally determined by enclosing the thermometer to be tested in a vessel of water, and observing the change of reading on exhausting or readmitting the air. The correction is generally between one and two thousandths of a degree per centimetre of mercury change of pressure, but must be determined for each thermometer, as it depends on the nature of the glass and on the form and thickness of the walls of the bulb. The coefficient of the correction for internal pressure is greater than that for external pressure by the difference between the compressibility of mercury and that of glass, and may be calculated from it by assuming this relation. If b_0, b_1, are the external and internal coefficients, expressed in degrees of temperature per centimetre of mercury, we have the relation

$$b_1=b_0+0{\cdot}00015,\ \text{degrees per cm. of mercury} \quad . \quad . \quad (6)$$

The coefficient of internal pressure can also be determined by taking readings in the horizontal and vertical positions when the thermometer is at some steady temperature such as that of ice or steam. The reading of the thermometer is generally reduced to an external pressure of one standard atmosphere, and to an internal pressure corresponding to the horizontal position. It is also possible to include the internal pressure correction in the scale correction, if the thermometer is always read in the vertical position. In addition to the variations of internal pressure due to the column of mercury in the stem, there are variations due to capillarity. The internal pressure is greater when the mercury is rising than when it is falling, and the reading is depressed to an extent depending on the fineness of the bore and the thinness of the walls of the bulb. The capillary pressure does not depend only on the bore of the tube, but also apparently to an even greater extent on the state of the walls of the tube. The least trace of dirt on the glass or on the mercury is capable of producing capillary pressures much greater than would be calculated from the diameter of the tube. Even in the best thermometers, when there are no inequalities of bore sufficient to account for the observed variations, it is seldom found that the mercury runs equally easily in all parts of the stem. These variations of capillary pressure are somewhat capricious, and set a limit to the order of accuracy attainable with the mercury thermometer. It appears that the difference of reading of a good thermometer between a rising and falling meniscus may amount to five or ten thousandths of a degree. The difference may be reduced by continuous tapping, but it is generally best to take readings always on a rising column, especially as the variations in the angle of contact, and therefore in the capillary pressure, appear to be much smaller for the rising meniscus. In ordinary work the zero reading and the steam reading would both generally correspond to a falling meniscus; the former necessarily, the latter on account of the phenomenon of the temporary depression of zero, which causes the thermometer to read higher during the first moments of its exposure to steam than it does when the expansion of the bulb has reached its limit. It is easy to secure a rising meniscus at the steam point by momentarily cooling the thermometer. At the zero point the meniscus generally begins to rise

TABLE I.—*Temperature of Steam at pressures from 790 to 710 mm.*

Pressure (corrected) . . .	790	780	770	760	750	740	730	720	710
Steam temp. = 100° C.+ . .	+1·083	+·726	+·365	0	−·369	−·742	−1·120	−1·502	−1·888

$$\text{Approximate formula } dt_1=\cdot0367(\text{H}-760)-\cdot000020(\text{H}-760)^2 \quad (5)$$

If the barometer has a brass scale correct at 0° C., and H be the reading in millimetres, the correction for temperature is made approximately by subtracting 0·00163 H mm.

If L is the latitude and M the height of the station in metres above the sea-level, the correction for gravitation is approximately made by subtracting (0·0026 cos 2L+0·0000002M) H mm.

The zero of the thermometer is observed immediately after the after five or ten minutes. The question, however, is not of much importance, as the error, if any, is regular, and the correction for capillarity is necessarily uncertain.

(IV) *Stem-Exposure Correction.*—When the bulb of a mercury thermometer is immersed in a bath at a temperature t, and a part of the column of mercury having a length of n degrees is exposed to a lower temperature t_2, the reading of the thermometer will be lower by $a \times n \times (t-t_2)$ degrees (nearly) than it would have been if the whole of the mercury and stem had been at the temperature t. The factor a in this expression is the apparent coefficient of expansion of mercury in glass, and varies from ·000150 to ·000165 for different kinds of glass. In order to apply this correction, it is usual to observe t_2 by means of an auxiliary "stem-thermometer" with its bulb placed near the middle of the emergent column n. Occasionally stem-thermometers with long thin bulbs are employed to give more nearly the average temperature of the whole emergent column. Owing to conduction along the stem of the thermometer, and to heated vapours near the bath, the mean temperature determined in this manner is generally too low. To allow for this empirically, an arbitrary reduction is often made in the value taken for n or a, but this cannot be regarded as satisfactory for work of precision. The only practical method of reducing the correction is to limit the number of degrees n exposed, or, in other words, to work with thermometers of "limited range." Each of these thermometers must then be corrected by comparison with a standard thermometer free from stem-exposure correction, such as a platinum-resistance thermometer. To secure results of any value the correction must be determined at each point under the actual conditions of observation under which the thermometer is to be used. In work of precision it is necessary to use ten or twenty thermometers to cover a range of 300°, as this is the only method of securing an open scale and reasonable accuracy as regards stem-exposure. To quote the opinion of C. E. Guillaume, one of the leading authorities on mercurial thermometry: "When this correction is large, it cannot generally be determined with sufficient approximation for measurements of precision. The mercury thermometer should then be replaced by other instruments, among which those based on the variation of the electrical resistance of metals hold the first rank."

(V) *Scale Correction.*—The correction required to reduce the readings of a mercurial thermometer to the normal scale may appropriately be called the "scale correction." One of the chief advantages of the mercurial thermometer for scientific purposes is that its scale agrees very closely with the thermodynamical scale between 0° and 200° C. The scale corrections of the standard French thermometers of *verre dur* have been very carefully determined over the range 0° to 80° C. by P. Chappuis using a constant-volume gas thermometer containing hydrogen (at an initial pressure of one metre of mercury at 0° C.) as the representative of the normal scale. His observations between 0° and 80° C. are represented by the quartic equation

$$t_h - t_m = t(t-100)\ (-61{\cdot}859 + 0{\cdot}47351\ t - 0{\cdot}0011577\ t^2) \times 10^{-6}, \quad (7)$$

in which t_h and t_m represent temperature on the scales of the hydrogen and mercury thermometers respectively. The *verre dur* mercury thermometer reads 0·112° C. above the hydrogen thermometer at 40° C. where the difference of the scales is a maximum. The scale corrections of the Jena-glass thermometers, deduced by comparison with the French *verre dur*, appear to be practically of the same magnitude, but show differences of as much as 0·010° C. on either side of the mean. It may be questioned whether it is possible to construct mercury thermometers with scales agreeing more closely than this, owing to inevitable variations in the quality and treatment of the glass. According to Guillaume, the scale of a French *cristal* thermometer t_c differs from that of the standard *verre dur* t_m between 0° and 50° C., according to the cubic formula

$$t_c - t_m = t(100-t)(14{\cdot}126 - 0{\cdot}0311t) \times 10^{-6} \quad . \quad . \quad (8)$$

According to some unpublished observations made by the writer in 1893–1894, the scale of an English flint-glass thermometer, tested by comparison with a platinum thermometer, does not differ from that of the constant-pressure air thermometer by more than one or two hundredths of a degree between 0° and 100° C. But for the comparison of the scales to be of any value, it would be necessary to study a large number of such thermometers. It is possible to obtain much more consistent results if the thermometers are not heated above 50° C.

The comparisons of the *verre dur* thermometers with the normal scale at the International Bureau at Paris have not as yet extended beyond 100° C. The most important observations on the mercury thermometer above these limits appear to be those of Regnault. The later observations of J. M. Crafts were confined to French thermometers of *cristal dur* (*Comptes Rendus*, 1882, 95, p. 863). He found the following deviations from the hydrogen scale:—

t_h	150°	170°	200°	230°	250°	280°	300°	330°
$t_h - t_m$	+·25	+·35	+·27	−·02	−·26	−·63	−1·21	−2·48

The correction changes sign at about 230° C., owing to the rapid increase in the expansion of mercury. Between 0° and 150° C. it would appear that the coefficient of expansion of glass increases more rapidly than that of mercury.

Poggendorff's Correction.—It should be observed that, since in the construction of a mercury thermometer the tube is divided or calibrated so as to read in divisions of equal volume when the whole of the tube is at one temperature, the degrees do not as a matter of fact correspond to equal increments of the apparent expansion of mercury. The scale does not therefore agree in practice with the theoretical formula (1) for the scale of the expansion of mercury, since the expansion is measured in a tube which itself is expanding. A similar argument applies to the method of the weight thermometer, in which the overflow is measured by weight. Even if the expansion of mercury and glass were both uniform, as measured on the thermodynamical scale, the scale of the mercury thermometer, as ordinarily calibrated, would not agree with the thermodynamical scale. The difference can be easily calculated if the actual expansion of mercury and glass is known. The correction is known as Poggendorff's, but is generally included in the scale correction, and is not applied separately. It has the effect of making the thermometer read higher at temperatures between 0° and 100° than it would if the divisions of the stem did

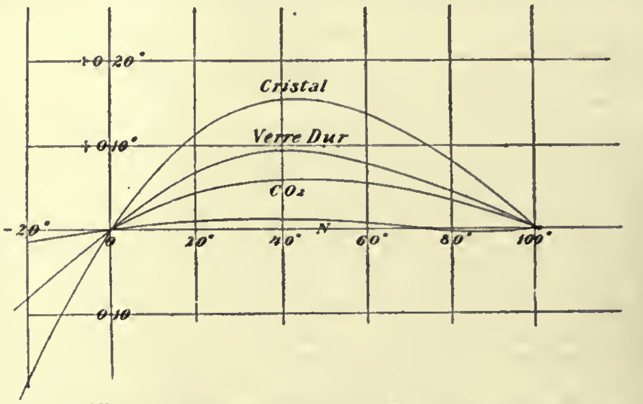

FIG. 2.—Differences between Scales of Mercury, and Gas Thermometers and Hydrogen Scale, according to Guillaume and Chappuis.

not expand as the temperature rose. The amount of the correction for *verre dur* is given by Guillaume as

$$\text{P.C.} = t(100-t)(23{\cdot}920 + 0{\cdot}0240t) \times 10^{-6} \quad . \quad . \quad (9)$$

The value of this correction is between ·060° and ·080° at 50° C. for different thermometers.

GAS THERMOMETRY

8. The deviations of the gas thermometer from the absolute scale are so small that this instrument is now universally regarded as the ultimate standard in thermometry. It had, in fact, already been adopted for this purpose by Regnault and others, on a priori considerations, before the absolute scale itself had been invented. Although the indications of a gas thermometer are not absolutely independent of the changes of volume of the envelope or bulb in which the gas is contained, the effect of any uncertainty in this respect is minimized by the relatively large expansibility of the gas. The capricious changes of volume of the bulb, which are so great a difficulty in mercurial thermometry, are twenty times less important in the case of the gas thermometer. As additional reasons for the choice we have the great simplicity of the laws of gases, and the approximate equality of expansion and close agreement of the thermometric scales of all gases, provided that they are above their critical temperatures. Subject to this condition, at moderate pressures and provided that they are not dissociated or decomposed, all gases satisfy approximately the laws of Boyle and Charles. These two laws are combined in the characteristic equation of the gaseous state, viz., $pv = \text{R}T$, in which p is the pressure and v the volume of unit mass of the gas in question, and R is a constant which varies inversely as the molecular weight of the gas, and is approximately equal to the difference of the specific heats.

9. *Practical Conditions.*—In practice it is not convenient to deal with unit mass, but with an arbitrary mass M occupying a space V, so that the specific volume $v = \text{V/M}$. It is also necessary to measure the pressure p in terms of mercury columns, and not in absolute units. The numerical value of the constant R is adjusted to suit these conditions, but is of no consequence in thermometry, as we are concerned with ratios and differences only. The equation may be written in the form $\text{T} = p\text{V/RM}$, but in order to satisfy the essential condition that T shall be a definite function of the temperature in the case of a gas which does not satisfy Boyle's law exactly, it is necessary to limit

the application of the equation to special cases which lead to definite, but not necessarily identical, thermometric scales. There are three special cases of practical importance, corresponding to three essentially distinct experimental methods.

(i.) *Volumetric Method* (constant-pressure).—In this method V is variable and p and M are constant. This method was employed by Gay-Lussac, and is typified in the ideal thermometer with reservoir of variable capacity designed by Lord Kelvin (*Ency. Brit.*, ed. ix., vol. xi. p. 575, fig. 10). It corresponds to the method ordinarily employed in the common liquid-in-glass thermometer, but is not satisfactory in practice, owing to the difficulty of making a bulb of variable and measurable volume the whole of which can be exposed to the temperature to be measured.

(ii.) *Manometric Method* (constant-volume or density).—In this method p is variable and V and M are constant. Variations of temperature are observed and measured by observing the corresponding variations of pressure with a mercury manometer, keeping a constant mass, M, of gas enclosed in a volume, V, which is constant except for the unavoidable but small expansion of the material of which the bulb is made.

(iii.) *Gravimetric Method* (constant-pressure).—In this method M is variable and p and V are constant. This method is generally confounded with (i.) under the name of the constant-pressure method, but it really corresponds to the method of the weight thermometer, or the "overflow" method, and is quite distinct from an experimental standpoint, although it leads to the same thermometric scale. In applying this method, the weight M of the vapour itself may be measured, as in Regnault's mercury-vapour thermometer, or in Deville and Troost's iodine-vapour thermometer. The best method of measuring the overflow is that of weighing mercury displaced by the gas. The mass of the overflow may also be estimated by observing its volume in a graduated tube, but this method is much less accurate.

In addition to the above, there are mixed methods in which both p and V or M are variable, such as those employed by Rudberg or Becquerel; but these are unsatisfactory for precision, as not leading to a sufficiently definite thermometric scale. There is also a variation of the constant-volume method (ii.), in which the pressure is measured by the volumetric compression of an equal mass of gas kept at a constant temperature, instead of by a manometer. This method is experimentally similar to (iii.), and gives the same equations, but a different thermometric scale from either (ii.) or (iii.). It will be considered with method (iii.), as the apparatus required is the same, and it is useful for testing the theory of the instrument. We shall consider in detail methods (ii.) and (iii.) only, as they are the most important for accurate work.

10. *Construction of Apparatus.*—The manometric or constant-volume method was selected by Regnault as the standard, and has been most generally adopted since his time. His apparatus has not been modified except in points of detail. A description of his instrument will be found in most text-books on heat.

A simple and convenient form of the instrument for general use is Jolly's (described in Poggendorff's *Jubelband*, p. 82, 1874), and represented in fig. 3. The two vertical tubes of the manometer are connected by an india-rubber tube properly strengthened by a cotton covering, and they can be made to slide vertically up and down a wooden pillar which supports them; they are provided with clamps for fixing them in any position and a tangent screw for fine adjustment. The connexion between the bulb and the manometer is made by means of a three-way tap. The scale of the instrument is engraved on the back of a strip of plane mirror before silvering, and the divisions are carried sufficiently far across the scale for the reflections of the two surfaces of the mercury to be visible behind the scale. Parallax can thus be avoided and an accurate reading obtained without the necessity of using a cathetometer. In order to allow for the expansion of the glass of the reservoir a weight-thermometer bulb is supplied with the instrument, made from another specimen of the same kind of glass, and the relative expansion of the mercury and the glass can thus be determined by the observer himself. The volume of the air-bulb and that of the capillary tube and the small portion of the manometer tube above the small beak of glass, the point of which serves as the fiducial mark, are determined by the instrument-makers. The improvements introduced by Chappuis, of the International Bureau at Sèvres, in the construction of the constant-volume hydrogen thermometer selected by the committee for the determination of the normal scale, are described in the text-books (*e.g.* Watson's *Physics*). The most important is the combination of the manometer and the barometer into a single instrument with a single scale, thus reducing the number of readings required. The level of the mercury in the branch of the manometer communicating with the bulb of the gas thermometer is adjusted in the usual manner up to a fixed contact-point, so as to reduce the contained gas to a constant volume. Simultaneously the barometer branch of the manometer is adjusted so that the surface of the mercury makes contact with another point fixed in the upper end of the barometer tube. The distance between the two contact-points, giving the pressure of the gas in the thermometer, is deduced from the reading of a vernier fixed relatively to the upper contact-point. This method of reading the pressure is probably more accurate than the method of the cathetometer which is usually employed, but has the disadvantage of requiring a double adjustment.

FIG. 3.

11. *Pressure Correction.*—In the practical application of the manometric method there are certain corrections peculiar to the method, of which account must be taken in work of precision. The volume of the bulb is not accurately constant, but varies with change of pressure and temperature. The thermal expansion of the bulb is common to all methods, and will be considered in detail later. The pressure correction is small, and is determined in the same manner as for a mercury thermometer. The value so determined, however, does not apply strictly except at the temperature to which it refers. If the pressure-coefficient were constant at all temperatures and equal to e, the pressure correction, dt, at any point t of the scale would be obtainable from the simple formula

$$dt = ep_0t(t-100)/T_0 \quad . \quad . \quad . \quad . \quad (10)$$

where p_0 is the initial pressure at the temperature T_0. But as the coefficient probably varies in an unknown manner, the correction is somewhat uncertain, especially at high temperatures. Another very necessary but somewhat troublesome correction is the reduction of the manometer readings to allow for the varying temperatures of the mercury and scale. Since it is generally impracticable to immerse the manometer in a liquid bath to secure certainty and uniformity of temperature, the temperature must be estimated from the readings of mercury thermometers suspended in mercury tubes or in the air near the manometer. It is therefore necessary to work in a room specially designed to secure great constancy of temperature, and to screen the manometer with the utmost care from the source of heat in measurements of high temperature. Regnault considered that the limit of accuracy of correction was one-tenth of a millimetre of mercury, but it is probably possible to measure to one-hundredth as a mean of several readings under the best conditions, at ordinary temperatures.

12. *Stem-Exposure.*—In all gas thermometers it is necessary in practice that the part of the gas in contact with the mercury or other liquid in the manometer should not be heated, but kept at a nearly constant temperature. The space above the mercury, together with the exposed portion of the capillary tube connecting the manometer with the thermometric bulb, may be called the "dead space." If the volume of the dead space is kept as nearly as possible constant by adjusting the mercury always up to a fixed mark, the quantity of air in this space varies nearly in direct proportion to the pressure, *i.e.* in proportion to the temperature of the thermometric bulb

at constant volume. This necessitates the application of a stem-exposure correction, the value of which is approximately given by the formula

$$dt = rt(t-100)/T_2, \quad . \quad . \quad . \quad . \quad (11)$$

where r is the ratio of the volume of the dead space to the volume of the thermometric bulb, and T_2 is the mean temperature of the dead space, which is supposed to be constant. The magnitude of the correction is proportional to the ratio r, and increases very rapidly at high temperatures. If the dead space is 1 per cent. of the bulb, the correction will amount to only one-tenth of a degree at 50° C., but reaches 5° at 445° C., and 30° at 1000° C. It is for this reason important in high-temperature work to keep the dead space as small as possible and to know its volume accurately. With a mercury manometer, the volume is liable to a slight uncertainty on account of changes of shape in the meniscus, as it is necessary to use a wide tube in order to secure accurate measurements of pressure.

13. *Compensation Method with Oil-Gauge.*—It is possible to avoid this difficulty, and to make the dead space very small, by employing oil or sulphuric acid or other non-volatile liquid to confine the gas in place of mercury (*Phil. Trans.*, A. 1887, p. 171). The employment of a liquid which wets the tube makes it possible to use a much smaller bore, and also greatly facilitates the reading of small changes of pressure. At the same time the instrument may be arranged so that the dead space correction is automatically eliminated with much greater accuracy than it can be calculated. This is effected as shown diagrammatically in fig. 4, by placing side by side with the tube AB, connecting the bulb B to the manometer A, an exact duplicate CD, closed at the end D, and containing liquid in the limb C, which is of the same size as the branch A of the manometer and in direct communication with it. The tube CD, which is called the compensating tube, contains a constant mass of gas under exactly similar conditions of volume and temperature to the tube AB. If therefore the level of the liquid is always adjusted to be the same in both tubes AB and CD, the mass of gas contained in the dead space AB will also be constant, and is automatically eliminated from the equations, as they contain differences only.

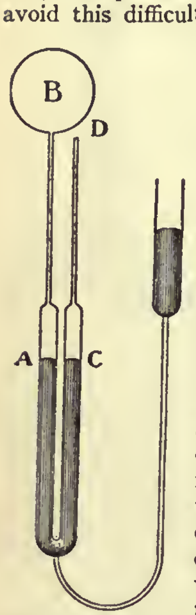

FIG. 4.—Method of Compensation.

14. *Gravimetric Method.*—In the writer's opinion, the gravimetric or overflow method, although it has seldom been adopted, and is not generally regarded as the most accurate, is much to be preferred to the manometric method, especially for work at high temperatures. It is free from the uncertain corrections above enumerated as being peculiar to the manometric method. The apparatus is much simpler to manipulate and less costly to construct. If the pressure is kept constant and equal to the external atmospheric pressure, there is no strain of the bulb, which is particularly important at high temperatures. There is no dead space correction so long as the temperature of the dead space is kept constant. The troublesome operation of reading and adjusting the mercury columns of the manometer is replaced by the simpler and more accurate operation of weighing the mercury displaced, which can be performed at leisure. The uncertain correction for the temperature of the mercury in the manometer is entirely avoided.

The reasons which led Regnault to prefer the constant-volume thermometer are frequently quoted, and are generally accepted as entirely conclusive, but it is very easy to construct the constant-pressure or gravimetric instrument in such a manner as to escape the objections which he urges against it. Briefly stated, his objections are as follows: (1) Any error in the observation of the temperature of the gas in the overflow space produces a considerable error in the temperature deduced, when the volume of the overflow is large. This source of error is very simply avoided by keeping the whole of the overflow in melting ice, an expedient which also considerably simplifies the equations. It happened that Regnault's form of thermometer could not be treated in this manner, because he had to observe the level of the mercury in order to measure the pressure and the volume. It is much better, however, to use a separate gauge, containing oil or sulphuric acid, for observing small changes of pressure. The use of ice also eliminates the correction for the variation of density of the mercury by which the overflow is measured. (2) Regnault's second objection was that an error in the measurement of the pressure, or in reading the barometer, was more serious at high temperatures in the case of the constant-pressure thermometer than in the constant-volume method. Owing to the incessant variations in the pressure of the atmosphere, and in the temperature of the mercury columns, he did not feel able to rely on the pressure readings (depending on observations of four mercury surfaces with the cathetometer) to less than a tenth of a millimetre of mercury, which experience showed to be about the limit of accuracy of his observations. This would be equivalent to an error of 0·036° with the constant-volume thermometer at any point of the scale, but with the constant-pressure thermometer the error would be larger at higher temperatures, since the pressure does not increase in proportion to the temperature. This objection is really unsound, because the ideal condition to be aimed at is to keep the *proportionate error* dT/T constant. That the proportionate error diminishes with rise of temperature, in the case of the constant-volume thermometer, is really of no advantage, because we can never hope to be able to measure high temperatures with greater proportionate accuracy than ordinary temperatures. The great increase of pressure at high temperatures in the manometric method is really a serious disadvantage, because it becomes necessary to work with much lower initial pressures, which implies inferior accuracy at ordinary temperatures and in the determination of the initial pressure and the fundamental interval.

15. *Compensated Differential Gas Thermometer.*—The chief advantage of the gravimetric method, which Regnault and others appear to have missed, is that it is possible to make the measurements altogether independent of the atmospheric pressure and of the observation of mercury columns. This is accomplished by using, as a standard of constant pressure, a bulb S, fig. 5, containing a constant mass of gas in melting ice, side by side with the bulb M, in which the volume of the overflow is measured. The pressure in the thermometric bulb T is adjusted to equality with the standard by means of a delicate oil-gauge G of small bore, in which the difference of pressure is observed by means of a cathetometer microscope. This kind of gauge permits the rapid observation of small changes of pressure, and is far more accurate and delicate than the mercury manometer. The fundamental measurement of the volume of the overflow in terms of the weight of mercury displaced at 0° C. involves a single weighing made at leisure, and requires no temperature correction. The accuracy obtainable at ordinary temperatures in this measurement is about ten times as great as that attainable under the best conditions with the mercury manometer. At higher temperatures the relative accuracy diminishes in proportion to the absolute temperature, or the error dt increases according to the formula

$$dt/t = -(T/T_0)\, dw/w, \quad . \quad . \quad . \quad . \quad (12)$$

where w is the weight of the overflow and dw the error. This diminution of the sensitiveness of the method at high temperatures is commonly urged as a serious objection to the method, but the objection is really without weight in practice, as the possible accuracy of measurement is limited by other conditions. So far as the weighing alone is concerned, the method is sensitive to one-hundredth of a degree at 1000° C., which is far beyond the order of accuracy attainable in the application of the other corrections.

16. *Method of Using the Instrument.*—A form of gas thermometer constructed on the principles above laid down, with the

addition of a duplicate set of connecting tubes C for the elimination of the stem-exposure correction by the method of automatic compensation already explained, is shown in fig. 5 (*Proc. R. S.* vol. 50, p. 243; Preston's *Heat*, p. 133).

In setting up the instrument, after cleaning, and drying and calibrating the bulbs and connecting tubes, the masses of gas on the two sides are adjusted as nearly as possible to equality, in order that any changes of temperature in the two sets of connecting tubes may compensate each other. This is effected with all the bulbs in melting ice, by adjusting the quantities of mercury in the bulbs M and S and equalizing the pressures. The bulb T is then heated in steam to determine the fundamental interval. A weight w_1 of mercury is removed from the overflow bulb M in order to equalize the pressures again. If W is the weight of the mercury at 0° C. which would be required to fill the bulb T at 0° C., and if $W+dW_1$ is the weight of mercury at 0° which would be required to fill a volume equal to that of the bulb in steam at t_1, we have the following equation for determining the coefficient of expansion a, or the fundamental zero T_0,

$$at_1 = t_1/T_0 = (w_1+dW_1)/(W-w_1), \quad . \quad . \quad . \quad (13)$$

Similarly if w is the overflow when the bulb is at any other temperature t, and the expansion of the bulb is dW, we have a precisely similar equation for determining t in terms of T_0, but with t and w and dW substituted for t_1 and w_1 and dW_1. In practice, if the pressures are not adjusted to exact equality, or if the volumes of

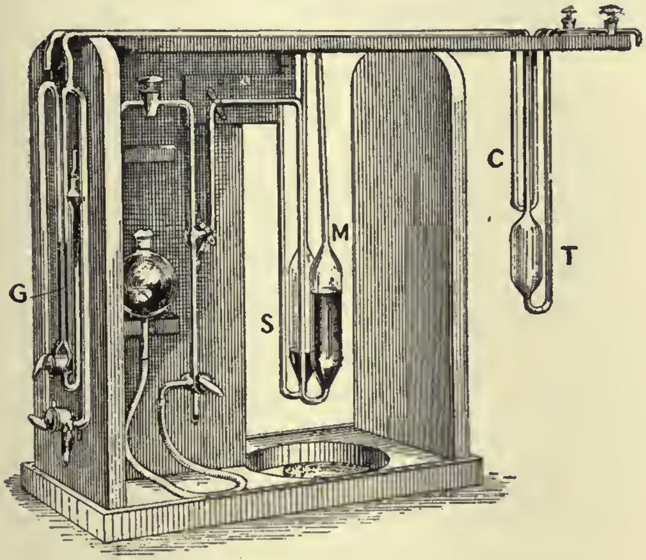

FIG. 5.—Compensated Differential Gas Thermometer.

the connecting tubes do not exactly compensate, it is only necessary to include in w a small correction dw, equivalent to the observed difference, which need never exceed one part in ten thousand.

It is possible to employ the same apparatus at constant volume as well as at constant pressure, but the manipulation is not quite so simple, in consequence of the change of pressure. Instead of removing mercury from the overflow bulb M in connexion with the thermometric bulb, mercury is introduced from a higher level into the standard bulb S so as to raise its pressure to equality with that of T at constant volume. The equations of this method are precisely the same as those already given, except that w now signifies the "inflow" weight introduced into the bulb S, instead of the overflow weight from M. It is necessary, however, to take account of the pressure-coefficient of the bulb T, and it is much more important to have the masses of gas on the two sides of the apparatus equal than in the other case. The thermometric scale obtained in this method differs slightly from the scale of the manometric method, on account of the deviation of the gas compressed at 0° C. from Boyle's law, but it is easy to take account of this with certainty.

Another use to which the same apparatus may be put is the accurate comparison of the scales of two different gases at constant volume by a differential method. It is usual to effect this comparison indirectly, by comparing the gas thermometers separately with a mercury thermometer, or other secondary standard. But by using a pair of bulbs like M and S simultaneously in the same bath, and measuring the small difference of pressure with an oil-gauge, a higher order of accuracy may be attained in the measurement of the small differences than by the method of indirect comparison. For instance, in the curves representing the difference between the nitrogen and hydrogen scales (fig. 1), as found by Chappuis by comparison of the nitrogen and hydrogen thermometers with the mercury thermometer, it is probable that the contrary flexure of the curve between 70° and 100° C. is due to a minute error of observation, which is quite as likely to be caused by the increasing aberrations of the mercury thermometer at these temperatures as by the difficulties of the manometric method. It may be taken as an axiom in all such cases that it is better to measure the small difference itself directly than to deduce it from the much more laborious observations of the separate magnitudes concerned.

17. *Expansion Correction.*—In the use of the mercury thermometer we are content to overlook the modification of the scale due to the expansion of the envelope, which is known as Poggendorff's correction, or rather to include it in the scale correction. In the case of the gas thermometer it is necessary to determine the expansion correction separately, as our object is to arrive at the closest approximation possible to the absolute scale. It is a common mistake to imagine that if the rate of expansion of the bulb were uniform, the scale of the apparent expansion of the gas would be the same as the scale of the real expansion—in other words, that the correction for the expansion of the bulb would affect the value of the coefficient of expansion $1/T_0$ only, and would be without effect on the value of the temperature t deduced. A result of this kind would be produced by a constant error in the initial pressure on the manometric method, or by a constant error in the initial volume on the volumetric method, or by a constant error in the fundamental interval on any method, but *not* by a constant error in the coefficient of expansion of the bulb, which would produce a modification of the scale exactly analogous to Poggendorff's correction. The correction to be applied to the value of t in any case to allow for any systematic error or variation in the data is easily found by differentiating the formula for t with respect to the variable considered. Another method, which is in some respects more instructive, is the following :—

Let T be the function of the temperature which is taken as the basis of the scale considered, then we have the value of t given by the general formula (1), already quoted in § 3. Let dT be the correction to be added to the observed value of T to allow for any systematic change or error in the measurement of any of the data on which the value of T depends, and let dt be the corresponding correction produced in the value of t, then substituting in formula (1) we have,

$$t+dt = 100(T-T_0+dT-dT_0)/(T_1-T_0+dT_1-dT_0),$$

from which, provided that the variations considered are small, we obtain the following general expression for the correction to t,

$$dt = (dT-dT_0)-(dT_1-dT_0)t/100. \quad . \quad . \quad (14)$$

It is frequently simpler to estimate the correction in this manner, rather than by differentiating the general formula.

In the special case of the gas thermometer the value of T is given by the formula

$$T = pV/RM = pV/R(M_0-M_2), \quad . \quad . \quad . \quad (15)$$

where p is the observed pressure at any temperature t, V the volume of the thermometric bulb, and M the mass of gas remaining in the bulb. The quantity M cannot be directly observed, but is deduced by subtracting from the whole mass of gas M_0 contained in the apparatus the mass M_2 which is contained in the dead space and overflow bulb. In applying these formulae to deduce the effect of the expansion of the bulb, we observe that if dV is the expansion from 0° C., and V_0 the volume at 0° C., we may write

$$V=V_0+dV, \quad T=p(V_0+dV)/RM=(pV_0/RM)\ (1+dV/V_0),$$

whence we obtain approximately

$$dT = TdV/V_0 \quad . \quad . \quad . \quad . \quad . \quad (16)$$

If the coefficient of expansion of the bulb is constant and equal to the fundamental coefficient f (the mean coefficient between 0° and 100° C.), we have simply $dV/V_0=ft$; and if we substitute this value in the general expression (14) for dt, we obtain

$$dt=(T-T_1)ft=ft(t-100) \quad . \quad . \quad . \quad (17)$$

Provided that the correction can be expressed as a rational integral function of t, it is evident that it must contain the factors t and $(t-100)$, since by hypothesis the scale must be correct at the fixed points 0° and 100° C., and the correction must vanish at these points. It is clear from the above that the scale of the gas thermometer is not independent of the expansion of the bulb even in the simple case where the coefficient is constant. The correction is by no means unimportant. In the case of an average glass or platinum reservoir, for which f may be taken as 0·000025 nearly, the correction amounts to $-0{\cdot}0625°$ at 50° C., to 3·83° at 445° C., and to 22·5° at 1000° C.

The value of the fundamental coefficient f can be determined with much greater accuracy than the coefficient over any other range of temperature. The most satisfactory method is to use the bulb itself as a mercury weight thermometer, and deduce the cubical expansion of the glass from the absolute expansion of mercury as determined by Regnault. Unfortunately the reductions of Regnault's observations by different calculators differ considerably even for the fundamental interval. The values of the fundamental coefficient range from ·00018153 Regnault, and ·00018210 Broch, to ·00018253 Wüllner. The extreme difference represents an uncertainty of about 4 per cent. (1 in 25) in the expansion of the glass. This uncertainty is about 100 times as great as the probable error of the weight thermometer observations. But the expansion is even less certain beyond the limits of the fundamental interval. Another method of determining the expansion of the bulb is to observe the linear expansion of a tube or rod of the same material, and deduce the cubical expansion on the assumption that the expansion is isotropic. It is probable that the uncertainty involved in this assumption is greater in the case of glass or porcelain bulbs, on account of the difficulty of perfect annealing, than in the case of metallic bulbs.

Except for small ranges of temperature, the assumption of a constant coefficient of expansion is not sufficiently exact. It is therefore usual to assume that the coefficient is a linear function of the temperature, so that the whole expansion from 0° C. may be expressed in the form $dV=t(a+bt)V_0$, in which case the fundamental coefficient $f=a+100b$. Making this substitution in the formula already given, we obtain the whole correction

$$dt=(f+bT)t(t-100) \qquad . \quad . \quad . \quad . \quad (18)$$

It will be observed that the term involving b becomes of considerable importance at high temperatures. Unfortunately, it cannot be determined with the same accuracy as f, because the conditions of observation at the fixed points are much more perfect than at other temperatures. Provided that the range of the observations for the determination of the expansion is co-extensive with the range of the temperature measurements for which the correction is required, the uncertainty of the correction will not greatly exceed that of the expansion observed at any point of the range. It is not unusual, however, to deduce the values of b and f from observations confined to the range 0° to 100° C., in which case an error of 1 per cent., in the observed expansion at 50° C., would mean an error of 60 per cent. at 445°, or of 360 per cent. at 1000° C. (Callendar, *Phil. Mag.* December 1899). Moreover, it by no means follows that the average value of b between 0° and 100° C. should be the same as at higher or lower temperatures. The method of extrapolation would therefore probably lead to erroneous results in many cases, even if the value could be determined with absolute precision over the fundamental interval. It is probable that this expansion correction, which cannot be reduced or eliminated like many of the other corrections which have been mentioned, is the chief source of uncertainty in the realization of the absolute scale of temperature at the present time. The uncertainty is of the order of one part in five or ten thousand on the fundamental interval, but may reach 0·5° at 500° C., and 2° or 3° at 1000° C.

18. *Thermodynamical Correction.*—Of greater theoretical interest, but of less practical importance on account of its smallness, is the reduction of the scale of the gas thermometer to the thermodynamical scale. The deviations of a gas from the ideal equation $pv=R\theta$ may be tested by a variety of different methods, which should be employed in combination to determine the form of the characteristic equation. The principal methods by which the problem has been attacked are the following:—

(1) By the comparison of gas thermometers filled with different gases or with the same gas at different pressures (employing both gravimetric and manometric methods) the differences in their indications are observed through as wide a range of temperature as possible. Regnault, employing this method, found that the differences in the scales of the permanent gases were so small as to be beyond the limits of accuracy of his observations. Applying greater refinements of measurement, Chappuis and others have succeeded in measuring small differences, which have an important bearing on the type of the characteristic equation. They show, for instance, that the equation of van der Waals, according to which all manometric gas thermometers should agree exactly in their indications, requires modification to enable it to represent the behaviour of gases even at moderate pressures.

(2) By measuring the pressure and expansion coefficients of different gases between 0° and 100° C. the values of the fundamental zero (the reciprocal of the coefficient of expansion or pressure) for each gas under different conditions may be observed and compared. The evidence goes to show that the values of the fundamental zero for all gases tend to the same limit, namely, the absolute zero, when the pressures are indefinitely reduced. The type of characteristic equation adopted must be capable of representing the variations of these coefficients.

(3) By observing the variations of the product pv with pressure at constant temperature the deviations of different gases from Boyle's law are determined. Experiment shows that the rate of change of the product pv with increase of pressure, namely $d(pv)/dp$, is very nearly constant for moderate pressures such as those employed in gas thermometry. This implies that the characteristic equation must be of the type

$$v=F(\theta)/p+f(\theta) \qquad . \quad . \quad . \quad . \quad (19)$$

in which $F(\theta)$ and $f(\theta)$ are functions of the temperature only to a first approximation at moderate pressures. The function $F(\theta)$, representing the limiting value of pv at zero pressure, appears to be simply proportional to the absolute temperature for all gases. The function $f(\theta)$, representing the defect of volume from the ideal volume, is the slope of the tangent at $p=0$ to the isothermal of θ on the pv, p diagram, and is sometimes called the "angular coefficient." It appears to be of the form $b-c$, in which b is a small constant quantity, the "co-volume," of the same order of magnitude as the volume of the liquid, and c depends on the cohesion or co-aggregation of the molecules, and diminishes for all gases continuously and indefinitely with rise of temperature. This method of investigation has been very widely adopted, especially at high pressures, but is open to the objection that the quantity $b-c$ is a very small fraction of the ideal volume in the case of the permanent gases at moderate pressures, and its limiting value at $p=0$ is therefore difficult to determine accurately.

(4) By observing the cooling effect $d\theta/dp$, or the ratio of the fall of temperature to the fall of pressure under conditions of constant total heat, when a gas flows steadily through a porous plug, it is possible to determine the variation of the total heat with pressure from the relation

$$Sd\theta/dp=\theta dv/d\theta-v \qquad . \quad . \quad . \quad . \quad (20)$$

(See THERMODYNAMICS, § 10, equation 15.) This method has the advantage of directly measuring the deviations from the ideal state, since $\theta dv/d\theta=v$ for an ideal gas, and the cooling effect vanishes. But the method is difficult to carry out, and has seldom been applied. Taken in conjunction with method (3), the observation of the cooling effect at different temperatures affords most valuable evidence with regard to the variation of the defect of volume $c-b$ from the ideal state. The formula assumed to represent the variations of c with temperature must be such as to satisfy both the observations on the compressibility and those on the cooling effect. It is possible, for instance, to choose the constants in van der Waals's formula to satisfy either (3) or (4) separately within the limits of experimental error, but they cannot be chosen so as to satisfy both. The simplest assumption to make with regard to c is that it varies inversely as some power n of the absolute temperature, or that $c=c_0(\theta_0/\theta)^n$, where c_0 is the value of c at the temperature θ_0. In this case the expression $\theta dv/d\theta-v$ takes the simple form $(n+1)c-b$. The values of n, c and b could be calculated from observations of the cooling effect $Sd\theta/dp$ alone over a sufficient range of temperature, but, owing to the margin of experimental error and the paucity of observations available, it is better to make use of the observations on the compressibility in addition to those on the cooling effect. It is preferable to calculate the values of c and b directly from equation (20), in place of attempting to integrate the equation according to Kelvin's method (*Ency. Brit.* ed. ix. vol. xi. p. 573), because it is then easy to take account of the variation of the specific heat S, which is sometimes important.

Calculation of the Correction.—Having found the most probable values of the quantities c, b and n from the experimental data, the calculation of the correction may be very simply effected as follows: The temperature by gas thermometer is defined by the relation $T=pv/R$, where the constant R is determined from the observations at 0° and 100° C. The characteristic equation in terms of absolute temperature θ may be put in the form $\theta=pv/R'+q$, where q is a small quantity of the same dimensions as temperature, given by the relation

$$q=(c-b)p/R \qquad . \quad . \quad . \quad . \quad (21)$$

The constant R′ is determined, as before, by reference to the fundamental interval, which gives the relation $R'/R=1+(q_1-q_0)/100$, where q_1, q_0 are the values of q at 100° and 0° C. respectively.

The correction to be added to the fundamental zero T_0 of the gas thermometer in order to deduce the value of the absolute zero θ_0 (the absolute temperature corresponding to 0° C.) is given by the equation,

$$\theta_0-T_0=q_0-(q_1-q_0)\theta_0/100 \qquad . \quad . \quad . \quad (22)$$

The correction dt to be added to the centigrade temperature t by gas thermometer reckoned from 0° C. in order to deduce the corresponding value of the absolute temperature also reckoned from 0° C. is given by the relation, deduced from formula (14),

$$dt=(q-q_0)-(q_1-q_0)t/100, \qquad . \quad . \quad . \quad (23)$$

where q is the value at t° C. of the deviation $(c-b)p/R$. The formulae may be further simplified if the index n is a simple integer such as 1 or 2. The values of the corrections for any given gas at different initial pressures are directly proportional to the pressure.

Values of the Corrections.—If we take for the gas hydrogen the values $c=1\cdot5$ c.c. at 0° C., $b=8\cdot0$ c.c., with the index $n=1\cdot5$, which satisfy the observations of Joule and Thomson on the cooling effect, and those of Regnault, Amagat and Chappuis on the compressibility, the values of the absolute zero θ_0, calculated from Chappuis's values of the pressure and expansion coefficients at 100 cms. initial pressure, are found to be 273·10° and 273·05° respectively, the reciprocals of the coefficients themselves being 273·03 and 273·22. The corrections are small and of opposite signs. For nitrogen, taking $c_0=1\cdot58$, $b=1\cdot14$, $n=1\cdot5$, we find similarly 273·10° and 273·13° for the absolute zero, the correction θ_0-T_0 in this case amounting to nearly 1°. The agreement is very good considering the difficulty of determining the small deviations c and b, and the possible errors of the expansion and pressure-coefficients. It appears certain that the value of the absolute zero is within a few hundredths of a degree of 273·10°. Other observations confirm this result within the limits of experimental error. The value of the index n has generally been taken as equal to 2 for diatomic gases, but this does not satisfy either the observations on the cooling effect or those on the compressibility so well as $n=1\cdot5$, although it makes comparatively little difference to the value of the absolute zero. The value deduced from Travers's observation of the pressure-coefficient of helium is 273·13°, taking $n=\frac{1}{2}$, which is the probable value of the index for a monatomic gas. The application of the method to the condensible gas carbonic acid is interesting as a test of the method (although the gas itself is not suited for thermometry), because its deviations from the ideal state are so large and have been so carefully studied. The observations of Joule and Thomson on the cooling effect give $c_0=3\cdot76$ c.c., $b=0\cdot58$ c.c., $n=2$, provided that allowance is made for the variation of the specific heat with temperature as determined by Regnault and Wiedemann. Chappuis's values of the pressure and expansion coefficients agree in giving 273·05° for the absolute zero, the values of the corrections θ_0-T_0 being 4·6° and 5·8° respectively.

The values of the scale correction dt deduced from these formulae agree with those experimentally determined by Chappuis in the case of carbonic acid within the limits of agreement of the observations themselves. The calculated values for nitrogen and hydrogen give rather smaller differences than those found experimentally, but the differences themselves are of the same order as the experimental errors. The deviations of hydrogen and helium from the absolute scale between 0° and 100° C. are of the order of ·001° only, and beyond the limits of accuracy of experiment. Even at −250° C. (near the boiling-point of hydrogen) the corrections of the constant volume hydrogen and helium thermometers are only a tenth of a degree, but, as they are of opposite signs, the difference amounts to one-fifth of a degree at this point, which agrees approximately with that observed by Travers. For a fuller discussion of the subject, together with tables of corrections, the reader may refer to papers by Callendar, *Phil. Mag.* v. p. 48 (1903), and D. Berthelot, *Trav. et Mém. Bur. Int. Paris*, xiii. (1903). Berthelot assumes a similar type of equation to that given above, but takes $n=2$ in all cases, following the so-called law of corresponding states. This assumption is of doubtful validity, and might give rise to relatively large errors in the case of monatomic gases.

19. *Limitations.*—In the application of the gas thermometer to the measurement of high temperatures certain difficulties are encountered which materially limit the range of measurement and the degree of accuracy attainable. These may be roughly classified under the heads—(1) changes in the volume of the bulb; (2) leakage, occlusion and porosity; (3) chemical change and dissociation. The difficulties arise partly from defects in the materials available for the bulb, and partly from the small mass of gas enclosed. The troubles due to irregular changes of volume of glass bulbs, which affect the mercury thermometer at ordinary temperatures, become so exaggerated at higher points of the scale as to be a serious source of trouble in gas thermometry in spite of the twentyfold larger expansion. For instance, the volume of a glass bulb will be diminished by from one-quarter to one-half of 1 per cent. the first time it is heated to the temperature of boiling sulphur (445° C.). This would not matter so much if the volume then remained constant. Unfortunately, the volume continues to change, especially in the case of hard glass, each time it is heated, by amounts which cannot be predicted, and which are too large to neglect. The most accurate method of taking account of these variations in a series of observations, without recalibrating and refilling and cleaning the bulb, is to assume the known constant value of the coefficient of expansion of the gas, and to calculate the volume of the bulb at any time by taking observations in ice and steam (*Phil. Trans.* A. 1891, vol. 182, p. 124). Similar changes take place with porcelain at higher temperatures. Metallic bulbs are far more perfect than glass bulbs in this respect. It is probable that silica bulbs would be the most perfect. The writer suggested the use of this material (in the *Journ. Iron and Steel Inst.* for 1892), but failed to construct bulbs of sufficient size. W. A. Shenstone, however, subsequently succeeded, and there seems to be a good prospect that this difficulty will soon be minimized. The difficulties of leakage and porosity occur chiefly with porcelain bulbs, especially if they are not perfectly glazed inside. A similar difficulty occurs with metallic bulbs of platinum or platinum-iridium, in the case of hydrogen, which passes freely through the metal by occlusion at high temperatures. The difficulty can be avoided by substituting either nitrogen or preferably argon or helium as the thermometric material at high temperatures. With many kinds of glass and porcelain the chemical action of hydrogen begins to be appreciable at temperatures as low as 200° or 300° C. In any case, if metallic bulbs are used, it is absolutely necessary to protect them from furnace gases which may contain hydrogen. This can be effected either by enclosing the bulb in a tube of porcelain, or by using some method of electric heating which cannot give rise to the presence of hydrogen. At very high temperatures it is probable that the dissociation of diatomic gases like nitrogen might begin to be appreciable before the limit of resistance of the bulb itself was reached. It would probably be better, for this reason, to use the monatomic and extremely inert gases argon or helium.

20. *Other Methods.*—Many attempts have been made to overcome the difficulties of gas pyrometry by adopting other methods of measurement. Among the most interesting may be mentioned: (i.) The variation in the wave-length of sound. The objection to this method is the difficulty of accurately observing the wave-length, and of correcting for the expansion of the material of the tubes in which it is measured. There is the further objection that the velocity varies as the square root of the absolute temperature. (ii.) A similar method, but more promising, is the variation of the refractivity of a gas, which can be measured with great accuracy by an interference method. Here again there is difficulty in determining the exact length of the heated column of gas, and in maintaining the temperature uniform throughout a long column at high temperatures. These difficulties have been ingeniously met by D. Berthelot (*Comptes Rendus*, 1895, 120, p. 831). But the method is not easy to apply, and the degree of accuracy attainable is probably inferior to the bulb methods. (iii.) Methods depending on the effusion and transpiration of gases through fine orifices and tubes have been put in practice by Barus and by the writer. The method of transpiration, when the resistance of the tube through which the current of gas is passed is measured on the Wheatstone bridge principle (*Nature*, 23rd March 1899), is extremely delicate, and the apparatus may be made very small and sensitive, but the method cannot be used for extrapolation at high temperatures until the law of increase of resistance has been determined with certainty. This may be successfully accomplished in the near future, but the law is apparently not so simple as is usually supposed.

On account of these and similar difficulties, the limit of gas thermometry at the present time must be placed at 1500° C., or even lower, and the accuracy with which temperatures near 1000° C. are known does not probably exceed 2° C. Although measurements can be effected with greater consistency than this by means of electrical pyrometers, the absolute values corresponding to those temperatures must remain uncertain to this extent, inasmuch as they depend on observations made with the gas thermometer.

Electrical Thermometry

21. The convenience of the mercurial thermometer lies in the fact that it is complete in itself, and can be read without subsidiary appliances beyond a magnifying glass. Its weakness lies in the very limited range of each single instrument, and in the troublesome and often uncertain corrections which must be applied to its readings in all work of precision. Electrical

thermometers have the disadvantage of requiring auxiliary apparatus, such as galvanometers and resistances, the use of which involves some electrical training. But they far surpass the mercurial thermometer in point of range, delicacy and adaptability, and can be applied to many investigations in which ordinary thermometers are quite useless.

There are two kinds of electrical thermometers, which depend on different effects of heat on the electrical properties of metals: (1) The *Thermocouple*, or *Thermopile*, which depends on the production of a thermoelectric force when the junctions of different metals in an electric circuit are at different temperatures; and (2) the *Electrical Resistance Thermometer*, the action of which depends on the fact that the resistance of a pure metal to the passage of an electric current increases very considerably when the temperature is raised. The theory of the thermocouple is discussed in the article THERMOELECTRICITY, as it possesses many points of interest, and has been studied by many skilful experimentalists. The electrical resistance thermometer is of more recent origin; but although the theory has been less fully developed, the practice of the method bids fair to surpass all others in the variety and accuracy of its applications. In order to secure the widest possible range and the greatest constancy, in either variety of electrical thermometer, advantage is taken of the great stability and infusibility characteristic of the metals of the platinum group. Other metals are occasionally used in work at low temperatures with thermocouples for the sake of obtaining a larger electromotive force, but the substitution is attended with loss of constancy and uncertainty of reduction, unless the range is greatly restricted.

22. *Applications of the Thermocouple.*—The principal uses of the thermocouple in thermometry are for measuring high temperatures, and for measuring small differences of temperature, more particularly when the temperature is required to be measured *at a point*, or in a very small space. The electromotive force of the couple depends only on the temperature at the plane of junction of the two metals, which can be very exactly located. A typical instance of a measurement to which the thermocouple is peculiarly suited, is the determination of the cyclical variations of temperature at accurately measured depths from one-tenth to one-hundredth of an inch in the metal of the cylinder of a heat engine, the interior surface of which is exposed to cyclical variations of temperature in the working of the engine.[1] The exact depth of the plane of junction can be measured without difficulty to the thousandth of an inch. The insertion of the wire makes the least possible disturbance of the continuity of the metal. There is no lag, as the thermometer itself is part of the metal. The instantaneous value of the temperature at any particular point of the stroke can be measured separately by setting a periodic contact to close the circuit of the galvanometer at the desired point. A further advantage is gained by measuring only the difference of temperature between two junctions of a thermocouple at different depths, instead of the whole interval from some fixed point. None of these advantages could be secured by the use of any ordinary thermometer; some depend on the fact that the method is electrical, but some are peculiar to the thermocouple, and could not be otherwise attained.

On the other hand, the thermocouple is not well suited for thermometry of precision on account of the smallness of the electromotive force, which is of the order of ten microvolts only per degree for the most constant couples. By the use of very delicate galvanometers it is possible to read to the hundredth or even in special cases to the thousandth of a degree on this small difference, but unfortunately it is not possible to eliminate accidental thermal effects in other parts of the circuit due to small differences of temperature and material. These accidental effects seldom amount to less than one or two microvolts even in the best work, and limit the accuracy attainable in temperature measurement to about the tenth of a degree with a single platinum thermocouple. This limit can be surpassed by using couples of greater thermoelectric power and less permanence, or by using a pile or series of couples, but in either case it is doubtful whether the advantage gained in power is not balanced by loss of simplicity and constancy. A method of avoiding these effects, which the writer has found to be of great use in delicate thermoelectric researches, is to make the whole circuit, including all the terminals and even the slide-wire itself, of pure copper. Platinoid, german silver, constantan and other alloys most commonly used for resistances and slide-wires, are particularly to be avoided, on account of their great thermoelectric power when connected to copper. Manganin and platinum-silver are the least objectionable, but the improvement effected by substituting copper is very marked. It is clear that this objection to the use of the couple does not apply so strongly to high temperatures, because the electromotive force of the couple itself is greater, and the accuracy attainable is limited by other considerations.

23. *The Resistance Thermometer.*—In practice the resistance thermometer is almost invariably made of platinum, since there is very seldom any advantage to be gained by the substitution of baser metals. The instrument is for this reason often referred to simply as the "platinum thermometer." It is important that the platinum should be pure, both for the sake of uniformity and also because the change of electrical resistance with temperature is greatly diminished by impurities. The observation of the fundamental coefficient, which is ·00390 (or rather larger than the coefficient of expansion of a gas) for the purest metal hitherto obtained, is one of the most delicate tests of the purity of the metal. In addition to the constancy and infusibility of the metal, a special advantage which is secured by the use of platinum is the close agreement of the thermodynamical scale with the platinum scale of temperature, as defined by the formula

$$pt = 100(R - R_0)/(R_1 - R_0), \quad . \quad . \quad . \quad (24)$$

in which the symbol pt stands for the temperature on the platinum scale centigrade, and R, R_1 and R_0 are the observed resistances of the thermometer at the temperatures pt, 100° and 0° C. respectively. A platinum thermometer is generally arranged to read directly in degrees of temperature on the platinum scale, just as a mercury thermometer is graduated in degrees of the mercury scale. The reduction to the scale of the gas thermometer is most conveniently effected by the difference formula

$$t - pt = dt(t - 100)/10{,}000, \quad . \quad . \quad . \quad (25)$$

in which d is a constant, called the difference-coefficient, the value of which for pure platinum is about 1·50, but varies slightly for different specimens. This formula was first given by the writer as the result of a series of comparisons of different platinum wires with each other and with other metals, and also with an air thermometer over the range 0° to 625° C. The platinum wire in these comparisons was enclosed inside the bulb of the air thermometer itself, and disposed in such a manner as to be at the mean temperature of the bulb in case the temperature was not quite uniform throughout (*Phil. Trans.* A. 1887, p. 161). The formula was subsequently verified by C. T. Heycock and F. H. Neville (*Journ. Chem. Soc.* February 1895), by the observation of a number of higher points up to the freezing-point of copper at 1082° C., which they showed to agree with the most probable mean of all the best determinations by various methods of gas thermometry. At still higher temperatures, beyond the present range of the gas thermometer, the writer has succeeded in obtaining presumptive evidence of the validity of the same formula by comparison with the scales of the expansion and the specific heat of platinum, which appear to follow similar laws (*Phil. Mag.* December 1899). If we assume that the coefficient of expansion of platinum, the coefficient of increase of resistance, and the specific heat are all three linear functions of the temperature, we obtain results which are in agreement within the limits of error of observation up to the fusing-point of platinum itself. The same formula has been independently verified by

[1] Hall, *Trans. Amer. Inst. Elect. Eng.* 1891, vol. viii. p. 226; Callendar and Nicolson, *Proc. Inst. C. E.* vol. cxxxi. p. 1.

the comparison of platinum thermometers with the constant-volume nitrogen thermometer by Harker and Chappuis (*Phil. Trans.* A. 1900), working at the International Bureau at Sèvres, over the range 0° to 650° C. It has also been shown to satisfy very closely the observations on the variation of electrical resistance of other metals over wide ranges of temperature. Although the theoretical explanation of the formula has not yet been given, owing to our ignorance of the true nature of electrical conduction and of the molecular constitution of metals, it may be regarded from an empirical point of view as being one of the most accurately established of all thermometric formulae. It will be observed that it also represents the simplest possible type of divergence from the thermodynamical scale.

24. *Methods and Apparatus.*—The methods of electrical thermometry may be roughly classified under two heads as (1) deflection methods, in which the temperature is deduced from the observed deflection of a galvanometer; and (2) balance methods, in which the resistance or the electromotive force is balanced against a known adjustable resistance or potential difference. The former methods are most suitable for rough work and rapid reading, the latter for accurate measurements. In the practice of the deflection method it is customary to use a movable-coil galvanometer, the sensitiveness of which can be varied by varying the resistance in circuit, or by varying the stiffness of the suspension. The accuracy attainable is of the order of one-half of 1 per cent. on the deflection, and is limited by variations of resistance of the galvanometer, and by the imperfect elasticity of the suspension. In any case the scale of the galvanometer should be calibrated or tested for uniformity. In this kind of work the thermocouple has the advantage over the resistance thermometer in that the latter requires an auxiliary battery to supply the current; but in many cases this is no disadvantage, because it permits a greater latitude of adjustment, and makes it possible to obtain greater power than with the thermocouple.

In cases where it is desired to obtain greater accuracy without abandoning the quickness of reading which is the principal advantage of the deflection method, it is possible to combine the two methods by balancing part of the potential difference by means of a potentiometer and using the galvanometer for the small changes only. In cases where the greatest accuracy is required, a very sensitive galvanometer should be used, and the whole of the potential difference should be balanced as nearly as possible, leaving very little to depend on the deflection of the galvanometer. The degree of sensitiveness and accuracy obtainable depends primarily on the delicacy of the galvanometer, on the power available, and on the steadiness of the conditions of experiment. For thermometry of precision the resistance thermometer possesses three very great advantages over the thermocouple: (1) The power available, owing to the use of a battery, is much greater; (2) it is possible completely to eliminate the errors due to accidental thermal effects by reversing the battery; (3) the Wheatstone bridge method can be employed in place of the potentiometer, so that the constancy of the battery is immaterial, and it is not necessary to use a standard cell. The conditions to be satisfied in the attainment of the greatest possible accuracy in the measurement of temperature by this method differ somewhat from those which obtain in ordinary measurements of resistance, so that a special type of apparatus has been evolved for the purpose, a brief description of which will be given.

25. *Compensated Bridge Apparatus.*—It is necessary that the thermometer should be connected to the measuring apparatus by wires or "leads" of considerable length, generally at least two or three metres, in order to avoid exposing the galvanometer and resistance box, or other delicate parts of the apparatus, to changes of temperature. It is also essential that the leads should not be too thick or heavy, for convenience in handling and to prevent conduction of heat along the stem of the thermometer. The resistance of that part of the leads which is exposed to variations of temperature necessarily changes, and would give rise to serious errors if it were not determined or compensated. The method now generally adopted in accurate work is to compensate the variations of resistance of the leads by an exactly similar pair of dummy leads called the "compensator" and connected as shown diagrammatically in fig. 6. The battery, consisting of a single cell, with a rheostat and reversing key in circuit, is connected to the terminals AB of the two equal resistance coils AG, GB, which form the ratio arms of the balance. These coils must be carefully tested for equality of temperature-coefficient, and placed in close proximity to each other so as to be always at the same temperature. If they are interwound on the same reel, they must be most carefully insulated from each other. In parallel circuit with the ratio coils are connected the compensator CC′ and the balancing resistances C′E, on one side of the bridge-wire EF, and the compensating resistances FP and the pyrometer and leads PRP′ on the other side. The galvanometer is connected to the point G between the ratio coils, and to the sliding contact D on the bridge-wire. Since the ratio coils are always equal, equal changes of resistance on either side of D are eliminated, and do not affect the balance. Thus the changes of the pyrometer leads PP′ are balanced by the equal changes of the compensator leads CC′ on the other side. As a further refinement, which is of some importance in delicate work, the ends of the compensator leads are connected by a short piece of the same wire as the pyrometer coil. For instance, in observing the variations of temperature of the steam in the cylinder of a steam engine at different points of the stroke with a very delicate thermometer made of wire one-thousandth of an inch in diameter (*Proc. Inst. C. E.*, vol. cxxxi. fig. 16, p. 23), the ends of the fine wire attached to the thick leads could not follow the rapid variations of temperature, and it was found necessary to adopt this device to eliminate the end-effect. It is also useful in other cases to eliminate the effect of conduction along the leads in cooling the ends of the fine wire coil. The balancing resistances C′E are made of some alloy such as manganin or platinum-silver, the resistance

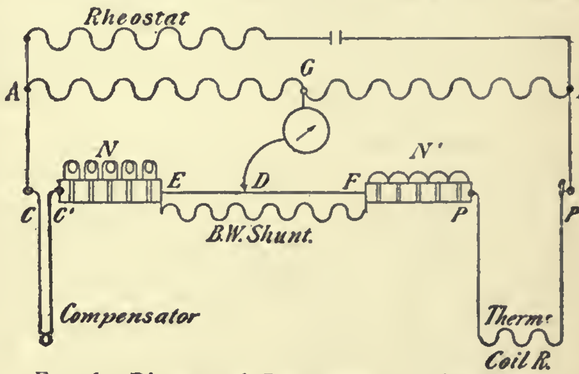

FIG. 6.—Diagram of Compensated Bridge Method.

of which varies very little with change of temperature. Platinum-silver is probably the best material, as it can be perfectly annealed at a red heat without risk of burning, and is then extremely constant. Unless the box can be kept at an absolutely constant and uniform temperature, which is not impossible but often inconvenient, it is necessary to allow for the change of resistance of the balancing coils C′E due to change in the temperature of the box. The temperature of the coils cannot be accurately determined with a mercury thermometer unless they are immersed in oil, but even in that case it is necessary to know the temperature-coefficient of each individual coil. A more convenient and accurate method, which eliminates the correction automatically, is to compensate each individual coil of the balancing coils C′E by a corresponding compensating coil at FP on the other side of the bridge-wire. The compensating coils are made of platinum, also annealed at a red heat, and each is placed in the box in close proximity to the coil it is intended to compensate. Each balancing coil and its compensator are tested together at various temperatures between 10° and 30° C., and are adjusted until their difference remains constant for any small variation of temperature in the neighbourhood of 20° C. This method of compensation was applied by the writer in 1887, but has not been generally adopted on account of the labour involved in adjusting the coils. The absolute values of the resistances are immaterial, but it is necessary to know the relative values with the greatest possible accuracy. For this reason it is preferable to arrange the resistances in the binary scale, each resistance being equal to twice the next smaller resistance, or to the sum of all the smaller resistances, the two smallest resistances being made equal. This arrangement permits the greatest accuracy of comparison in the simplest manner with the fewest observations. The bridge-wire EF provides a continuous scale for reading small changes of resistance. Any change of resistance of the pyrometer coil necessitates the movement of the balance point D through an equivalent resistance along the bridge-wire. The equivalent resistance of the bridge-wire per unit length of the attached scale is preferably adjusted, by means of a shunt shown in parallel with it in fig. 5, to be an exact submultiple of the smallest resistance coil. It is usual also to adjust the resistances of the thermometers so that their fundamental intervals are convenient multiples of this unit, generally either 100, 200, 500, or 1000, so that the bridge-wire may read directly in degrees of temperature on the platinum scale. It is easy to get a scale of 10 cms. or more to the degree, and it is not difficult with a suitable galvanometer to read to the ten-thousandth part of a degree. The length of the bridge-wire itself need not be more than 20 or 30 cms., as the balancing resistances enable the scale to be indefinitely extended. Thus the instrument possesses the great advantage over the mercury thermometer that the most open scale may be easily secured without unwieldy length, and without restricting the range of each thermometer.

26. *Errors and Corrections.*—It is most instructive to consider the errors and corrections involved in platinum thermometry on the same lines as those on which the corresponding errors of the mercury thermometer have already been treated.

I. The changes of zero of the mercury thermometer arise chiefly from the small expansibility of mercury combined with the imperfect elasticity of the containing tube. In platinum thermometry the containing tube has nothing to do with the reading, and the effect of any possible strain of the fine wire of the coil is minimized by its small dimensions and by the large temperature-coefficient of the increase of resistance, which is more than twenty times greater than the coefficient of apparent expansion of mercury in glass. It is not surprising, therefore, that the changes of zero of a platinum thermometer should be practically negligible, provided that the wire is not strained and contaminated with impurities. It is probable that with ordinary care the changes of zero due to exposure to any given limits of temperature are in all cases less than the limit of accuracy of observation, due to other causes at the extreme limit of the range considered.

II. *The fundamental interval* of each thermometer must be determined as usual by observations in ice and steam, and a correction must be applied by the method already described in the case of the mercury thermometer. The difference of the temperature of the steam from 100° C. should be determined on the platinum scale by the approximate formula

$$dpt_1 = \cdot 985 dt_1 = \cdot 0362(H-760) - \cdot 000020(H-760)^2 \quad . \quad (26)$$

III. *Pressure Correction.*—The effect of change of pressure on a platinum thermometer of the ordinary tube form is of course nothing, as the wire itself is not exposed to the pressure. Even if the wire is naked and directly exposed to large changes of pressure, the change of reading is almost inappreciable. Similarly there is no source of error analogous to the effects of capillarity, which are so troublesome with delicate mercury thermometers.

IV. *Stem Exposure.*—The reading of a platinum thermometer with compensated leads depends only on the temperature of the coil of wire forming the bulb, and not on the temperature of the stem, provided that the immersion is sufficient to avoid errors due to conduction or convection along the stem. It is desirable that the top of the bulb should be immersed to a depth equal to from three to ten times the diameter of the tube, according to the accuracy required.

V. *Scale Correction.*—The reduction to the thermodynamical scale may be effected, within the limits of probable error of the most accurate measurements at present available, by the very simple difference formula (25) already given, over the whole range from −100° C. to +1100° C. This is in striking contrast with the mercury thermometer, which requires a cubic formula to cover the range 0° to 200° C. with equal accuracy. The value of the constant *d* in the formula varies but little, provided that the wire be fairly pure and the thermometers properly constructed. In order to determine its value in any special case, it is best to take an observation at the boiling-point of sulphur (S.B.P.) for temperatures above 0° C., or at that of oxygen for temperatures below 0° C. down to −200° C. It appears probable that there is a point of inflection in the curve of resistance-variation of platinum and some other metals in the neighbourhood of −200° C., and that the formula does not apply accurately below this point. It has become the custom to assume the boiling-point of sulphur (S.B.P.) under normal pressure to be 444·53° C., as determined by Callendar and Griffiths, using a constant-pressure air thermometer, and to take the rate of change of temperature with pressure as ·082° per mm. from Regnault's observations. According to experiments made at Kew Observatory with platinum thermometers (Chree, *Proc. R. S.*, 1900), the rate of change is somewhat larger than that given by Regnault's formula, namely, about ·090° per mm., and it appears desirable to determine this constant with greater accuracy. The difference between the above formulae reaches a tenth of a degree if the barometer differs by 12 mm. from 760 mm. The uncertainty in the absolute boiling-point of sulphur, however, is probably somewhat greater than one-tenth of a degree, on account of the uncertainty of the expansion correction of the gas thermometer (*Phil. Mag.*, December 1899). The thermodynamical correction of the gas thermometer, which amounts to half a degree at this point, is also to some extent uncertain, on account of the extrapolation. Provided, however, that some exact value of the S.B.P. is chosen for reference, for the reduction of observations with platinum thermometers, the results so reduced will be strictly comparable, and can be corrected at any subsequent time when the value of the S.B.P. is more accurately determined. The boiling-point of oxygen may be taken as −182·5° C. with sufficient approximation for a similar purpose.

VI. *Calibration Correction.*—The calibration of the resistance box and the bridge-wire corresponds to the calibration of the stem of the mercury thermometer, but the process is much simpler for several reasons. It is more easy to obtain a uniform wire than a uniform tube. The scale of the wire is much more open, it corresponds to a very small part of the whole scale, and the process of calibration is easier. One box when calibrated will serve for any number of thermometers of different ranges and scales, and covers the whole range of temperature (see CALIBRATION).

27. *Electrical Precautions.*—The platinum thermometer is so far superior to the mercury thermometer in all the points above enumerated that, if there were no other difficulties, no one would ever use a mercury thermometer for work of precision. In using a platinum thermometer, however, some electrical training is essential to obtain the best results. The manipulation and adjustment of a delicate galvanometer present formidable difficulties to the non-electrical observer. Bad contacts, faulty connexions, and defective insulation, are not likely to trouble the practised electrician, but present endless possibilities of error to the tyro. A useful discussion of these and similar details is given in the paper by Chree already referred to. Bad insulation of the pyrometer and connexions can easily be detected, in the compensated instrument already described, by disconnecting one of the C leads from the battery and one of the P leads from the bridge-wire. Under these conditions the galvanometer should not deflect if the insulation is perfect. Defective insulation is most likely to be due to damp in the thermometer at low temperatures. This source of error is best removed by drying and hermetically sealing the thermometers. Trouble from bad contacts generally arises from the use of plugs for the resistance coils. If plugs are used, they must be specially designed so as not to disturb each other, and must be well fitted and kept very clean. Mercury cups with large copper terminals, well amalgamated, as used with standard resistance coils, are probably the simplest and most satisfactory method of changing connexions. Accidental thermoelectric effects in the circuit are a possible source of error, as with the thermocouple, but they are always very small if the thermometer is properly constructed, and are relatively unimportant owing to the large E.M.F. available. In any case they may be completely eliminated by reversing the battery. The heating effect of the current through the thermometer is often negligible, but should be measured and allowed for in accurate work. With a current of ·01 ampere the rise of temperature should not exceed $\frac{1}{10}$ or $\frac{1}{100}$ of a degree. With a delicate galvanometer it is possible to read to the ten-thousandth of a degree with a current of only ·002 ampere, in which case the heating effect is generally less than $\frac{1}{1000}$ of a degree. It can be very easily measured in any case by changing from one cell to two, thus doubling the current in the thermometer, and quadrupling the heating effect. The correction is then applied by subtracting one-third of the difference between the readings with one and two cells from the reading with one cell. The correction is always very small, if a reasonably sensitive galvanometer is used, and is frequently negligible, especially in differential work, which is one of the most fruitful applications of the platinum thermometer.

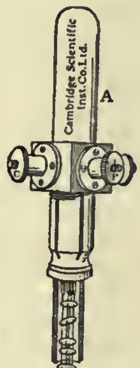

FIG. 7.—Platinum Thermometer.

28. *Construction of Thermometers.*—One of the chief advantages of the platinum thermometer for research work is the endless variety of forms in which it may be made, to suit the particular exigencies of each individual experiment. It is peculiarly suited for observing the average temperature throughout a length or space, which is so often required in physical experiments. For this purpose the wire may be disposed in a straight length, or in a spiral, along the space in question. Again, in observing the temperature of a gas, the naked wire, on account of its small mass and extremely low radiative power, is far superior to any mercury thermometer. The commonest form of platinum thermometer (fig. 7), and the most suitable for general purposes, contains a coil B from ½ in. to 2 in. long, wound on a cross of thin mica, and enclosed in a tube, about ¼ to ½ in. in diameter, of glass or porcelain according to the temperature for which it is required. The pyrometer leads and the compensator leads are insulated and kept in place by passing through mica disks fitting the tube, which serve also to prevent convection currents up and down the tube. The protecting tube of glass or porcelain is fitted with a wooden head A carrying four insulated terminals, PP, CC, to which the pyrometer

and compensator leads are respectively connected, and which serve to connect the instrument to the measuring apparatus. For work of the highest precision these terminals are often omitted, and the leads are directly soldered to a flexible cable in order to avoid possible errors from thermoelectric effects and changes of resistance of the screw terminals. For temperatures above 500° C. the protecting tube must be of porcelain, and the leads of platinum throughout that part of the tube which is exposed to high temperatures. For lower temperatures a tube of hard glass and leads of copper or silver may be employed, but it is better in any case to make the lower part of the leads of platinum in order to diminish the conduction of heat along the stem. For laboratory work a tube 30 or 40 cm. in length usually suffices, but for large furnaces the length of the protecting tube is often 5 to 10 ft. In the latter case it is usual to protect the porcelain tubes with an external steel tube, which may be removed for delicate measurements.

29. *Special Forms of Thermometer.*—In the measurement of linear expansion it is a great advantage to employ a thermometer with the bulb or sensitive portion equal in length to the bar or column under test, so as to obtain the mean temperature of the whole length. In measuring the linear expansion of a standard metre or yard, a fine platinum wire enclosed in a glass capillary, or otherwise insulated, is employed, its length being equal to that of the bar. The same method has been applied by Callendar (*Phil. Trans.* A, 1887) and Bedford (*Phil. Mag.*, 1898) to the expansion of glass and porcelain at high temperatures, employing a fine wire supported along the axis of the tube under test. An equivalent method, applied to the expansion of silica by Callendar, is to enclose a rod of the material inside a platinum tube which is heated by an electric current. This is a very rapid and convenient process, since the mean temperature of the rod must be equal to that of the enclosing tube. Any temperature up to the melting-point of platinum is readily obtained, and easily regulated. The temperature may be obtained by observing either the resistance of the platinum tube or its linear expansion. Either method may also be employed in J. Joly's meldometer, which consists of an electrically heated strip for observing the melting-points of minerals or other substances in small fragments. In observing the temperature of a long column of mercury, as in the method of equilibrating columns for determining the absolute expansion of mercury, a platinum thermometer with a bulb equal in length to the column may similarly be employed with advantage. The application is here particularly important because it is practically impossible to ensure perfect uniformity of temperature in a vertical column, 6 ft. or more in length, at high temperatures.

30. *Sensitive Thermometers.*—Where quickness of reading is essential, the mercury thermometer, or the tube form of electric thermometer, is unsuitable. In cases where the thermometer has to be immersed in a conducting liquid or solution, the fine wire forming the bulb may be insulated by enclosing it in a coiled glass capillary. This method has been employed by Callendar and Barnes and by Jaeger, but the instrument is necessarily fragile, and requires careful handling. For non-conducting liquids or gases the bare wire may be employed with great advantage. This is particularly important in the case of gases owing to the extreme sensitiveness thus obtained and the almost complete immunity from radiation error at moderate temperatures. Thermometers constructed in the form of a flat grid of bare wire mounted on a mica and ebonite frame have been employed by H. Brown (*Proc. R. S.*, 1905, B 76, p. 124) for observing the temperature of leaves and of air currents to which they were exposed. They have also been employed for observing the air-temperature for meteorological purposes in Egypt and Spain with very satisfactory results (*Proc. R. S.*, 1905, A 77, p. 7). The fine wire, owing to its small size and bright metallic surface, very rapidly acquires the temperature of the air, and is very little affected by radiation from surrounding objects, which is one of the chief difficulties in the employment of mercurial thermometers for the observation of the temperature of the air.

For the observation of rapidly varying temperatures, such as those occurring in the cylinder of a gas- or steam-engine, an electrical thermometer with very fine wire, of the order of ·001 in. diameter is practically the only instrument available. The temperature at any particular moment may be obtained by setting a mechanical contact-maker to close the circuit at the desired point. The sensitive part of the thermometer consists simply of a loop of fine wire from half an inch to an inch long, connected by suitable leads to the measuring apparatus as employed by Burstall (*Phil. Mag.*, October 1895) in the gas-engine, and Callendar and Nicolson (*Proc. Inst. C. E.*, 1898) in the steam-engine. The explosion temperatures cannot be satisfactorily measured in a gas-engine in this manner, because the radiation error at high temperatures is excessive unless the wire is very fine, in which case it is very soon melted even with weak mixtures. Callendar and Dalby accordingly devised a mechanical valve (*Proc. R. S.*, A 80, p. 57) for exposing the thermometer only during the admission and compression strokes, and have deduced the actual explosion temperatures from the indicator diagram. B. Hopkinson (*Proc. R. S.*, A 77, p. 387) succeeded in following the course of an explosion in a closed vessel by means of a similar thermometer connected to a galvanometer of short period giving a continuous record on a moving photographic film. When the flame reached the wire the temperature rose 1200° C. in about $\frac{1}{50}$ of a second, which illustrates the order of sensitiveness attainable with a fine wire of this size. O. R. Lummer and E. Pringsheim, in their measurements of the ratio of the specific heats of gases by observing the fall of temperature due to sudden expansion, employed a very thin strip of foil with the object of securing greater sensitiveness. This was a somewhat doubtful expedient, because such a strip is extremely fragile and liable to be injured by air currents, and because the sensitiveness is not as a matter of fact appreciably improved, whereas the radiation error is increased in direct proportion to the surface exposed. One of the principal sources of error in employing a short loop of fine wire for observing rapidly varying temperatures is that the ends of the loop close to the thick leads are affected by conduction of heat to or from the leads, and cannot follow the rapid variations of temperature. This error may be readily avoided by the method first employed by Callendar and Nicolson, of connecting the compensating leads with a short length of the same fine wire. The end effect is then eliminated by observing the difference of resistance between two loops of different lengths. Thermocouples of very fine wire have also been employed for similar measurements, but they are more difficult to make than the simple loop of one wire, and the sensitiveness attainable is much less, owing to the small E.M.F. of a single thermocouple.

31. *Radiation Thermoscopes.*—For measuring the intensity of radiation, some form of thermometer with a blackened bulb or sensitive area is employed. It is assumed that the rise of temperature of the thermometer is approximately proportional to the intensity of the radiation according to Newton's law of cooling (see HEAT) for small differences of temperature. A mercury maximum thermometer with a small blackened bulb is still very generally employed in meteorological observatories for registering the maximum solar radiation. But the indications are liable to error and very difficult to interpret, and an instrument of this type is not sufficiently sensitive or quick in action for weak sources of radiation. Sir John Leslie employed an air thermoscope, similar to that of Galileo (HEAT, fig. 1), with a blackened bulb. This has the advantage of a small capacity for heat, and is still employed in various forms for demonstration purposes, but is not sufficiently sensitive for accurate work. Electrical thermometers are now generally employed on account of their superior sensitiveness, and also on account of the greater facility of adaptation for the requirements of each particular experiment. The most familiar instrument is M. Melloni's thermopile, which is built up of a number of small bars of antimony and bismuth, or other alloys of high thermoelectric power, arranged in the form of a cube with alternate junctions on opposite faces. When connected to a galvanometer of suitable resistance, this arrangement gives a high degree of sensitiveness on account of the multiplication of couples, but owing to the large mass of metal involved in its construction it takes a considerable time to acquire a steady state. This defect has been remedied in the radiomicrometer of C. V. Boys (*Phil. Trans.*, 1888, 180 A, p. 159) by employing a single junction attached to a small disk of very thin copper. The free ends of the minute bars forming the couple are connected to a loop of thin copper wire suspended by a fine quartz fibre between the poles of a magnet. This arrangement forms a very delicate galvanometer and gives the maximum sensitiveness attainable with a single couple, since all unnecessary connecting wires are avoided. It is incomparably quicker and more dead-beat in action than the ordinary thermopile, but has the disadvantage that it must be set up permanently on a steady support and the radiation brought to it in a horizontal direction. An instrument of similar delicacy is the radiometer, the action of which depends on the repulsive effect of the residual gas in a nearly perfect vacuum on a delicately balanced vane suspended by a fine fibre. An instrument of this type was first constructed by Sir William Crookes (see RADIOMETER); the instrument was applied to radiation measurements, and its sensitiveness greatly improved by E. F. Nichols. It requires a very steady mounting, like the radiomicrometer, but has the additional defect that the radiation must be introduced through a window, which may give rise to selective absorption. Other varieties of thermopile, in which the sensitive parts are constructed, as in Boys' radiomicrometer, so as to have a very small capacity, but are connected like the ordinary pile to a separate galvanometer, have been employed by Lord Rosse for observations of lunar heat and by W. H. Julius and Callendar for the solar corona.

In cases where the radiation can be concentrated on a very small area, such as the receiving disk of the radiomicrometer, the thermoelectric method is probably the most sensitive. But if there is no restriction as to the area of the receiving surface, considerable advantage may be gained in convenience of manipulation, without loss of sensitiveness, by the electric resistance method. An instrument of this type was first employed by S. P. Langley (*Proc. Amer. Acad.*, 1881, 16, p. 342) under the name of the bolometer, by which it has since been known. The sensitive surface is made in the form of a blackened grid of thin metallic foil, generally platinum coated with platinum black, connected in one of the arms of a Wheatstone bridge. The rise of temperature of the grid when exposed to radiation is measured by its increase of resistance in the usual manner. In order to compensate for changes of temperature of the surrounding air the balancing resistance is made of a precisely similar grid, placed in close proximity to the first but screened from radiation. The foil should be as thin as possible consistent with strength, in order to secure the maximum sensitiveness. For spectroscopic work a single strip or linear bolometer is employed. For absolute measurements, where it is necessary to absorb the whole radiation admitted through a given area, two grids are placed with the strips of one behind the interspaces of the other.

32. *Absolute Measurement of Radiation.*—In many cases the object is not to secure the maximum degree of sensitiveness, but an absolute measurement of the intensity of the radiant energy, in calories per square centimetre per minute, or other suitable units. For this purpose some form of radiation thermometer is generally employed, but the method of procedure is modified. The earlier methods as exemplified in C. S. M. Pouillet's pyrheliometer, or L. J. G. Violle's actinometer, consisted in observing the rate of rise of temperature of a small calorimeter, or thermometer of known thermal capacity, when exposed to a given area of the radiation to be measured. To secure greater sensitiveness A. P. P. Crova substituted a copper disk with an attached thermocouple for the calorimetric thermometer. The method is very simple and direct, but has the disadvantage that the correction for external loss of heat is somewhat uncertain and difficult to apply, since the conditions are unsteady and the observation depends on rate of change of temperature. For this reason static methods, depending on the steady temperature finally attained, in which the rate of loss of heat is directly determined by an electric compensation method, have come more prominently into favour in recent years. In K. J. Ångström's pyrheliometer (*Acta Soc. Upsala*, 1893) two similar blackened strips of equal area and resistance are fixed side by side in a suitable case in such a manner that either may be exposed to the radiation to be measured while the other is simultaneously heated by an electric current. Attached to the backs of the strips, but insulated from them by thin paper, are the two junctions of a thermocouple which indicates when the temperatures are equal. When this condition is secured the intensity of the radiation is equal to the rate of generation of heat per unit area by the electric current, which is deduced, from a knowledge of the resistance and area of the strip, by observing the current required to balance the radiation. The instrument is very quick and sensitive in action, and the method avoids any assumption with regard to the rate of loss of heat, except that it is the same for the two similar strips at the same temperature. The accuracy of the method is limited chiefly by the measurement of the resistance and width of the strips, and by the difficulty of securing exact similarity and permanence in the attachment of the junctions of the thermocouple. Small differences in this respect may be eliminated by interchanging the strips, but there remain outstanding differences between different instruments of the same make which often exceed 5 per cent.

An electric method proposed by F. Kurlbaum (*Wied. Ann.*, 1898, 65, p. 748) consists in observing the rise of temperature produced by radiation in a bolometer grid, then cutting off the radiation and observing the increase of current required to produce the same rise of temperature. There is no difficulty in this case in measuring the area exposed or the resistance of the bolometer, and no uncertainty can arise as to the temperature of the strip, because the heated strip itself serves as its own thermometer. The current is easily deduced from a knowledge of the resistances and the E.M.F. of the battery. The chief source of uncertainty mentioned by Kurlbaum lies in possible differences between the effects of radiation and current-heating near the ends of the strips, the area so affected representing a large proportion of the whole area. In Ångström's method this is not so important because the temperature indicated by the couple is that near the middle of the strip. In the case of the bolometer this end-effect may be compensated, as explained by Callendar (*Proc. R. S.*, 1907, 77 A, p. 7), in the same manner as for sensitive thermometers, by employing two similar bolometers with strips of different lengths.

An important defect of all the methods so far considered is that the measurement depends on the coefficient of absorption of the black with which the receiving surface is coated. The error is probably small, of the order of 1 or 2 per cent., but is difficult to determine accurately, and varies to some extent with the quality of the radiation. The absorptive power is generally less for rays of great wave-length than for visible rays. If we assume that the loss of heat by conduction and convection is independent of the nature of the surface the defect in question may be avoided by the following method. Two bolometer strips, one bright and the other black, but otherwise exactly similar, are simultaneously exposed to the radiation to be measured, and are traversed by the same electric current. The black strip will be more heated by the radiation than the bright, but the rise of temperature of the bright strip due to the current will be greater than that of the black strip because its emissive power is lower. If the current is adjusted until the temperatures of the two strips are equal the losses by convection and conduction will be equal, and also the rate of generation of heat by the current in each strip. The rise of temperature must therefore be such that each strip loses as much heat by radiation to the surrounding case as it gains from the incident radiation to be measured. Assuming Kirchhoff's law, the ratio of the emissive to the absorptive power is the same for all bodies at the same temperature, and is equal to the emissive power of a perfectly black body. The rise of temperature of each strip, when balance is attained, will be the same as that of a perfectly black strip under the same conditions of exposure. The electric current in this method serves to eliminate losses by convection and conduction, and the result is obtained in terms of the observed rise of temperature and the radiation constant for a black body. The method works well for a source at 100° C.; but, for a high temperature source, a correction is required because the absorptive powers of the strips may differ appreciably from their emissive powers.

Another electric compensation method of special interest is the method of the "Peltier cross." A small disk of copper is supported by two thermoelectric couples forming a cross. One of the couples serves to measure the rise of temperature, while the other is traversed by an electric current, which may be employed to compensate the radiation by the heat absorption due to the Peltier effect. The advantage of this method is that the Peltier effect is easily determined from an observation of the thermoelectric power (see THERMOELECTRICITY) in absolute measure, and that it is proportional to the first power of the current. Loss or gain of heat by conduction from the supporting wires, and changes of temperature in the surrounding case, are readily compensated by mounting two similar disks side by side. Small differences between the disks are eliminated by exposing them to radiation alternately, with reversal of the current, so that the irradiated disk is cooled or the other disk heated by the Peltier effect. The current is adjusted in each case so that the temperatures of the disks are equal, as indicated by the second couple connecting the disks. The method is about equal in sensitiveness to that of Ångström, but it is easier to secure conditions of exact similarity and to measure the quantities involved in the absolute determination, namely, the area of the hole through which the radiation is admitted, and the coefficient of the Peltier effect. The uncertainty due to imperfect blackness of the disks may be eliminated by using cups in place of disks; and the sensitiveness and range may be increased by using thermopiles in place of single couples.

33. *Optical or Radiation Pyrometers.*—Since the intensity of radiation increases very rapidly with the temperature of the source of radiation, instruments for measuring radiation may be applied for measuring temperature, assuming that the laws connecting radiation and temperature are known. The advantage of this method is that the measurement may be made from a distance without exposing any part of the measuring apparatus to the destructive action of high temperatures. Apart from the difficulty of calibrating the measuring apparatus to give temperature in terms of radiation, the chief source of uncertainty in the application of the method is the emissive power of the source of radiation. The methods principally employed may be divided into two classes:—(1) Radiation methods, depending on the measurement of the radiant energy by means of a radiometer, thermocouple or bolometer; (2) optical or photometric methods, depending on the colour or luminous intensity of the radiation as compared with a suitable standard.

Of the radiation methods the simplest in theory and practice depends on observing the total intensity of radiation, which varies as the fourth power of the absolute temperature according to the Stefan-Boltzmann law (see HEAT) for a perfectly black body or full radiator. In applying this method it is very necessary to allow for the emissive power of the source, in case this does not radiate as a black body. Thus the emissive power of polished platinum at 1000° Abs. is only 10 per cent., and that of black iron oxide about 40 per cent. of that of a black body; and the percentage varies differently for different bodies with change of temperature, and also for the same body according to the part of the spectrum used, for the measurement. Owing to the rapid increase of radiation with temperature the error due to departure from black body radiation is not so serious as might be imagined at first sight. If the temperature of a polished platinum strip at 1500° C. were estimated by the radiation formula, assuming the constant for a perfectly black body, the error for red light would be about 125°, for green about 100°, and for blue about 75°. Such errors may be corrected when the emissive power of the source at various temperatures is known from previous experiments, but it is preferable to observe, whenever possible, the radiation from the interior of a uniformly heated enclosure which approximates very closely to that of a black body (see HEAT).

Radiation pyrometers of this type are generally calibrated by the method of sighting on the interior of an electric furnace containing a thermocouple or gas-thermometer by which the temperature is measured. The gas-thermometer has been employed for verifying the law of radiation up to 1500° C., but the difficulties of obtaining accurate results with the gas-thermometer increase so rapidly above 1200° C. that it is questionable whether any advantage is gained by using it beyond this point. The law of radiation has been so closely verified by observations at lower temperatures that the uncertainty involved in applying it at higher temperatures, in the case of a black body is probably less than the uncertainty of the gas-thermometer measurements, and much less than the uncertainty of extrapolating an empirical formula for a thermocouple. Thus L. F. C. Holborn and W. Wien (*Wied. Ann.*, 1895, (6), by extrapolating their thermoelectric formula, found the value 1587° C. for the melting-point of palladium, whereas Violle found 1500° C. by the calorimetric method, and Callendar and Eumorfopoulos (*Phil. Mag.*, 1899, 48) found 1540° and 1550° C. by the methods of the expansion and the change of resistance of platinum respectively. By a later thermoelectric extrapolation Holborn and Henning (*Berlin Akad.*, 1905, 12, p. 311) found 1535° C. for the melting-point of palladium, and 1710° C. for that of platinum, values which were strikingly confirmed by J. A. Harker at the National Physical Laboratory, and by Waidner and Burgess at the Bureau of Standards, U.S.A. Holborn and Valentiner employing an optical method (*Ann. Phys.*, 1907, 22, p. 1) found 1582° C. and 1789° C. for palladium and platinum respectively. There can be little doubt that the extrapolation of the parabolic formula for the thermocouple at these temperatures is quite untrustworthy (see THERMOELECTRICITY) and that the values given by the electrical resistance method, or by the laws of radiation, are more likely to be correct. Assuming that the total radiation varies as the fourth power of the absolute temperature, a radiation pyrometer can be calibrated by a single observation at a known temperature, such as the melting-point of gold, 1062° C. if a black body is employed as the source; and its indications will probably be accurate at higher temperatures under a similar restriction. If the pyrometer is sighted on the interior of a furnace through a small observation

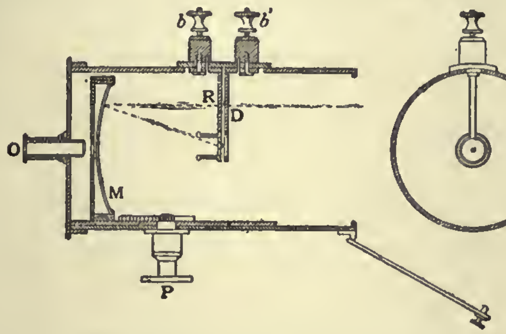

FIG. 8.—Féry's Mirror Pyrometer (Camb. Scient. Inst. Co.). For temperatures from 500° C. to 1100° C

hole it will indicate the temperature of the furnace correctly, provided that the temperature is uniform. But it must be remembered that this condition does not generally exist in large furnaces. Suppose, for instance, that it is required to find the temperature of the molten metal on the hearth of a furnace viewed through a thick layer of furnace gases, which are probably at a much higher temperature. It is evident that the radiation from the intervening flame may be much greater than that from the metal, and may introduce serious errors. The same objection applies with greater force to optical pyrometers, as the luminous radiation from gases may be of a highly selective character. If, on the other hand, it is required to observe the temperature of metal in a ladle before casting, the surface of the metal must be cleared of scum, and it is necessary to know the emissive power of the metal or oxide exposed.

For scientific measurements of temperature by the radiation method, the thermopile, or bolometer, or radiomicrometer, previously calibrated by exposure to a black body at a known temperature, is directly exposed at a known distance to a known area of the source of radiation. The required result may then be deduced in terms of the area and the distance. The use of extraneous optical appliances is avoided as far as possible on account of selective absorption. For practical purposes, in order to avoid troublesome calculations and measurements, an optical arrangement is employed, either lens or mirror, in order to form an image of the source on the receiving surface. Fig. 8 illustrates Féry's mirror pyrometer, in which a mirror M, focused by the pinion P, forms an image of the source on a disk, supported by wires of constantan and copper forming a thermocouple, connected by the brass strips D and R to the terminals *b*, *b'*. The observation hole in the wall of the furnace is sighted through the eyepiece O, and is made to overlap the disk slightly. The rise of temperature of the junction is assumed to be proportional to the intensity of radiation, and is indicated by the deflexion of a delicate galvanometer connected to the terminals *b*, *b'*. A lens may be substituted for the mirror at high temperatures, but it is necessary to allow for the selective absorption of the lens, and to a less extent for that of the mirror, by a special calibration of the scale.

Assuming Wien's laws for the distribution of energy in the spectrum (see HEAT), the temperature of a black body may also be measured by observing (1) the wave-length corresponding to maximum intensity in the normal spectrum, which varies inversely as the absolute temperature, or (2) the maximum intensity itself, which varies as the fifth power of the absolute temperature, or (3) the intensity of radiation corresponding to some particular radiation or colour, which varies as an exponential function, the exact form of which is somewhat uncertain. Methods (1) and (2) require elaborate apparatus and are impracticable except for purposes of scientific research. The *exact* application of method (3) is almost equally difficult, and is less certain in its results, but for optical purposes this method may be realized with a fair degree of approximation by the use of coloured glasses, and forms the basis in theory of the most trustworthy optical pyrometers.

34. *Optical or Photometric Pyrometers.*—The change of colour of a heated body from red to white with rise of temperature, and the great increase of intrinsic brilliancy which accompanies the change, are among the most familiar methods of estimating high temperatures. For many processes eye estimation suffices, but a much greater degree of accuracy may be secured by the employment of suitable photometers. In Mesuré and Nouel's pyrometric telescope, the estimation of temperature depends on observing the rotation of a quartz polarimeter required to reduce the colour of the radiation to a standard tint. It has the advantage of requiring no auxiliary apparatus, but, owing to the lack of a standard of comparison, its indications are not very precise. In the majority of photometric pyrometers, a standard of comparison for the intensity of the light, either an amyl-acetate or gasoline lamp, or an electric glow-lamp, is employed. The optical pyrometer of H. L. Le Chatelier (*Comptes Rendus*, 1892, 114, p. 214) was one of the earliest, and has served as a model for subsequent inventors. The standard of comparison is an amyl-acetate lamp, the flame of which is adjusted in the usual manner and viewed in the same field as the image of the source. The two halves of the field are adjusted to equality of brightness by means of a cat's eye diaphragm and absorption glasses, and are viewed through a red glass, giving nearly monochromatic radiation in order to avoid the difficulty of comparing lights of different colours. Assuming Wien's law, the logarithm of the intensity of monochromatic radiation for a black body is a linear function of the reciprocal of the absolute temperature, and the instrument can be graduated by observing two temperatures; but it is generally graduated at several points by comparison with temperatures observed by means of a thermocouple.

The Wanner Pyrometer (*Phys. Zeits.*, 1902, p. 112) is a modification of Konig's spectrophotometer, in which the two halves of the field, corresponding to the source and the standard of comparison, are illuminated with monochromatic red light polarized in planes at right angles to each other. The two halves may be equalized by rotating the analyzer, the circle of which is graduated to read in degrees of temperature. The instrument has a somewhat restricted range of maximum sensitiveness, and cannot be used below 900° C. owing to the great loss of light in the complicated optical system. It cannot be sighted directly on the object since no image is formed as in the Le Chatelier or Féry instruments, but the methods of securing monochromatic light by a direct vision spectroscope, and of adjusting the fields to equality by rotating the analyser, are capable of great precision, and lead to simple theoretical formulae for the ratio of the intensities in terms of Wien's law.

The Féry Absorption Pyrometer (*Journ. Phys.*, 1904, p. 32) differs from Le Chatelier's only in minor details, such as the replacement of the cat's eye diaphragm by a pair of absorbing glass wedges. The principles of its action and the method of calibration are the same. The pyrometers of Morse, and of L. F. C. Holborn and F. Kurlbaum depend on the employment of a glow lamp filament as standard of comparison, the current through which is adjusted to make the intrinsic brilliancy of the filament equal to that of the source. When this adjustment is made the filament becomes invisible against the image of the source as background, and the temperature of the source may be determined from an observation of the current required. Each lamp requires a separate calibration, but the lamps remain fairly constant provided that they are not overheated. To avoid this, the source is screened by absorption glasses (which also require calibration) in observing high temperatures. Except at low temperatures the comparison is effected by placing a red glass before the eyepiece. At low temperatures a special advantage of the glow-lamp as a standard of comparison is that it matches the source in colour as well as in brightness, so that the instrument is very sensitive. At high temperatures the red glass serves chiefly to mitigate the glare.

35. *Registering and Recording Thermometers.*—The term registering thermometer is usually applied to an instrument with an index which requires setting, and when set will indicate the maximum or minimum temperature occurring, or will register the temperature at a particular time or place. A recording instrument is one constructed to give a continuous record of the temperature, and requires a revolving drum or some equivalent clockwork mechanism

for recording the time. The most familiar types of registering thermometers are modifications of the common liquid-in-glass thermometer.

John Rutherford's maximum, invented before 1790, was an ordinary mercurial thermometer placed horizontally; the column pushed before it a small steed index which was left at the highest point reached and was drawn down again to the liquid by a magnet when the instrument had to be reset. It is little used now. Negretti and Zambra's maximum has a constriction in the tube near the bulb, past which the mercury easily expands but cannot return when the temperature falls, since the column breaks at the narrowed point when the fluid in the bulb begins to contract. The instrument is set for a fresh observation by shaking the detached portion of the column back down the tube. The clinical thermometers used by physicians are instruments of this type, and are made with a very open scale to read only in the neighbourhood of the normal temperature of the human body. In the Phillips or Walferdin maximum a portion of the mercury is separated from the rest by a minute bubble of air. It is placed horizontally and as the temperature rises the detached portion of the column is pushed forward but is not withdrawn when the main column retreats towards the bulb in cooling. It is set for a new observation by bringing it into a vertical position and tapping it slightly. By reducing the length of the index and the bore of the stem this thermometer may be made suitable for use in any position without altering its register.

The minimum thermometer in most common use is that of Rutherford, invented in 1790. It is a spirit thermometer, preferably filled with amyl alcohol, to reduce risk of distillation, in the column of which a small porcelain index is included. The instrument is hung horizontally, and, as the temperature falls, the index is drawn back through surface tension by the end of the column. When the temperature rises the liquid flows past the index, which is left at the lowest point attained. To prepare the instrument for a fresh observation it is inverted, when the index falls back against the end of the column. James Six's combined maximum and minimum thermometer (*Phil. Trans.*, 1782) consists of a U-tube, the bend of which is filled with mercury. One leg contains spirit above the mercury and terminates in a bulb also full of spirit. The other leg also contains a column of spirit above the mercury, but terminates in a bulb containing air and vapour of spirit mixed. With increase of temperature the spirit in the full bulb expands; the mercury in consequence is pushed round the bend and rises to a greater or less extent in the other leg, carrying before it a steel index which thus marks the maximum temperature. With cold the spirit in the full bulb contracts, and the mercury moves back carrying with it a second index which marks the minimum temperature. The instrument is set by drawing down the two indices upon the two ends of the mercury column by means of a magnet.

With a mercury thermometer a continuous record of temperature can only be obtained by the aid of photography, a method which has been in use for many years at some first-class observatories, but which cannot be generally employed on account of the expense and the elaborate nature of the apparatus required. The commonest type of recording thermometer works on the principle of the Bourdon pressure-gauge. The bulb consists of a curved metallic tube filled with liquid, the expansion of which with rise of temperature tends to straighten the tube. The movements are recorded on a revolving drum by a pen carried at the end of a light lever attached to the bulb. This form of instrument is widely employed for rough work, but it has a very limited range and is unsuitable for accurate work on account of want of sensitiveness and of great liability to change of zero, owing to imperfect elasticity of the metal tube. For accurate work, especially at high temperatures, electrical thermometers possess many advantages, and are often the only instruments available. They are comparatively free from change of zero over long periods, and the thermometer or pyrometer itself may be placed in a furnace or elsewhere at a considerable distance from the recording apparatus. The principal types are the thermocouple and the platinum resistance thermometer already described, which may be employed for recording purposes, without altering the thermometer itself, by connexion to a suitable recording mechanism. The methods in use for recording the indications of electrical thermometers may be classified as in § 24 under the two headings of (1) deflexion methods and (2) balance methods. Deflexion methods, in which the deflexion of the galvanometer is recorded, are more suitable for rough work, and balance methods for accurate measurements. The most delicate and most generally applicable method of recording the deflexions of a mirror galvanometer is by photographing the movements of the spot of light on a moving film. Almost any required scale or degree of sensitiveness may be obtained in this manner, but the record cannot be inspected at any time without removal and development. Since the forces actuating the needle of the galvanometer are very small, it is out of the question to attach a pen or marking point directly to the end of the pointer for recording a continuous trace on a revolving drum, because the errors due to friction with the recording sheet would be excessive. This difficulty has been avoided in many electrical instruments by depressing the pointer so as to mark the paper only at regular intervals of a minute or so, leaving it completely free for the greater part of the time. The record thus obtained is discontinuous, but is sufficient for many purposes. For accurate measurement, or for obtaining an open scale over a particular range of temperature, it is necessary to employ some form of balance method as already explained in § 24.

36. *Electric Recorder, Balance Method.*—The application of the electric balance, potentiometer or Wheatstone-bridge for recording changes of resistance or electromotive force has been effected by employing a galvanometer of the movable coil type as a relay. The deflexion of the galvanometer to right or left, according as the resistance or E.M.F. increases or diminishes, is made to actuate one or other of a pair of motors for moving the contact point on the bridge wire and the recording pen on the drum in the corresponding direction. A continuous record free from friction error is thus obtained, since the galvanometer does not actuate the pen directly. With an electrical resistance thermometer it is possible in this way to obtain continuous pen-and-ink records on a scale of an inch or more to the degree, reading to ·01° C. and practically free from zero error over any desired range from $-200°$ to $+1500°$ C. With a thermocouple, employing the potentiometer method, the same apparatus can be used with advantage, but it is not possible to obtain so open a scale on account of the smallness of the thermoelectromotive force available.

The attainment of sufficient delicacy in the relay mechanism turns on the employment of a rotating or vibrating contact in combination with a moving coil galvanometer of the siphon-recorder type. This was first successfully effected by Callendar (*Trans. R. S. Canad.*, 1897) for records of radiation and temperature, and has since been applied to submarine telegraphy by S. G. Brown and by A. Muirhead. The mechanism of Callendar's electrical recorder, as arranged for temperature measurements, is described and illustrated in *Engineering*, May 26, 1899, and in a treatise on *Pyrometry* by Le Chatelier and Boudouard. Electrical recording instruments of both types are now coming into extensive use for industrial purposes in the measurement of furnace temperatures, &c., for which they are particularly suitable, because the recording apparatus can be placed at any distance from the furnaces which may be considered most convenient, and can be connected to any one of a set of furnaces in succession whenever it is desired to obtain a record.

AUTHORITIES.—There is no special work on the subject of thermometry in English, but most of the principles and methods are described in text-books on heat, of which Preston's *Theory of Heat* may be specially mentioned. For recent advances in thermometry the reader should consult the original papers, the most important of which have been cited. The greater part of the recent work on the subject will be found in the publications of the Bureau International des Poids et Mesures de Sèvres (Paris), of the Reichsanstalt (Berlin), of the Bureau of Standards, U.S.A. (Washington), and of the National Physical Laboratory (London). (H. L. C.)

THERMOPYLAE (Gr. θερμός, hot, and πύλη, gate), a Greek pass leading from Locris into Thessaly between Mount Oeta and the sea (Maliac Gulf). It is chiefly famous for the heroic defence made by Leonidas, the Spartan king, with 300 Spartan soldiers against the Persian army of Xerxes advancing upon Greece in 480 (see LEONIDAS and authorities there quoted). Two other famous battles took place at the pass. In 279 B.C. Brennus and the Gauls were checked for several months by a Greek army under the Athenian Calippus, and in 191 Antiochus of Syria vainly attempted to hold the pass against the Romans under M'. Acilius Glabrio. In the time of Leonidas the pass was a narrow track (probably about 14 yds. wide) under the cliff. In modern times the deposits of the Spercheius have widened it to a breadth of 1½ to 3 m. broad. The hot springs from which the pass derived its name still exist close to the foot of the hill. There is one large spring used as a bath and four smaller ones, and the water, which is of a bluish green colour and contains lime, salt, carbonic acid and sulphur, is said to produce good effects in cases of scrofula, sciatica and rheumatism. The accommodation for bathers is, however, quite inadequate.

For the topography see Grundy, *Great Persian War*, pp. 277–291.

THÉROIGNE DE MÉRICOURT, ANNE JOSÈPHE (1762–1817), a Frenchwoman who was a striking figure in the Revolution, was born at Marcourt (from a corruption of which name she took her usual designation), a small town in Luxembourg, on the banks of the Ourthe, on the 13th of August 1762. She was the daughter of a well-to-do farmer, Peter Théroigne. She appears to have been well educated, having been brought up in the convent of Robermont; she was quick-witted, strikingly handsome in appearance and intensely passionate in temper; and she had a vigorous eloquence, which she used with great effect upon the mobs of Paris during that short space of her life (1789–93) which alone is of historical interest. The story of her having been betrayed by a young *seigneur*, and having in consequence devoted her life to avenge her wrongs upon aristocrats, a story which is told by Lamartine and others, is unfounded, the truth being that she left her home on account of a quarrel with her stepmother. In her career as courtesan she visited London in 1782, was back in Paris in 1785, and in Genoa in 1788, where she was a concert singer. In 1789 she returned to Paris. On the outbreak of the Revolution, she was surrounded by a coterie of well-known men, chief of whom were Pétion and Desmoulins; but she did not play the rôle which legend has assigned her. She took no part in the taking of the Bastille nor in the days of the 5th and 6th of October, when the women of Paris brought the king and queen from Versailles. In 1790 she had a political salon and spoke once at the club of the Cordeliers. The same year she left Paris for Marcourt, whence after a short stay she proceeded to Liége, in which town she was seized by warrant of the Austrian Government, and conveyed first to Tirol and thereafter to Vienna, accused of having been engaged in a plot against the life of the queen of France. After an interview, however, with the emperor Leopold II., she was released; and she returned to Paris in January 1792, crowned of course with fresh laurels because of her captivity, and resumed her influence. In the clubs of Paris her voice was often heard, and even in the National Assembly she would violently interrupt the expression of any moderatist views. Known henceforth as "la belle Liégoise," she appeared in public dressed in a riding habit, a plume in her hat, a pistol in her belt and a sword dangling at her side, and excited the mob by violent harangues. Associated with the Girondists and the enemies of Robespierre, she became in fact the "Fury of the Gironde." She commanded in person the 3rd corps of the so-called army of the faubourgs on the 20th of June 1792, and again won the gratitude of the people. She shares a heavy responsibility for her connexion with the riots of the 10th of August. A certain contributor to the journal, the *Acts of the Apostles*, Suleau by name, earned her savage hatred by associating her name, for the sake of the play upon the word, with a deputy named Populus, whom she had never seen. On the 10th of August, just after she had watched approvingly the massacre of certain of the national guard in the Place Vendôme, Suleau was pointed out to her. She sprang at him, dragged him among the infuriated mob, and he was stabbed to death in an instant. She took no part in the massacres of September, and, moderating her conduct, became less popular from 1793. Towards the end of May the Jacobin women seized her, stripped her naked, and flogged her in the public garden of the Tuileries. The following year she became mad, a fate not surprising when one considers her career. She was removed to a private house, thence in 1800 to La Salpetrière for a month, and thence to a place of confinement called the Petites Maisons, where she remained—a raving maniac—till 1807. She was then again removed to La Salpetrière, where she died, never having recovered her reason, on the 9th of June 1817.

See M. Pellet, *Étude historique et biographique sur Théroigne de Méricourt* (1886); L. Lacour, *Les Origines du féminisme contemporain. Trois femmes de la Révolution* (Paris, 1900); Vicomte de Reiset, *La Vraie Théroigne de Méricourt* (Paris, 1903); E. and J. de Goncourt, *Portraits intimes du XVIII^e. siècle* (2 vols., 1857–58); and the play *Théroigne de Méricourt* of M. Paul Hervieu, produced at the Théâtre Sarah Bernhardt in 1902.

THERSITES, the ugliest man in the Greek camp before Troy, celebrated for his biting tongue. The special objects of his attack were the leaders of the army, and Homer (*Iliad*, ii. 212) tells how he was chastised by Odysseus for daring to abuse the commander-in-chief. According to a later story, Achilles, after he had slain the Amazonian queen Penthesilea, bitterly lamented her death; for this he was reviled by Thersites, who even insulted the body of the dead queen. Achilles thereupon slew Thersites with a blow of his fist (Quint. Smyrn. i. 722). There was a play by Chaeremon called *Achilles the Thersites-slayer*, probably a satyric drama, the materials of which were taken from the *Aethiopis* of Arctinus.

THESAURUS (Gr. θησαυρός), the term in architecture given to the Greek treasure house, and at one time applied to the beehive tombs of Mycenae and other parts of Greece, now recognized as tombs; the subterranean chambers under some of the Greek temples were probably used as treasure rooms. Sometimes in the rear of the cella of a Greek temple there was a chamber, known as the opisthodomus, in which the treasures were kept; and, failing this provision, the epinaos or rear portico of the temple was enclosed with large railings and utilized for the same purpose; in this case the term opisthodomus was applied to it. "Thesaurus" is also used of a dictionary, or lexicon, as being a "treasure house" or store of knowledge.

THESEUS, the great hero of Attic legend,[1] son of Aegeus, king of Athens, and Aethra, daughter of Pittheus, king of Troezen. Thus through his father he was descended from Erechtheus and the original stock of Attica; through his mother he came of the Asiatic house of Pelops. The legend relates that Aegeus, being childless, went to Pittheus, who contrived that Aegeus should have intercourse with his daughter Aethra, and that in due time Aethra brought forth Theseus. It was given out that the child's father was Poseidon, the great god of Troezen, and that Aethra raised a temple to Athena Apaturia, at which Troezenian maids used to dedicate their girdles before marriage. For his tutor and guardian young Theseus had one Cannidas, to whom, down to Plutarch's time, the Athenians were wont to sacrifice a black ram on the eve of the festival of Theseus. On passing out of boyhood Theseus was sent by his mother to Athens. He encountered many adventures on the way. First he met and slew Periphetes, surnamed Corynetes (Clubman). At the isthmus of Corinth dwelt Sinis, called the Pine-Bender, because he killed his victims by tearing them asunder between two pine-trees. Theseus hoisted the Pine-Bender on his own pine-tree. Next Theseus despatched the Crommyonian sow (or boar). Then he flung over a cliff the wicked Sciron, who used to kick his guests into the sea, while perforce they washed his feet. In Eleusis Theseus wrestled with Cercyon and killed him. A little farther on he slew Procrustes, who fitted all comers to his only bed: if his guest was too short for the bed, he stretched him out; if he was too long, he cut him down to the requisite length. As he passed through the streets of Athens, his curls and long garment reaching to his ankles drew on him the derision of some masons, who were putting on the roof of the new temple of Apollo Delphinius: "Why," they asked, "was such a pretty girl out alone?" In reply Theseus took the bullocks out of their cart and flung them higher than the roof of the temple. He found his father married to Medea, who had fled from Corinth. Being a witch, she knew Theseus before his father did, and tried to persuade Aegeus to poison his son; but Aegeus recognized him by his sword and took him to his arms. Theseus was now declared heir to the throne, and the Pallantids,[2] who had hoped to succeed to the childless king, conspired against Theseus, but he crushed the conspiracy. He then attacked the fire-breathing bull of Marathon and brought it alive to Athens, where he sacrificed it to Apollo Delphinius. Next came the adventure of the Cretan Minotaur (*q.v.*), whom Theseus slew by the aid of Ariadne (*q.v.*). While Theseus was in Crete, Minos,

[1] The story of Theseus is a strange mixture of (mostly fictitious) political tradition, of aetiological myths invented to explain misunderstood acts of ritual and of a cycle of tales of adventure analogous to the story of the labours of Heracles. All the passages in the *Iliad* and *Odyssey* in which his name or allusions to his legend occur are regarded with more or less probability as spurious (but see O. Gruppe, *Gr. Myth.*, i. p. 581).

[2] The sons of Pallas, the brother of Aegeus.

wishing to see whether Theseus was really the son of Poseidon, flung his ring into the sea. Theseus dived and brought it up, together with a golden crown, the gift of Amphitrite. On the return voyage the ship touched at Naxos, and there Theseus abandoned Ariadne. He landed also at Delos, and there he and his comrades danced the crane dance, the complicated movements of which were meant to imitate the windings of the Labyrinth.[1] In historical times this dance was still danced by the Delians round a horned altar. Theseus had promised Aegeus that, if he returned successful, the black sail with which the fatal ship always put to sea should be exchanged for a white one.[2] But he forgot his promise; and when Aegeus from the Acropolis at Athens descried the black sail out at sea, he flung himself from the rock and died. Hence at the festival which commemorated the return of Theseus there was always weeping and lamentation. Theseus now carried out a political revolution in Attica by abolishing the semi-independent powers of the separate townships and concentrating those powers at Athens, and he instituted the festival of the Panathenaea,[3] as a symbol of the unity of the Attic race. Further, according to tradition, he instituted the three classes or castes of the eupatrids (nobles), geomori (husbandmen), and demiurgi (artisans). He extended the territory of Attica as far as the isthmus of Corinth.

He was the first to celebrate in their full pomp the Isthmian games in honour of Poseidon; for the games previously instituted by Hercules in honour of Melicertes had been celebrated by night, and had partaken of the nature of mysteries rather than of a festival. Of Theseus's adventures with the Amazons there were different accounts. According to some, he sailed with Hercules to the Euxine, and there won the Amazon Antiope as the meed of valour; others said that he sailed on his own account, and captured Antiope by stratagem. Thereafter the Amazons attacked Athens. Antiope fell fighting on the side of Theseus, and her tomb was pointed out on the south side of the acropolis. By Antiope Theseus had a son, Hippolytus. On the death of Antiope, Theseus married Phaedra. She fell in love with her stepson Hippolytus, who, resisting her advances, was accused by her to Theseus of having attempted her virtue. Theseus in a rage imprecated on his son the wrath of Poseidon. His prayer was answered: as Hippolytus was driving beside the sea, a bull issuing from the waves terrified his horses, and he was thrown and killed. This tragic story is the subject of one of the extant plays of Euripides.[4]

The famous friendship between Theseus and Pirithous, king of the Lapiths, originated thus. Hearing of the strength and courage of Theseus, Pirithous desired to put them to the test. Accordingly he drove away from Marathon some cows which belonged to Theseus. The latter pursued, but when he came up with the robber the two heroes were so filled with admiration of each other that they swore brotherhood. At the marriage of Pirithous to Hippodamia (or Deidamia) a fight broke out between the Lapiths and Centaurs, in which the Lapiths, assisted by Theseus, were victorious, and drove the Centaurs out of the country. Theseus and Pirithous now carried off Helen from Sparta, and when they drew lots for her she fell to the lot of Theseus, who took her to Aphidnae, and left her in charge of his mother Aethra and his friend Aphidnus. He now descended to the lower world with Pirithous, to help his friend to carry off Proserpine. But the two were caught and confined in Hades till Heracles came and released Theseus. When Theseus returned to Athens he found that a sedition had been stirred up by Menestheus, a descendant of Erechtheus, one of the old kings of Athens. Failing to quell the outbreak, Theseus in despair sent his children to Euboea, and after solemnly cursing the Athenians sailed away to the island of Scyrus, where he had ancestral estates. But Lycomedes, king of Scyrus, took him up to a high place, and killed him by casting him into the sea. Long afterwards, at the battle of Marathon (490 B.C.), many of the Athenians fancied they saw the phantom of Theseus, in full armour, charging at their head against the Persians. When the Persian war was over the Delphic oracle bade the Athenians fetch the bones of Theseus from Scyrus, and lay them in Attic earth. It fell to Cimon's lot in 469 B.C. to discover the hero's grave at Scyrus and bring back his bones to Athens. They were deposited in the heart of Athens, and henceforth escaped slaves and all persons in peril sought and found sanctuary at the grave of him who in his life had been a champion of the oppressed. His chief festival, called Theseia, was on the 8th of the month Pyanepsion (October 21st), but the 8th day of every other month was also sacred to him.[5]

Whatever we may think of the historical reality of Theseus, his legend almost certainly contains recollections of historical events, *e.g.* the συνοικισμός, whether by this we understand the political centralization of Attica at Athens or a local union of previously separate settlements on the site of Athens. The birth of Theseus at Troezen points to the immigration of an Ionian family or tribe. With this agrees the legend of the contest between Athena and Poseidon for supremacy on the acropolis of Athens, for Theseus is intimately connected with Poseidon, the great Ionian god. Aegeus, the father of Theseus, has been identified by some modern scholars with Poseidon.

The well-preserved Doric temple to the north of the acropolis at Athens, commonly known as the Theseum, was long supposed to be the sanctuary in which the bones of Theseus reposed. But archaeologists have generally abandoned this conjecture. There were several (according to Philochorus, four) temples or shrines of Theseus at Athens. Milchhöfer considers he has found one of them in the neighbourhood of Peiraeus.[6]

Our chief authority for the legend of Theseus is the life by Plutarch, which is a compilation from earlier writers; see also Bacchylides. G. Gilbert, who has investigated the sources from which Plutarch drew for his life of Theseus, believes that his chief authority was the *Atthis* of Ister, and that Ister mainly followed Philochorus (*Philologus*, xxxiii., 1874, p. 46 sq.).

There is a modern Greek folk-tale which preserves some features of the legend of Theseus and the Minotaur, but for the Minotaur has been substituted a seven-headed snake. See Bernhard Schmidt, *Griechische Märchen, Sagen und Volkslieder* (1877), p. 118 sq.

Among modern monographs on Theseus may be mentioned: A. Schultz, *De Theseo* (Breslau, 1874); Th. Kausel, *De Thesei Synoikismo* (Dillenburg, 1882); E. Prigge, *De Thesei rebus gestis* (Marburg, 1891); O. Wulff, *Zur Theseussage* (Dorpat, 1892); see also O. Gruppe, *Griechische Mythologie*, i. pp. 581–608; J. E. Harrison, *Mythology and Monuments of Ancient Athens* (1890); "Der Theseische Synoikismos" in C. F. Hermann's *Lehrbuch der griechischen Staatsaltertümer*, i. (1892), pp. 303–306; A. Baumeister, *Denkmäler des klassischen Altertums*, iii. (1888).

THESMOPHORIA, an ancient Greek festival, celebrated by women only in honour of Demeter Θεσμοφόρος. At Athens, Abdera, and perhaps Sparta, it lasted three days. At Athens the festival took place on the 11th, 12th and 13th of the month

[1] The Ostiaks of Siberia have an elaborate crane dance, in which the dancers are dressed up with skins and the heads of cranes (P. S. Pallas, *Reise durch verschiedene Provinzen des russischen Reichs*, iii. 1778).

[2] So, too, the ship that sailed annually from Thessaly to Troy with offerings to the shade of Achilles put to sea with sable sails (Philostratus, *Heroica*, xx. 25). The ship that was to bring Iseult to the mortally wounded Tristram was to hoist a white sail if she was on board, a black sail if she was not. The black sails recur in the modern Greek version of the tale of Theseus. Cf. *Asiatick Researches*, ix. 97.

[3] Besides the Panathenaea Theseus is said to have instituted the festival of the *Synoikia* or *Metoikia*. Wachsmuth ingeniously supposes that the latter festival commemorated the local union in a single city of the separate settlements on the Acropolis and its immediate neighbourhood, while the Panathenaea commemorated the political union of the whole of Attica. (C. Wachsmuth, *Die Stadt Athen im Alterthum*, 1874, p. 453 sq.).

[4] Theseus is also said to have taken part in the Argonautic expedition and the Calydonian boar-hunt.

[5] The Athenian festival in October, popularly supposed to commemorate the return of Theseus from Crete, is interesting, as some of its features are identical with those of harvest-festivals still observed in the north of Europe. Thus the *eiresiōnē*, a branch of olive wreathed with wool and decked with fruits, bread, &c., which was carried in procession and hung over the door of the house, where it was kept for a year, is the *Erntemai* (Harvest-may) of Germany. See W. Mannhardt, *Antike Wald- und Feld-Kulte* (1877), p. 212 sq.

[6] See *Erläuternder Text* to the *Karten von Attika* (Berlin, 1881), i. p. 37 sq.

Pyanepsion (24th, 25th and 26th October), the first day being called Anodos (ascent), or, according to others, Kathodos (descent), the second Nesteia (fast), and the third Kalligeneia (fair-born).[1] If to these days we add the Thesmophoria, which were celebrated on the 10th at Halimus, a township on the coast near Athens, the festival lasted four days.[2] If further we add the festival of the Stenia, which took place on the 9th, the whole festival lasted five days.[3] The Stenia are said by Photius to have celebrated the return of Demeter from the lower world (Anodos), and the women railed at each other by night.[4] The Thesmophoria at Halimus seem to have included dances on the beach.[5] The great feature of the next day (the Anodos) is generally assumed to have been a procession from Halimus to Athens, but this assumption seems to rest entirely on an interpretation of the name Anodos, and it loses all probability when we observe that the day was by others called Kathodos.[6] Probably both names referred to the descent of Demeter or Persephone to the nether world, and her ascent from it.[7] The next day Nesteia, was a day of sorrow, the women sitting on the ground and fasting.[8] As to what took place on the Kalligeneia we have no information.[9] Nor can we define the time or nature of the secret ceremony called the "pursuit," or the "Chalcidian pursuit," and the sacrifice called the "penalty."[10]

During the Thesmophoria (and for nine days previously, if Ovid, *Met.*, x. 434, is right, and refers to the Thesmophoria) the women abstained from intercourse with their husbands, and to fortify themselves strewed their beds with *Agnus castus* and other plants. The women of Miletus strewed their beds with pine branches, and put fir-cones in the sanctuaries of Demeter.[11] Whether unmarried women were admitted to the festival seems doubtful; in Lucian's time it would appear that they were.[12] The women of each deme (township) elected two married women of their number to preside over them at the festival; and every married man in the township who possessed property to the value of three talents had to provide a feast for the women on behalf of his wife.[13] During the festival the women seem to have been lodged by twos in tents or huts, probably erected within the sacred precincts of the Thesmophorion.[14] They were not allowed to eat the seeds of the pomegranate or to wear garlands of flowers.[15] Prisoners were released at the festival,[16] and during the Nesteia the law-courts were closed and the senate did not meet.[17] Aristophanes's play on the festival sheds little light on the mode of its celebration.

At Thebes Thesmophoria were celebrated in summer on the acropolis (Cadmeia); at Eretria during the Thesmophoria the women cooked their meat, not at fires, but by the heat of the sun, and they did not invoke Kalligeneia (which seems to mean that they did not celebrate the last day of the festival); at Syracuse, during the festival, cakes called ***mylloi***, made of sesame and honey in the shape of ***pudenda muliebria***, were handed round.[18] Agrigentum, Ephesus and Dryme, in Phocis, had also their Thesmophoria.[19]

The above was nearly all that was known about the Thesmophoria down to 1870. In that year E. Rohde published in the *Rheinisches Museum*, n.s., xxv., p. 548 sq., a scholion on Lucian (*Dial. Meretr.*, ii. 1), which he discovered in the Vatican MS. Palatinus 73, and which furnishes some curious details about the Thesmophoria. It also explains two obscure and corrupt passages of Clemens Alexandrinus and Pausanias, the true meaning of which had been divined by Lobeck (*Aglaophamus*, p. 828). The substance of the scholion is this. When Persephone was carried off by Pluto, a swineherd called Eubuleus was herding his swine at the spot, and his herd was engulfed in the chasm down which Pluto had vanished with Persephone. Accordingly at the Thesmophoria it was customary, in memory of Eubuleus, to fling pigs into the "chasms of Demeter and Persephone." (These "chasms" may have been natural caverns or perhaps vaults. The scholiast speaks of them also as *adyta* and *megara*.[20]) In these chasms or adyta there were supposed to be serpents, which guarded the adyta and consumed most of the flesh of the pigs that were thrown in. The decayed remains of the flesh were afterwards fetched by women called "drawers" (*antletriai*), who, after observing rules of ceremonial purity for three days, descended into the caverns, and, frightening away the serpents by clapping their hands, brought up the remains and placed them on the altars.[21] Whoever got a portion of this decayed flesh and sowed it with the seed in the

[1] [Or, mother of a fair daughter, *i.e.* Persephone.] Schol. on Aristoph., *Thesmophoriazusae*, 80 and 585; Diog. Laërt., ix. 43; Hesychius, s.v. τριήμερος (the reading here is uncertain) and ἄνοδος; Alciphron, iii. 39; Athenaeus, vii. 307 f. Plutarch (*Vit. Demosth.*, 30) states that the Nesteia took place on the 16th of Pyanepsion, but in this he stands alone.

[2] Schol. on Aristoph., *Thesm.*, 80; Photius, *Lex.*, s.v. Θεσμοφορίων ἡμέραι δ′ (where Naber should not have altered the MS. reading δ′ into ιδ′); Hesychius, s.v. τρίτη Θεσμοφορίων.

[3] Schol. on Aristoph., *Thesm.*, 834.

[4] Photius, *Lex.*, s.v. στήνια; cf. Apollodorus, i. 5, 1.

[5] Plut., *Solon*, 8; for this passage probably refers to the Thesmophoria, the Cape Colias mentioned being near Halimus (see *Erläuternder Text* to the *Karten von Attika*, ii. 1 sq.). The Thesmophorion at Halimus is mentioned by Pausanias (i. 31, 1).

[6] Hesychius (s.v. ἄνοδος) and the Schol. on Arist., *Thesm.*, 585, suppose that the day was so called because the women ascended to the Thesmophorion, which (according to the scholiast) stood on a height. But no ancient writer mentions a procession from Halimus. For the name *Kathodos*, see Schol., *loc. cit.*; Photius, *Lex.*, s.v. Θεσμοφορίων ἡμέραι δ′. For the statement that at one part of the festival (commonly assumed, by the writers who accept the statement, to be the Anodos) the women carried on their heads the "books of the law," we have only the authority of the scholiast on Theocritus, iv. 25, who displays his ignorance by describing the women as virgins (see below), and saying that they went in procession to Eleusis. The statement may therefore be dismissed as an etymological fiction. Aristophanes, *Eccles.*, 222, is no evidence for the book-carrying.

[7] The Boeotian festival of Demeter, which was held at about the same time as the Athenian Thesmophoria, and at which the *megara* (see below) were opened, is distinctly stated by Plutarch (*De Is. et Osir.*, 69) to have been a mourning for the descent (Kathodos) of Persephone.

[8] Plut., *Dem.*, 30; Id., *De Is. et Osir.*, 69.

[9] [It was a day of holiday and rejoicing.]

[10] Hesychius, s.v. δίωγμα [perhaps the pursuit of Persephone]; Suïdas, s.v. χαλκιδικὸν δίωγμα [according to whom, the prayers of the women at the Thesmophoria caused the flight of the enemy to Chalcis]; Hesychius, s.v. ζημία. For flight and pursuit as parts of religious ceremonies, cf. Plutarch, *Quaest. Graec.*, 38, *Quaest. Rom.*, 63, *De Def. Orac.*, 15; Aelian, *Nat. An.*, xii. 34; Pausanias, i. 24, 4, viii. 53, 3; Diodorus, i. 91; Lobeck, *Aglaophamus* (1829), p. 676; Marquardt, *Staatsverwaltung*, 2nd ed. (1885), iii. 323.

[11] Aelian, *Nat. An.*, ix. 26; Schol. on *Theocr.*, iv. 25; Hesychius s.v. κνέωρον; Pliny, *N. H.*, 24, 59; Dioscorides, i. 135 (134, ed. Sprengel); Schol. on Nicander, *Ther.*, 70 sq.; Galen, xi. 808, ed. Kühn; Steph. Byz., s.v. Μίλητος.

[12] Lucian, *Dial. Meretr.*, ii. 1. On the other hand, we read in Strabo (i. 3, 20) of virgins at Alponus ascending a tower as spectators (κατὰ θέαν) of the Thesmophoria. which would seem to imply that they did not participate in it.

[13] Isaeus, *De Cironis Hered.*, 19; Id., *De Pyrrhi Hered.*, 80.

[14] Aristoph., *Thesm.*, 624, 658, with the Schol. *ad ll.* As to the custom of camping out at festivals, Plutarch (*Quaest. Conviv.*, iv. 6, 2) compares the Jewish Feast of Tabernacles with the Greek Dionysia; from which we may perhaps infer that the worshippers camped out at the Dionysia. Cf. J. Gumilla, *Histoire de l'Orénoque*, i. p. 256 sq. [1758].

[15] Clem. Alex., *Protrep.*, ch. ii. [p. 16, ed. Potter]; Schol. on Sophocles, *Oed. Col.*, 681.

[16] Marcellinus on Hermogenes, in *Rhetores Graeci*, ed. Walz, iv. 462; Sopater, *ibid.*, viii. 67.

[17] Aristoph., *Thesm.*, 80. The word τρίτη seems to mean the Nesteia, as the Schol. *ad l.* takes it. That the "middle day" was the Nesteia we know from Athenaeus, vii. 307 f.

[18] Xenophon, *Hellen.*, v. 2, 29; Plutarch, *Quaest. Gr.*, 31; Athenaeus, xiv. 647*a*.

[19] Polyaenus, v. 1, 1; Herodotus, vi. 16; Pausanias, x. 33, 11.

[20] C. T. Newton discovered in the sanctuary of Demeter and the Infernal Deities at Cnidus a chamber which may have been one of the *megara* referred to by the scholiast. It contained bones of pigs and marble figures of pigs. The chamber was not, however, originally subterranean. See Newton's *Discoveries at Halicarnassus* (1863), ii. p. 383, *Travels and Discoveries in the Levant* (1865), ii. p. 180 sq. According to Porphyry (*De Antro Nympharum*, 6) the Infernal Deities had *megara*, as the Olympian had temples, and the sacrificial pits of the former corresponded to the altars of the latter.

[21] Compare the functions of the two Arrephoroi at Athens (Paus., i. 27, 3). For serpents in connexion with Demeter, compare Strabo, ix. 1, 9.

ground was supposed thereby to secure a good crop.[1] The rest of the scholion is obscure, and perhaps corrupt, but the following seems to be the sense. The ceremony above described was called the arretophoria [the carrying of things which must not be spoken of], and was supposed to exercise the same quickening and fertilizing influence on men as on fields. Further, along with the pigs, sacred cakes made of dough, in the shape of serpents and of phalli, were cast into the caverns, to symbolize the productivity of the earth and of man. Branches of pines were thrown in[2] for a similar reason.

The custom described in this important scholion is clearly the same as that referred to by Clemens Alexandrinus (*Protrep.*, ch. ii.) [p. 14, ed. Potter] and Pausanias (ix. 8, 1). From the latter we learn that the pigs were sucking pigs, and from the former (if we adopt Lobeck's emendation μεγάροις ζῶντας for μεγαρίζοντες) that they were thrown in alive. From Pausanias we may further perhaps infer (though the passage is corrupt) that the remains of the pigs thrown down in one year were not fetched up till the same time next year (cf. Paus., x. 32, 14). The question remains, At what point of the Thesmophoria did the ceremony described by the scholiast on Lucian take place? Rohde thinks that it formed part of the ceremonies at Halimus, his chief ground being that Clemens (*Protrep.*, 34) and Arnobius (*Adv. Gentes*, v. 28) mention phalli in connexion with the "mysteries at Halimus"; but it is not certain that these mysteries were the Thesmophoria. The legend of Eubuleus seems to show that the ceremony commemorated the descent of Persephone to the nether world; and, if we are right in our interpretation of the name Kathodos as applied to the first day of the Thesmophoria proper, the ceremony described would naturally fall on that day. Further, if our interpretation of Pausanias is correct, the same day must have witnessed the descent of the living pigs and the ascent of the rotten pork of the previous year. Hence the day might be indifferently styled Kathodos or Anodos ("descent" or "ascent"); and so in fact it was.

It is usual to interpret Thesmophorus "lawgiver" and Thesmophoria "the feast of the lawgiver." But the Greek for "lawgiver" is not Thesmophorus but Thesmothetes (or Nomothetes, when *nomos* displaced *thesmos* in the sense of "law"). If we compare such names of festivals as Oschophoria, Lampadephoria, Hydrophoria, Scirophoria ("the carryings of grapes, of torches, of water, of umbrellas") with the corresponding Oschophorus, Lampadephorus, Hydrophorus, also Thallophorus and Kanephorus, we can scarcely help concluding that Thesmophoria must originally have meant in the literal and physical sense the carrying of the *thesmoi*, and Thesmophorus the person who so carried them; and, in view of the ceremony disclosed by the scholiast on Lucian (compared with the analogous ceremony observed by the Arrephoroi at Athens), we are strongly tempted to suppose that the women whom he calls Antletriai may have been also known, at one time or other, as Thesmophoroi, and that the *thesmoi* were the sacra which they carried and deposited on the altar. The word would then be used in its literal sense, "that which is set down." How the name Thesmophorus should have been transferred to the goddess from her ministers is of course a difficulty, which is hardly disposed of by pointing to the epithets Amallophorus ("sheaf-bearing") and Melophorus ("apple-bearing"), which were applied to men as well as to the goddess.

As to the origin of the Thesmophoria, Herodotus (ii. 171) asserts that they were introduced into Greece from Egypt by the daughters of Danaus; while, according to Plutarch (*Fragments*, p. 55, ed. Dübner [*Frag. Incerta*, 84]), the feast was introduced into Athens by Orpheus the Odrysian. From these statements we can only infer the similarity of the Thesmophoria to the Orphic rites and to the Egyptian representation of the sufferings of Osiris, in connexion with which Plutarch mentions them. The Thesmophoria would thus form one of that class of rites, widely spread in Western Asia and in Europe, in which the main feature appears to be a lamentation for the annual decay of vegetation or a rejoicing at its revival. This seems to have been the root, *e.g.*, of the lamentations for Adonis and Attis. See W. Mannhardt, *Antike Wald- und Feld-Kulte*, p. 264 sq.

On the Thesmophoria, see Meursius, *Graecia Feriata*, p. 151 sq.; L. Preller, *Demeter und Persephone* (1837), p. 335 sq., *Griech. Myth.*, [3], i. p. 639 sq.; Fritzsche's ed. of the *Thesmophoriazusae* (1838), p. 577 sq.; Aug. Mommsen, *Heortologie* (1864), p. 287 sq.; *Rheinisches Museum*, xxv. (1870), p. 548; *Gazette Archéologique* (1880), p. 17; Andrew Lang, "Demeter and the Pig," in *Nineteenth Century*, April 1887; J. G. Frazer, *Golden Bough*, ii. 44; J. E. Harrison, *Prolegomena to the Study of Greek Religion* (1903); and especially the exhaustive articles by L. C. Purser in Smith's *Dictionary of Antiquities* (ed. 3, 1891) and by F. Lenormant (on CERES) in Daremberg and Saglio, *Dictionnaire des Antiquités*.

(J. G. FR.; X.)

[1] This, as Andrew Lang has pointed out, resembles the Khond custom of burying the flesh of the human victim in the fields to fertilize them. The human victim was with the Khonds, like the pig with the Greeks, a sacrifice to the Earth goddess. See *Memorials of Service in India . . . of Major S. C. Macpherson*, ed. William Macpherson (1865), p. 129.

[2] Reading ἐμβάλλουσι, with Rohde, for λαμβάνουσι. Compare the custom of Miletus *supra*. The pine-tree played an important part in the worship of Cybele. Cf. Marquardt, *Staatsverwaltung* (1885), iii. 371.

THESPIAE, an ancient Greek city of Boeotia. It stood on level ground commanded by the low range of hills which runs eastward from the foot of Mount Helicon to Thebes. The deity most worshipped at Thespiae, according to Pausanias, was Eros, whose primitive image was an unwrought stone. The town contained many works of art, among them the Eros of Praxiteles, dedicated by Phryne in her native place; it was one of the most famous statues in the ancient world, and drew crowds of people to Thespiae. It was carried off to Rome by Caligula, restored by Claudius, and again carried off by Nero. There was also a bronze statue of Eros by Lysippus. The Thespians also worshipped the Muses, and celebrated a festival in their honour in the sacred grove on Mount Helicon. Remains of what was probably the ancient citadel are still to be seen, consisting of an oblong or oval line of fortification, solidly and regularly built. The adjacent ground to the east and south is covered with foundations, bearing witness to the extent of the ancient city. The neighbouring village Eremokastro, on higher ground, was thought by Ulrichs to be probably the site of the ancient Ceressus. In 1882 there were discovered, about 1200 yds. east of Eremokastro, on the road to Arkopodi (Leuctra), the remains of a *polyandrion*, including a colossal stone lion. The tomb dates from the 5th century B.C., and is probably that of the Thespians who fell at Plataea, for those who fell at Thermopylae were buried on the field.

History.—Thespiae figures chiefly in history as an enemy of Thebes, whose centralizing policy it had all the more to fear because of the proximity of the two towns. During the Persian invasion of 480 B.C. it stood almost alone among Boeotian cities in rejecting the example of treason set by the Thebans, and served the national cause with splendid devotion. Seven hundred Thespians accompanied Leonidas to Thermopylae and of their own free will shared his last stand and destruction. The remaining inhabitants, after seeing their city burnt down by Xerxes, furnished a force of 1800 men to the confederate Greek army at Plataea. In 424 B.C. the contingent which the Thespians had been compelled to furnish sustained heavy losses at Delium, and in the next year the Thebans took advantage of this temporary enfeeblement to accuse their neighbours of friendship towards Athens and to dismantle their walls. In 414 they interfered again to suppress a democratic rising. In the Corinthian war Thespiae sided with Sparta, and between 379 and 372 repeatedly served the Spartans as a base against Thebes. In the latter year they were reduced by the Thebans and compelled to send a contingent to Leuctra (371). It was probably shortly after this battle that the Thebans used their new predominance to destroy Thespiae and drive its people into exile. The town was rebuilt at some later time. In 171 B.C., true to its policy of opposing Thebes, it sought the friendship of Rome. It is subsequently mentioned by Strabo as a place of some size, and by Pliny as a free city.

See Herodotus, v. 79, vii. 132–ix. 30; Thucydides, iv. 93, 133, vi. 95; Xenophon, *Hellenica*, iv. vi.; Pausanias, ix. 13, 8–14, 2, 26–27; Strabo, ix. pp. 409–10; B. V. Head, *Historia Numorum* (Oxford, 1887), pp. 479–80; Leake, *Travels in Northern Greece*, ii. 479 sq.; Dodwell, *Tour through Greece*, i. 253; Bursian, *Geogr. von Griechenland*, i. 237 sq.; Ulrichs, *Reisen u. Forschungen in Griechenland*, ii. 84 sq.; *Mitteil. d. deutsch. archäol. Inst. in Athen* (1879), pp. 190 sq., 273 sq.; Πρακτικὰ τῆς ἀρχ. Ἑταιρίας (1882), pp. 65–74.

THESPIS (6th cent. B.C.), Greek poet, of Icaria, in Attica, generally considered the inventor of tragedy, flourished in the time of the Peisistratidae. According to Diogenes Laërtius (iii. 56), he introduced for the first time in the old dithyrambic choruses a person distinct from the chorus, who conversed with the leader, and was hence called ὑποκριτής ("answerer").[3]

[3] According to another explanation, he was so called from repeating the words of another—the poet or composer.

His claim to be regarded as the inventor of tragedy in the true sense of the term depends upon the extent to which this person was really an "actor" (see DRAMA). Suïdas gives the titles (of doubtful authenticity) of several of his plays (not confined to the legends of Dionysus, but embracing the whole body of heroic legends), but the fragments quoted in various writers as from Thespis are probably forgeries by Heracleides of Pontus. The statement of Horace (*Ars Poetica*, 276) that Thespis went round Attica with a cart, on which his plays were acted, is due to confusion between the origin of tragedy and comedy, and a reminiscence of the scurrilous jests which it was customary to utter from a waggon (σκώμματα ἐξ ἁμάξης) at certain religious festivals. A. and M. Croiset (*History of Greek Literature*, Eng. tr., 1904), who attach more importance to the part played by Thespis in the development of tragedy, accept the testimony of Horace. According to them, Thespis, actor and manager, transported his apparatus on a cart to the deme in which he intended to produce his drama, formed and trained a chorus, and gave a representation in public.

See DRAMA; and W. Christ, *Griechische Litteraturgeschichte* (1898).

THESSALONIANS, EPISTLES TO THE, two books of the New Testament. The Christian community in Thessalonica (mod. Salonica) was founded by Paul, Silvanus and Timothy, shortly before the visit to Athens and Corinth. The Gospel preached covered not only the general Christian convictions as to monotheism, belief in Jesus as Messiah Lord, and the impending judgment, but also the specifically Pauline doctrine of the indwelling Christ or Spirit, the earnest of acquittal at the Day of the Lord and of life with Christ for ever. It is the same Gospel as that preached in Galatia, in spite of the fact that the word "justification" does not appear in the Thessalonian letters (cf. 2 Thess. i. 11 f.). The converts, mainly Gentiles and chiefly manual labourers (many of whom, according to the episodical narrative of Acts xvii., had been already attached more or less loosely to Judaism), suffered persecution from the beginning at the hands of their fellow-countrymen. Some of them, moreover, owing partly to this persecution, but mainly to the belief that the Lord was soon to return, gave up work, thus creating most of the difficulties with which Paul, in these letters, has to cope. Forced to leave Thessalonica after a brief sojourn (how long is uncertain), Paul hastened to Athens, from which place he sent Timothy back to Thessalonica, being himself unable to go, much as he longed to see his converts. From Athens, Paul went on to Corinth, where Timothy joined him, bringing good news about the Thessalonian converts, especially about their endurance under affliction, and bringing likewise, as Rendel Harris has suggested, a letter from the leaders of the church. The report was, however, not wholly favourable. The sudden departure of Paul, and his failure to return, had been misinterpreted. Some were insinuating that Paul had preached with intent to deceive and as a pretext to cover impure designs (1 Thess. ii. 5); some, perhaps the same people, disregarding Paul's injunction (2 Thess. iii. 10), had remained idle, had fallen into drunken habits (1 Thess. v. 7), had been tempted to revert to the impure worship of the heathen gods (1 Thess. iv. 3 ff.), and, in their lack of funds, had demanded, speaking in the spirit (cf. *Didachē* xi. 12), money from the church officers, thus disturbing the peace of the church, and causing the soberer minds to question the validity of spiritual gifts (1 Thess. iv. 11 ff., v. 12 ff.).

First Epistle.

Paul's reply, the First Epistle to the Thessalonians, written from Corinth in A.D. 53 or 48, is as tactful as Philemon and as personal as Galatians. In the first three chapters, he reviews his relation to the church from the beginning, commending highly the reception accorded to the Gospel and its messengers, and meeting the insinuations already alluded to by reminding the readers that, although as an apostle he was entitled not only to special respect but to an honorarium, yet he earned his own living and loved them as a father. As to his failure to return, he explained that it was not his own fault. He wanted to go back but Satan hindered him. Even now, as he writes, he is praying that he may soon see them face to face. After the prayer, he takes up the points in which they had shown want of faith. To those who are tempted by the heathen worship, he points out that Christian consecration is something ethical, to be won only in the power of the consecrating Spirit. Respect for one's wife is an antidote to this enticement, and marriage with pure motives a safeguard against adultery. Passing on to other points, he urges that there would be no schism in love of the brethren, if the idlers would work and mind their own business (1 Thess. iv. 1–12). There is no advantage at the Parousia of the living over the dead, for both simultaneously will meet the Lord. The desire for more accurate information about times and seasons is unnecessary, for their present knowledge is accurate enough, viz. that the day is to come suddenly and it is a day of destruction for the wicked. The main thing for them is to be prepared for that day (1 Thess. iv. 13–v. 11). With the specific situation still in mind, he adds his final injunctions. Respect your presiding officers, purposely called "the labourers," and let there be peace. Warn the idlers, encourage those who are impatient of the Parousia, and cling to those tempted by the heathen worship. In spite of the temptation to avenge your persecutors, be patient with them, return good for evil, exemplifying to all what is the Christian good. In spite of affliction, let there be joy, prayer and thanksgiving (1 Thess. v. 14–18). The charismata are to be respected, and at the same time tested (*ibid.* 19–22). A prayer for complete consecration, a charge that all should hear the letter read (apparently the leaders were tempted to neglect the idlers and the idlers had threatened not to listen to any epistolary communication from Paul), and a benediction bring the letter to an end (*ibid.* 23–28).

Such a letter, dominated as it is by the spirit of the Paul we know and fitting nicely the recoverable situation, is unquestionably genuine, and few there be who deny it.

What effect this letter had, it is impossible fully to say. Apparently, it did not quell the excitement for which the idlers were largely responsible. Paul's discussion of the relation of dead and living at the Parousia seemed insufficient. His refusal to go further into times and seasons than the statement "the day comes as a thief in the night," is made the point of departure for the idlers to assert, on the basis of alleged spiritual utterances, corroborated, to the dismay of the leaders, by a reference to an anonymous letter reckoned to the account of Paul, that "the day is present." The troubled leaders send post-haste a letter to Corinth stating the situation and asking definite opinions as to the Parousia and the assembling of the saints. Paul is grievously disturbed, both because the first letter, in his judgment, was clear, and because of the association of his authority with the anonymous letter. Only a short interval has elapsed, to be reckoned in weeks, when Paul, with the first letter distinctly in mind and with a vivid recollection of his oral teaching on mooted points, hastens with Silvanus and Timothy to write the Second Epistle.

Second Epistle.

In one long sentence of prayer and thanksgiving (2 Thess. i. 3–12), he insists tactfully that their religious-ethical growth makes it his bounden duty to thank God, in spite of their written demurrer, compels him indeed of his own motion to boast of their faith and endurance, qualities which are evidence of the Divine purpose to account them worthy of the kingdom for which they, as they wrote, as well as he, are suffering. Suddenly remembering a Pharisaic Psalm, not unlike in purport to one of the Psalms of Solomon, and admirably adapted to his present purpose, namely, of contrasting the fate of the wicked with that of the righteous at the Parousia, he quotes it, making a few Christian touches in his own style (2 Thess. i. 6–10). Whereupon he prays, as they too prayed in their letter, that God would deem them worthy of the calling, and ensure them of the acquittal at the last day, by giving them in the power of the Spirit that present life in the Spirit which guarantees the future life in Christ. Then, disregarding the request for more information about the assembling, of which, he thinks, he had spoken sufficiently in his first letter, he addresses himself to the other question of the "when" of the Parousia, supplementing what was said in the first letter, but adding nothing to what he had already said orally in their presence, and stoutly disclaiming all authority whatever for the statement "the day is present." Briefly and allusively, in language which has nothing specifically Christian in it and in style similar to the first chapter (verses 6–10), he recalls the familiar story. The day does not come until the final revolt in heaven and until the lawless one (the man of lawlessness, the son of Perdition) is revealed, which revelation cannot happen, until the controlling or restraining thing or person is removed. Then, however, the tool of Satan will appear, but the Lord will destroy him with the breath of his mouth and annihilate him with the majesty of his presence (2 Thess. ii. 1–12). Following the formal order of the First Epistle, he again thanks God that his converts are chosen to salvation and prays that they may have strength and obey his orders oral or written. Even with a "finally," as in the first letter, he is not quite through, for the second point of the letter remains to be treated —the idlers. These, he says, must remember both his example (he was never guilty of begging) and his precept ("if any man will not work let him not eat"). They must work quietly and eat their own food. Those who refuse to heed his written orders are to be noted. The test of the genuineness of his letters is his autograph greeting (2 Thess. ii. 13–iii. 18).

The letter meets the known situation excellently. The new material, compared with the First Epistle, is the supplementary discussion of the time of the Parousia (2 Thess. ii. 1 ff.) and the fuller treatment of the idlers (2 Thess. iii. 1 ff.), the points about which the leaders sought advice. The style is Pauline even in the adaptation of Jewish apocalyptic material to Christian purposes. Indeed, the outline of the letter is strikingly similar to that of the First Epistle, and many phrases hold over. At the same time there is a freedom of style suggesting not the imitator but the same author. And above all, especially in the treatment of the idlers, the letter reveals a knowledge of the situation which is even more explicit than that of the First Epistle. On such grounds, together with the excellent external attestation, it is probable, as recent writers hold (*e.g.* Zahn, Wohlenberg, Harnack, Jülicher, Findlay, Askwith, Charles, Bacon, McGiffert, Moffatt, Milligan, *et al.*), that the letter is Paul's.

The objection to the Pauline authorship felt by the Tübingen school may, for brevity's sake, be here disregarded. The modern difficulties, expressed mainly by recent German scholars (*e.g.* Wrede and Holtzmann and others), centre not in the un-Pauline language or in the lack of the personal element, but in the eschatology and the over-Pauline character of the language. As to the first objection, the eschatology, it is replied that the section ii. 1–12 is scarcely an interpolation, since it is one of the two main reasons for the letter; that the material of the section is a distinct allusion to, if not a direct quotation of, a definite bit of Jewish apocalyptic, even if we do not connect it, as Bousset does, with a so-called Antichrist legend; that the alleged inconsistency between the eschatology of the First and the Second Epistle does not exist, for in the first letter Paul says not that the day is present, but that the day, when it comes, comes suddenly "as a thief in the night," while in the second letter he expressly denies the statement attributed to him, namely, that "the day is present." Wrede, in his brilliant argument against the genuineness of the letter (*Die Echtheit des zweiten Thessalonicherbriefes*, 1903), inclines to admit that the argument from eschatology is secondary.

As to the second objection, the over-Pauline character of the letter, an objection used with rigour by McGiffert (whose article on these letters in the *Ency. Biblica* is the most satisfactory discussion known to the present writer), and renewed independently by Wrede, it is to be admitted that the similarity of the second to the first letter is striking, particularly in the formal arrangement of the material. At the same time, the differences, both in arrangement and in the content of the reminiscences, are not to be overlooked, as McGiffert and after him Wernle (*Gött. gel. Anz.*, 1905, pp. 347–52) have both rightly maintained. Again there should be no disparagement of the new material such as is to be found in Holtzmann's acute discussion (*Z. N. T. W.*, 1901, pp. 97–108). On the whole, the perplexing situation seems to be met on the assumption that Paul writes the Second Epistle either with a letter from Thessalonica before him, which itself suggested the main points of his own epistle, or with a copy or a summary of that epistle before him (cf. Zahn and McGiffert).

The alternative is forgery, as Holtzmann, Wrede and Hollmann (*Z. N. T. W.*, 1904, pp. 28–38) actually hold. The difficulty with this hypothesis is that it does not explain so many facts as the hypothesis of Pauline authorship. As it is improbable that the forger would write during the lifetime of Paul, the date has to be put either shortly after his death, or with Wrede at the end of the century. But this late date creates the insuperable difficulty that iii. 1 ff. gives a more explicit account of the original situation in Thessalonica touching the idlers than does the First Epistle. The purpose moreover of the forgery could not be to discredit the First Epistle as un-Pauline, for the alleged trouble is that the Second Epistle is too Pauline. Hence the purpose is to correct the statements of the First Epistle. If, however, there is no inconsistency between the two letters on the score of eschatology, what is the forger's purpose? The teaching about premonitory signs is not new to Thessalonica, but is assumed as known, hence the allusive character of the second chapter. The statements in ii. 2 and iii. 17 are easily explicable on the hypothesis that the idlers found an anonymous letter and attributed it to Paul, especially when they thought, perhaps in good faith, that the Spirit had indicated that the day is present. Finally, the forger handles Paul's style with miraculous knowledge, not only reproducing phrases from the first letter, but knowing how to amend them to present purposes with singular naturalness. When it comes to putting Christian touches to a Jewish fragment, the touches turn out to be uniquely Pauline, although they are not obviously Pauline (*e.g.* i. 6–10 "εἴπερ," "obey the Gospel," "was believed"). And even with the thought of Paul, he is curiously at home. So certain is he of the substance of Paul's thought, that he can reproduce it in a concise sentence without recourse to the word "justification" (*e.g.* i. 11). On the whole, then, the situation created by the literary relation of the two letters is best met by the hypothesis that Paul is the author of the Second Epistle.

In addition to the literature mentioned under Colossians, Epistle to the, and the special literature already named in this article, reference should be made to the commentaries on these letters by Ellicott (1858), Jowett (1859), Eadie (1877), Hutchinson (1883), Lightfoot (Notes, 1895), Drummond (1899), Findlay (1892 and 1904), Milligan (1908), and Moffatt (1908); and by Schmidt (1885), Zimmer (1885–93), Schmiedel (1892), Zöckler (1894), Bornemann (1894), B. Weiss (1896) and Wohlenberg (1903).

(J. E. F.)

THESSALY, a district of northern Greece, between Macedonia and the more purely Hellenic countries towards the south, and between the upland region of Epirus and the Aegean Sea. It forms an irregular square, extending for about sixty miles in each direction, and this area, which is for the most part level, is enclosed by well-marked boundaries—by the Cambunian Mountains on the north, and by Othrys on the south, while on its western side runs the massive chain of Pindus, which is the backbone of this part of Greece, and towards the east Ossa and Pelion stand in a continuous line; at the north-eastern angle is Olympus, the keystone of the whole mountain system. The elevation of some of the summits in these ranges is considerable, for three of the peaks of Pindus are over 5000 ft., and Olympus, Ossa and Pelion reach respectively the height of 9790, 6398 and 5350 ft. The country that is contained within these limits is drained by a single river, the Peneius, which, together with the water of its numerous confluents, passes into the sea through the Vale of Tempe.

On the north side of Thessaly there was an important pass from Petra in Pieria by the western side of Olympus, debouching on the plain northward of Larissa; it was by this that Xerxes entered, and we learn from Herodotus (vii. 173) that, when the Greeks discovered the existence of this passage, they gave up all thoughts of defending Tempe. On the side of Epirus the main line of communication passed over that part of Pindus which was called Mount Lacmon, and descended the upper valley of the Peneius to Aeginium in the north-west angle of Thessaly. This was the route by which Julius Caesar arrived before the battle of Pharsalia. Another pass through the Pindus chain was that of Gomphi, farther south, by means of which there was communication with the Ambracian Gulf. The great southern pass was that of Coela, which crosses Mount Othrys nearly opposite Thermopylae. These Thessalian passes were of the utmost importance to southern Greece, as commanding the approaches to that part of the country.

Though Thessaly is the most level district of Greece, it does not present a uniform unbroken surface, but is composed of a number of sections which open out into one another, divided by ranges of hills. The principal of these were called Upper and Lower Thessaly, the former comprising the western and south-western part, which contains the higher course of the Peneius and all those of its tributaries that flow from the south—the Enipeus, the Apidanus, the Onochonus and the Pamisus; while the latter, which reaches eastward to the foot of Ossa and Pelion, is inundated in parts at certain seasons of the year by the Peneius, the flood-water from which forms the lake Nessonis, and, when that is full, escapes again and pours itself into the lake of Boebe. The chief city of the latter of these districts was Larissa; and the two were separated from one another by a long spur, which runs southwards from the Cambunian Mountains on the western side of that city. Again, when Thessaly, is entered from the south by the pass of Coela, another plain, containing a small lake, which was formerly called Xynias, intervenes, and a line of low hills has to be crossed before the town of Thaumaki is reached, which from its commanding position overlooks the whole of the upper plain. The view from this point has been described by Livy in the following remarkable passage:—"When the traveller, in passing through the rugged districts of Thessaly, where the roads are entangled in the windings of the valleys, arrives at this city, on a sudden an immense level expanse, resembling a vast sea, is outspread before him in such a manner that the eye cannot easily reach the limit of the plains extended beneath" (xxxii. 4). To the north-east of this, where a portion of the great plain begins to run up into the mountains, the Plain of Pharsalia is formed, which is intersected by the river Enipeus; and still farther in the same direction is the scene of another great battle, Cynoscephalae. Thessaly was further subdivided into four districts, of which Pelasgiotis embraced the lower plain of the Peneius, and Hestiaeotis and Thessaliotis respectively the northern and the southern portions of the upper plain; while the fourth, Phthiotis, which lies towards the south-east, was geographically distinct from the rest of the country, being separated from it by a watershed. The determining feature of this is the Pagasaeus Sinus (Gulf of Volo), a landlocked basin, extending from Pagasae at its head to Aphetae at its narrow outlet, where the chain of Pelion, turning at right angles to its axis at the end of Magnesia, throws out a projecting line of broken ridges, while on the opposite side rise the heights of Othrys. In the heroic age this district was of great importance. It was the birthplace of Greek navigation, for this seems to be implied in the story of the Argonauts, who started from this neighbourhood in quest of the golden fleece. From it the great Achilles came, and, according to Thucydides (i. 3), it was the early home of the Hellenic race. The site of Iolcus, the centre of so many poetic legends, is at no great distance from the modern Volo. Near that town also, at a later period, Demetrius Poliorcetes founded the city of Demetrias, which was called by Philip V. of Macedon one of the three fetters of Greece, Chalcis and Corinth being the other two.

The history of Thessaly is closely connected with its geography. The fertility of the land offered a temptation to invaders, and was thus the primary cause of the early migrations. It was this motive which first induced the Thessalians to leave their home in Epirus and descend into this district, and from this movement arose the expulsion of the Boeotians from Arne, and their settlement in the country subsequently called Boeotia; while another wave of the same tide drove the Dorians also southward, whose migrations changed the face of the Peloponnese. Again, this rich soil was the natural home of a powerful aristocracy, such as the families of the Aleuadae of Larissa and the Scopadae of Crannon; and the absence of elevated positions was unfavourable to the foundation of cities, which might have fostered the spirit of freedom and democracy. The plains, also, were suited to the breeding of horses, and consequently the force in which the Thessalian nation was strong was cavalry, a kind of troops which has usually been associated with oligarchy. The wealth and the semi-Hellenic character of the people—for in race, as in geographical position, the Thessalians held an intermediate place between the non-Hellenic Macedonians and the Greeks of pure blood—caused them to be wanting in patriotism, so that at the time of the Persian wars we find the Aleuadae making common cause with the enemies of Greece. When they were united they were a formidable power, but, like other half-organized communities, they seldom combined for long together, and consequently they influenced but little the fortunes of the Greeks.

For several centuries during the middle ages Rumanian immigrants formed so large a part of the population of Thessaly that that district was called by the Byzantine writers Great Wallachia (Μεγάλη Βλαχία): the Jewish traveller, Benjamin of Tudela, who passed through the country in the latter half of the 12th century, describes them as then occupying it. At the present day only a few colonies of that race remain, the principal of which are found on the western side of Olympus and in some of the gorges of Pindus. The Turkish inhabitants were settled in the larger towns, and here and there in the country districts, the most important colony being those called Koniarates, who were brought from Konia in Asia Minor shortly before the taking of Constantinople, and planted under the south-west angle of Olympus. The Greeks, however, form the vast majority of the population, so much so that, even while the country belonged to the Ottomans, Greek was employed as the official language. In accordance with the provisions of the Berlin treaty, Thessaly was ceded to the Greeks by the Porte in 1881, and became a portion of the Hellenic kingdom. Since that time the prosperity of the province has greatly increased. The port of Volo, which is almost the only outlet of the trade of the whole district, has become an important town of 23,000 inhabitants, and daily communication by steamers now exists between it and Athens. The interior of the country has also been opened up by means of railways. One line runs north-westwards from Volo by way of Velestino (the ancient Pherae) to Larissa, which is situated on the Salambria (Peneius), and has a population of 18,000 souls, including 2000 Jews. The Greeks, Turks and Jews here occupy different quarters of the city, but most of the Turkish inhabitants have now quitted the country, so that only four of the numerous mosques remain in use. From Velestino another line branches off to the west by Phersala (Pharsalos), Domokos (Thaumaki), Karditsa, and Trikkala (Trika), to Kalabaka (Aeginium), where the upper valley of the Salambria is entered. In the neighbourhood of the last-named place, where the Cambunian chain of mountains descends in steep precipices to the plain, are the Meteora ("mid-air") monasteries (see METEORA).

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THETFORD, a market town and municipal borough of England, mostly in the south-western parliamentary division of Norfolk, but partly in the Stowmarket division of Suffolk, 91 m. N.N.E. from London by the Great Eastern railway. Pop. (1901) 4613. The town lies in a level, fertile country at the junction of the river Thet with the Little Ouse. In the time of Edward III. the town had twenty churches and eight monasteries. There are now three churches—St Peter's, St Cuthbert's and St Mary's—principally of Perpendicular flint work; of these St Mary's, on the Suffolk side, is the largest. There are a few monastic remains, the chief being two gate-houses. The most important relic of antiquity is the Castle Hill, a mound 1000 ft. in circumference and 100 ft. in height. The grammar school was founded in 1610. In King Street is the mansion-house occupied as a hunting-lodge by Queen Elizabeth and James I. The chief public buildings are a gild hall and a mechanics' institute; there are several charities. Brewing and tanning are carried on; and there are also manure and chemical works, brick- and lime-kilns, flour-mills and agricultural implement works, engineering works and iron foundries. The Little Ouse is navigable for barges down to the Great Ouse. Thetford is a suffragan bishopric in the diocese of Norwich. The town is governed by a mayor, 4 aldermen, and 12 councillors. Area, 7096 acres.

Early antiquaries identified Thetford (Theodford, Tetford, Tefford) with Sitomagus, but modern research shows that there is no conclusive evidence of a permanent settlement before the coming of the Angles. Tradition tells that Uffa, who probably threw up the earthworks called the Castle Hill, established the capital of East Anglia here about 575. Thetford owned a royal mint in the 9th century and was a flourishing town when the Conqueror acquired it. Richard I. granted it to Hamelin, Earl Warenne, and when his heirs failed, it merged in the duchy of Lancaster and so in the crown. About 1290 its principal officers were a mayor and coroner, afterwards assisted by eight burgesses, whom Henry VIII. increased to ten. The town, never very prosperous since the Conquest, had then fallen into great decay, but the petitions of the burgesses for a charter were not heeded till 1573 when Elizabeth incorporated it under a mayor and common council. This charter, restored in 1692 after its surrender to Charles II., remained in force till 1835 when the borough was re-constituted. Thetford returned two members to parliament from 1529 till its disfranchisement in 1868. Its Saturday market, which certainly existed in the 13th century, was granted by the charter of 1573 and also a Magdalen fair (the 22nd of July). Fisheries were important in the 13th century.

See A. L. Hunt, *Capital of East Anglia* (1870); T. Martin, *History of Thetford* (1779).

THETIS, in Greek mythology, daughter of Nereus, wife of Peleus and mother of Achilles. The chief of the fifty Nereids, she dwelt in the depths of the sea with her father and sisters. When Dionysus leaped into the sea to escape from the pursuit of Lycurgus, king of the Thracian Edones, and Hephaestus was flung out of heaven by Zeus, both were kindly received by Thetis. Again, when Hera, Athena and Poseidon threatened to bind Zeus in chains, she sent the giant Aegaeon, who delivered him out of their hands. She was married against her will to Peleus (*q.v.*; see also ACHILLES). Thetis is used by Latin poets simply for the sea.

THEURIET, CLAUDE ADHÉMAR ANDRÉ (1833–1907), French poet and novelist, was born at Marly-le-Roi (Seine et Oise) on the 8th of October 1833, and was educated at Bar-le-Duc in his mother's province of Lorraine. He studied law in Paris and entered the public service, attaining the rank of *chef de bureau* before his retirement in 1886. He published in 1867 the *Chemin des bois*, a volume of poems, many of which had already appeared in the *Revue des Deux Mondes; Le bleu et le noir, poèmes de la vie réelle* (1874), *Nos oiseaux* (1886), and other volumes followed. M. Theuriet gives natural, simple pictures of rustic and especially of woodland life, and Théophile Gautier compared him to Jaques in the forest of Arden. The best of his novels are those that deal with provincial and country life. Among them are: *Le mariage de Gérard* (1875); *Raymonde* (1877); *Le fils Maugars* (1879); *La maison des deux Barbeaux* (1879); *Sauvageonne* (1880); *Reine des bois* (1890); *Villa tranquille* (1899); *Le manuscrit du chanoine* (1902). Theuriet received in 1890 the *prix Vitet* from the French Academy, of which he became a member in 1896. He died on the 23rd of April 1907, and was succeeded at the Academy by M. Jean Richepin.

See Emm. Besson, *André Theuriet* (1890).

THÉVENOT, JEAN DE (1633–1667), French traveller in the East, was born in Paris on the 16th of June 1633, and received his education in the college of Navarre. The perusal of works of travel moved him to go abroad, and his circumstances permitted him to please himself. Leaving France in 1652, he first visited England, Holland, Germany and Italy, and at Rome he fell in with D'Herbelot, who invited him to be his companion in a projected voyage to the Levant. D'Herbelot was detained by private affairs, but Thévenot sailed from Rome in May 1655, and, after vainly waiting five months at Malta, took passage for Constantinople alone. He remained in Constantinople till the end of the following August, and then proceeded by Smyrna and the Greek islands to Egypt, landing at Alexandria on New Year's Day, 1657. He was a year in Egypt, then visited Sinai, and, returning to Cairo, joined the Lent pilgrim caravan to Jerusalem. He visited the chief places of pilgrimage in Palestine, and, after being twice taken by corsairs, got back to Damietta by sea, and was again in Cairo in time to view the opening of the canal on the rise of the Nile (on the 14th of August 1658). In January 1659 he sailed from Alexandria in an English ship, taking Goletta and Tunis on the way, and, after a sharp engagement with Spanish corsairs, one of which fell a prize to the English merchantman, reached Leghorn on the 12th of April. He now spent four years at home in studies useful to a traveller, and in November 1663 again sailed for the East, calling at Alexandria and landing at Sidon, whence he proceeded by land to Damascus, Aleppo, and then through Mesopotamia to Mosul, Bagdad and Mendeli. Here he entered Persia (the 27th of August, 1664), proceeding by Kermanshah and Hamadan to Isfahan, where he spent five months (October 1664–February 1665), and then joining company with the merchant Tavernier, proceeded by Shiraz and Lar to Bander-Abbasi, in the hope of finding a passage to India. This was difficult, because of the opposition of the Dutch, and though Tavernier was able to proceed, Thévenot found it prudent to return to Shiraz, and, having visited the ruins of Persepolis, made his way to Basra and sailed for India on the 6th of November 1665, in the ship "Hopewell," arriving at the port of Surat on the 10th of January 1666. He was in India for thirteen months, and crossed the country by Golconda to Masulipatam, returning overland to Surat, from which he sailed to Bander-Abbasi and went up to Shiraz. He passed the summer of 1667 at Isfahan, disabled by an accidental pistol-shot, and in October started for Tabriz, but died on the way at Miyana on the 28th of November 1667.

Thévenot was an accomplished linguist, skilled in Turkish, Arabic and Persian, and a curious and diligent observer. He was also well skilled in the natural sciences, especially in botany, for which he made large collections in India. His personal character was admirable, and his writings are still esteemed, though it has been justly observed that, unlike Chardin, he saw only the outside of Eastern life. The account of his first journey was published at Paris in 1665; it forms the first part of his collected *Voyages*. The licence is dated December 1663, and the preface shows that Thévenot himself arranged it for publication before leaving on his second voyage. The second and third parts were posthumously published from his journals in 1674 and 1684 (all 4to). A collected edition appeared at Paris in 1689, and a second in 12mo at Amsterdam in 1727 (5 vols.). There is an indifferent English translation by A. Lovell (fol., London, 1687).

THIAZINES, in organic chemistry, a series of cyclic compounds containing a ring system of four carbon atoms, one nitrogen and one sulphur atom. These may be grouped in three ways, giving the following skeletal structures:—

$$\text{(I.)}\ \begin{array}{c}C\cdot C\cdot N\\ \dot{C}\cdot C\cdot \dot{S}\end{array}\ ,\qquad \text{(II.)}\ \begin{array}{c}C\cdot N\cdot C\\ \dot{C}\cdot C\cdot \dot{S}\end{array}\ ,\qquad \text{(III.)}\ \begin{array}{c}C\cdot N\cdot C\\ \dot{C}\cdot S\cdot \dot{C}\end{array}$$

Members of the first series have not as yet been isolated. Derivatives of the second type have been obtained by A. Luchmann (*Ber.* 1896, 29, p. 1429) by condensing γ-chlorbutylamine with carbon bisulphide or with mustard oils in the presence of caustic alkali; by M. Kahan (*ibid.*, 1897, 30, p. 1321) on condensing bromhexylamine hydrobromide with thiobenzamide:

$$\begin{array}{l}\quad CH_2\cdot CH(CH_3)Br\\ (CH_3)_2\dot{C}\cdot NH_2\end{array} + \begin{array}{l}\quad HS\\ HN:\dot{C}\cdot C_6H_5\end{array} \rightarrow \begin{array}{l}\quad CH_2\cdot CH(CH_3)\cdot S\\ (CH_3)_2\dot{C}-N=\!=\!=\!=\dot{C}\cdot C_6H_5\end{array}$$

Benzothiazines are obtained from ortho-aminobenzyl halides and thio-amides:

$$C_6H_4\left\langle\begin{array}{l}CH_2Br\\ NH_2\end{array}\right. + H_2N\cdot CS\cdot CH_3 \rightarrow C_6H_4\left\langle\begin{array}{l}CH_2\cdot S\\ \quad\ \ \ |\\ N=\!=C\cdot CH_3.\end{array}\right.$$

The most important thiazines are those derived from class III., thiodiphenylamine, $C_6H_4\left\langle\begin{array}{c}N\\ S\end{array}\right\rangle C_6H_4$, being the parent substance of the methylene blue series of dyestuffs. Thiodiphenylamine is obtained synthetically by heating sulphur with diphenylamine or by the condensation of ortho-aminothiophenol with pyrocatechin. It is a compound of neutral reaction. The first known dyestuff of this series was Lauth's violet, which was prepared by oxidizing paraphenylene diamine in acid solution in the presence of sulphur. By using dimethyl paraphenylene diamine in place of the simple diamine, methylene blue is obtained. The relationship of these substances to thiodiphenylamine was shown by A. Bernthsen, who, by nitration of thiodiphenylamine, cbtained a dinitro-compound which on reduction was converted into the corresponding di-amino-derivative and this on oxidation yielded Lauth's violet.

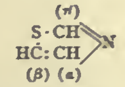
$$C_6H_4\left\langle{NH \atop S}\right\rangle C_6H_4 \rightarrow NO_2\cdot C_6H_3\left\langle{NH \atop S}\right\rangle C_6H_3\cdot NO_2 \rightarrow NH_2\cdot C_6H_3\left\langle{NH \atop S}\right\rangle C_6H_3\cdot NH_2 \rightarrow HN:C_6H_3\left\langle\!\left\langle{N \atop S}\right\rangle\right. C_6H_3\cdot NH_2$$

Methylene blue is the most important of all blue basic dyes and is put on the market frequently in the form of its zinc chloride double salt, which is soluble in water. Acid oxidants in dilute aqueous solution convert it into methylene azure.

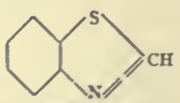
See further A. Bernthsen, *Ann.*, 230, p. 73; 251, p. 1; German Patents 45839 (1887); 47374 (1888). For a discussion as to the constitution of these dyestuffs, whether they are quaternary ammonium salts or thionium salts, see A. Hantzsch, *Ber.*, 1906, 39, pp. 153, 1365; F. Kehrmann, *ibid.*, 1906, 39, p. 914.

THIAZOLES, in organic chemistry, a series of heterocyclic compounds containing the grouping shown below; the replaceable hydrogen atoms in which are designated α, β and μ. They are prepared by condensing thio-amides with α-haloid ketones or aldehydes, the thio-amide reacting as the tautomeric thio-imino acid. Amino derivatives similarly result from thio-ureas and α-haloid ketones; the oxy derivatives from α-sulphocyanoketones by the action of caustic alkali; and the carboxylic acids from chloro-aceto-acetic ester, &c. and thioamides. The thiazoles are somewhat basic in character, and combine with the alkyl iodides to form thiazolium iodides.

Dihydrothiazoles, or thiazolines, are obtained by condensing ethylene dibromides with thio-amides; by the action of β-haloid alkylamines on thio-amides (S. Gabriel, *Ber.*, 1891, 24, p. 783; 1896, 29, p. 2610); and by the action of phosphorus pentasulphide on acyl-β-bromalkylamides (A. Salomon, *Ber.*, 1893, 26, p. 1328). They are much less stable than the thiazoles. The benzothiazoles are a series of weak bases formed by condensing carboxylic acids with ortho-aminothiophenols (A. W. Hofmann, *Ber.*, 1880, 13, p. 1224), by heating the acid anilides with sulphur or by the oxidation of thio-anilides. On fusion with caustic alkalis they decompose into their constituent aminothiophenol and acid. Derivatives of this group are important as substantive cotton dyestuffs.



Thiazole.



Benzothiazole.

THIBAUDEAU, CLAIR ANTOINE, Comte (1765–1854), French politician, was born on the 23rd of March 1765, the son of Antoine de Thibaudeau (1739–1813), a lawyer of Poitiers and a deputy to the States-General of 1789. He was admitted to the bar in 1787, and in 1789 accompanied his father to the States-General at Versailles. When he returned to Poitiers in October he immediately set up a local revolutionary club, and in 1792 was returned as a deputy to the Convention.

Thibaudeau joined the party of the Mountain and voted for the death of Louis XVI. unconditionally. Nevertheless he incurred a certain amount of suspicion because he declined to join the Jacobin Club. In May 1793 he was on a special mission in the west and prevented his department from joining the Federalist movement. Thibaudeau occupied himself more particularly with educational business, notably in the organization of the museum of the Louvre. It was he who secured the inclusion of Tom Paine's name in the amnesty of Girondist deputies. Secretary and then president of the Convention for a short period, he served on the Committee of Public Safety and of Generaly Security. After the insurrection of 13 Vendémiaire (5th October 1795) he opposed those Thermidorians who wished to postpone the dissolution of the Convention. At the elections for the Corps Législatif he was elected by no less than thirty-two departments. It was only by the intervention of Boulay de la Meurthe that he escaped transportation after the *coup d'état* of 18 Fructidor (4th September 1797), and he then returned to the practice of his profession. The establishment of the consulate brought him back to public life. He was made prefect of the Gironde, and then member of the council of state, in which capacity he worked on the civil code. He at this time had Napoleon's confidence, and gave him wholehearted support. He did not entirely conceal his disapproval of the foundation of the Legion of Honour, of the Concordat and of the Consulate for life, and his appointment as prefect of the Bouches du Rhône, with consequent banishment from Paris, was a semi-disgrace.

A peer of the Hundred Days, he fled at the second Restoration to Lausanne. During his exile he lived in Vienna, Prague, Augsburg and Brussels, occupying himself with his *Mémoires sur la Convention et le Directoire* (Paris, 2 vols., 1824); *Mémoires sur le Consulat: par un ancien conseiller d'état* (Paris, 1827); *Histoire générale de Napoléon Bonaparte* (6 vols., Paris and Stuttgart, 1827–28, vol. iii. not printed); *Le Consulat et l'Empire* vol. i. of which is identical with vol. vi. of the *Histoire de Napoléon* (10 vols.; 1834). The revolution of 1830 permitted his return to France, and he lived to become a member of the Imperial Senate under the third empire. He died in Paris on the 8th of March 1854 in his eighty-ninth year.

The special value of Thibaudeau's works arises from the fact that he wrote only of those events of which he had personal knowledge, and that he quotes with great accuracy Napoleon's actual words. His *Mémoires sur le Consulat* has been translated into English, with introduction and necessary notes, by G. K. Fortescue with the title of *Bonaparte and the Consulate* (1908). Among the papers left by Thibaudeau were documents entitled *Ma Biographie* and *Mémoires avant ma nomination à la Convention.* These were published in a small volume (Paris and Niort, 1875) which includes a list of his works and of the narrative of his life.

THIBAUT (or Theobald) **IV.** (1201–1253), count of Champagne and Brie, and king of Navarre, French poet, was born at Troyes in 1201. His father, Thibaut III. of Champagne, died before his son's birth, and his mother, Blanche of Navarre, was compelled to resign the guardianship of the young prince to Philip Augustus, king of France, but there is little doubt that the child was acquainted with Chrétien de Troyes and the other trouvères who found patronage at the court of Champagne. Thibaut's verses belong to what is called "courteous" poetry, but they have a personal note that distinguishes them from mere exercises. They are addressed to Blanche of Castille, the wife of Louis VIII., and Thibaut's relations with her have been the subject of much controversy. The count took part with Louis in the crusade against the Albigenses, but in 1226, with no apparent reason, left the king and returned to Champagne. Three months later Louis died under doubtful circumstances, and Thibaut was accused by his enemies of poisoning him to facilitate his own intrigue with Blanche. The real reason for Thibaut's desertion appears to have been a desire to consolidate his position as heir-apparent of Navarre by an alliance with the disaffected nobility of the south of France, but from this confederation Blanche was skilful enough to detach him. The resentment of the league involved him in a war in which Champagne was laid waste, and his capital saved only by the royal intervention. In 1234 he succeeded his uncle, Sancho VII., as king of Navarre, and from this period date his most fervent songs in praise of his lady. The crusade turned Thibaut's thoughts to religion, and he announced his intention of singing henceforth only in honour of the Virgin. Unfortunately his devotion took darker forms, for before sailing for the Holy Land he ordered and witnessed the burning of a hundred and eighty-three unfortunate men and women convicted of Manichaeism. The years 1239 and 1240 were spent in Palestine, and from the time of his return Thibaut devoted himself to efforts for the improvement of his dominions that won for him the title of *le Bon*. He died at Pampeluna on the 14th of July 1253.

Thibaut was the most popular of all the 13th century song-writers, and his work is marked by a grace and sweetness which he owes perhaps in part to his association with the troubadours of the south. He is said to have set his own songs to music. It seems doubtful whether the notes that have come down to us can with justice be attributed to him, but there is no contesting the musical quality of his verse. His fame spread beyond the Alps, and Dante admired his poetry. He was one of the most celebrated authors of *jeux-partis*, elaborate discussions between two interlocutors, usually on the subject of love.

His works were edited in 1851 by P. Tarbé in his *Chansonniers de Champagne*.

THIBAUT, ANTON FRIEDRICH JUSTUS (1774–1840), German jurist, was born at Hameln, in Hanover, on the 4th of January 1774, the son of an officer in the Hanoverian army, of French Huguenot descent. After passing his school-days in Hameln and Hanover, young Thibaut entered the university of Göttingen as a student of jurisprudence, went thence to Königsberg, where he studied under Kant, and afterwards to Kiel, where he was a fellow-student with Niebuhr. Here, after taking his degree of *doctor juris*, he became a *Privatdozent*. In 1798 he was appointed extraordinary professor of civil law, and in the same year appeared his *Versuche über einzelne Theile der Theorie des Rechts* (1798), a collection of essays on the theory of law, of which by far the most important was entitled *Über den Einfluss der Philosophie auf die Auslegung der positiven Gesetze*, wherein he sought to show that history without philosophy could not interpret and explain law. In 1799 was published his *Theorie der logischen Auslegung des römischen Rechts*, one of his most remarkable works. In 1802 he published a short criticism of Feuerbach's theory of criminal law, which recalls in many ways the speculations of Bentham. The same year appeared *Über Besitz und Verjährung*, a treatise on the law of possession and the limitation of actions. In 1802 Thibaut was called to Jena, where he spent three years and wrote, in Schiller's summer-house, his chief work, *System des Pandektenrechts* (1803), which ran into many editions. The fame of this book depends before all else upon the fact that it was the first modern complete compendium of the subject, distinguished alike by the accuracy of its sources and the freedom and unpedantic manner in which the subject is handled. It is, in effect, a codification of the Roman law as it then obtained in Germany, modified by Canon law and the practice of the courts into a comprehensive system of Pandect law. At the invitation of the grand-duke of Baden he went to Heidelberg to fill the chair of civil law and to assist in organizing the university; and he never quitted that town, though he received in after years, as his fame grew, invitations to Göttingen, Munich and Leipzig. His class was large, his influence great; and, except Gustav Hugo and Savigny, no civilian of his time was so well known. In 1814 appeared his *Civilistische Abhandlungen*, of which the principal was his famous essay, the parent of so much literature, on the necessity of a national code for Germany (*vide infra*). In 1819 he was appointed to the upper house of the newly constituted Baden parliament. He was also made member of the Scheidungsgericht (divorce court). In 1836 Thibaut published his *Erörlerungen des römischen Rechts*. One of his last works was a contribution in 1838 to the *Archiv für die civilistische Praxis*, of which he was one of the editors (see below). Thibaut married, in 1800, a daughter of Professor Ahlers of Kiel. He died after a short illness, at Heidelberg, on the 29th of March 1840.

Thibaut, a man of strong personality and manly consistent nature, was much more than a jurist: he deserves to be remembered in the history of music. Palestrina and the early composers of church music were his delight; and in 1824 appeared anonymously his work, *Über die Reinheit der Tonkunst*, in which he eulogized the old music, and especially that of Palestrina. He was an ardent collector of old compositions, and often sent young men to Italy, at his own expense, to discover interesting musical manuscripts. Among the masters of German prose, too, Thibaut holds no mean place. His style is simple and manly, but rich in the happy accidents of expression which come only to true artists.

Most of Thibaut's works have already been mentioned, but his essay on the necessity of a code for Germany (*Über die Nothwendigkeit eines allegemeinen bürgerlichen Rechts für Deutschland*), which was inspired by the enthusiasm of the war of Liberation and written in fourteen days, deserves further notice. Thibaut himself explained in the *Archiv für die civilistische Praxis*, in 1838, the origin of this memorable essay. He had realized the change denoted by the march of German soldiers to Paris in 1814, and the happy future opened up for Germany. The system of small states he hoped and believed would continue; for the big state he considered crushing to the life of the individual and harmful as concentrating the "warm life" of the nation in one central point. In his judgment the only unity practicable and needful for Germany was that of law; and for this he urged all the German governments to labour. The essay was as much a condemnation of the entire state of jurisprudence as an argument for codification; it was a challenge to civilians to justify their very existence. Savigny took up the challenge thus thrown down; and a long controversy as to points not very clearly defined took place. The glory of the controversy belonged to Savigny; the real victory rested with Thibaut.

The framers of the new German civil code (*bürgerliches Gesetzbuch*) in 1879 were indebted for the arrangement of their matter in no small degree to Thibaut's method and clear classification, but beyond this, the code, based on the common law of the several German states, which was adroitly blended by the *usus pandectarum* into an harmonious whole, does not reflect his influence. He was one of the earliest to criticize the divisions found in the Institutes, and he carried on with Gustav Hugo a controversy as to these points.

In modern German legal literature Thibaut's influence is not very perceptible. Even at Heidelberg it was quickly superseded by that of his successor, Karl Adolf von Vangerow (1805–1870), and in Germany his works are now little used as text-books. But those best able to judge Thibaut have most praised him. Austin, who owed much to him, describes him as one "who for penetrating acuteness, rectitude of judgment and depth of learning and eloquence of exposition, may be placed by the side of von Savigny, at the head of all living civilians."

For further information as to Thibaut's life and work, see Baumstark, *Thibaut, Blätter der Erinnerung* (1841); Karl Hagemann, *Aus dem Leben H. F. J. Thibaut, mit Correspondenz*, in *die Preuss. Jahrbücher* (1880); Teichmann, in *Holtzendorff's Rechtslexikon;* and E. Landsberg, in *Allgemeine Deutsche Biographie*, vol. 37.

THIBAW, or HSIPAW, one of the Northern Shan States of Burma. It is called by the Shans, and officially, Hsipaw, and also frequently Ông Pawng (the name of an old capital). It includes four states—Thibaw, the main state, and the sub-states of Möng Lông, Möng Tung and Thonzè (or Hsumhsai). The whole state has an area of 5086 sq. m., and the population in 1901 was 104,700. The main state lies on the geological fault which runs east and west across the Shan States, from the Salween at Kunlông and beyond to nearly the rim of the Shan tableland at Gôkteik. It is therefore broken up into a mass of not very well-defined ridges and spurs, crossing and re-entering. The chief plain land is in the valley of the Nam Tu (Myit-ngè), near Thibaw town, and the valley or strath of the Pyawng Kawng, Nawng Ping neighbourhood. Elsewhere the valleys are insignificant. The hills on the Möng Tung border reach their highest elevations in the peaks Loi Pan (6848 ft.) and Loi Htan (6270 ft.). To the north-west of Thibaw town, on the Tawng Peng border, Loi Lam rises to 6486 ft. The valley of the Nam Tu marks the lowest point in the state at Thibaw town, about 1400 ft., and rises on the east in Möng Tung to a plain level of about 2500 ft., and on the west in Möng Lông to a confused mass of hills with an average height of 4500 ft., broken up by the Nam Yawn and Nam Kaw valleys, which are about 3000 ft. above mean sea-level.

The chief river is the Nam Tu or Myit-ngè, also frequently called by its classical name the Dôktawadi. The main stream rises in the Salween-Irrawaddy watershed, and is enlarged by considerable tributaries. At Thibaw town it is 250 yds. wide and about 8 ft. deep, with a fairly strong current. The Nam Tu is navigable only in local stretches, and between Thonzè and Lawksawk (Yatsauk) it flows through a gorge between cliffs 3000 to 4000 ft. high. At the gorge of Hokût (Ngôkteik) the Nam Htang and the Nam Pasè unite to form the Nam Küt, which passes into the ground at the natural bridge where the Mandalay-Kunlông railway crosses the gorge, and reappears to join the Nam Tu. The bed of the Nam Küt is about 1500 ft. below the general level of the country. Coal is found at various places in the state, but is not of very high quality. Salt-wells are worked by the inhabitants of Mawhkio (Bawgyo) about 7 m. from Thibaw town. The average maximum temperature at the beginning of April is about 96°, and the minimum about the same period 65°. The rainfall averages about 70 in. for the year. The chief crops are rice, cotton, sesamum, tea in the hills, and *thanat*, the leaf of a tree used for the wrapper of the Burma, or "green" cheroot. Cotton cloth was formerly much more generally manufactured than it now is, and a coarse country paper is also made. Other industries are merely of articles for local use. The government cart road to Lashio passes through the centre of the state, and from this various unmetalled roads radiate to different parts of the state and the neighbouring states. The Mandalay-Kunlông railway, now open as far as Lashio, also passes through the capital. Teak forests exist along the banks of the Nam Tu and in the Möng Lông states, but both have been practically exhausted, and will have to be closed for many years. Previous to the annexation, and in a general way still, the state is administered by the *sawbwa*, or chief, aided by a council of six *amats* or ministers. Under them are a number of *nè-baings*, who are in charge of circles and townships. Each *nè-baing* has an *asiyin*, or clerk, and each village has a headman, or *kin-man*. The *amats* supervise the administration of a certain number of districts. The old system is now being assimilated to that followed in Burma. The chief Sao Hkè was for a time in England. (J. G. Sc.)

THIELMANN, JOHANN ADOLF, Freiherr von (1765–1824), Prussian cavalry soldier, was born at Dresden. Entering the Saxon cavalry in 1782, he saw service against the French in the Revolutionary Wars and in the Jena campaign. When, after the disaster of Jena, Saxony allied herself with her conqueror, Thielmann accompanied the Saxon contingent which fought at the siege of Danzig and at Friedland. In 1809, as colonel of a Free-Corps, he opposed the advance of the Austrians into Saxony, and was rewarded for his services with the grade of major-general, further promotion to lieutenant-general following in 1810. As commander of the Saxon Heavy Cavalry Brigade he took part in the advance on Moscow two years later, and his conduct at Borodino attracted the attention of Napoleon, who took Thielmann into his own suite. His own sovereign at the same time made him Freiherr. In the war of Liberation Thielmann took a prominent part; as governor of Torgau, by his king's orders he at first observed the strictest neutrality, but on receipt of an order to hand over the fortress to the French he resigned his command and, accompanied by his staff officer Aster, joined the allies. As a Russian general he was employed in reorganizing the Saxon army after Leipzig, and in 1814 he commanded the Saxon corps operating in the Low Countries. Early in the following year he became a lieutenant-general in the Prussian service, and in command of the 3rd army corps he took part in the Waterloo campaign. From the field of Ligny he retired with the rest of Blücher's army on Wavre, and when the other corps marched towards Waterloo, Thielmann covered this movement against Grouchy, fighting the spirited action of Wavre (June 18–19). He was later a corps commander at Münster and at Coblenz, and at the latter place he died in 1824.

See von Hütel, *Biographische Skizze des Generals von Thielmann* (Berlin, 1828); von Holzendorff, *Beiträge zur Biographie des Generals Freiherrn von Thielmann* (Dresden, 1830); von Petersdorf, *General Johann Adolf Freiherr von Thielmann* (Leipzig, 1894).

THIERRY, the name of two French historians, the brothers Augustin and Amédée, both of whom, though their literary and historical powers were far from being equal, displayed the same devotion to historical study.

I. Jacques Nicolas Augustin Thierry (1795–1856), the elder and more gifted, was born at Blois on the 10th of May 1795. He had no advantages of birth or fortune, but was greatly distinguished at the Blois Grammar School, and entered the *École normale supérieure* (1811). In 1813 he left it, and was sent as a professor to Compiègne, but stayed there a very short time. His ardent and generous nature led him to embrace the ideas of the French Revolution with enthusiasm, and he became fired with Saint Simon's ideal society of the future. He became the secretary, and, as he would say himself, the "adopted son" of the famous visionary (1814–17); but, while most of Saint Simon's followers turned their attention to the affairs of life, devoting themselves to the problems, both theoretical and practical, of political economy, Thierry turned his to history. His imagination had been powerfully impressed by reading *Les Martyrs*, in which Châteaubriand had contrasted the two civilizations and the two races from which the modern world has sprung. His romantic ardour was later still further nourished by the works of Sir Walter Scott, and though he did not himself actually write romances, his conception of history fully recognized the dramatic element. His main ideas on the Germanic invasions, the Norman Conquest, the formation of the Communes, the gradual ascent of the nations towards free government and parliamentary institutions are already observable in the articles contributed by him to the *Censeur européen* (1817–20), and later in his *Lettres sur l'histoire de France* (1820). From Fauriel he learnt to use the original authorities; and by the aid of the Latin chronicles and the collection, as yet very ill understood, of the Anglo-Saxon laws, he composed his *Histoire de la Conquête de l'Angleterre par les Normands*, the appearance of which was greeted with great enthusiasm (1825). It was written in a style at once precise and picturesque, and was dominated by an idea, at once generous and false, that of Anglo-Saxon liberty resisting the invasions of northern barbarians, and reviving, in spite of defeat, in the parliamentary monarchy. His artistic talent as a writer makes the weaknesses and deficiencies of his scholarship less obvious. This work, the preparation of which had required several years of hard work,. cost Thierry his eyesight; in 1826 he was obliged to engage secretaries and in 1830 became quite blind. Notwithstanding, he continued to produce works. In 1827 he republished his *Lettres sur l'histoire de France*, with the addition of fifteen new ones, in which he described some of the more striking episodes in the history of the rise of the medieval communes. The chronicles of the 11th and 12th centuries and a few communal charters provided him, without requiring a great amount of erudition, with materials for a solid work. For this reason his work on the communes has not become so out of date as his Norman Conquest; but he was too apt to generalize from the facts furnished by a few striking cases which occurred in a small portion of France, and helped to spread among the public, and even among professional historians, mistaken ideas concerning one of the most complex problems relating to the social origins of France.

Thierry was ardent in his applause of the July Revolution and the triumph of liberal ideas; at this time, too, his brother Amédée was appointed prefect, and he went to live with him for four years. He now re-edited, under the title of *Dix ans d'études historiques*, his first essays in the *Censeur européen* and the *Courrier français* (1834), and composed his *Récits des temps mérovingiens*, in which he reproduced in a vivid and dramatic form some of the most characteristic stories of Gregory of Tours. These *Récits* appeared first in the *Revue des deux mondes*; when collected in volume form, they were preceded by long and interesting *Considérations sur l'histoire de France.* From the 7th of May 1830, Thierry had already been a member of the *Académie des Inscriptions et Belles Lettres;* in 1841, on the motion of Villemain, the French Academy awarded him the first *Prix Gobert*, which became a kind of literary inheritance for him, being renewed in his favour fifteen years in succession. Moreover, he had been allotted the task of publishing in the series of the *Documents inédits* a selection of acts bearing on the history of the Third Estate. By the aid of zealous collaborators (including Bourquelot and Louandre) he compiled, in four volumes, a valuable *Recueil des monuments inédits de l'histoire du Tiers État* (1850–70), which, however, bear only on the northern part of France. The preface appeared afterwards in a separate volume under the title of *Histoire du Tiers État.* To Thierry belongs the credit for inaugurating in France the really critical study of the communal institutions, and we cannot make him responsible for the neglect into which it relapsed after his death. The last years of his life were clouded by domestic griefs and by illness. In 1844 he lost his wife, Julie de Quérengal, an intelligent woman, who had been to him a collaborator as capable as she was devoted. The revolution of 1848 inflicted on him a final blow.

by overturning that régime of the Liberal *bourgeoisie* the triumph of which he had hailed and justified as the necessary outcome of the whole course of French history. He began to distrust the rationalistic opinions which had hitherto estranged him from the Church. When Catholic writers animadverted on the "historical errors" in his writings he promised to correct them, and accordingly we find that in the final edition of his *Histoire de la Conquête* his severe judgments on the policy of the court of Rome, together with some faults of detail, are eliminated. Though he did not renounce his Liberal friends, he sought the conversation of enlightened priests, and just before his death he seems to have been disposed to enter the pale of the Church. He died in Paris on the 22nd of May 1856, after several years of suffering endured with heroism.

II. Amédée Simon Dominique Thierry (1797–1873) was the younger brother of Augustin, and was born on the 2nd August 1797. He began life as a journalist (after an essay, like his brother, at schoolmastering), was connected with the famous romantic harbinger the *Globe*, and obtained a small government clerkship. His first book was a brief history of Guienne in 1825, and three years later appeared the first volume of the *Histoire des Gaulois*, which was received with much favour, and obtained him, from the royalist premier Martignac, a history professorship at Besançon. He was, however, thought too liberal for the government of Charles X., and his lectures were stopped, with the result of securing him, after the revolution, the important post of prefect of the Haute-Saône, which he held eight years. During this time he published nothing. In 1838 he was transferred to the council of state as master of requests, which post he held through the revolution of 1848 and the *coup d' état* till 1860, when he was made senator—a paid office, it must be remembered, and, in effect, a lucrative sinecure. He also passed through all the ranks of the Legion of Honour, became a member of the Académie des Inscriptions in 1841, and in 1862 received the honorary degree of D.C.L. at Oxford. He had, except during the time of his prefecture, never intermitted his literary work, being a constant contributor to the *Revue des deux mondes*, his articles (usually worked up afterwards into books) almost all dealing with Roman Gaul and its period. The chief were the *Histoire des Gaulois*, 3 vols. (1828, 1834, 1845; the 8th edition of vol. i. appeared in 1870); *Histoire de la Gaule sous l'administration romaine* (3 vols., 1840–47; 2nd ed. 1871); *Histoire d'Attila, de ses fils et successeurs jusqu'à l'établissement des Hongrois en Europe* (1856; 5th ed. in 1874); *Tableau de l'Empire romain* (1862; 5th ed. in 1871; now quite out of date); *Récits de l'histoire romaine au Ve siècle: la lutte contre les Barbares*, and *les luttes religieuses* (1860; 2nd ed. in 6 vols. 1880). He died in Paris on the 27th of March 1873. His son, Gilbert Augustin Thierry (born 1843), who began a literary career by articles on *Les Révolutions d'Angleterre* (1864) and some *Essais d'histoire religieuse* (1867), afterwards confined himself to the writing of novels. (C. B.*)

THIERS, LOUIS ADOLPHE (1797–1877), French statesman and historian, was born at Marseilles on the 16th of April 1797. His family are somewhat grandiloquently spoken of as "cloth merchants ruined by the Revolution," but it seems that at the actual time of his birth his father was a locksmith. His mother belonged to the family of the Chéniers, and he was well educated, first at the lycée of Marseilles, and then in the faculty of law at Aix. Here he began his lifelong friendship with Mignet, and was called to the bar at the age of twenty-three. He had, however, little taste for law and much for literature; and he obtained an academic prize at Aix for a discourse on Vauvenargues. In the early autumn of 1821 Thiers went to Paris, and was quickly introduced as a contributor to the *Constitutionnel*. In each of the years immediately following his arrival in Paris he collected and published a volume of his articles, the first on the salon of 1822, the second on a tour in the Pyrenees. He was put out of all need of money by the singular benefaction of Cotta, the well-known Stuttgart publisher, who was part-proprietor of the *Constitutionnel*, and made over to Thiers his dividends, or part of them. Meanwhile he became very well known in Liberal society, and he had begun the celebrated *Histoire de la révolution française*, which founded his literary and helped his political fame. The first two volumes appeared in 1823, the last two (of ten) in 1827. The book brought him little profit at first, but became immensely popular. The well-known sentence of Carlyle, that it is "as far as possible from meriting its high reputation," is in strictness justified, for all Thiers's historical work is marked by extreme inaccuracy, by prejudice which passes the limits of accidental unfairness, and by an almost complete indifference to the merits as compared with the successes of his heroes. But Carlyle himself admits that Thiers is "a brisk man in his way, and will tell you much if you know nothing." Coming as the book did just when the reaction against the revolution was about to turn into another reaction in its favour, it was assured of success.

For a moment it seemed as if the author had definitely chosen the lot of a literary man, not to say of a literary hack. He even planned an *Histoire générale*. But the accession to power of the Polignac ministry in August 1829 changed his projects, and at the beginning of the next year Thiers, with Armand Carrel, Mignet, and others started the *National*, a new opposition newspaper. Thiers himself was one of the souls of the actual revolution, being credited with "overcoming the scruples of Louis Philippe," perhaps no Herculean task. At any rate he had his reward. He ranked as one of the Radical supporters of the new dynasty, in opposition to the party of which his rival Guizot was the chief literary man, and Guizot's patron, the duc de Broglie, the main pillar. At first Thiers, though elected deputy for Aix, obtained only subordinate places in the ministry of finance. After the overthrow of his patron Laffitte, he became much less radical, and, after the troubles of June 1832, was appointed to the ministry of the interior. He repeatedly changed his portfolio, but remained in office for four years, became president of the council and in effect prime minister, and began his series of quarrels and jealousies with Guizot. At the time of his resignation in 1836 he was foreign minister, and, as usual, wished for a spirited policy in Spain, which he could not carry out. He travelled in Italy for some time, and it was not till 1838 that he began a regular campaign of parliamentary opposition, which in March 1840 made him president of the council and foreign minister for the second time. But he held the position barely six months, and, being unable to force on the king an anti-English and anti-Turkish policy, resigned on the 29th of October. He now had little to do with politics for some years, and spent his time on his *Histoire du Consulat et de l'Empire*, the first volume of which appeared in 1845. Though he was still a member of the chamber he spoke rarely, till after the beginning of 1846, when he was evidently bidding once more for power. Immediately before the revolution of February he went to all but the greatest lengths, and when it broke out he and Odillon Barrot were summoned by the king; but it was too late. Thiers was unable to govern the forces he had helped to gather, and he resigned.

Under the republic he took up the position of conservative republican, which he ever afterwards maintained, and he never took office. But the consistency of his conduct, especially in voting for Prince Louis Napoleon as president, was often and sharply criticized, one of the criticisms leading to a duel with a fellow-deputy, Bixio. He was arrested at the *coup d'état*, was sent to Mazas, and then escorted out of France. But in the following summer he was allowed to return. For the next decade his history was almost a blank, his time being occupied for the most part on *The Consulate and the Empire*. It was not till 1863 that he re-entered political life, being elected by a Parisian constituency. For the seven years following he was the chief speaker among the small band of anti-Imperialists in the French chamber, and was regarded generally as the most formidable enemy of the empire. While nominally protesting against its foreign enterprises, he perpetually harped on French loss of prestige, and so contributed more than any one else to stir up the fatal spirit which brought on the war of 1870. Even when the Liberal-Imperialist Ollivier ministry was formed, he maintained at first an anything but benevolent neutrality, and then an open opposition, and it is impossible to be sure whether mere "canniness," or something better, kept him from joining the government of the National Defence, of which he was in a manner the author.

Nevertheless the collapse of the empire was a great opportunity for Thiers, and it was worthily accepted. He undertook in the latter part of September and the first three weeks of October a circular tour to the different courts of Europe in the hope of obtaining some intervention, or at least some good offices. The mission was unsuccessful; but the negotiator was on its conclusion immediately charged with another—that of obtaining, if possible, an armistice directly from Prince Bismarck. The armistice having been arranged, and the opportunity having been thus obtained of electing a National Assembly, Thiers was chosen deputy by more than twenty constituencies (of which he preferred Paris), and was at once elected by the Assembly itself practically president, nominally *chef du pouvoir exécutif*. He lost no time in choosing a coalition cabinet, and then personally took up the negotiation of peace. Probably no statesman has ever had a more disgusting task; and the fact that he discharged it to the satisfaction of a vast majority is the strongest testimony to Thiers's merits. He succeeded in convincing the deputies that the peace was necessary, and it was (March 1, 1871) voted by more than five to one.

Thiers held office for more than two years after this event, which shows the strength of the general conviction that he alone could be trusted. He had at first to meet and crush at once the mad enterprise of the Paris commune. Soon after this was accomplished he became (August 30th) in name as well as in fact president of the republic.

His strong personal will and inflexible opinions had much to do with the resurrection of France; but the very same facts made it inevitable that he should excite violent opposition. He was a confirmed protectionist, and free trade ideas had made great way in France under the empire; he was an advocate of long military service, and the devotees of *la revanche* were all for the introduction of general and compulsory but short service. Both his talents and his temper made him utterly indisposed to maintain the attitude supposed to be incumbent on a republican president; and his tongue was never a carefully governed one. In January 1872 he formally tendered his resignation; and though it was refused, almost all parties disliked him, while his chief supporters—men like Rémusat, Barthélemy Saint-Hilaire and Jules Simon—were men rather of the past than of the present.

The year 1873 was, as a parliamentary year in France, occupied to a great extent with attacks on Thiers. In the early spring regulations were proposed, and on April 13th were carried, which were intended to restrict the executive and especially the parliamentary powers of the president. On the 27th of the same month a contested election in Paris, resulting in the return of the opposition candidate, M. Barodet, was regarded as a grave disaster for the Thiers government, and that government was not much strengthened by a dissolution and reconstitution of the cabinet on May 19th. Immediately afterwards the question was brought to a head by an interpellation moved by the duc de Broglie. The president declared that he should take this as a vote of want of confidence; and in the debates which followed a vote of this character (though on a different formal issue, and proposed by M. Ernoul) was carried by 16 votes in a house of 704. Thiers at once resigned (May 24th).

He survived his fall four years, continuing to sit in the Assembly, and, after the dissolution of 1876, in the Chamber of Deputies, and sometimes, though rarely, speaking. He was also, on the occasion of this dissolution, elected senator for Belfort, which his exertions had saved for France; but he preferred the lower house, where he sat as of old for Paris. On May 16th 1877, he was one of the "363" who voted want of confidence in the Broglie ministry (thus paying his debts), and he took considerable part in organizing the subsequent electoral campaign. But he was not destined to see its success, being fatally struck with apoplexy at St Germain-en-Laye on September 3rd. Thiers had long been married, and his wife and sister-in-law, Mlle Dosne, were his constant companions; but he left no children, and had had only one—a daughter—who long predeceased him. He had been a member of the Academy since 1834. His personal appearance was remarkable, and not imposing, for he was very short, with plain features, ungainly gestures and manners, very near-sighted, and of disagreeable voice; yet he became (after wisely giving up an attempt at the ornate style of oratory) a very effective speaker in a kind of conversational manner, and in the epigram of debate he had no superior among the statesmen of his time except Lord Beaconsfield.

Thiers was by far the most gifted and interesting of the group of literary statesmen which formed a unique feature in the French political history of the 19th century. There are only two who are at all comparable to him—Guizot and Lamartine; and as a statesman he stands far above both. Nor is this eminence merely due to his great opportunity in 1870; for Guizot might under Louis Philippe have almost made himself a French Walpole, at least a French Palmerston, and Lamartine's opportunities after 1848 were, for a man of political genius, illimitable. But both failed—Lamartine almost ludicrously—while Thiers in hard conditions made a striking if not a brilliant success. But he only showed well when he was practically supreme. Even as the minister of a constitutional monarch his intolerance of interference or joint authority, his temper at once imperious and intriguing, his inveterate inclination towards *brigue*, that is to say, underhand rivalry and caballing for power and place, showed themselves unfavourably; and his constant tendency to inflame the aggressive and chauvinist spirit of his country neglected fact, was not based on any just estimate of the relative power and interests of France, and led his country more than once to the verge of a great calamity. In opposition, both under Louis Philippe and under the empire, and even to some extent in the last four years of his life, his worst qualities were always manifested. But with all these drawbacks he conquered and will retain a place in what is perhaps the highest, as it is certainly the smallest, class of statesmen—the class of those to whom their country has had recourse in a great disaster, who have shown in bringing her through that disaster the utmost constancy, courage, devotion and skill, and who have been rewarded by as much success as the occasion permitted.

As a man of letters Thiers is very much smaller. He has not only the fault of diffuseness, which is common to so many of the best-known historians of his century, but others as serious or more so. The charge of dishonesty is one never to be lightly made against men of such distinction as his, especially when their evident confidence in their own infallibility, their faculty of ingenious casuistry, and the strength of will which makes them (unconsciously, no doubt) close and keep closed the eyes of their mind to all inconvenient facts and inferences, supply a more charitable explanation. But it is certain that from Thiers's dealings with the men of the first revolution to his dealings with the battle of Waterloo, constant, angry and well-supported protests against his unfairness were not lacking. Although his search among documents was undoubtedly wide, its results are by no means always accurate, and his admirers themselves admit great inequalities of style in him. These characteristics reappear (accompanied, however, by frequent touches of the epigrammatic power above mentioned, which seems to have come to Thiers more readily as an orator or a journalist than as an historian) in his speeches, which after his death were collected in many volumes by his widow. Sainte-Beuve, whose notices of Thiers are generally kindly, says of him, "M. Thiers sait tout, tranche tout, parle de tout," and this omniscience and "cocksureness" (to use the word of a prime minister of England contemporary with this prime minister of France) are perhaps the chief pervading features both of the statesman and the man of letters.

His histories, in many different editions, and his speeches, as above, are easily accessible; his minor works and newspaper articles have not, we believe, been collected in any form. Several years after his death appeared *Deux opuscules* (1891) and *Mélanges inédites* (1892), while *Notes et souvenirs*, 1870–73, were published in 1901 by "F. D.," his sister-in-law and constant companion, Mlle Félicie Dosne. Works on him, by M. Laya, M. de Mazade, his colleague and friend M. Jules Simon, and others, are numerous.

(G. Sa.)

THIERS, a town of central France, capital of an arrondissement in the department of Puy-de-Dôme, 24 m. E.N.E. of Clermont-Ferrand, on the railway between that town and St Étienne. Pop. (1906) town, 12,601; commune, 17,418. Thiers is most picturesquely situated on the side of a hill at the foot of which the Durolle rapidly descends through a narrow valley into the Dore, a tributary of the Allier. The streets rising in steep rows contain a large number of stone and wooden houses, some of which date to the 15th century. A fine view of the Plain of Limagne and the Dôme mountain is obtainable from the terraces. The church of St Genès was built in 575 by Avitus, bishop of Clermont, and rebuilt in the 12th century. It has some curious mosaic work of the Merovingian period and a fine tomb of the 13th century. The church of Le Moutier, which formerly formed part of a Benedictine monastery, dates chiefly from the 11th century. Thiers is the seat of a sub-prefect and has tribunals of first instance and of commerce, a chamber of commerce, a board of trade arbitration, a communal college, a commercial and industrial school, and a branch of the Bank of France. Its special industry is the manufacture of cutlery, which employs some 12,000 hands in the town and its vicinity. The manufacture of handles and buttons of bone, pasteboard, stamping, hand-made and other papers and machinery are also carried on.

Thiers was sacked about 531 by the soldiers of Thierry, son of Clovis. About the same period Gregory of Tours speaks of a wooden chapel which may have occupied the site of the present church of Le Moutier. The commercial importance of the town was much increased in the 16th century when the manufacture of cutlery was introduced from the neighbouring town of Chateldon.

THIERSCH, FRIEDRICH WILHELM (1784–1860), German classical scholar and educationist, was born at Kirchscheidungen near Freiburg on the Unstrut, on the 17th of June 1784. In 1809 he became professor at the gymnasium at Munich, and in 1826 professor of ancient literature in the university of Landshut, transferred in that year to Munich. He died at Munich on the 25th of February 1860. Thiersch, the "tutor of Bavaria" (*praeceptor Bavariae*), found an extremely unsatisfactory system of education in existence. There was a violent feud between the Protestant "north" and the Catholic "south" Germans; Thiersch's colleagues, chiefly old monks, offered violent opposition to his reforms, and an attempt was made upon his life. His schemes, however, were carried out, and have remained the governing principle of the educational institutions of Bavaria. Thiersch was an ardent supporter of Greek independence. In 1832 he visited Greece, and it is said that his influence had much to do with securing the throne of the newly created kingdom for Otto of Bavaria. He wrote a Greek grammar, a metrical translation of Pindar, and an account of Greece (*L'État actuel de la Grèce* (1833).

Biography by his son, H. W. J. Thiersch (1866); see also G. M. Thomas, *Gedächtnissrede auf Friedrich von Thiersch* (1860); articles by A. Baumeister in *Allgemeine Deutsche Biographie* and O. Zöckler in Herzog-Hauck's *Realencyclopädie für protestantische Theologie*, xix.; J. E. Sandys, *History of Classical Scholarship*, iii. (1908).

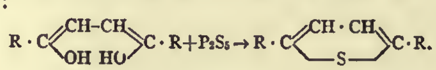
THIETMAR (DIETMAR or DITHMAR) **OF MERSEBURG** (975–1018), German chronicler, was a son of Siegfried, count of Walbeck, and was related to the family of the emperor Otto the Great. Born on the 25th of July 975 he was educated at Quedlinburg and at Magdeburg and became provost of Walbeck in 1002 and bishop of Merseburg seven years later. He took some part in the political events of the time; in 994 he was a hostage in the hands of the Northmen, and he was not unfamiliar with the actualities of war. He died on the 1st of December 1018.

Thietmar wrote a *Chronicon* in eight books, which deals with the period between 908 and 1018. For the earlier part he used Widukind's *Res gestae Saxonicae*, the *Annales Quedlinburgenses* and other sources; the latter part is the result of personal knowledge. It is rough in form and the author shows no power of discriminating between important and unimportant events; yet the chronicle is an excellent authority for the history of Saxony during the reigns of the emperors Otto III. and Henry II. No kind of information is excluded, but the fullest details refer to the bishopric of Merseburg and to the wars against the Wends and the Poles. The original manuscript of the work is preserved at Dresden and has been published in facsimile by L. Schmidt (Dresden, 1905). It has been edited by J. M. Lappenberg in Band III. of the *Monumenta Germaniae historica, Scriptores;* and by F. Kurze (Hanover, 1889); and has been translated into German by J. Laurent (new ed. revised by W. Wattenbach, Leipzig, 1892). See F. Kurze, *Bischof Thietmar von Merseburg und seine Chronik* (Halle, 1890); and W. Wattenbach, *Deutschlands Geschichtsquellen*, Band II. (Berlin, 1904).

THIMBLE, an implement for use in sewing, serving as a protective covering for the finger in pushing the needle through the material worked upon. For ordinary purposes the thimble is a bell-shaped cap reaching to the first joint and is usually worn on the middle finger. It is made of silver or other metal, sometimes of horn, ivory or bone. The sail-maker's thimble or "thummel" is a heavy ring, worn on the thumb, with a disc attached which is the part used to press against the needle. The O.E. *thymel*, from which the word descends, is formed, with the suffix -el, from *thūma*, the thumb, the protective covering having been formerly worn on that digit. The thumb by etymology means the "thick" finger, and is to be referred to the root *tum*, to swell up, become thick, seen in Lat. *tumere*, "tumid," &c. The term "thimble" is used of many mechanical appliances, especially of various forms of sleeve, bushing or joining for the ends of pipes, or shaftings, or as covering for an axle, &c. In nautical usage the "thimble" is a metal ring concave on the outside in which a rope runs; it is a protection against chafing.

THIOPHEN, C_4H_4S, a compound occurring in small quantities in crude coal-tar benzene, from which it was first isolated in 1883 by V. Meyer (*Ber.*, 1883, 16, p. 1465). The method adopted by Meyer to recover the thiophen was as follows. Ten volumes of the purest coal-tar benzene were shaken for four hours with one volume of sulphuric acid, the acid layer was removed and neutralized with lead carbonate, and the lead thiophen sulphonate obtained was distilled with an equivalent quantity of ammonium chloride. The distillate obtained was diluted with one hundred volumes of ligroin (previously purified by shaking with fuming sulphuric acid) and then shaken for one or two hours with sulphuric acid (using ten volumes of acid to one volume of the distillate), the acid layer diluted with water, neutralized by lead carbonate and the lead salt again distilled with an equivalent quantity of ammonium chloride. The distillate is finally rectified. It may be obtained in small quantity by passing ethylene or acetylene into boiling sulphur; by passing ethyl sulphide through a red-hot tube; by heating crotonic acid, butyric acid or erythrite with phosphorus pentasulphide; by heating succinic anhydride with phosphorus pentasulphide or sodium succinate with phosphorus trisulphide (J. Volhard and H. Erdmann, *Ber.*, 1885, 18, p. 454); or by heating succindialdehyde with two parts of phosphorus trisulphide (C. Harries, *Ber.*, 1901, 34, p. 1496).

It is a colourless liquid having a faint smell resembling that of benzene and boiling at 84° C. In its chief properties it very much resembles benzene, being readily brominated, sulphonated, and nitrated; also, the side chains in the alkyl thiophens are readily oxidized to carboxyl groups. On passing its vapour through a red-hot tube it yields di-thiënyl, $C_8H_6S_2$. It is completely decomposed by hydriodic acid at 140° C. It condenses with aldehydes (in chloroform solution) in the presence of phosphorus pentoxide to give dithiënyl hydrocarbons (A. Nahke, *Ber.*, 1897, 30, p. 2037). It can be readily recognized by the blue colour produced when a trace of thiophen is added to isatin dissolved in concentrated sulphuric acid (the *indophenin* reaction). The thiophen ketones may be prepared by the interaction of thiophen and its homologues with acid chlorides in the presence of anhydrous aluminium chloride. The thiophen homologues are best prepared by heating the 1·4 diketones with phosphorus pentasulphide, the diketones reacting in the enolic form:



Thiolenol, or oxymethyl thiophene, is prepared by heating laevulinic acid with phosphorus pentasulphide (W. Kues and C. Paal, *Ber.*, 1886, 19, p. 555). On this group see also V. Meyer, *Die Thiophengruppe.*

THIRLBY (or Thirleby), **THOMAS** (*c.* 1506–1570), English prelate, was born at Cambridge and was educated at Trinity Hall in the university there, becoming a fellow of his college. Through the good offices of his friend, Thomas Cranmer, he was introduced to the court of Henry VIII., and he served this king, one of whose chaplains he had become, in several ways. Among his numerous public appointments were those of dean of the chapel royal and member of the council of the north. In 1540 he was made bishop of Westminster, being the first and only occupant of that see; in 1550, three years after Henry VIII.'s death, he resigned the bishopric, which was dissolved, and became bishop of Norwich. As a diplomatist Thirlby had a long and varied experience; on several occasions he was sent on embassies to the emperor Charles V., and he helped to arrange the peace between England and France in 1559. He appears to have served Edward VI. loyally throughout his short reign, both at home and abroad, although it is certain that he disliked the religious changes and he voted against the act of uniformity in 1549. He was thus more at ease when Mary ascended the throne. Translated in 1554 to the bishopric of Ely, he took part in the trial of Cranmer at Oxford and in the consecration of Reginald Pole as archbishop of Canterbury, but he himself did not take severe measures against heretics. When Elizabeth became queen the bishop refused to take the oath of supremacy; in other ways he showed himself hostile to the proposed religious changes, and in 1559 he was deprived of his bishopric. For preaching against the innovations he was arrested in 1560, and he was in honourable confinement at Lambeth Palace when he died on the 26th of August 1570.

THIRLWALL, CONNOP (1797–1875), English bishop and historian, was born at Stepney, London, on the 11th of January 1797. His family was of Northumbrian extraction. He was a precocious boy, learning Latin at three, reading Greek at four, and writing sermons at seven. He went to the Charterhouse school, where George Grote and Julius Hare were among his schoolfellows. He went up to Trinity College, Cambridge, in October 1814, and gained the Craven university scholarship and the chancellor's classical medal. In October 1818 he was elected to a fellowship, and went for a year's travel on the Continent. At Rome he gained the friendship of Baron (Christian C. J.) von Bunsen, which had a most important influence on his life. On his return, "distrust of his own resolutions and convictions" led him to abandon for the time his intention of being a clergyman, and he settled down to the study of the law, "with a firm determination not to suffer it to engross my time so as to prevent me from pursuing other branches of knowledge." How little his heart was with it was shown by the labour he soon undertook of translating and prefacing Schleiermacher's essay on the Gospel of St Luke. He further rendered two of Tieck's most recent *Novellen* into English. In 1827 he at length made up his mind to quit the law, and was ordained deacon the same year.

Thirlwall now joined with Hare in translating Niebuhr's *History of Rome*; the first volume appeared in 1828. The translation was attacked in the *Quarterly* as favourable to scepticism, and the translators jointly replied. In 1831 the friends established the *Philological Museum*, which lived through only six numbers, though among Thirlwall's contributions was his masterly paper on the irony of Sophocles—"the most exquisite criticism I ever read," says Sterling. On Hare's departure from Cambridge in 1832, Thirlwall became assistant college tutor, which led him to take a memorable share in the great controversy upon the admission of Dissenters which arose in 1834. Thomas Turton, the regius professor of divinity (afterwards dean of Westminster and bishop of Ely), had written a pamphlet objecting to the admission, on the ground of the apprehended unsettlement of the religious opinions of young churchmen. Thirlwall replied by pointing out that no provision for theological instruction was in fact made by the colleges except compulsory attendance at chapel, and that this was mischievous. This attack upon a time-hallowed piece of college discipline brought upon him a demand for the resignation of his office as assistant tutor. He complied at once; his friends generally thought that he ought to have tested the master's power. The occurrence marked him out for promotion by a Liberal Government, and in the autumn he received from Lord Brougham as chancellor the living of Kirby-under-Dale in Yorkshire. Though devoted to his parochial duties, he found time to begin his principal work, the *History of Greece*. This work was a commission from Lardner's *Cabinet Cyclopaedia*, and was originally intended to have been condensed into two or three duodecimo volumes. The scale was enlarged, but Thirlwall always felt cramped. He seems a little below his subject, and a little below himself. As compared with Grote's history it lacks enthusiasm for a definite political ideal and is written entirely from the standpoint of a scholar. It is in this respect superior, and further shows in places a more impartial treatment of the evidence, especially in respect of the aristocratic and absolute governments of Greece. For these reasons its popularity was not so immediate as that of Grote's work, but within recent years its substantial merits have been more adequately recognized. A noble letter from Thirlwall to Grote, and Grote's generous reply, are published in the life of the latter. John Sterling pronounced Thirlwall "a writer as great as Thucydides and Tacitus, and with far more knowledge than they." The first volume was published in 1835, the last in 1847.

In 1840 Thirlwall was raised to the see of St David's. The promotion was entirely the act of Lord Melbourne, an amateur in theology, who had read Thirlwall's introduction to Schleiermacher, and satisfied himself of the propriety of the appointment. "I don't intend to make a heterodox bishop if I know it," he said. In most essential points he was a model bishop, and he acquainted himself with Welsh, so as to preach and conduct service in that language. He was not greatly beloved by his clergy, who felt their intellectual distance too great, and were alternately frozen by his taciturnity and appalled by his sarcasm. The great monument of his episcopate is the eleven famous charges in which he from time to time reviewed the position of the English Church with reference to whatever might be the most pressing question of the day—addresses at once judicial and statesmanlike, full of charitable wisdom and massive sense. His endeavours to allay ecclesiastical panic, and to promote liberality of spirit, frequently required no ordinary moral courage. He was one of the four prelates who refused to inhibit Bishop Colenso from preaching in their dioceses, and the only one who withheld his signature from the addresses calling upon Colenso to resign his see. He took the liberal side in the questions of Maynooth, of the admission of Jews to parliament, of the Gorham case, and of the educational conscience clause. He was the only bishop who voted for the disestablishment of the Irish Church, though a scheme of concurrent endowment would have been much more agreeable to him. He would have made an admirable successor to Howley in the primacy, but such was the complexion of ecclesiastical politics that the elevation of the most impartial prelate of his day would have been resented as a piece of party spirit.

Thirlwall's private life was happy and busy. Though never married, he was fond of children and of all weak things except weak-minded clergymen. He had a very judicial mind, and J. S. Mill said he was the best orator he had ever heard. During his latter years he took great interest in the revision of the authorized version of the Bible, and was chairman of the revisers of the Old Testament. He resigned his see in May 1874, and retired to Bath, where he died on the 27th of July 1875. He lies in Westminster Abbey in the same grave as Grote.

As scholar, critic and ecclesiastical statesman Thirlwall stands very high. He was not a great original thinker; he lacked the creative faculty and the creative impulse. His character, with its mixture of greatness and gentleness, was thus read by Carlyle: "A right solid, honest-hearted man, full of knowledge and sense, and, in spite of his positive temper, almost timid."

Thirlwall's *History of Greece* remains a standard book. His *Remains, Literary and Theological*, were edited by J. J. S. Perowne in three volumes (1877–78), two of which are occupied by his charges. His *Letters, Literary and Theological*, with a connecting memoir, were edited by J. J. S. Perowne and L. Stokes (1881). His *Letters to a Friend* (Miss Johnes of Dolaucothy) are a splendid monument to his memory. They were originally published by Dean Stanley, and there is a revised and corrected edition. For a general view of Thirlwall's life and character, see the *Edinburgh Review*, vol. cxliii.; for a picture of him in his diocese, *Temple Bar*, vol. lxxvi.

THIRSK, a market-town in the Thirsk and Malton parliamentary division of the North Riding of Yorkshire, England, 22 m. N.W. by N. from York by the North-Eastern railway. Pop. (1901) 3093. It lies in a fertile plain W. of the Hambleton Hills, on the Codbeck, a small tributary of the Swale. The church of St Mary, entirely Perpendicular, with parvise, chancel, nave, aisles, porch, and tower 80 ft. in height, is one of the most beautiful churches in the Riding. The original work of oak is especially noteworthy. The moat of the ancient castle built by the Mowbrays about 980 remains. The principal modern buildings are the assembly rooms, mechanics' institute, and court-house. Standing in the fertile district of the Vale of Mowbray, the town has an extensive agricultural trade. Agricultural implements are largely manufactured. Iron-founding, engineering, tanning and brick-making are carried on, and there are large flour-mills.

At the time of the Domesday Survey, Thirsk (Treske) was a manor of little importance belonging partly to the king and partly to Hugh, son of Baldric. Soon afterwards it was granted to Robert de Mowbray, who often resided there, and is said to have raised the castle round which the borough grew up. His estates, being forfeited for treason against William Rufus, were restored by Henry I. to Nigel de Albini, Robert's cousin, who took the name of Mowbray. Roger, son of Nigel, took part in the rebellion against Henry II. in 1174, and although he was allowed to retain his estates, his castle at Thirsk was destroyed. The manor remained in his family until the death of John de Mowbray, duke of Norfolk, without issue male in 1475, and after passing through several families was finally sold in 1723 to Ralph Bell, whose descendants thereafter held the manor. Thirsk is first mentioned as a borough in a charter granted by Roger de Mowbray to Newburgh Priory in the reign of Henry II. It was governed by a bailiff elected by the burgesses at the court leet of the lord of the manor, and never received a charter of incorporation. The burgesses were represented in parliament by two members in 1295 and again from 1552–53 to 1832, when by the Municipal Reform Act the number was reduced to one. In 1885 the town was disfranchised. Roger de Mowbray held a market by prescription in Thirsk in the 13th century, and by Camden's time (*c.* 1586) it had become one of the best markets in the North Riding. It is still held by the lord of the manor.

See *Victoria County History: Yorkshire;* William Grainge, *The Vale of Mowbray: a historical and topographical account of Thirsk and its neighbourhood* (1859).

THIRTY YEARS' WAR (1618–1648), the general name of a series of wars in Germany which began formally with the claim of Frederick the elector palatine to the throne of Bohemia and ended with the treaty of Westphalia. It was primarily a religious war and was waged with the bitterness characteristic of such wars, but at the same time political and feudal quarrels were interwoven with the religious question, with the consequence that the armies, considering themselves as their masters' retainers rather than champions of a cause, plundered and burned everywhere, military violence being in no way restrained by expediency. In a war based on the principle *cujus regio ejus religio* it was vain to expect either the professional or the national type of army to display its virtues.

Nature of the struggle.

Fifty years before the outbreak of the war the Convention of Passau had compromised the burning questions of the Reformation, but had left other equally important points as to the secularization of church lands and the consecration of Protestant bishops to the future. Each such case, then, came before the normal government machine—a Diet so constituted that even though at least half of the secular princes and nine-tenths of their subjects were Protestants, the voting majority was Catholic in beliefs and in vested interests. Moreover, the Jesuits had rallied and disciplined the forces of Catholicism, while Protestantism, however firm its hold on the peoples, had at the courts of princes dissipated itself in doctrinal wrangles. Thus, as it was the princes and the free cities, and by no means the mass of the people, that settled religious questions, the strongest side was that which represented conservatism, peace and Catholicism. Realizing this from the preliminary mutterings of the storm, the Protestant princes formed a union, which was promptly answered by the Catholic League. This group was headed by the wise and able Maximilian of Bavaria and supported by his army, which he placed under a soldier of long experience and conspicuous ability, Count Tilly.

The "Union" and the "League" formed.

The war arose in Bohemia, where the magnates, roused by the systematic evasion of the guarantees to Protestants, refused to elect the archduke Ferdinand to the vacant throne, offering it instead to Frederick, the elector palatine. But the aggrandizement of this elector's power was entirely unacceptable to most of the Protestant princes—to John George of Saxony above all. They declared themselves neutral, and Frederick found himself an isolated rebel against the emperor Ferdinand, and little more than the nominal head of an incoherent nobility in his new kingdom.

Bohemian movement.

Even thus early the struggle showed itself in the double aspect of a religious and a political war. Just as the Protestants and their nominee found themselves looked upon askance by the other Protestants, so the emperor himself was unable to call upon Maximilian's Army of the League without promising to aggrandize Bavaria. Indeed the emperor was at first—before Frederick intervened—almost a mere archduke of Austria waging a private war against his neighbours. Only the incoherence of his enemies saved him. They ordered taxes and levies of soldiers, but the taxes were not collected, and the soldiers, unpaid and unfed, either dispersed to their homes or plundered the country-side. The only coherent force was the mercenary corps of Ernst von Mansfeld, which, thrown out of employment by the termination of a war in Italy, had entered the service of the Union. Nevertheless, the Bohemians were conspicuously successful at the outset. Under Count Thurn they won several engagements, and Ferdinand's army under Carl Bonaventura de Longueval, Count Buquoi (1571–1621), was driven back. Thurn appeared before Vienna itself. Moravia and Silesia supported the Bohemians, and the Austrian nobles attempted, in a stormy conference, to wrest from Ferdinand not only religious liberty but also political rights that would have made Austria and Bohemia a loose confederation of powerful nobles. Ferdinand firmly refused, though the deputation threatened him to his face, and the tide ebbed as rapidly as it had flowed. One or two small military failures, and the enormous political blunder of bringing in the elector palatine, sealed the fate of the Bohemian movement, for no sooner had Frederick accepted the crown than Maximilian let loose the Army of the League. Spanish aid arrived. Spinola with 20,000 men from the Low Countries and Franche Comté invaded the Palatinate, and Tilly, with no fears for the safety of Bavaria, was able to combine with Buquoi against the Bohemians, whose resistance was crushed at the battle of the Weisser Berg near Prague (8/18 November 1620). With this the Bohemian war ended. Some of the nobles were executed, and Frederick, the "Winter King," was put to the ban of the Empire.

Defeat of Frederick.

The menace of Spinola's invasion broke up the feeble Protestant Union. But the emperor's revenge alarmed the Union princes. They too had, more or less latent, the tendency to separatism and they were Protestants, and neither in religion nor in politics could they suffer an all-powerful Catholic emperor. Moreover, the alternative to a powerful emperor was a powerful Bavaria, and this they liked almost as little.

There still remained for the armies of Tilly and Buquoi the reduction of the smaller garrisons in Bohemia, and these when finally expelled rallied under Mansfeld, who was joined by the disbanded soldiery of the Protestant Union's short-lived army. Then there began the wolf-strategy that was the distinguishing mark of the Thirty Years' War. An army even of ruffians could be controlled, as Tilly controlled that of the League, if it were paid. But Mansfeld, the servant of a shadow king, could not pay. Therefore "he must of necessity plunder where he was. His movements would be governed neither by political nor by military considerations. As soon as his men had eaten up one part of the country they must go on to another, if they were not to die of starvation. They obeyed a law of their own, quite independent of the wishes or needs of the sovereign whose interests they were supposed to serve." These movements were for preference made upon hostile territory, and Mansfeld was so far successful in them that the situation in 1621 became distinctly unfavourable to the emperor. He had had to recall Buquoi's army to Hungary to fight against Gabriel Bethlen, the prince of Transylvania, and in an unsuccessful battle at Neuhäusel (July 10) Buquoi was killed. Tilly and the League Army fought warily and did not risk a decision. Thus even the proffered English mediation in the German war might have been accepted but for the fact that in the Lower Palatinate a corps of English volunteers, raised by Sir Horace Vere for the service of the English princess Elizabeth, the fair queen of Bohemia, found itself compelled, for want of pay and rations, to live, as Mansfeld lived, on the country of the nearest probable enemy—in their case the bishop of Spire. This brought about a fresh intervention of Spinola's army, which had begun to return to the Low Countries to prosecute the interminable Dutch war. Moreover Mansfeld, having so thoroughly eaten up the Palatinate that the magistrates of Frederick's own towns begged Tilly to expel his general, decamped into Alsace, where he seized Hagenau and wintered in safety.

Predatory armies.

The winter of 1621–22 passed in a series of negotiations which failed because too many interests, inside and outside Germany, were bound up with Protestantism to allow the Catholics to speak as conquerors, and because the cause of Protestantism was too much involved with the cause of the elector palatine to be taken in hand with energy by the Protestant princes. But Frederick and Mansfeld found two allies. One was Christian of Brunswick, the gallant young knight-errant, titular bishop of Halberstadt, queen Elizabeth's champion, and withal, though he called himself *Gottes Freund, der Pfaffen Feind*, a plunderer of peasants as well as of priests. The other was the margrave George Frederick of Baden-Durlach, reputed to be of all German princes the most skilful sequestrator of ecclesiastical lands. In April 1622, while Vere garrisoned the central fortresses of the Palatinate, Mansfeld, Christian and George Frederick took the field against Tilly, who at once demanded assistance from Spinola. The latter, though engaged with the Dutch, sent a corps under his subordinate Cordova. Before this arrived Mansfeld and the margrave of Baden had defeated Tilly at Wiesloch, south of Heidelberg (17/27 April 1622). Nevertheless Tilly's army was not as easily dissolved as one of theirs, and soon the allies had to separate to find food. Then Cordova came up, and Tilly and the Spaniards combined defeated George Frederick at Wimpfen on the Neckar (26 April/6 May). Following up this success, Cordova chased Mansfeld back into Alsace, while Tilly went north to oppose Christian of Brunswick on the Main. On June 10/20 the latter's army was almost destroyed by the League Army at Höchst. Mansfeld, and with him Frederick, had already set out from Alsace to join Christian, but when that leader arrived with only a handful of beaten men, the war was practically at an end. Frederick took Mansfeld and Christian back to Alsace, and after dismissing their troops from his employment, retired to Sedan. Henceforth he was a picturesque but powerless exile, and his lands and his electoral dignity, forfeited by the ban, went to the prudent Maximilian, who thus became elector of Bavaria. Finally Tilly conquered the Palatinate fortresses, now guarded only by the English volunteers.

Fresh combatants in the war.

The next act in the drama, however, had already begun with the adventures of the outlaw army of Mansfeld and Christian. After Höchst, had it not been for them, the war might have ended in compromise. James I. of England was busy as always with mediation schemes. Spain, being then in close connexion with him, was working to prevent the transfer of the electorate to Maximilian, and the Protestant princes of North Germany being neutral, a diplomatic struggle over the fate of the Palatinate, with Tilly's and Cordova's armies opposed in equilibrium, might have ended in a new convention of Passau that would have regulated the present troubles and left the future to settle its own problems. The struggle would only have been deferred, it is true, but meanwhile the North German Protestants, now helpless in an unarmed neutrality, would have taken the hint from Maximilian and organized themselves and their army. As it was, they remained powerless and inactive, while Tilly's army, instead of being disbanded, was kept in hand to deal with the adventurers.

Mansfeld and Christian of Brunswick.

These, after eating up Alsace, moved on to Lorraine, whereupon the French government "warned them off." But ere long they found a new employment. The Dutch were losing ground before Spinola, who was besieging Bergen-op-Zoom, and the States-General invited Mansfeld to relieve it. Time was short and no détour by the Lower Rhine possible, and the adventurers therefore moved straight across Luxemburg and the Spanish Netherlands to the rescue. Cordova barred the route at Fleurus near the Sambre, but the desperate invaders, held together by the sheer force of character of their leaders, thrust him out of their way (19/29 August 1622) and relieved Bergen-op-Zoom. But ere long, finding Dutch discipline intolerable, they marched off to the rich country of East Friesland.

Mansfeld marches to Friesland.

Their presence raised fresh anxieties for the neutral princes of North Germany. In 1623 Mansfeld issued from his Frisian stronghold, and the threat of a visitation from his army induced the princes of the Lower Saxon Circle to join him. Christian was himself a member of the Circle, and although he resigned his bishopric, he was taken, with many of his men, into the service of his brother, the duke of Brunswick-Wolfenbüttel; around the mercenary nucleus gathered many thousands of volunteers, and the towns and the nobles' castles alike were alarmed at the progress of the Catholics, who were reclaiming Protestant bishoprics. But this movement was nipped in the bud by the misconduct of the mercenaries. The authorities of the Circle ordered Christian to depart. He returned to Holland, therefore, but Tilly started in pursuit and caught him at Stadtlohn, where on 28 July/6 August 1623 his army was almost destroyed. Thereupon the Lower Saxon Circle, which, like the Bohemians, had ordered collectively taxes and levies of troops that the members individually furnished either not at all or unwillingly, disbanded their army to prevent brigandage. Mansfeld, too, having eaten up East Friesland, returned to Holland in 1624.

The only material factor was now Tilly's ever-victorious Army of the League, but for the present it was suspended inactive in the midst of a spider's web of European and German diplomacy. Spain and England had quarrelled. The latter became the ally of France, over whose policy Richelieu now ruled, and the United Provinces and (later) Denmark joined them. Thus the war was extended beyond the borders of the Empire, and the way opened for ceaseless foreign interventions. From the battle of Stadtlohn to the pitiful end twenty years later, the decision of German quarrels lay in the hands of foreign powers, and for two centuries after the treaty of Westphalia the evil tradition was faithfully followed.

Foreign intervention.

France was concerned chiefly with Spain, whose military possessions all along her frontier suggested that a new Austrasia, more powerful than Charles the Bold's, might arise. To Germany only subsidies were sent, but in Italy the Valtelline, as the connecting link between Spanish possessions and Germany, was mastered by a French expedition. James, in concert with France, re-equipped Mansfeld and allowed him to raise an army in England, but Richelieu was unwilling to allow Mansfeld's men to traverse France, and they ultimately went to the Low Countries, where, being raw pressed-men for the most part, and having neither pay (James having been afraid to summon parliament) nor experience in plundering, they perished in the winter of 1625. At the same time a Huguenot rising paralysed Richelieu's foreign policy. Holland after the collapse of Mansfeld's expedition was anxious for her own safety owing to the steady advance of Spinola. The only member of the alliance who intervened in Germany itself was Christian IV. of Denmark, who as duke of Holstein was a member of the Lower Saxon Circle, as king of Denmark was anxious to extend his influence over the North Sea ports, and as Protestant dreaded the rising power of the Catholics. Gustavus Adolphus of Sweden, judging better than any of the difficulties of affronting the Empire and Spain, contented himself for the present with carrying on a war with Poland.

Intervention of Christian of Denmark.

Christian IV. raised an army in his own lands and in the Lower Saxon Circle in the spring of 1625. Tilly at once advanced to meet him. But he had only the Army of the League, Ferdinand's troops being occupied with repelling a new inroad of Gabriel Bethlen. Then, like a *deus ex machina*, Wallenstein, duke of Friedland, came forward and offered to raise and maintain an army in the emperor's service. It was an army like Mansfeld's in that it lived on the country, but its exactions were systematic and the products economically used, so that it was possible to feed 50,000 men where Mansfeld and his like had barely subsisted 20,000. This method, the high wages which he paid, and his own princely habits and commanding personality gave it a cohesion that neither a free company nor an army of mere Lower Saxon contingents could ever hope to attain.

Wallenstein raises an army.

In 1625, in spite of Tilly's appeals, Wallenstein did nothing but levy contributions about Magdeburg and Halberstadt, keeping his new army well away from the risks of battle until he could trust it to conquer. It was fortunate for Ferdinand that he did so. Christian IV., who had been joined by Mansfeld and Christian of Brunswick, had in 1626, 60,000 men. Wallenstein and Tilly together had only a very slight numerical superiority, and behind them was nothing. Even the hereditary provinces of Austria were threatening revolt owing to their having to maintain Maximilian's troops (the new elector thus recouping his expenses in the Palatinate war) and Gabriel Bethlen was again in the field. But on the other side the English subsidies failed, and the Protestant armies soon began to suffer in consequence. Tilly opposed Christian IV., Wallenstein Mansfeld. The latter, having stood still about Lübeck and in the outskirts of Brandenburg till the food was exhausted, advanced upon Wallenstein, attacked him in an entrenched position at the Bridge of Dessau and was thoroughly defeated (15/25 April 1626). He then wandered across Germany into Silesia and joined Bethlen. Wallenstein followed up, and by taking up strong positions, compelled Mansfeld and Bethlen to choose between attacking him and starving. So, without a battle, he brought about a truce, whereby Bethlen was disarmed and Mansfeld was required to leave Hungary. Mansfeld and Christian of Brunswick died soon afterwards, the one in Hungary, the other in Westphalia. King Christian, left alone and unable without English subsidies to carry on the war methodically, took the offensive, as Mansfeld had done, in order to live on the Thuringian countryside. But Tilly, with whom Wallenstein had left a part of his army, moved as quickly as the king, brought him to action at Lutter-am-Barenberge in Brunswick and totally defeated him (17/27 August).

Defeat and death of Mansfeld.

With this, armed opposition to Tilly and Wallenstein in the field practically ceased until 1630. But there was enough danger to prevent the disbandment of their armies, which continued to live on the country. In the intervening years the balance of forces, political and military, was materially altered. France opposed Spain and the emperor in Italy with such vigour as Huguenot outbreaks permitted, England quarrelled with France, but yet like France sent subsidies to the North German Protestants. Gustavus held his hand, while Christian slowly gave up fortress after fortress to Tilly. Wallenstein, returning from the campaign against Gabriel Bethlen, subdued Silesia, where a small part of Mansfeld's army had been left in 1626, and afterwards drove Christian's army through Jutland (1627). But Wallenstein, with his dreams of a united Germany free in conscience and absolutely obedient to the emperor, drifted further and further away from the League. Ferdinand thought that he could fulfil the secular portion of Wallenstein's policy while giving satisfaction to the bishops. The princes and bishops of the League continued to oppose any aggrandizement of the emperor's power at their expense and to insist upon the resumption of church lands. In this equilibrium the North German Protestant cities were strong enough to refuse to admit Wallenstein's garrisons. In 1628 Wallenstein, who had received the duchy of Mecklenburg on its rightful lord being put to the ban for his share in the Danish war, began to occupy his new towns, and also to spread along the coasts, for his united Germany could never be more than a dream until the possibility of Danish and Swedish invasions was removed. But the Hanse towns rejected his overtures, and Stralsund, second-rate seaport though it was, absolutely refused to admit a garrison of his wild soldiery. The result was the famous siege of Stralsund (February to August 1628), in which, with some slight help from oversea, the citizens compelled the hitherto unconquered Wallenstein army to retire. The siege was, as the result proved, a turning-point in German history. The emperor's policy of restoring order had practically universal support. But the instrument of the restoration was a plundering army. Even this might have been borne had Wallenstein been able to give them, as he wished, not only peace but religious freedom. But when Christian signed the peace of Lübeck, and the Edict of Restitution (1629) gave back one hundred and fifty northern ecclesiastical foundations to the Catholics, men were convinced that one ruler meant one religion. Rather than endure this the North Germans had called in Gustavus Adolphus, and, just as Gustavus landed, the resentment of the princes of the League against Wallenstein's policy and Wallenstein's soldiers came to a head, and the emperor was forced to dismiss him. His soldiers were taken over by Tilly, and for the moment he disappeared from the scene.

Lull in the struggle.

Siege of Stralsund.

Gustavus Adolphus of Sweden.

A thoroughly trained army, recruited from good yeomen and good soldiers of fortune, paid good wages, and led by a great captain, was a novelty in war that more than compensated for Tilly's numerical superiority. Gustavus, however, after landing at Peenemünde in June, spent the rest of the year in establishing himself firmly in Mecklenburg and Pomerania, partly for military reasons, partly in view of a future Swedish hegemony of the Baltic, and most of all in order to secure the active support of the more important Protestant princes, so as to appear as an auxiliary rather than a principal in the German conflict. First the old duke Bogislav of Pomerania, then George William of Brandenburg joined him, very unwillingly. He was soon afterwards allied with France, by the treaty of Bärwalde (January 1631). John George of Saxony, still attempting to stifle the war by his policy of neutrality, sent a last appeal to Vienna, praying for the revocation of the Edict of Restitution. Meanwhile Tilly had marched into north-eastern Germany. On the 19/29 March 1631, the old general of the League destroyed a Swedish garrison at New Brandenburg, and although Gustavus concentrated upon him with a swiftness that surprised the old-fashioned soldiers, Tilly wasted no time in manoeuvres but turned back to the Elbe, where his lieutenant Pappenheim was besieging Magdeburg. This city had twice defied Wallenstein's attempts to introduce a garrison, and it was now in arms against the League. But John George, their prince, had not yet decided to join Gustavus. The latter, as yet without active allies, thought it impossible to go forward alone, and could only hope that his sudden and brilliant storm (3/13 April) of Frankfurt-on-Oder[1] would bring back Tilly from the Elbe. But the hope was vain. Tilly and Pappenheim pressed the siege of Magdeburg, and although the citizens, directed by Swedish officers, fought desperately the place was stormed, sacked and burnt on the night of the 10th of May 1631, amidst horrors that neither of the imperialist generals was able to check, or even to mitigate. The Catholics rejoiced as though for another St Bartholomew's day, the Protestants were paralysed, and even Gustavus, accused on all hands of having allowed the Magdeburgers to perish without giving them a helping hand, sorrowfully withdrew into Pomerania. But Tilly, in spite of Pappenheim's remonstrances, turned westward against Hesse-Cassel and other minor principalities whose rulers had declared for Gustavus. The king of Sweden, thereupon, clearing away the remaining League garrisons, on the Oder, advanced to Werben (at the junction of the Elbe and the Havel), where the army entrenched itself, and, in spite of sickness and famine, stoically awaited the attack. The desired result was achieved. At the end of July Tilly, returning from the west before he had accomplished its reduction, made his appearance and was twice repulsed (13/23 and 18/28 July), losing 6000 men out of 22,000. Moreover, Ferdinand having in his moment of triumph flatly rejected John George's appeal against the Edict, Saxony took up arms. Thereupon Tilly, turning away from Gustavus's entrenchments, invaded Saxony, being reinforced *en route* by 20,000 men from Italy (the war there being left to the Spaniards). The elector at once made an alliance with the Swedes.

Sack of Magdeburg.

[1] In which he exacted life for life and plunder for plunder in return for the slaughter at New Brandenburg.

Then Gustavus advanced in earnest. Tilly had taken no measures to hold him off while the invasion of Saxony was in progress, and he crossed the Elbe at Wittenberg. 16,000 Saxons joined the 26,000 Swedes at Düben, and some of the western Germans had already come in. Tilly had just captured Leipzig, and outside that place, carried away by Pappenheim's enthusiasm, he gave battle on the 7/17 September to the now superior allies. The first battle of Breitenfeld (*q.v.*) was a triumphant success for Gustavus and for the new Swedish system of war, such a battle as no living soldier had seen. The raw Saxons, who were commanded by Arnim, once Wallenstein's lieutenant, were routed by Tilly's men without the least difficulty, and the balance of numbers returned again to the imperialist side. But the veterans of the League army were nevertheless driven off the field in disorder, leaving 6000 dead. Tilly himself was thrice wounded, and only the remnant of his own faithful Walloon regiments remained with him and bore him from the field.

Battle of Breitenfeld.

All Protestant Germany hailed Gustavus as the liberator. Wallenstein, glad of the defeat of the Catholic army, proposed to co-operate with the Swedes. John George, the Swedish general Horn and the Swedish chancellor Oxenstierna united in advising Gustavus to march straight upon Vienna. Richelieu, who desired to humble Ferdinand rather than to disestablish the power of the Catholic princes, was of the same mind. But Gustavus deliberately chose to move into South Germany, there to relieve the Protestants oppressed by Maximilian, to organize the cities and the princes in a new and stronger Protestant Union, the *Corpus Evangelicorum*, and to place himself in a country full of resources whence he could strike out against the emperor, Tilly, and the Rhine Spaniards in turn. To the Saxons he left the task of rousing the Bohemian Protestants, perhaps with the idea of thoroughly committing them to the war upon Ferdinand. The Swedish army pushed on through Halle, Erfurt, Würzburg to Mainz, where in the middle of the "Pfaffengasse," the long lane of bishoprics and abbacies along the Main and the Rhine, it wintered in luxury. The Palatinate was reorganized under Swedish officials and the reformed religion established again. In March 1632 the campaign was resumed. Nuremberg and Donauwörth welcomed Gustavus. Tilly's army, rallied and re-organized for the defence of Bavaria, awaited him on the Lech, but after a fierce battle the passage was forced by the Swedes (4/14 April) and Tilly himself was mortally wounded. Augsburg, Munich and all the towns and open country south of the Danube were occupied without resistance. At the same time John George's army entered Prague without firing a shot.

Strong position of Gustavus Adolphus.

The emperor had now either to submit or to reinstate Wallenstein. Wallenstein demanded as the price of his services the reversal of the Edict, and power to dethrone every prince who adhered to the Swedes. His terms were accepted, and in April 1632 he took the field as the emperor's *alter ego* with a new army that his recruiters had gathered in a few weeks. He soon expelled the Saxons from Bohemia and offered John George amnesty and the rescinding of the Edict as the basis of peace. The elector, bound by his alliance with Gustavus, informed the Swedish king of this offer, and a series of negotiations began between the three leaders. But John George had too much in common with each to follow either Wallenstein or Gustavus unreservedly, and the war recommenced. Gustavus's first danger was on the Rhine side, where Pappenheim, aided by the Spaniards, entered the field. But Richelieu, the half-hearted enemy of distant Catholic princes, was a vigorous enough opponent of Spain on his own frontier, and Gustavus was free in turn to meet Wallenstein's new army of 60,000, composed of the men immortalized by Schiller's play, excellent in war and in plundering, destitute of all home and national ties, and owning allegiance to its general alone. While Gustavus in Franconia was endeavouring with little success to consolidate his *Corpus Evangelicorum* Wallenstein came upon the scene. Gustavus, as soon as his Rhine detachments had rejoined, offered him battle. But as in 1625 Wallenstein would risk no battle until his army had gained confidence. He entrenched himself near Fürth, while Gustavus camped his army about Nuremberg and a contest of endurance ensued, in which the Swedes, who, although they had learned to plunder in Bavaria, were kept rigidly in hand, fared worse. Wallenstein, aided by his superiority in irregular cavalry, was able to starve for three days longer than the king, and at last Gustavus furiously attacked the entrenchments (battle of the Alte Veste, 24 August/3 September, 1632) and was repulsed with heavy losses. Thereupon Gustavus retired, endeavouring in vain to tempt Wallenstein out of his stronghold by making his retreat openly and within striking distance of the imperialists. Wallenstein had other views than simple military success. Instead of following Gustavus, who first retired north-westward and then returned to the Danube at Ingolstadt, he marched into Saxony, his army plundering and burning even more thoroughly than usual in order to force the Saxons into peace. Gustavus followed with the swiftness that was peculiar to the Swedish system, and his detachments on the Main under Bernhard of Saxe-Weimar having secured the road through Thuringia, he concentrated at Erfurt when Wallenstein had scarcely mastered Leipzig. But it was now late in the season, and Wallenstein, hoping to spin out the few remaining weeks of the campaign in an entrenched position, allowed Pappenheim, who had joined him, to return towards the Weser country, where, as in many other districts, spasmodic minor campaigns were waged by local forces and small detachments from the lesser bodies. Within forty-eight hours Pappenheim was called back. Gustavus, without waiting for Arnim's Saxons to join him, had suddenly moved forward, and on the 6/16 November the battle of Lützen (*q.v.*) was fought, a battle as fierce even as Breitenfeld. Gustavus and Pappenheim were slain, and Wallenstein's army, yielding to Bernhard's last attack, retreated.

Wallenstein returns to the imperial service.

The lines of Nuremberg.

Battle of Lützen.

The fall of Gustavus practically determined the intervention of France, for Richelieu supported all electors, Catholic or Protestant, against the central power at Vienna as part of his anti-Spanish policy, and French assistance was now indispensable to the Protestants. For although Lützen was a victory and the Protestant circles formed the League of Heilbronn in April 1633, the emperor was really in the ascendant. John George of Saxony, uneasy both at the prospect of more foreign armies in Germany and at the expressed intention of Bernhard to carve out a principality for himself, needed but little inducement to make peace. But the tragedy of Lützen was soon to be followed by the tragedy of Eger. Wallenstein, gradually forming the resolve of forcing peace on Germany with his army, relaxed his pressure on Saxony, and drawing Arnim's army out of Silesia to protect Dresden, he flung himself upon the Swedish garrisons in Silesia. Winning a victory at Steinau (October 11, 1633) and capturing one town after another, he penetrated almost to the Baltic. But he was recalled to the south-west before his operations had had any effect. The Swedish army, under Bernhard, Horn and Banér, had before the formation of the League of Heilbronn returned to the Palatinate, and while Horn and Banér operated against an imperial army under Aldringer in the Neckar country, Bernhard took Regensburg from Maximilian's army. But it was now late in the year and Wallenstein was intent upon peace. With this object he endeavoured to secure the higher officers of the army, but these were gradually won over by Spanish emissaries; the emperor, having decided to continue the war in alliance with Spain, dismissed his general for the second time. Wallenstein then openly attempted to unite the Swedish, Saxon and other Protestant armies with his own, so as to compel all parties to make peace. But his army would not follow, the *coup d'état* failed, and Wallenstein was murdered at Eger (15/25 February 1634).

League of Heilbronn.

Dismissal and murder of Wallenstein.

All unity, Catholic or Protestant, died with him, and for the next fourteen years Germany was simply the battle-ground of French, Spanish, Austrian and Swedish armies, which, having learned the impunity and advantages of plunder in the school of Mansfeld and Wallenstein, reduced the country to a state of misery that no historian has been able to describe, save by detailing the horrors of one or other village among the thousands that were ruined, and by establishing the net result that Germany in 1648 was worse off than England in 1485, so much worse that while England was the healthier for having passed through the fever of the Wars of the Roses, Germany remained for 150 years more in the stillness of exhaustion.

Success was for the present with the emperor and Spain. Gallas, now appointed to Wallenstein's place, was Aldringer's companion from boyhood, whereas Bernhard, the Rupert of the German war, disagreed with Horn. Under the leadership nominally of the king of Hungary, Ferdinand's heir, but really of Gallas, the army recaptured Regensburg and Donauwörth, and when the Spanish Cardinal Infante joined them with 15,000 men on his way from Italy to the Netherlands, they were invincible. Bernhard attacked them in an entrenched position at Nördlingen (27 August/6 September 1634) and was beaten with a loss of 17,000 men to 2000 of the defenders.

Battle of Nördlingen.

Nördlingen was to the Swedes what Malplaquet was seventy-five years later to the Dutch. The model army of Gustavus perished there, and for the rest of the war a Swedish army, except for some advantages of organization and technical form, was intrinsically no better than another. Gallas reconquered the towns in southern Franconia. John George, having obtained from Ferdinand a compromise on the question of the Edict—its complete revocation Wallenstein's death and Bernhard's defeat had made impossible—agreed to the peace of Prague (20/30 May 1635), wherein all that was Protestant in 1627 was to remain so, or if since resumed by the Roman Church to be returned to the Lutherans.

Peace of Prague.

A certain number of princes followed John George's example on the same terms, but those who were excepted by name from the amnesty and those who had to gain or to regain the lands lost before 1627 continued the war. There was now no ideal, no objective, common even to two or three parties. The Catholic claims were settled by compromise. The power of the central authority, save in so far as the army could without starvation make itself successively felt at one place and another, had long disappeared. Gustavus's *Corpus Evangelicorum* as a German institution was moribund since Nördlingen, and Richelieu and the Spaniards stepped forward as the protagonists, the League of Heilbronn and the emperor respectively being the puppets.

The centre of gravity was now the Rhine valley, the highroad between Spanish Italy and the Spanish Netherlands. Richelieu had, as the price of his assistance after Nördlingen, taken over the Alsatian fortresses held by Bernhard, and in May, just before the treaty of Prague was signed, he declared war on Spain. The French army numbered 130,000 men in 1635, and 200,000 in the year after.

Aggressive policy of France.

One army assembled in Upper Alsace for the attack of the Spaniards in Franche Comté; another occupied Lorraine, which had been conquered in 1633; a corps under Henri de Rohan was despatched from the same quarter across Switzerland, doubling itself from soldiers of fortune met with *en route*, to expel the enemy from the Valtelline, and so to cut the route to the Netherlands. Another force, co-operating with the duke of Savoy, was to attack the Milanese. Bernhard was to operate in the Rhine and Main country, French garrisons holding the places of Alsace. Having thus arranged to isolate the Spanish Netherlands, Richelieu sent his main army, about 30,000 strong, thither to join Frederick Henry of Orange and so to crush the Cardinal Infante. This was strategy on a scale hitherto unknown in the war. Tilly, Wallenstein and Gustavus had made war in the midst of political and religious troubles that hung over a confused country. They had therefore made war as they could, not as they wished. Richelieu had unified France under the single authority of the king, and his strategy, like his policy, was masterful and clear. But the event proved that his scheme was too comprehensive. To seize and to hold with an unshakeable grip the neck of the Spanish power when Gallas and the imperialists were at hand was a great undertaking in itself and absorbed large forces. But not content with this Richelieu proposed to strike at each of the two halves of his enemy's power at the same time as he separated them. His forces were not sufficient for these tasks and he was therefore compelled to eke them out, both in Italy and the Netherlands, by working with allies whose interests were not his.

Spain attacked in Italy and the Netherlands.

The army on the Meuse won a victory at Avins, south of Huy, and afterwards joined Frederick Henry in the siege of Maestricht. But the Brabanters and Flemings had in sixty years of warfare parted so far from their former associates over the Waal that the inroad of Frederick Henry's army produced one of those rare outbursts of a momentary "people's war," which occur from time to time in the wars of the 17th and 18th centuries. The effect of it was that Frederick Henry withdrew to his own country, and in 1636 the French northern army had to face the whole of the Cardinal Infante's forces. In Italy the Franco-Piedmontese army achieved practically nothing, the gathering of the French contingent and its passage of the Alps consuming much time. In the Valtelline Rohan conducted a successful mountain campaign, which even to-day is quoted as a model of its kind.[1]

In Alsace and Lorraine, besides the Spaniards, the dispossessed duke of Lorraine was in the field against the French. Neither side was strong enough to prevail completely. Bernhard waged a desultory campaign in Germany, and then, when supplies gave out and Gallas advanced, joined the French. Towards the end of the year his army was taken into the French service, he himself remaining in command and receiving vague promises of a future duchy of Alsace. Gallas's army from Frankfort-on-Main pushed far into Lorraine, but it was late in the season and want of food compelled it to retreat. In eastern Germany the consequences of the peace of Prague were that Saxony, Brandenburg and other states, signatories to the treaty, were *ipso facto* the enemies of those who continued the war. Thus John George turned his arms against the Swedes in his neighbourhood. But their commander Banér was as superior in generalship as he was inferior in numbers, and held the field until the renewal of Gustavus's truce with Poland, which expired in this year, set free a fresh and uncorrupted Swedish corps that had been held ready for eventualities in that country. This corps, under Torstensson, joined him in October, and on the 1st of November they won an action at Dömitz on the Elbe.

Thus Richelieu's great scheme was only very partially executed. The battle of Avins and Rohan's Valtelline campaign, the only important military events of the year, took place outside Germany; within Germany men were chiefly occupied in considering whether to accept the terms of the peace of Prague. But the land had no rest, for the armies were not disbanded.

In 1636 the movements foreshadowed in 1635 were carried out with energy. John George, aided by an imperialist army, captured Magdeburg, drove back Banér to Lüneburg, and extended his right wing (imperialists) through Mecklenburg into Pomerania, where, however, a Swedish force under the elder Wrangel checked its progress. The Saxons then passed over the Elbe at Tangermünde and joined the imperialists, threatening to interpose between Banér and the Baltic. But Banér was too quick for them. He destroyed an isolated brigade of imperialists at Perleberg, and before the Brandenburg contingent could join John George, brought on a general action at Wittstock (24 September/4 October 1636). The elector had 30,000 men against 22,000 and sought to attack both in front and rear. But while his entrenchments defied the frontal attack Banér threw most of his army upon the enveloping force and crushed it.

Battle of Wittstock.

The Swedes lost 5000 killed and wounded, the combined army 11,000 killed and wounded and 8000 prisoners. The prestige of so brilliant a victory repaired even Nördlingen, and many North German princes who were about to make peace took fresh heart.

In the west, though there were no such battles as Wittstock, the campaign of 1636 was one of the most remarkable of the whole war. The Cardinal Infante was not only relieved by the retreat of the Dutch, but also reinforced by a fresh army[2] under a famous cavalry officer, Johann von Weert. He prepared, therefore, to invade France from the north-west. Even though the army that had fought at Avins and Maestricht returned by sea from Holland, the French were too much scattered to offer an effective resistance, and Prince Thomas of Savoy-Carignan and Johann von Weert, the Cardinal Infante's generals, took Corbie, La Capelle, and some other places, passed the Somme and advanced on Compiègne. For a moment Paris was terror-stricken, but the Cardinal Infante, by ordering Prince Thomas not to go too far in case he were needed to repel a Dutch inroad into Belgium, missed his opportunity.

Invasion of France.

Louis XIII. and Richelieu turned the Parisians from panic to enthusiasm. The burghers armed and drilled, the workmen laboured unceasingly at the dilapidated walls, and the old Huguenot marshal, Jacques Nompart, duc de La Force (d. 1642), standing on the steps of the Hôtel de Ville, raised men for the regular army by the hundred. Money, too, was willingly given, and some 12,000 volunteers went to Compiègne, whither Gaston from Orleans, Longueville from Normandy, and Condé, from Franche Comté, brought levies and reinforcements. Thus the army at Compiègne was soon

[1] See Shadwell, *Mountain Warfare*; and Hardÿ de Périni, *Batailles françaises*, vol. iii., for details.

[2] Composed partly of Bavarians, who had fought their way from the Danube to the Weser, partly of Cologne troops who had joined the Bavarians against the Protestants of north-west Germany.

50,000 strong. The army of Lorraine under Duke Bernhard and Louis de Nogaret, Cardinal de La Valette (d. 1639), placed itself at Épinal to prevent any junction between Prince Thomas and the army of Gallas. But Gaston of Orleans, the king's lieutenant at Compiègne, was no more enterprising as a defender of the country than he had been as a rebel and conspirator, and the army itself was only half mobile owing to its rawness and its "trained-band" character, and the Spaniards and Bavarians retired unmolested to oppose Frederick Henry in the Low Countries. They left a garrison in the little fortress of Corbie, which Monsieur's army recaptured in November. The gallantry of the defenders, which bore heavily on the townspeople, was alloyed with a singular trait of professionalism. The time had come for the Cardinal Infante to distribute his forces in winter quarters, and the garrison of Corbie, it is said, surrendered in good time in order not to be omitted in the allotment of comfortable billets in Belgium.

War in Lorraine and Burgundy.

During the episode of Corbie another storm burst on the eastern frontier of France. The prince of Condé, governor of Burgundy, had in the spring entered Franche Comté and besieged Dôle, but the inhabitants as well as the Spanish troops vigorously opposed him, and his army ultimately went to swell that of Gaston. But, although Duke Charles IV. was active in repossessing himself of Lorraine, Gallas with the main imperialist army[1] stood still in Lower Alsace during the summer. At first he had to await the coming of the nominal commander, Ferdinand's son, but afterwards, when heavy detachments from the defending armies had gone to Compiègne, Gallas himself missed his opportunity. It was not until September that he joined the duke of Lorraine, and later still when he made his inroad into Burgundy. He took a few small towns, but Dijon and the entrenchments of Bernhard's army there defied him, and his offensive dwindled down to an attempt to establish his army in winter quarters in Burgundy, an attempt of which the heroic defence of the little town of St Jean-de-Losne sufficed to bring about the abandonment. Charles IV., however, continued a small war in Lorraine with some success.

War in Italy.

In Italy the duke of Savoy with his own army and a French corps under Créqui advanced to the Ticino, and an action in which both sides lost several thousand men was fought at Tornavento a few miles from the future battlefield of Magenta, to which in its details this affair bears a singular resemblance (June 22, 1636). But the victory of the French was nullified by the refusal of Victor Amadeus, for political reasons, to advance on Milan, and Rohan, who had come down from the Valtelline to co-operate, hastily drew back into his stronghold. On the edges of the western Pyrenees a few towns were taken and retaken.

The campaign of 1637, on the French and Spanish side, was not productive of any marked advantage to either party. From Catalonia a Spanish army invaded Languedoc, but was brought to a standstill in front of the rocky fortress of Leucate and defeated with heavy losses by the French relieving army under Schomberg, duc d'Halluin. In Italy nothing was done. In the Valtelline the local regiments raised by Rohan mutinied for want of pay and Rohan had to retire to France. On the Low Countries frontier the cardinal de La Valette captured Câteau Cambrésis, Landrecies and Maubeuge. The deaths of Ferdinand II., the landgrave of Hesse-Cassel, the duke of Savoy and the duke of Mantua, which occurred almost simultaneously, affected the political foundations of the war but little. The balance, such as it was, however, was unfavourable to France, for the duchess of Mantua went over to the imperialists and the duchess of Savoy was opposed by the princes of her house. On the other hand, Ferdinand III., in spite of Spain, had to concede more power to the electors as the price of the imperial dignity.

War on the Rhine.

On the Rhine and in the adjacent countries Johann von Weert, returning from Belgium with his Bavarians, captured Ehrenbreitstein, the citadel of Coblenz, and expelled small French detachments from the electorate of Trier, whose ruler, the archbishop, had been put to the ban by the emperor. Then, passing into the Main valley, he took Hanau. The main imperialist army, still under Gallas, had departed from Alsace to the east in order to repair the disaster of Wittstock, and Charles of Lorraine, with his own small force and a detachment under Count Mercy left by Gallas, was defeated by Bernhard on the Saône in June, after which Bernhard advanced vigorously against Piccolomini, the imperialist commander in Alsace, and crossed the Rhine at Rheinau. But soon Piccolomini was joined by Johann von Weert, and Bernhard retired again.

[1] For the first time in the history of western Europe Cossacks appeared on the Rhine. Their march through Germany was marked by extraordinary atrocities. They did not remain long at the front, for their insubordination and misconduct were so flagrant that even Gallas found them intolerable and dismissed them.

War in northern and north-eastern Germany.

In the north-east, the effect of Wittstock proved but transient. The widow of the landgrave of Hesse-Cassel, after an attempt at resistance, agreed to the treaty of Prague. In 1638 Banér after taking Erfurt and Torgau found himself the target of several opponents—the Bavarians under Götz, who had remained on the Weser to subdue Hesse-Cassel when their comrades passed into Belgium in 1635, the beaten army of Wittstock, and a potential Brandenburg contingent. The Saxons did no more than defend their own country, but the imperialists and Bavarians uniting under General Geleen manœuvred Banér out of his strongholds on the Elbe. He retreated on the Oder, but there found, not the expected assistance of Wrangel's Pomeranian army, but Gallas with the main imperial army which had hurried over from the west to cut off the Swedes. Banér escaped only by a stratagem. Deluding Gallas with an appearance of retreat into Poland, he turned northwards, joined Wrangel, and established himself for a time in Pomerania. But Gallas ruined his army by exposing it to an open winter in this desolate country, and at last retired to the Elbe. Pomerania, by the death of the old duke Bogislav, became a bone of contention between rival claimants, and in the prevailing equilibrium of greater powers its fate remained unsettled, while a feeble small war slowly consumed what Wallenstein and Gustavus, Gallas and Wrangel had spared.

Fighting in the Netherlands and Alsace.

In 1638 the French operations in Italy, Belgium and Spain were in the main unsuccessful. In Italy Créqui was killed in an action on the 17th of March, and the Spanish commander in the Milanese, Leganez, advanced to the Sesia and took Vercelli. In the Low Countries Prince Thomas and Piccolomini repulsed in turn the Dutch and the French. In the south Condé led from Bayonne an invading army that was to dictate terms at Madrid, but the fortress of Fontarabia, though invested by land and sea, checked the French until a relieving army arrived and drove Condé in disorder to Bayonne. So angry was King Louis at this failure that Condé's lieutenant-general, the brother of Cardinal de La Valette, was condemned for high treason. But the case was different in Alsace. There Richelieu was more than ever determined to strike at the Spanish power, and there too was Bernhard, who hoped that Alsace was to be his future principality, and under whom served the survivors of Breitenfeld and Nördlingen, now in French pay under the name of the "Weimar Army." After the raid into south Germany Bernhard had wintered about Basle, and began operations by taking a few towns in the Black Forest. He then besieged Rheinfelden. Johann von Weert, however, fell upon him by surprise and drove him away (February 28th). Rohan was amongst the dead on the French side. But Bernhard reassembled his adventurers and invited them to return and beat the imperialists at once. The outcome was the battle of Rheinfelden, in which the redoubtable Weert, who had terrified Paris in 1636, was taken prisoner and his army dissipated (March 3rd). Although the Bavarians in the Weser country hurried south to oppose him, Bernhard took Rheinfelden and Freiburg. Lastly he invested Breisach—the town that, scarcely known to-day, was then the "Key of Alsace." Götz's Bavarians and Charles of Lorraine's army hastened thither, but Bernhard beat them in turn at Wittenweiher (August 9th) and Thann (October 15th), and received the surrender of Breisach, when the garrison had eaten the cats, dogs and rats in the place, on the 17th of December.

Beginning of negotiations for peace.

In the course of 1638 peace negotiations were carried on at Cologne and Hamburg, but the war still dragged on. In the east, 1639 began with Banér's pursuit of the retreating Gallas. Thanks to his skill the Swedish star was again in the ascendant. Banér crossed the Elbe, captured Halle and Freiburg, inflicted a severe defeat on the imperialists at Chemnitz (April 14, 1638), and then after overrunning western Saxony advanced into Bohemia, judging rightly that Bernhard was too much occupied with his prospective duchy to co-operate with him in the south-west. Ferdinand III. sent his brother, the archduke Leopold William, to take command of Gallas's army and sent all available reinforcements to Bohemia. But Banér contented himself, after an unsuccessful attempt upon Prague, with thoroughly eating up the country and, as winter came on, he retired into the Saxon mountains. The other Swedish troops overran Brandenburg and fomented a revolt in Silesia.

France and Spain.

In 1639, as before, Richelieu's attacks on Spain, other than those directed upon Alsace and Baden, were unsuccessful. In the north the French devoted this year, as they had devoted 1637 and 1638, to a methodical conquest of walled towns in view of a future *frontière de fer*. The two objectives selected, Hesdin and Thionville, were far apart, and a covering army to protect both sieges against Piccolomini was posted midway between them. Piccolomini, by a forced march from Liége and Huy through the Ardennes, flung himself upon the besiegers of Thionville before their "circumvallation" was completed, and being greatly superior in numbers he almost annihilated them (June 7, 1639) before the covering or rescuing army had even passed the Argonne. Then, however, Piccolomini, whose troops had bought the victory dearly, stood still for a time, and Hesdin, besieged with much pomp by Richelieu's nephew, La Meilleraye, surrendered on the 29th of June. On the side of the Pyrenees Condé as usual showed himself both unlucky and incapable. In Italy Cardinal de La Valette died, after allowing Prince Thomas to win over Savoy to the emperor's side and seeing every French post except Casale, Chivasso and the citadel of Turin taken by Thomas and Leganez.

His successor was the duc d'Harcourt, called by his men "Cadet-la-Perle" on account of his earrings, but a bold and exceedingly competent soldier. Under him served Turenne, hitherto known only as a younger brother of the duke of Bouillon. Harcourt reviewed his army for the first time late in October. The day after the review he advanced from Carignano to revictual Casale, detaching Turenne as flank-guard to hold off Prince Thomas on the side of Turin. The enterprise was entirely successful, but Thomas and Leganez determined to cut off the French on the return march. Leganez beset a defile on the Chieri-Carignano road (whence the action is called the *Route de Quiers*) while Thomas lay in wait to the north. But Turenne and the flank-guard sharply repulsed the prince, and by hard fighting the French returned safe and victorious (November 29th).

In Alsace Bernhard was carried off by a fever just as he was preparing to fight his way to a junction with Banér. Nevertheless he was fortunate in the opportunity of his death, for his dream of a duchy of Alsace had already brought him into conflict with Richelieu, and their conflict could only have ended in one way. Marshal Guébriant at once took steps to secure his army [1] for the service of France, and Richelieu's officers were placed in charge of the fortresses he had conquered. At the same time the long negotiations between the landgravine of Hesse-Cassel and the various powers ended in her allying herself with France and raising an army in return for a subsidy. Another event of importance in this year was the episode of the Spanish fleet in the Downs. Now that the land route was imperilled the sea communications of Spain and Belgium were brought into use. A squadron sailed from Spain for the Netherlands, and, though it evaded the now powerful French navy, it was driven into English territorial waters by the Dutch. Charles I. of England offered France free access to the victim if France would restore the elector palatine, and offered Spain protection if she would furnish him with funds for his army. Richelieu in reply encouraged the growing opposition to Charles at home, and the Dutch, contemptuous of his neutrality, sailed in and destroyed the fleet at anchor.

Death of Bernhard of Saxe-Weimar and its effects.

Fate of the Spanish fleet.

In 1640 the French still kept up their four wars in Belgium, Germany, Italy and Spain. But the Belgian and Spanish frontiers were no longer directly attacked. On the side of Languedoc there was no further danger, for the foolish imposition of strict military forms, and equally foolish threats to punish those who did not appear at the rendezvous, caused the Catalans, who were already defending themselves against the French both efficiently and vigorously, to turn their arms against the old enemy Castile. In December 1640 Portugal declared herself independent under a king of the house of Braganza. In the Low Countries Louis XIII. himself presided over the siege of the important fortress of Arras, which surrendered on the 8th of August.

In Italy, however, Cadet-la-Perle kept the moral ascendancy he had won in the brave action of the *Route de Quiers*. In April with 10,000 men he advanced from Carignan against the 20,000 Spaniards who were besieging Casale and attacked their line of circumvallation boldly and openly on the 29th of April. He himself on horseback led his stormers over the parapet. Turenne spread out his cavalry in one thin line and, thus overlapping Leganez's cavalry on both flanks and aiding his charges with the fire of his dismounted dragoons, drove it away. The Spanish infantry rearguard was cut off and destroyed, and at the end of the day half of Leganez's army was killed or captive. After this, Harcourt promptly turned upon Prince Thomas, and then followed one of the most remarkable episodes in military history. Thomas, himself defending Turin, was besieging the French who still held the citadel, while Harcourt, at once besieging the town and attempting to relieve the citadel, had, externally, to protect himself against Leganez's army which was reorganized and reinforced from Naples and the Papal States. For long it seemed as though the latter, master of the open country, would starve the small army of Harcourt into submission. But Harcourt's courage and the disunion of his opponents neutralized this advantage. Their general attack of the 11th of July on the French lines was made not simultaneously but successively, and Harcourt repulsed each in turn with heavy losses. Soon afterwards the French received fresh troops and a large convoy. The citadel was relieved and the town surrendered soon afterwards. Leganez retired to Milan, Prince Thomas was allowed to take his few remaining troops to Ivrea, and recognized the duchess's regency.

Casale and Turin.

[1] Forestalling others who desired its services, notably the Winter King's son, who intended to ally himself with Spain and so to force the retrocession of the Palatinate. The war had indeed progressed far since the days of the Protestant Union!

In Germany Banér's course was temporarily checked. The archduke dislodged him from his few remaining posts in Bohemia, and when at last Bernhard's old army, under the duc de Longueville, crossed the Rhine at Bacharach and joined Banér in Thuringia, the Austrians held them in check in the broken country about Saalfeld until the country would no longer support the combined army. The Weimar army then retired to the Rhine valley and Banér to Waldeck, and, in the hope of detaching both George of Lüneburg and the landgravine of Hesse-Cassel from the Swedish alliance, the imperial general wasted their territories, ignoring Banér. After the departure of the Lüneburgers and Hessians, recalled for home defence, the Swedish general could only watch for his opportunity.

The Swedes checked.

This came in the winter months of 1640–41. Negotiations for peace were constantly in progress, but no result seemed to come out of them. The Diet was assembled at Regensburg, the imperial army scattered over north-western Germany. Banér suddenly moved south heading for Ratisbon, for the defence of which the archduke's and all available troops—even Piccolomini's from the upper Rhine—were hurried up by the emperor. The Weimar Army under Guébriant joined the Swedes *en route*, and the combined army reached the objective. But a thaw hindered them and gave the emperor time to concentrate his forces, and after a variety of minor operations Banér's army found itself again in possession of Hesse, Lüneburg, Brunswick, &c. Guébriant's army, however, had again separated from him in order to live, and in May was at Bamberg—even an army of 18,000 could hardly keep the field at this stage of the war. On the 20th of May Banér, worn out by fatigue, died, and after some intrigues and partial mutinies, Torstensson succeeded to the command. The last fortified place held by the Austrians in Lower Saxony, Wolfenbüttel, was now besieged by Torstensson's Swedes and Germans and Guébriant's French and Weimarians, and the archduke and Piccolomini advancing to its relief were defeated outside the walls on the 29th of June. The war had now receded far from Alsace, which was firmly held by France, and no longer threatened even by Charles of Lorraine, who had made his peace with Louis XIII. in the spring, and whose army had followed Guébriant into Germany. The losses of the Germans at Wolfenbüttel caused some of their princes to accept the peace of Prague, but, on the other hand, the new elector of Brandenburg (Frederick William, the Great Elector) gave up the Austrian alliance and neutralized his dominions.

Banér's last successes.

In 1641 Harcourt thoroughly established his position, without much fighting, in Piedmont. In Spain the Catalan and Portuguese insurrections continued and the French occupied Barcelona, but underwent a serious reverse at Tarragona. In the north La Meilleraye captured and held some of the Artois towns, but was driven out of the open country by the superior army of the Cardinal Infante. A formidable conspiracy against Richelieu brought about a civil war in which the king's troops were defeated at La Marfée, near Sedan (the fortress of Turenne's discontented brother, the semi-independent duke of Bouillon), by a mixed army of rebels, Spaniards and Imperialists (July 6th). This, however, led to nothing further and the conspiracy collapsed. Charles of Lorraine having joined the rebels, his newly regained fortresses were reoccupied by the French.

Civil war in France.

In December 1641 there began at Münster and Osnabrück in Westphalia the peace negotiations which, after eight more years of spasmodic fighting, were to close this ruinous war.

In 1642 Torstensson, having cleared up the war for a moment in the north-west, turned upon Silesia, defeated an imperialist corps at Schweidnitz and took some fortresses, but drew back when the archduke and Piccolomini came up with the main Austrian army. In October, however, he was joined by fresh troops from the north-east, crossed the Elbe and besieged Leipzig. The imperialist army, which was joined by the Saxons when their country was again the theatre of war, marched to the rescue. But Torstensson defeated them with enormous loss in the second battle of Breitenfeld [2] (November 2, 1642). But, although the Austrians feared an advance on Vienna itself, the victors waited for the fall of Leipzig and then took up winter quarters. Guébriant had throughout the year operated independently of the Swedes. The Bavarians had advanced into the lower Rhine region in order to support, in concert with the Belgian army of Spain, a fresh outbreak in France (Cinq-Mars' conspiracy). But Lamboy, the Spanish general, was attacked and defeated before Hatzfeldt's Bavarians came up, at Hulst between Kempen and Crefeld (January 17th), whereupon the Bavarians took shelter under the guns of the fortress of Jülich.

Torstensson's victory of Breitenfeld.

On the northern frontier of France Harcourt, the brilliant commander of the Italian army, failed to prevent the Spaniards from capturing Lens and La Bassée, and Guiche, with another army farther east at Le Câtelet, was defeated and routed at Honnecourt (May 26th), saving only 2000 of his 9000 men. But Francisco de

[2] The emperor executed all the officers and every tenth man of the regiment in which the panic began.

Melo, the Cardinal Infante's successor, did not profit by his victory, turning back instead to oppose the Dutch and Guébriant. In Italy Thomas of Savoy and his brother, submitting to the regency of the duchess, led her troops in concert with the French against the Spaniards of the Milanese, and took Tortona. Louis himself conquered Roussillon, Richelieu crushed the conspiracy of Cinq Mars by executing its leaders, and Marshal de la Motte-Houdencourt held Catalonia and defeated Leganez at Lerida (October 7th).

Before the next campaign opened Louis and Richelieu were dead. One of the last acts of the king was to designate the young duc d'Enghien, son of the incapable Condé, as general of his northern army. Harcourt had strangely failed, Guébriant was far away, and the rest of the French marshals were experienced but incapable of commanding an army. Yet it was no small matter to put in their place a youth of twenty-one, who might prove not merely inexperienced but also incompetent. But Enghien's victory was destined to be the beginning for the French army of a long hegemony of military Europe.

The Duc d'Enghien.

Melo had selected the Meuse route for his advance on Paris. On it he would meet only the places of Rocroi and Rethac; these mastered, he would descend upon Paris by the open lands between the Marne and the Oise. He began by a feint against Landrecies, and under cover of this secretly massed his Sambre and Ardennes corps on the Meuse, while Enghien, having the safety of Landrecies in mind, moved to St Quentin. There, however, the young general learned at the same moment that Louis XIII. was dead and that the Spaniards had invested Rocroi. With the resolution and swiftness which was to mark his whole career, he marched at once to offer them battle. Enghien's more experienced counsellors, the generals of the old school, were for delay. To risk the only French army at such a moment would, they said, be madness, and even the fiery Gassion asked, "What will become of us if we are beaten?" But Enghien replied, "That will not concern me, for I shall be dead," and his personality overcame the fears of the doubters. The battle took place on the 19th of May 1643, in a plain before Rocroi, without any marked tactical advantage of ground in favour of either side. Melo's cavalry was routed, and nearly all the infantry, 18,000 men of the best regiments in the Spanish army, the old Low Countries *tercios*, with their general the Conde de Fuentes,[1] a veteran of fifty years' service, in their midst, stood their ground and were annihilated. 8500 were dead and 7000 prisoners. Two hundred and sixty colours and standards went to grace Nôtre Dame.

Battle of Rocroi.

But even Rocroi, under the existing conditions of warfare, was decisive only in so far as, by the destruction of Spain's superiority in Belgium, it saved France from further inroads from the north. Enghien indeed followed up the débris of Melo's army beyond the Sambre, but on the Rhine Guébriant had marched away from the region of Cologne into Württemberg, and there was nothing to prevent the imperialists in the north-west from joining Melo. The thorough establishment of the French on the Rhine and the need of co-operating with the Swedes was considered by the young general to be more important than fighting Melo in front of Brussels, and in spite of the protests of the Regent and Mazarin, he decided to attack Thionville. Taking a leaf out of Melo's book, he threatened Brussels in order to draw all the defenders thither, and then suddenly turned eastward. Enghien arrived on June 18th, a corps from Champagne had already reached the place on the 16th, and on the 8th of August Thionville surrendered. The small fortress of Sierck followed suit (September 8th).

Surrender of Thionville.

Guébriant meanwhile had attempted without success to cover the French and Protestant posts in Württemberg against the united forces of his old opponents from the lower Rhine (Hatzfeldt's Bavarians) and a fresh Bavarian army under Mercy, and had retired into Alsace. Thither Enghien, before dispersing his army into rest-quarters in October, sent him a corps under Josias Rantzau to enable him to recross the Rhine and to seize winter-quarters in Germany so as to spare Alsace. Guébriant did so, but he was mortally wounded in the siege of Rottweil, a town at the source of the Neckar, and Rantzau, taking over the command, allowed himself to be surprised in the act of dispersing into winter-quarters by Charles of Lorraine (who had again changed sides and now commanded his own, Hatzfeldt's and Mercy's armies[2]). At Tuttlingen on the headwaters of the Danube, Rantzau was taken prisoner with the greater part of his army of 12,000 men (November 24th), and the rest hurriedly fell back into Alsace.

In the east the campaign had as usual turned more upon subsistence than upon military operations. Torstensson, by his halt before Leipzig after Breitenfeld, had given the emperor a whole winter in which to assemble a new army. The hereditary provinces, as the devastations of war approached their own borders, willingly supplied a force of 12,000 men, which under Piccolomini manoeuvred for a while to the west of Dresden. But Piccolomini was replaced by Gallas, who, though cherishing visionary schemes of uniting Hatzfeldt's troops and Götz's Cologne-Bavarian-North German army with his own for a decisive blow, had in fact to fall back through Bohemia. The Swedes followed. Taking the small towns and avoiding the large places, Torstensson swept through Bohemia and Moravia, his steps dogged through the devastated country by Gallas, until he reached Brünn. Thence, however, he suddenly retreated to the shores of the Baltic. Christian of Denmark had declared war on Sweden, and threatened to isolate the Swedish forces in Germany. Torstensson, therefore, wintered in Holstein, Gallas, unable to follow him through districts already eaten up, in Saxony. In Italy and Spain there was no event of any importance.

Torstensson against Gallas.

In 1644 Gaston of Orleans, with La Meilleraye and Gassion under him, began the conquest of the Dunkirk region, capturing Gravelines in July. Melo, having no army to oppose them, remained inactive. In Italy Prince Thomas and Marshal Plessis-Praslin undertook nothing serious, while in Spain La Motte-Houdencourt lost Lerida, and was imprisoned by Mazarin in consequence. But the Rhine campaign is memorable for the first appearance of Turenne at the head of an army, and for the terrible battle of Freiburg.

The war in the Netherlands and in Italy.

The momentary combination of forces on the other side that had ruined Guébriant's expedition soon broke up. Hatzfeldt was called by the emperor to join Gallas, Charles of Lorraine wandered with his mercenaries to the Low Countries, and Mercy's Bavarians alone were left to oppose Turenne, who spent the first months of the year in restoring discipline and confidence in the shaken Weimar Army. But Mercy was still considerably superior in strength, and, repulsing Turenne's first inroad into the Black Forest, besieged Freiburg. Turenne made one cautious attempt at relief, then waited for reinforcements. These came in the shape of Enghien's army, and Enghien as a prince of the blood took over the supreme command. But both armies together numbered hardly 17,000 men when Enghien and Turenne united at Breisach on the 2nd of August. On the 3rd, although Freiburg had meantime surrendered, they crossed the Rhine and attacked Mercy's position, which was of great natural and artificial strength, in front and flank. Three separate battles, which cost the Bavarians one-third of their force and the French no less than half of theirs, ended in Mercy's retreat (see FREIBURG) on the 10th of August. Enghien did not follow him into the mountains, but having assured himself that he need not fear interference, he proceeded to the methodical conquest of the middle Rhine fortresses (Philippsburg, Heidelberg, Mannheim, Mainz, &c.), and returned with his own army to the Moselle, leaving Turenne and the Weimar Army at Spire.

Battles around Freiburg.

In the east, or rather in the north, a desultory campaign was carried on during 1644 between Torstensson and the younger Wrangel, on the one side, the Danes and Gallas on the other, and in the end Gallas retreated to Austrian territory, so completely demoralized that for want of supervision his army dwindled on the way from 20,000 men to 2000. Torstensson followed him, having little to fear from the Danes. Meanwhile the prince of Transylvania, George Rakóczy, playing the part of Gabriel Bethlen his predecessor, made war upon the emperor, who not being able on that account to send fresh troops against Torstensson, called upon Hatzfeldt, as above mentioned, to reform the wrecks of Gallas's army on the nucleus of his own. Maximilian of Bavaria sent most of his own troops under Weert on the same errand—hence Mercy's defeat at Freiburg. But Torstensson pressed on by Eger, Pilsen and Budweis towards Vienna, and on the 24 February/6 March 1645 he inflicted a crushing defeat on Götz, Weert and Hatzfeldt at Jankau near Tabor. Götz was killed and half of his army dead or captive. In his extremity Ferdinand offered part of Bohemia and Silesia to Maximilian in return for soldiers. But the Bavarian ruler had no soldiers to give, for Turenne was advancing again from the Rhine.

Battle of Jankau.

At the end of March the Weimar Army was at Durlach, on the 6th of April at Pforzheim. Thence it marched to Heilbronn, and Rothenburg-on-Tauber, when Turenne resolved to go northward in search of supplies and recruits in the territories of his ally and

[1] Paul Bernard Fontaine de Fougerolles, a noble of Franche Comté.

[2] The three "armies" combined were hardly more than 25,000 strong.

cousin the landgravine of Hesse-Cassel. But at this point the army, headed by Bernhard's old colonels, demanded to be put into rest-quarters, and Turenne allowing them to disperse as they wished, was surprised by Mercy and Weert—who brought his courage, if nothing else, back from the field of Jankau—and lost two-thirds of his forces. But Turenne instead of retreating to the Rhine installed himself in the landgravine's country, where he collected reinforcements of Hessians and Swedes, while Enghien hurried up from the Moselle and crossed the Rhine to repair the disaster. The "Army of Weimar" and the "Army of France" joined forces, as in 1644, almost under the eyes of the enemy. Enghien at once pushed forward from Ladenburg, by Heidelberg, Wimpfen, Rottenburg and Dinkelsbühl. But from day to day the balance leaned more and more on the Bavarian side, for Torstensson, after threatening Vienna (April), had drawn off into Moravia without waiting for the dilatory Rakóczy, and the emperor was able to give Maximilian an Austrian corps to be added to Mercy's army. Mercy therefore, after manoeuvring for a time on Enghien's left flank, placed himself in a strong position at Allerheim near Nördlingen, directly barring the way to the Danube. The second battle of Nördlingen (August 3, 1645) was as desperately fought as the first, and had not Mercy been killed at the crisis of the day Enghien would probably have been disastrously defeated. As it was, the young duke was victorious, but he had only 1500 infantry left in rank and file out of 7000 at the end. Soon afterwards Enghien fell ill, and his army returned to France. Turenne, left with a few thousand men only, attempted in vain to hold his ground in Germany and had to make a hasty retreat before the archduke Leopold William, who had meantime made peace with Rakóczy, and, leaving Torstensson's[1] successor Wrangel undisturbed in his Silesian cantonments, brought Gallas's and Hatzfeldt's troops to aid Weert's. Turenne wintered around Philippsburg, almost the only remaining conquest of these two brilliant but costly campaigns. But before he settled down into winter quarters he sent a corps to the Moselle, which dislodged the imperialist garrison of Trier and restored the elector in his archbishopric. In Flanders Gaston of Orleans conquered a number of fortresses, and his army united with that of the Dutch. But the allies separated again almost at once, each to undertake the sieges which suited its own purposes best.

Turenne's Army.

Second battle of Nördlingen.

From Silesia Wrangel passed into Bohemia, where he remained until the forces employed against Rakóczy and Turenne could send help to the imperialists opposed to him. He then drew away into Hesse[2] to support the landgravine of Cassel against the landgrave of Darmstadt, the archduke Leopold William and the Bavarians following suit.

The campaign of 1646 in Hesse up to August was as usual uneventful, each army being chiefly concerned with its food. But at last the archduke retired a little, leaving Turenne and Wrangel free to join their forces. Turenne had no intention of repeating the experiences of Freiburg and Nördlingen. War had by now settled down into the groove whence it did not issue till 1793. It was more profitable to attain the small objects that were sought by manoeuvre than by battle, and the choice of means practically lay between manoeuvring the enemy's army into poor districts and so breaking it up by starvation, and pushing one's own army into rich districts regardless of the enemy's army. The usual practice was the first method. Turenne chose the second.

Turenne's strategy.

Delayed at the opening of the year by orders from Mazarin to stand still—the elector of Bavaria had opened negotiations in order to gain time for the archduke Leopold William to march into the west—Turenne found it impossible to reach Hesse by the short and direct route, and he therefore made a rapid and secret march down the Rhine as far as Wesel, whence, crossing unopposed, he joined Wrangel on the upper Lahn (August 10th). The united armies were only 19,000 strong. Then the imperialists, fearing to be hemmed in and starved between Turenne and the Rhine, fell back to Fulda, leaving the Munich road clear. The interior of Bavaria had not been fought over for eleven years, and was thus almost the only prosperous land in desolated Germany. Turenne and Wrangel marched straight forward on a broad front. On the 22nd of September, far ahead of the pursuers, for whom they left nothing to eat, they reached

[1] Torstensson, suffering from gout and worn out by the campaign, retired after the unsuccessful Vienna raid.

[2] John George of Saxony, seeing that his country was faring worse in a state of open war against Sweden than it would even in the most impotent neutrality, had made a truce with Wrangel on what terms he could obtain.

Augsburg, and for the rest of the year they devastated the country about Munich in order to force Maximilian to make terms. An armistice was concluded in the winter, Maximilian having been finally brought to consent by an ill-judged attempt of the emperor (who feared that Bavaria would go the way of Brandenburg and Saxony) to seduce his army. The French and Swedes wintered in southern Württemberg.

In Flanders, Gaston of Orleans and Enghien took Dunkirk and other fortresses. In Italy, where the Tuscan fortresses were attacked, the French and Prince Thomas their ally were completely checked at first, until Mazarin sent a fresh corps thither and restored the balance. In Catalonia Harcourt underwent a serious reverse in front of Lerida at the hands of his old opponent Leganez, and Mazarin sent Enghien, now Prince of Condé, to replace him.

Last months of the war.

1647 was a barren year. The Low Countries Spaniards, concluding a truce with the Dutch, threw their whole force upon France, but this attack dissipated itself in sieges. In Italy Plessis-Praslin won an unprofitable victory over the viceroy of the Milanese on the Oglio (July 4th). In Spain Condé, resuming the siege of Lerida, was repulsed with even more loss than Harcourt had been the year before, and had to retire upon the mere appearance of a relieving army. In Germany Turenne and Wrangel parted company. The latter returned to Hesse, whence he raided into Bohemia, but was driven back by the imperialists under their new general, Melander-Holzapfel. As the few obtainable supply areas gave out one by one, the Swedes gradually retired almost to the coast, but the imperialists did not follow, swerving into Hesse instead to finish the quarrel of the landgravine and the landgrave. Turenne meanwhile had had to send all the French troops to Luxemburg to help in the defence of northern France against the Spaniard. The Weimar Army had refused to follow him to the Meuse, and mutinied for its arrears of pay. Turenne, however, promptly seized the ringleaders and after a sharp fight disarmed the rest. Thus ignominiously Bernhard's old army vanished from the scene.

In the autumn the elector of Bavaria was reconciled to the emperor and his army re-entered the field. Turenne was therefore sent back to Germany to assist the Swedes. But winter came on before any further inroads could be made into south Germany.

The campaign of 1648 brought the decision at last. Turenne and Wrangel, having refitted their forces and united in Hesse as in 1646, steadily drove back the imperialists and Bavarians, whose 30,000 combatants were accompanied by a horde of nearly 130,000 hangers-on—men, women and children—to the Danube. For a moment, at Nördlingen, the French and the Swedes separated, but they soon reunited, moved on to and beyond the Danube, and at Zusmarshausen (May 17th) catching the enemy in the act of manoeuvring, they destroyed his rear-guard, Melander being amongst the dead. The victors advanced as far as the Inn, but Piccolomini, reorganizing the débris of the Austro-Bavarian army, checked their further progress and even drove them back to the line of the Isar. Meantime, however, the Swedish general Königsmarck, gathering all the scattered forces of his side in Saxony and Silesia, had entered Bohemia and was besieging Prague. This caused the recall of Piccolomini's army, and Turenne and Wrangel invested Munich. But Mazarin ordered the French to retire into Suabia so as not to compromise the peace negotiations at the critical moment, and Wrangel followed suit. Before Königsmarck was in a position to assault Prague news came of peace.

Battle of Zusmarshausen.

Meanwhile in Artois Condé had repulsed the Spanish invasion by his brilliant victory of Lens (August 5th), which was a second Rocroi. After the thanksgiving service for the victory at Nôtre Dame, Mazarin arrested the leaders of the Parlement of Paris, and in a few hours the streets were barricaded and a civil war in progress. This was the Fronde (*q.v.*), which went on for another eleven years.

AUTHORITIES.—S. R. Gardiner, *Thirty Years' War;* A. Gindely, *Gesch. des 30jähr. Krieges;* Chemnitz, *Gesch. des Schwedischen Krieges;* v. Pufendorf, *26 Bücher der Schwedish-deutschen Kriegsgeschichte* (1688); Hon. E. Noel, *Gustaf Adolf;* Hardÿ de Périni, *Batailles Françaises,* iii. and iv.; lives of Turenne, Condé, Wallenstein, Gustavus, &c.; vols. ix. and x. of Clausewitz's works; Lorentzen, *Schwedens Armee im 30jähr. Kriege;* Loewe, *Organisation der Wallensteinschen Heere; Précis des Campagnes de Gustave Adolphe* (Brussels, 1887). (C. F. A.)

THISTLE, a name, as generally employed, of vague application, being given to almost any herbaceous plant that is of a spiny character. More strictly, it is applied to the species of *Carduus*. These are Composite herbs with very spiny leaves, and similar bracts surrounding a head of purplish-white, tubular, five-parted flowers seated on a pitted and hairy receptacle. The anthers have appendages both at the apex and at the base, and the style has a ring of hairs at the point of bifurcation of the two stigmas. The fruit is surmounted by a tuft of silky-white hairs. The species, chiefly natives of Europe and Western Asia, are numerous, and some are of great beauty, though, not unnaturally, looked on with disfavour by the farmer. The blessed thistle is *Carduus benedictus*; Lady's thistle, the leaves of which are spotted with white, is *C. marianus*. The common *C. lanceolatus* seems to be the most suitable prototype for the Scots thistle. though that honour is also conferred on an allied plant *Onopordon acanthium*, the cotton thistle, remarkable for its covering of white down, a doubtful native, and on other species. The carline thistle is *Carlina vulgaris*, a member of the same family. as is also the sow-thistle, *Sonchus oleraceus*. The great objection to thistles from an agricultural point of view resides in the freedom with which they produce seed, and in the vigour of their underground growth, which makes their uprooting a matter of difficulty. Partial uprooting may, indeed, in the case of the perennial species, increase the mischief, for each fragment left behind may grow into a distinct plant. Annual species might be kept in check were they cut down before the flowers appear, but unless all the cultivators in a particular district co-operate the efforts of individuals are of little avail. The Artichoke (*q.v.*), *Cynara scolymus*, and Cardoon (*q.v.*) are very near allies of the thistles. The Safflower, *Carthamus*, another thistle, yields a serviceable dye; the Burdock, *Arctium lappa*, a member of the same family, has an edible root; and numerous allied species have medicinal properties.

THISTLEWOOD, ARTHUR (1770–1820), the principal instigator of the Cato Street conspiracy, a plot formed to murder many British ministers in 1820. A son of William Thistlewood, and born at Tupholme in Lincolnshire, young Thistlewood passed his early years in a desultory fashion; he became a soldier and visited France and America, imbibing republican opinions abroad and running into debt at home. Then taking up his residence in London he joined the Spencean Society, a revolutionary body; associated himself with James Watson (d. 1838) and other agitators; and in December 1816 helped to arrange a meeting in Spa Fields, London, which was to be followed by the seizure of the Tower of London and the Bank of England, and by a general revolution. The proposed rising was a dismal failure, but the Habeas Corpus Act was suspended and Thistlewood and Watson were seized, although upon being tried they were acquitted. Becoming more violent Thistlewood formed other plots, talked of murdering the prince of Wales, and was sentenced to a year's imprisonment for challenging the home secretary, Lord Sidmouth, to a duel. After his release in May 1819, having broken away from Henry Hunt and the more moderate reformers, he prepared a new and comprehensive plot. On the 23rd of February 1820, at a time of great distress and during the unrest caused by the death of George III., the cabinet ministers had arranged to dine at the earl of Harrowby's house in Grosvenor Square. Thistlewood knew of the dinner. With some associates he hired a room in the neighbouring Cato Street, collected arms and made ready to fall upon Harrowby's guests. However the authorities had been informed of the plot, probably by one of the conspirators named George Edwards; officers appeared upon the scene and arrested some of the conspirators; and although Thistlewood escaped in the confusion he was seized on the following day. Tried for high treason, Thistlewood and four others were sentenced to death, and were hanged on the 1st of May 1820.

See Sir S. Walpole, *History of England* (1890), vol. i.

THÖKÖLY, IMRE (EMERICH), PRINCE (1657–1705), Hungarian statesman, was born at Késmark on the 25th of September 1657. He lost both parents while still a child. In 1670, fleeing from the dangers of Upper Hungary, where the Protestants and Imperialists were constantly in arms against each other, he took refuge with his kinsman Michael Teleki, the chief minister of Michael Apafy, prince of Transylvania. Here he came into contact with the Magyar refugees, who had great hopes of the high-born, high-gifted youth who was also a fellow sufferer, a large portion of his immense estates having been confiscated by the emperor. The discontent reached its height when Leopold (Feb. 27, 1673) suspended the Hungarian constitution, appointed Johan Gaspar Ampringen dictator, deprived 450 Protestant clergy of their livings and condemned 67 more to the galleys. Encouraged by promises of help from Louis XIV., the Magyars now rose *pro libertate et justitia*, and chose the youthful Thököly as their leader. The war began in 1679. Upper Hungary and the mining towns were soon in Thököly's possession. In 1681, reinforced by 10,000 Transylvanians and a Turkish army under the pasha of Nagyvárad, he compelled the emperor to grant an armistice. On the 15th of June 1682 he married Helen Zrinyi, the widow of Prince Francis Rákóczy I. Thököly's distrust of the emperor now induced him to turn for help to the sultan, who recognized him as prince of Upper Hungary on condition that he paid an anuual tribute of 40,000 florins. In the course of the same year Thököly captured fortress after fortress from the emperor and extended his dominions to the Waag. He refused, however, the title of king offered to him by the Turks. At the two Diets held by him, at Kassa and Tályа, in 1683, the estates, though not uninfluenced by his personal charm, showed some want of confidence in him, fearing lest he might sacrifice the national independence to the Turkish alliance. They refused therefore to grant him either subsidies or a *levée en masse*, and he had to take what he wanted by force. Thököly materially assisted the Turks in the Vienna campaign of 1683, and shared the fate of the gigantic Turkish army. The grand vizier nevertheless laid the blame of the failure on Thököly, who thereupon hastened to Adrianople to defend himself before the sultan. Shortly afterwards, perceiving that the Turkish cause was now lost, he sought the mediation of Sobieski to reconcile him with the emperor, offering to lay down his arms if Leopold would confirm the religious rights of the Magyar Protestants and grant him, Thököly, the thirteen north-eastern counties of Hungary with the title of prince. Leopold refused these terms and demanded an unconditional surrender. Thököly then renewed the war. But the campaign of 1685 was a series of disasters, and when he sought help from the Turks at Nagyvárad they seized and sent him in chains to Belgrade, possibly because of his previous negotiations with Leopold, whereupon most of his followers made their peace with the emperor. In 1686 Thököly was released from his dungeon and sent with a small army into Transylvania, but both this expedition and a similar one in 1688 ended in failure. The Turks then again grew suspicious of him and imprisoned him a second time. In 1690, however, the Turks despatched him into Transylvania a third time with 16,000 men, and in September he routed the united forces of General Heister and Michael Teleki at Zernest. After this great victory Thököly was elected prince of Transylvania by the Keresztenymez Diet, but could only maintain his position against the imperial armies with the utmost difficulty. In 1691 he quitted Transylvania altogether. He led the Turkish cavalry at the battle of Slankamen, and in fact served valiantly but vainly against Austria during the remainder of the war, especially distinguishing himself at Zenta. He was excluded by name from the amnesty promised to the Hungarian rebels by the peace of Karlowitz (Jan. 26, 1699). After one more unsuccessful attempt, in 1700, to recover his principality, he settled down at Galata with his wife. From the sultan he received large estates and the title of count of Widdin. He was buried in the great Armenian cemetery at Nicomedia, but in the course of 1906 his relics were transferred to Hungary.

See *Correspondence of Thököly* (Hung.), ed. by Kálmán Thaly (Budapest, 1896); V. Fraknói, *Papst Innocenz XI. und Ungarn's Befreiung von de Türkenherrschaft* (Freiburg, 1902); *Memoirs of*

Emeric Count Teckely (London, 1693); *Correspondence of Michael Teleki* (Hung.), ed. by S. Gergely (Budapest, 1905–1906). (R. N. B.)

THOLOBATE (Gr. θόλος, a circular structure, dome, and βάσις, a base), the architectural term given to the cylindrical drum on which a dome is raised. In the earlier Byzantine churches, the dome rested direct on the pendentives and the windows were pierced in the dome itself; in later examples, between the pendentive and the dome an intervening circular wall was built, in which the windows were pierced, and this is the type which was universally employed by the architects of the Renaissance, of whose works the best-known examples are those of St Peter at Rome, St Paul's in London, and the churches of the Invalides, the Val de Grace and the Sorbonne in Paris.

THOLOS (θόλος), the term given in Greek architecture to a circular building, with or without a peristyle; the earliest examples are those of the beehive tombs at Mycenae and in other parts of Greece, which were covered by domes built in horizontal courses of masonry. The Tholos at Epidaurus, built by Polycleitus (*c.* 400 B.C.), and the Tholos at Olympia, known as the Philippeion, are the most remarkable examples, and in both cases were covered with a sloping roof and not with a dome.

THOLUCK, FRIEDRICH AUGUST GOTTREU (1799–1877), German Protestant divine, was born at Breslau, on the 30th of March 1799. He received his education at the gymnasium and university of his native town, and early distinguished himself by great versatility of mind and power of acquiring languages. A love of Oriental languages and literature led him to exchange the university of Breslau for that of Berlin, that he might study to greater advantage, and there he was received into the house of the Orientalist Heinrich Friedrich von Diez (1750–1817). He was introduced to pietistic circles in Berlin, and came specially under the influence of Baron Hans Ernst von Kottwitz (1757–1843), who became his "spiritual father," and of the historian Neander. Before deciding on the career of theological professor, he had in view that of a missionary in the East. Meanwhile he was feeling the influence to a certain degree of the romantic school, and of Schleiermacher and Hegel too, though he never sounded the depths of their systems. At length, in his twenty-first year, he finally decided to adopt the academical calling. In 1821 he was *Privatdozent* and in 1823 became professor extraordinarius of theology in Berlin, though he was at the same time active in the work of home and foreign missions. He lectured on the Old and New Testaments, theology, apologetics and the history of the church in the 18th century. In 1821 appeared his first work, *Sufismus, sive theosophia Persarum pantheistica*; following the same line of study he published *Blütensammlung aus der morgenländischen Mystik* (1825) and *Speculative Trinitätslehre des späteren Orients* (1826). His well-known essay on the nature and moral influence of heathenism (1822) was published by Neander, with high commendation, in his *Denkwürdigkeiten*; and his Commentary on the Epistle to the Romans (1824) secured him a foremost place amongst the most suggestive, if not the most accurate, Biblical interpreters of that time. Another work, which was soon translated into all the principal European languages, *Die wahre Weihe des Zweiflers* (1823; 9th ed., with the title *Die Lehre von der Sünde und dem Versöhner*, 1870), the outcome of his own religious history, procured for him the position which he ever after held of the modern Pietistic apologist of Evangelical Christianity. In 1825, with the aid of the Prussian government, he visited the libraries of England and Holland, and on his return was appointed (in 1826) professor ordinarius of theology at Halle, the centre of German rationalism, where he afterwards became preacher and member of the supreme consistorial council. Here he made it his aim to combine in a higher unity the learning and to some extent the rationalism of J. S. Semler with the devout and active pietism of A. H. Francke; and, in spite of the opposition of the theological faculty of the university, he succeeded in changing the character of its theology. This he effected partly by his lectures, particularly his exegetical courses, but, above all, by his personal influence upon the students, and, after 1833, by his preaching. His theological position was that of a mild and large-hearted orthodoxy, which laid more stress upon Christian experience than upon rigid dogmatic belief. On the two great questions of miracles and inspiration he made great concessions to modern criticism and philosophy. The battle of his life was on behalf of personal religious experience, in opposition to the externality of rationalism, orthodoxy or sacramentarianism. Karl Schwarz happily remarks that, as the English apologists of the 18th century were themselves infected with the poison of the deists whom they endeavoured to refute, so Tholuck absorbed some of the heresies of the rationalists whom he tried to overthrow. He was also one of the prominent members of the Evangelical Alliance, and few men were more widely known or more beloved throughout the Protestant churches of Europe and America than he. He died at Halle on the 10th of June 1877. As a preacher, Tholuck ranked among the foremost of his time. As a teacher, he showed remarkable sympathy and won great success. As a thinker he can hardly be said to have been endowed with great creative power.

After his commentaries (on Romans, the Gospel of John, the Sermon on the Mount and the Epistle to the Hebrews) and several volumes of sermons, his best-known books are *Stunden christlicher Andacht* (1839; 8th ed., 1870), intended to take the place of J. H. D. Zschokke's standard rationalistic work with the same title, and his reply to David Strauss's *Life of Jesus* (*Glaubwürdigkeit der evangelischen Geschichte*, 1837). He published at various times valuable contributions towards a history of rationalism—*Vorgeschichte des Rationalismus* (1853–1862), *Geschichte des Rationalismus* (1865), i. and a number of essays connected with the history of theology and especially of apologetics. His views on inspiration were indicated in his work *Die Propheten und ihre Weissagungen* (1860), in his essay on the "Alte Inspirationslehre," in *Deutsche Zeitschrift für christliche Wissenschaft* (1850), and in his *Gespräche über die vornehmsten Glaubensfragen der Zeit* (1846; 2nd ed., 1867).

He also contributed many articles to Herzog's *Realencyklopädie*, and for several years edited a journal (1830–1849), *Literarischer Anzeiger*.

See *Das Leben Tholucks*, by L. Witte (2 vols., 1884–1886); *A. Tholuck, ein Lebensabriss*, by M. Kähler (1877), and the same author's art. "Tholuck," in Herzog's *Realencyklopädie*; "Zur Erinnerung an Tholuck," by C. Siegfried, *Protestantische Kirchzeitung* (1885), No. 45, and 1886, No. 47; Karl Schwarz, *Zur Geschichte der neuesten Theologie* (4th ed., 1869); F. W. F. Nippold's *Handbuch der neuesten Kirchengeschichte*; cf. Philip Schaff, *Germany; its Universities, Theology and Religion* (1857), and the article in the *Allgemeine deutsche Biographie*.

THOMA, HANS (1839–), German painter, was born at Bernau in the Black Forest. Having started life as a painter of clock-faces, he entered in 1859 the Carlsruhe academy, where he studied under Schirmer and Des Coudres. He subsequently studied and worked, with but indifferent success, in Düsseldorf, Paris, Italy, Munich and Frankfort, until his reputation became firmly established as the result of an exhibition of some thirty of his paintings in Munich. In spite of his studies under various masters, his art has little in common with modern ideas, and is formed partly by his early impressions of the simple idyllic life of his native district, partly by his sympathy with the early German masters—particularly with Altdorfer and Cranach. In his love of the details of nature, in his precise (though by no means faultless) drawing of outline, and in his predilection for local colouring, he has distinct affinities with the pre-Raphaelites. Many of his pictures have found their way into two private collections in Liverpool. A portrait of the artist, and two subject pictures, "The Guardian of the Valley" and "Spring Idyll," are at the Dresden Gallery; "Eve in Paradise" and "The Open Valley" at the Frankfort Museum. Other important pictures of his are "Paradise," "Christ and Nicodemus," "The Flight into Egypt," "Charon," "Pietà," "Adam and Eve," "Solitude," "Tritons," besides many landscapes and portraits. He has also produced numerous lithographs and pen drawings, and some decorative mural paintings, notably in a café at Frankfort, and in the music room of Mr Pringsheimer's house in Munich.

THOMAR, a town of central Portugal, in the district of Santarem; on the river Nabão, a tributary of the Zezere, 4 m. from Paialvo railway station, which is 89 m. N.E. of Lisbon by the main line to Oporto. Pop. (1900), 6888. Thomar contains examples of the best Portuguese architecture from the 12th century to the 17th. The ruined castle of the Knights Templar, given to that order in 1159, is said to occupy the site of the ancient Nabantia. On the suppression of the Templars, who had done good service against the Moors, King Diniz of Portugal founded the Order of Christ in 1314. The convent palace of the Knights of Christ includes a church and cloister dating from the 12th century, two cloisters and a chapter-house added in the 15th century by Prince Henry the Navigator, a very fine 16th century church built in the Manoellian or Manueline style by João de Castilho, to which the older church served as a chancel, and other buildings erected later. The convent contains Flemish and Portuguese paintings of the 16th century, of the so-called "Grão Vasco" school. Its aqueduct, 3 m. long, was built 1595–1615. Other interesting buildings are the churches of Santa Maria do Olival, rebuilt in the Gothic style in 1450 on the site of an older Templar foundation; São João Baptista, also Gothic, built in 1490, but with Manoellian additions; Nossa Senhora da Conçeição, Renaissance of 1579; and the palace of Prince Henry the Navigator, restored in the 16th century by Queen Catherine, widow of John III.

THOMAS, ST, one of the twelve apostles. The synoptical Gospels give only his name, associating him in their lists with Matthew (Matt. x. 3; Mark iii. 18; Luke vi. 15); in Acts i. 13 he is coupled with Philip. In the Gospel of John (xi. 16; xiv. 5; xx. 24 seq.; xxi. 2) he appears in a characteristic light, full of personal devotion and ready to die with his Master, but slow to grasp the true significance of the personality of Jesus, and incredulous of the resurrection till direct evidence convinces him of its truth and at the same time of the Divinity of his risen Lord. John translates the Aramaic name or surname Thomas by the Greek equivalent Didymus (twin). Tradition has it that he was the twin brother of a sister Lysias (his parents being Diophanes and Rhoa, and his birthplace Antioch; "XII. Apost. Patriae," in *Chron. Pasch.* ii. 142), or of a brother Eliezer (*Hom. Clem.* ii. 1), or, according to the Syriac *Acta Thomae* (ed. Wright, *Eng. trans.* pp. 155, 180), of Jesus Himself. The last form of the tradition seems to be derived from the name Judas Thomas, which he bears in Edessene legend (cf. Eusebius, *H. E.* i. 13, 10), and implies the identification of Thomas with Judas, the brother of the Lord. The most ancient tradition makes Thomas the evangelist of Parthia (Eus. *H.E.* iii. 1, 1); and at Edessa, which claimed to possess his bones, it was related that their missionary Addai (*Doctrine of Addai*, ed. Phillips, 1876, p. 5), whom Eusebius calls Thaddaeus (*H.E.* i. 13), was sent to them by him. Later tradition, originating with the *Acta Thomae*, and accepted by catholic teachers from the middle of the 4th century, makes him proceed to India and there suffer martyrdom. The Indian king Gundaphar of the *Acta* is, however, certainly identical with the historical Gondophares, whose dynasty was Parthian, though his realm included regions loosely reckoned to India. The Parthian and Indian missions of Thomas may perhaps therefore be regarded as derived from a single tradition, but it is very doubtful whether it is based on any historical facts. The oldest extant tradition is that St Thomas did not suffer martyrdom at all (Heracleon *ap.* Clem. Alex. *Strom.* iv. 9). The best investigation of the traditions connecting St Thomas with India is that by W. R. Philipps (*Indian Antiquary*, 1903, xxxii. 1–15, 145–160). The ingenious conjectures of von Gutschmid (*N. Rhein. Mus.* xix. 161 seq.) and Sylvain Lévi (*Journ. asiatique*, 1897, p. 27 seq.) are greatly weakened by the fact that they do not start from a consideration of the names in their original Syriac form. Bishop Medlycott's *India and the Apostle Thomas* (1905) is wholly uncritical.

The *Acta Thomae*, very imperfectly published by Thilo (1823) and Tischendorf (1851), have been edited in Greek by Bonnet (Leipzig, 1883, 2nd ed., with new matter, 1903), and in the original Syriac, with an English translation, by W. Wright (*Apocryphal Acts*, 2 vols., London, 1871). See also Lipsius, *Die apocryphen Apostelgesch.*, ii. (2nd. ed.) 423–425 (Brunswick); F.C. Burkitt in *Journ. Theol. St.* i. 280 seq., ii. 94. The *Acta* are said by Photius to be a part of the Περίοδοι τῶν ἀποστόλων of the Gnostic Leucius Charinus, but this unknown personage is to be thought of as a collector of Gnostic "Acts of Apostles," rather than as the first author. In spite of extensive Catholic revision, the "Acts of Thomas" form one of the most interesting monuments of Syriac Gnosticism. Internal evidence assigns them with great probability to the school of Bardesanes, and the very ancient allegorical hymn about the soul which is preserved in the Syriac text (p. 274 seq., Eng. trans., p. 238 seq.) is perhaps by Bardesanes himself (cf. Nöldeke in *Z.D.M.G.*, 1871, p. 676). This hymn was translated into the Greek *Acta*, along with the rest of the work (Bonnet, pp. 219–224, *Anal. bolland.* xx. 158–164). It is one of the most remarkable pieces in Syriac literature, and has been edited separately by A. A. Bevan, *Texts and Studies*, v. 3 (Cambridge, 1897). A metrical English version is given in F. C. Burkitt's *Early Eastern Christianity*, p. 218 seq. (London, 1904). (F. C. B.)

"Christians of St Thomas" is a name often applied to the members of the ancient Christian churches of southern India, which claim him as their first founder, and honour as their second founder a certain bishop named Thomas, who is said to have come with some presbyters from Jerusalem to Malabar in A.D. 345.[1] According to their tradition, St Thomas went from Malabar to Mylapur, now a suburb of Madras, where the shrine of his martyrdom, rebuilt by the Portuguese in 1547, still stands on Mt St Thomas, and where a miraculous cross is shown with a Pahlavi inscription which may be as old as the end of the 7th century. We know from Cosmas Indicopleustes that there were Christian churches of Persian (East-Syrian) origin, and doubtless of Nestorian creed, in Ceylon, in Malabar, and at Caliana (north of Bombay) before the middle of the 6th century, and even then St Thomas, the reputed apostle of Persia, may have been their special saint. The ancient churches of southern India never died out or wholly lost their sense of connexion with their mother church, for we find them sending deputies in 1490 to the Nestorian patriarch Simeon, who furnished them with bishops (Assemani, *Bib. or.* iii. 1, 590 seq.). Hard pressed by the Moslems, they welcomed the approach of the Portuguese, but proved by no means tractable to efforts to bring them within the Roman obedience. At length a formal union with Rome was carried through in the synod of Diamper (1599). Syriac was to remain the ecclesiastical language, but the service books were corrected and purified from error. A century and a half of foreign Jesuit rule followed, but the love of independence was not lost. A great schism took place in 1653, and of 200,000 Christians of St Thomas only 400 remained loyal to Rome, though many of their churches were soon won back by the Carmelites. Those who remained independent fell under the influence of the Jacobite Mar Gregorius, styled patriarch of Jerusalem, who reached Malabar in 1665 as an emissary from Ignatius, patriarch of Antioch. From his time the independent Christians have been Jacobites, the counter-efforts of the Nestorians under Mar Gabriel, bishop of Azerbaijan, having apparently come to nothing after his death in 1730. Since the visit of Claudius Buchanan, whose *Christian Researches in Asia* (1811) excited great interest, much has been done for the Christians of South India by English missionary effort, and Anglicans have cultivated friendly relations with the clergy of the independent native church, while discouraging dependence on the Jacobite patriarch of Antioch.

A valuable though tedious and ill-arranged history of the Christians of St Thomas is that by W. Germann, *Die Kirche der Thomaschristen*. (Gütersloh, 1877). See also La Croze, *Histoire du christianisme des Indes* (The Hague, 1724); Alexius de Menezes, *Historia ecclesiae malabaricae* (Latin by F. Raulin, Rome, 1745) (especially for the synod of Diamper); Paulinus a S. Bartholomaeo, *India orientalis christiana* (4to, Rome, 1794); George Milne Rae, *The Syrian Church in India* (Edinburgh and London, 1892).

THOMAS À KEMPIS (*c.* 1380–1471), the name by which the Augustinian canon and writer Thomas Hammerken (Hammerchen, Malleolus) is commonly known. He was born in 1379 or 1380 in the town of Kempen, lying about 15 miles north-west of Düsseldorf, in one of the many patches of territory between

[1] See the sketch in Syriac of the history of the church of Malabar printed and translated by Land, *Anecd. Syr.* i. 24 seq. It was sent to Schaaf at Leiden in 1720 by Mar Gabriel, the last Nestorian bishop in Malabar (see Germann, p. 542).

the Meuse and the Rhine belonging to the archiepiscopal principality of Cologne. "Ego Thomas Kempis," he says in his chronicle of the monastery of Mount St Agnes, "scholaris Daventriensis, ex diocesi Coloniensi natus." His father was a poor hard-worked peasant; his mother "ad custodiam rei domesticae attenta, in opere alacris, in victu sobria, in potu abstemia, in verbo pauca, in factis pudica," as her son fondly says, kept a dame's school for the younger children of the town. John and Gertrude Hammerken had two sons, John and Thomas, both of whom found their way to Deventer, and thence to Zwolle and to the convent of Mount St Agnes. Thomas reached Deventer when he was barely twelve years old, was taught by a dame the beginnings of his learning, and in a few months to his great joy entered the classes of Florentius Radewyn. After the fashion of the time he was called Thomas from Kempen, and the school title, as was often the case then, pushed aside the family name. Thomas Hammerken was forgotten; Thomas à Kempis has become known to the whole Christian world.

This school at Deventer had become famous long before Thomas à Kempis was admitted to its classes. It had been founded by Gerhard Groot (*q.v.*), a wealthy burgher who had been won to pious living mainly through the influence of Ruysbroeck, the Flemish mystic. It was at Deventer, in the midst of this mystical theology and hearty practical benevolence, that Thomas à Kempis was trained. Gerhard Groot was his saintly ideal. Florentius Radewyn and Gerhard's other early disciples were his heroes; their presence was his atmosphere, the measure of their lives his horizon. But he was not like them; he was not an educational reformer like Radewyn, nor a man of affairs like Gerhard. He liked books and quiet corners all his days, he says; and so, when conviction of sin and visions of God's grace came to him in the medieval fashion of a dream of the anger and forgiveness of the Virgin, Florentius told him that a monk's life would suit him best, advised him to join the Augustinian order, and sent him to Zwolle to the new convent of Mount St Agnes, where his brother John was prior. Thomas was received there in 1399, he professed the vows in 1407, received priest's orders in 1413, became sub-prior in 1425 and died on the 8th of August 1471, being ninety-one years old.

The convent of Mount St Agnes was poor, and most of the monks had to earn money to support their household by copying MSS. Thomas was a most laborious copyist: missals, books of devotion and a famous MS. Bible were written by him. He also wrote a large number of original writings, most of them relating to the convent life, which was the only life he knew. He wrote a chronicle of the monastery and several biographies—the life of Gerhard Groot, of Florentius Radewyn, of a Flemish lady St Louise, of Groot's original disciples; a number of tracts on the monastic life—*The Monk's Alphabet*, *The Discipline of Cloisters*, *A Dialogue of Novices*, *The Life of the Good Monk*, *The Monk's Epitaph*, *Sermons to Novices*, *Sermons to Monks*, *The Solitary Life*, *On Silence*, *On Poverty*, *Humility and Patience*; two tracts for young people—*A Manual of Doctrine for the Young*, and *A Manual for Children*; and books for edification—*On True Compunction*, *The Garden of Roses*, *The Valley of Lilies*, *The Consolation of the Poor and the Sick*, *The Faithful Dispenser*, *The Soul's Soliloquy*, *The Hospital of the Poor*. He also left behind him three collections of sermons, a number of letters, some hymns and the famous *Imitatio Christi* (though his authorship of this has been disputed). These writings help us to see the man and his surroundings, and contemporary pious records make him something more than a shadow. We see a real man, but a man helpless anywhere save in the study or in the convent—a little fresh-coloured man, with soft brown eyes, who had a habit of stealing away to his cubiculum whenever the conversation became too lively; somewhat bent, for it is on record that he stood upright when the psalms were chanted, and even rose on his tiptoes with his face turned upwards; genial, if shy, and occasionally given to punning, as when he said that he preferred Psalmi to Salmones; a man who perhaps led the most placid uneventful life of all men who ever wrote a book or scribbled letters. It was not that he lived in uneventful times: it is impossible to select a stormier period of European history, or a period when the stir of the times made its way so well into the obscurest corners. Bohemia, Huss leading, was ablaze in revolt at one end of Europe; France and England, then France and Burgundy, were at death-grips at the other. Two popes anathematized each other from Avignon and from Rome, and zealous churchmen were at their wit's end to concoct ways and means, by general councils of Constance and Basel and otherwise, to restore peace to a distracted church, and to discipline the clergy into decent living. But Thomas knew nothing about all this. He was intent on his copying, on his little books, and on his quiet conversations. His very biographies are colourless. He had not even the common interest in the little world coming up to the convent gate which most monks may be supposed to have. His brethren made him oeconomiae prefectus, but he was too "simple in worldly affairs" and too absent-minded for the post, and so they deposed him and made him sub-prior once more. And yet it is this placid kindly fresh-coloured old man who has come down to us as the author of that book the *Imitation of Christ*, which has been translated into more languages than any other book save the Bible, and which has moved the hearts of so many men of all nations, characters and conditions of life.

On the controversy as to the author of the *Imitatio*, see the article IMITATION OF CHRIST. See also James Williams, *Thomas of Kempen* (1910). The classical edition of the works of Thomas à Kempis by Sommalius—*Thomas Malleoli à Kempis opera omnia* (3 vols. in 1, 1607)—has been many times reprinted. A critical edition in 8 vols. by M. J. Pohl, has also been undertaken. The best accounts in English of Thomas à Kempis are those by S. Kettlewell (1882) and F. R. Cruise (1887), written from the Protestant and the Catholic standpoints respectively. A penny tract by F. R. Cruise, entitled *Outline of the Life of Thomas à Kempis* (1904), contains substantially all that is known concerning him. (T. M. L.)

THOMAS (d. 1100), archbishop of York, was a native of Bayeux, and is usually called Thomas of Bayeux. His father was a priest named Osbert, and Samson, bishop of Worcester from 1086 until his death in May 1112, was his brother. Owing largely to the generosity of Odo, bishop of Bayeux, Thomas studied in France, Germany and Spain and became known as a scholar; then he became one of Bishop Odo's officials and after 1066 one of William the Conqueror's chaplains, or secretaries. In 1070 he succeeded Aldred as archbishop of York, but declining to promise obedience to the archbishop of Canterbury, Lanfranc, the latter prelate refused to consecrate him. King William, however, induced him to submit and he was consecrated, but his profession of obedience was to Lanfranc personally and not to the archbishops of Canterbury. In 1071 both archbishops travelled to Rome for their palls and while there Thomas wished Pope Alexander II. to decree the equality of the sees of Canterbury and York. The pope, however, referred the dispute to a council of English prelates, and this met at Windsor at Whitsuntide 1072. It was then decided that the archbishop of Canterbury was the superior of the archbishop of York, who had no rights south of the Humber, but whose province included Scotland. But this decision did not put a period to the dispute. It broke out again, and in 1092 and again in 1093 Thomas protested against what he regarded as infringements of his archiepiscopal rights. The first of these occasions was over the dedication of the cathedral built by Remigius at Lincoln and the second was over the consecration of St Anselm to the archbishopric of Canterbury. In 1100, during Anselm's exile, Thomas reached London too late to crown Henry I., the ceremony having been hurriedly performed by Maurice, bishop of London, but his anger at this slight was soon appeased. He died at York on the 18th of November 1100. Thomas rebuilt the minster at York, where he appears to have been an excellent archbishop; he knew something of church music and wrote hymns.

Thomas had a nephew, Thomas, the son of his brother Samson, who was also archbishop of York. The younger Thomas became archbishop in 1108 and like his uncle he refused to promise obedience to the archbishop of Canterbury; his consecration was then delayed and the dispute was still unsettled when St Anselm died in April 1109. Henry I. and his bishops then decided against Thomas, who was forced to make the necessary promise and was consecrated in London in June 1109. He died at Beverley on the 24th of February 1114.

THOMAS, surnamed MAGISTER (*i.e.* officiorum),[1] also known as a monk by the name Theodulos Monachos, a native of Thessalonica, Byzantine scholar and grammarian and confidential adviser of Andronicus II. (1282–1328). His chief work, Ἐκλογὴ Ὀνομάτων καὶ Ῥημάτων Ἀττικῶν, is a collection of selected Attic words and phrases, partly arranged in alphabetical order, compiled as a help to Greek composition from the works of Phrynichus, Ammonius, Herodian and Moeris. He also wrote scholia on Aeschylus, Sophocles, Euripides (with life), and three of the comedies of Aristophanes; the scholia on Pindar, attributed to him in two MSS., are now assigned to Demetrius Triclinius. His speeches and letters consist partly of declamations on the usual sophistical themes, partly deal with contemporary historical events: an argument between the fathers of Cynegirus and Callimachus (two Athenians who fell at Marathon) as to which had the better claim to have the funeral oration pronounced over him first; a discussion on the duties of a king and of his subjects; a defence of the Byzantine general Chandrenos addressed to the emperor; a letter on the cruelties of the Catalans and Turks in Thessaly and Macedonia; a congratulatory letter to Theodorus Metochita; a panegyric on the king of Cyprus.

Editions of the Ἐκλογὴ by F. Ritschl (1832), C. Jacobitz (1833) and C. D. Beck (1836); other works in J. P. Migne, *Patrologia graeca*, cxlv.; see also C. Krumbacher, *Geschichte der byzantinischen Litteratur* (1897).

THOMAS OF CELANO, Franciscan friar and disciple and biographer of St Francis of Assisi. Born at Celano in the Abruzzi, he joined St Francis probably about 1214, and he appears to have been one of the first band of friars who went into Germany. He was commissioned by Gregory IX. to write the Life of St Francis, and in 1229 he completed the *First Legend*; in 1247 at the command of the minister general he composed the *Second Legend*, and a few years later the *Tract on the Miracles of St Francis*. He also composed in 1255 the *Legend of St Clare*; and he is one of those to whom the sequence *Dies irae* is attributed.

Thomas of Celano's writings on St Francis have been critically edited by E. d'Alençon in 1906; the value of this work is enhanced by the fact that critical opinion is veering round to the view that Thomas of Celano is the best authority for the life of the saint (see "Note on the Sources," appended to article FRANCIS OF ASSISI). An English translation (*The Lives of S. Francis of Assisi by Brother Thomas of Celano*) by A. G. Ferrers Howell appeared in 1908. All that is known of Thomas of Celano is brought together in Edouard d'Alençon's *Prolegomena*; see also introduction to Ferrers Howell's translation. (E. C. B.)

THOMAS OF ERCELDOUNE, called also THE RHYMER, and sometimes given the surname of LEARMONT (*fl.* ? 1220–? 1297), poet and prophet in the legendary literature of Scotland. The historical person of that name figures in two charters of the 13th century, and from these it appears that he owned lands in Erceldoune (now Earlstoun), in Berwickshire, which were made over by his son and heir on the 2nd of November 1294 to the foundation of the Holy Trinity at Soltra (or Soutra) on the borders of the same county. This would seem to imply that Thomas the Rhymer was already dead, but J. A. H. Murray, who edited *The Romance and Prophecies* (E.E.T.S., 1875), thinks that he was living three years later in a Cluniac priory in Ayrshire. He figures in the works of Barbour and Harry the Minstrel as the sympathizing contemporary of their heroes, and Walter Bower, who continued the *Scotichronicon* of Fordun, tells how he prophesied the death of Alexander III. in 1285. Barbour makes the bishop of St Andrews in 1306 express a hope that a prophecy of Thomas referring to Bruce will come true; and Wyntoun says that he foretold the battle of Kilblane. In the folk-lore of Scotland his name is associated with numerous fragments of verse of a gnomic and prophetic character. The romance of Thomas and the elf-queen was attributed to Erceldoune by Robert Mannyng de Brunne, but the earliest text, in the Auchinleck MS. in the Advocates' library, Edinburgh, is in a dialect showing southern forms, and dates from the beginning of the 14th century. It may be based on a genuine work of Thomas, a version by him of the widely diffused Tristan Saga. This text was published in 1804 by Sir Walter Scott, and was by him assigned to the Rhymer. The most widely accepted opinion is that it is a translation of a French original. The Rhymer's lands at Earlstoun are still identified. In 1840 died the last of a family named Learmont, which claimed descent from the poet. It may be noted that the Russian poet Michael Lermontov claimed Thomas of Erceldoune as his ancestor.

See J. A. H. Murray's edition of *The Romance and Prophecies* (E.E.T.S., 1875); Brandl's *Thomas of Erceldoune* (Berlin, 1880), and Kölbing's *Die nordische und die englische Version der Tristransage* (Heilbronn, 1882); also McNeill's *Sir Tristrem* (S.T.S., 1886); Lumby's *Early Scottish Prophecies* (E.E.T.S., 1870), and the reprint of the *Whole Prophesie of Scotland* (1603) by the Bannatyne Club (1833).

THOMAS OF MARGĀ, a Nestorian bishop and author of an important monastic history in Syriac, who flourished in the 9th century A.D. He was born early in the century, probably of Persian parents, in the region of Salakh to the north-east of Mosul. As a young man he became in 832 a monk of the famous Nestorian monastery of Beth 'Ābhē, which was situated at the confluence of the Great Zab with one of its tributaries, about 25 m. due east of Mosul. A few years later he was acting as secretary to Abraham, who had been abbot of Beth 'Ābhē, and was catholicus (patriarch) of the Nestorians from 837 to 850. At some date during these 13 years Thomas was promoted by Abraham to be bishop of Margā, a diocese in the same district as Beth 'Ābhē, and afterwards he was further advanced to be a metropolitan of Beth Garmai, a district farther to the south-east in the mountains which border the Tigris basin. It was during the period of his life at Beth 'Ābhē and his bishopric that he composed *The Book of Governors*, which is in the main a history of his own monastery, but includes lives of holy men in other parts of Mesopotamia and the regions east of the Tigris. The work was probably planned in imitation of the famous *Paradise* of Palladius, the history of Egyptian monasticism which had become well known to Syriac-speaking Christians in the version of 'Ānān-Īshō' (6th century).

The Book of Governors has been edited with an English translation and a copious introduction by E. W. Budge (2 vols., London, 1893), who claims that "it occupies a unique position in Syriac literature, and it fully deserves the veneration with which it has been and is still regarded by all classes of Nestorians to whom it is known." It gives a detailed history of the great monastery of Beth 'Ābhē during its three centuries of existence down to the author's time. It is full of interesting narratives of saintly men told in a naïve and candid spirit, and it throws much light on the history of Christianity in the Persian dominions. There is a later edition by P. Bedjan (Paris, 1901). (N. M.)

THOMAS, ARTHUR GORING (1850–1892), English musical composer, was the youngest son of Freeman Thomas and Amelia, daughter of Colonel Thomas Frederick. He was born at Ratton Park, Sussex, on the 20th of November 1850, and educated at Haileybury College. He was intended for the Civil Service, but delicate health interfered with his studies, and in 1873 he went to Paris to cultivate the musical talent he had displayed from an early age. Here he studied for two years with Émile Durand. In 1875 he returned to England, and in 1877 entered the Royal Academy of Music, where for three years he studied under Ebenezer Prout and Arthur Sullivan, winning twice the Lucas medal for composition. At a later period he received some instruction in orchestration from Max Bruch. His first published composition was a song, "Le Roi Henri," which appeared in 1871. An early comic opera, *Don Braggadocio* (libretto by his brother, C. I. Thomas), was apparently unfinished; some of the music in it was afterwards used for *The Golden Web*. A selection from his second opera, *The Light of the Harem* (libretto by Clifford Harrison), was performed at the Royal Academy of Music on the 7th of November 1879, with such success that Carl Rosa commissioned him to write

[1] For the duties of this important office, see J. B. Bury, *Later Roman Empire* (1889), i. 45.

Esmeralda (libretto by T. Marzials and A. Randegger), which was produced at Drury Lane on the 26th of March 1883. Two years later it was given (in German) at Cologne and Hamburg, and in 1890 (in French) at Covent Garden. On the 16th of April 1885 Rosa produced at Drury Lane Thomas's fourth and best opera, *Nadeshda* (libretto by Julian Sturgis), a German version of which was given at Breslau in 1890. A fifth opera, *The Golden Web* (libretto by F. Corder and B. C. Stephenson), slighter than its predecessors, was produced (after the composer's death) at Liverpool, Feb. 15, and at the Lyric Theatre, London, Mar. 11, 1893. Besides these dramatic works Thomas's chief compositions were a psalm, "Out of the Deep," for soprano solo and chorus (London, 1878); a choral ode, "The Sun Worshippers" (Norwich, 1881), and a suite de ballet for orchestra (Cambridge, 1887). A cantata, *The Swan and the Skylark,* was found in pianoforte score among his MSS. after his death: it was orchestrated by C. Villiers Stanford, and produced at the Birmingham Festival of 1894. His minor compositions include over 100 songs and duets. In 1891 Thomas became engaged to be married; shortly afterwards he showed signs of mental disease, and his career came to a tragic end on the 20th of March 1892. He was buried in Finchley cemetery. Goring Thomas occupies a distinct place among English composers of the 19th century. His music, which shows traces of his early French training, reveals a great talent for dramatic composition and a real gift of refined and beautiful melody. Personally the most amiable of men, he was most critical of his own work, never attempting anything for which he felt he was unfitted, and constantly revising and rewriting his compositions. (W. B. S.*)

THOMAS, CHARLES LOUIS AMBROISE (1811–1896), French musical composer, was born at Metz on the 5th of August 1811. He studied at the Paris Conservatoire, and won the Grand Prix de Rome in 1832. Five years later (in 1837) his first opera, *La Double échelle*, was produced at the Opéra Comique. For the next five-and-twenty years Thomas's productivity was incessant, and most of his operatic works belonging to this period enjoyed an ephemeral popularity. A few of these are still occasionally heard on the continent, such as *Le Caïd* (1849), *Le Songe d'une nuit d'été* (1850), *Psyché* (1857). The overture to *Raymond* (1851) has remained popular. So far the composer's operatic career had not been marked by any overwhelming success. He occupied a place among the recognized purveyors of operas in the French capital, but could scarcely claim to having achieved European renown. The production of *Mignon* at the Opéra Comique in 1866, however, at once raised Ambroise Thomas to the position of one of the foremost French composers. Goethe's touching tale had very happily inspired the musician; Mme Galli Marié, the original interpreter of the title-rôle, had modelled her conception of the part upon the well-known picture by Ary Scheffer, and *Mignon* at once took the fancy of the public, its success being repeated all over the continent. It has since remained one of the most popular operas belonging to the second half of the 19th century. Thomas now attempted to turn Shakespeare's *Hamlet* to operatic account. His opera of that name was produced with success at the Paris Opéra in 1868, where it enjoyed a long vogue. If the music is scarcely adequate to the subject, it nevertheless contains some of the composer's best work. The scene of the esplanade is genuinely dramatic, the part of Ophelia is poetically conceived, and the ballet music is very brilliant. Ambroise Thomas's last opera, *Françoise de Rimini*, was given at the Opéra in 1882, but has not maintained itself in the *répertoire.* Seven years later *La Tempête*, a ballet founded on Shakespeare's play, was produced at the same theatre. Ambroise Thomas succeeded Auber as director of the Paris Conservatoire in 1871. His music is often distinguished by refined touches which reveal a sensitive mind, and there is a distinct element of poetry in his *Mignon* and *Hamlet*, two operas that should suffice to keep the composer's memory green for some time to come. He died on the 12th of February 1896. (A. He.)

THOMAS, GEORGE (*c.* 1756–1802), British military adventurer in India. Thomas was born of poor parentage in Ireland in 1756, deserted from the British Navy in Madras, and made his way north to Delhi, where he took service under the begum Samru of Sardhana. Supplanted in her favour by a Frenchman, he transferred his allegiance to Appa Rao, a Mahratta chieftain, and subsequently set up an independent kingdom of his own in Hariana with his capital at Hansi. Thomas was a man of great personal strength and daring, and considerable military genius. In the turmoil of falling kingdoms in the India of that day his sword was always at the service of the highest bidder; but he had the virtues of his profession—he never betrayed an employer, was kind and generous to his soldiers, and was always ready to succour a woman in distress. He cherished dreams of conquering the Punjab, and fought one of his best campaigns against the Sikh chiefs; but he was finally defeated and captured by Sindhia's army under General Perron (*q.v.*). His iron constitution was broken by exposure and excessive drinking, and he died on his way down the Ganges on the 22nd of August 1802.

See Francklin, *Military Memoirs of Mr George Thomas* (1803); Compton, *Military Adventurers of Hindustan* (1892).

THOMAS, GEORGE HENRY (1816–1870), American general, was born in Southampton county, Virginia, on the 31st of July 1816. Graduating from West Point in 1840, he served as an artillery subaltern in the war against the Seminole Indians in Florida (1841), and in the Mexican War at the battles of Fort Brown, Resaca de la Palma, Monterey and Buena Vista, receiving three brevets for distinguished gallantry in action. From 1851 to 1854 he was an instructor at West Point. In 1855 he was appointed by Jefferson Davis, then secretary of war, a major of the 2nd Cavalry. His regimental superiors were A. S. Johnston, R. E. Lee and Hardee. All three resigned at the outbreak of the Civil War and Thomas was long in doubt as to his duty. He finally decided to adhere to the United States. He was promoted in rapid succession to be lieutenant-colonel and colonel in the regular army, and brigadier-general of volunteers. In command of an independent force in eastern Kentucky, on the 19th of January 1862, he attacked the Confederate General Zollicoffer at Mill Springs, and completely routed him, gaining by vigorous attack and relentless pursuit the first important Union victory in the West. He served under Buell and was offered, but refused, the chief command in the anxious days before the battle of Perryville. Under Rosecrans he was engaged at Stone River and was in charge of the most important part of the manœuvring from Decherd to Chattanooga. At the battle of Chickamauga (*q.v.*) on the 19th of September 1863 he achieved great distinction, his firmness on that disastrous field, where he gained the name of "The Rock of Chickamauga," being all that saved a terrible defeat from becoming a hopeless rout. He succeeded Rosecrans in command of the Army of the Cumberland shortly before the great victory of Chattanooga (*q.v.*), in which Thomas and his army played a most conspicuous part, his divisions under Sheridan, Wood and Baird carrying Missionary Ridge in superb style. In Sherman's advance through Georgia in the spring of 1864, the Army of the Cumberland numbered over 60,000 men present for duty. Thomas handled these with great skill in all the engagements and flanking movements from Chattanooga to Atlanta. When J. B. Hood broke away from Atlanta in the autumn of 1864, menaced Sherman's long line of communications and endeavoured to force Sherman to follow him, Sherman determined to abandon his communications and march to the sea, leaving to Thomas the difficult task of dealing with Hood. Thomas hastened back with a comparatively small force, racing with Hood to reach Nashville, where he was to receive reinforcements. At the battle of Franklin on the 30th of November 1864, a large part of Thomas's force, under command of Schofield, checked Hood long enough to cover the concentration at Nashville (*q.v.*). Here Thomas had to organize his force, which was drawn from all parts of the West and included many young troops and even quartermaster's employés. He declined to attack until his army was ready and the ice which covered the ground had melted sufficiently to enable his men to move. The whole of the North, and even General Grant himself, were impatient of the delay. General Logan was sent with an order to supersede Thomas, and soon afterwards Grant left the Army of the Potomac to take command in person. Before either arrived Thomas made his attack (December 15th–16th, 1864) and inflicted on Hood the most crushing defeat sustained in the open field by any army on either side in the whole war. Hood's army was completely ruined and never again appeared on the field. For this brilliant victory Thomas was made a major-general in the regular army and received the thanks of Congress. After the termination of the Civil War he commanded military departments in Kentucky and Tennessee until 1869, when he was ordered to command the division of the Pacific with headquarters at San Francisco. He died there of apoplexy, while writing an answer to an article criticizing his military career, on the 28th of March 1870.

Thomas was beloved by his soldiers, for whom he always had a fatherly solicitude. He was a man of solid rather than brilliant attainments; he remained in the army all his life, and never had any ambitions outside of it; the nickname of "Slow Trot Thomas" given him by the cadets at West Point characterized him physically and mentally; his mind acted deliberately, and his temperament was somewhat sluggish; but his judgment was accurate, his knowledge of his profession was complete in every detail, and when he had finally grasped a problem, and the time arrived for action, he struck his blow with extraordinary vigour and rapidity. The only two battles in which he was in chief command—Mill Springs and Nashville, one at the beginning and the other near the end of the war—were signal victories, without defect and above criticism. His service during the intervening three years of almost incessant conflict and manœuvring was marked by loyal obedience to his superiors, skilful command of his subordinates, and successful accomplishment of every task entrusted to him.

THOMAS, ISAIAH (1749–1831), American printer, was born in Boston, Massachusetts, on the 19th of January 1749. He was apprenticed in 1755 to Zechariah Fowle, a Boston printer, with whom, after working as a printer in Halifax, Portsmouth, New Hampshire, and Charleston, South Carolina, he formed a partnership in 1770. He issued in Boston the *Massachusetts Spy* three times each week, then (under his sole ownership) as a semi-weekly, and beginning in 1771, as a weekly which soon espoused the Whig cause and which the government tried to suppress. On the 16th of April 1775 (three days before the battle of Concord, in which he took part) he took his presses and types from Boston and set them up at Worcester, where he was postmaster for a time; here he published and sold books and built a paper-mill and bindery, and he continued the paper until about 1802 except in 1776–1778 and in 1786–1788. The *Spy* supported Washington and the Federalist party. In Boston Thomas published, in 1774, the *Royal American Magazine*, which was continued for a short time by Joseph Greenleaf, and which contained many engravings by Paul Revere; and in 1775–1803 the *New England Almanac*, continued until 1819 by his son. He set up printing houses and book stores in various parts of the country, and in Boston with Ebenezer T. Andrews, published the *Massachusetts Magazine*, a monthly, from 1789 to 1793. At Walpole, New Hampshire, he published the *Farmer's Museum*. About 1802 he gave over to his son, Isaiah Thomas, junr., his business at Worcester including the control of the *Spy*. Thomas founded in 1812 the American Antiquarian Society. He died in Worcester on the 4th of April 1831.

His *History of Printing in America, with a Biography of Printers, and an Account of Newspapers* (2 vols., 1810; 2nd ed., 1874, with a catalogue of American publications previous to 1776 and a memoir of Isaiah Thomas, by his grandson B. F. Thomas) is an important work, accurate and thorough.

THOMAS, PIERRE (1634–1698), sieur du Fossé, French scholar and author, was the son of a master of accounts at Rouen. He was sent as a child to be educated at Port Royal, and there he received his final bent towards the life of a recluse, and even of a hermit, which drew him to establish himself in the neighbourhood of Port Royal des Champs. In 1661 he came to Paris, and in 1666 was arrested along with I. L. Le Maistre (de Sacy), and after a month in the Bastille was exiled to his estate of Fossé. He later made yearly visits to Paris. Apart from his collaboration with de Sacy, Thomas wrote some hagiographic works and left Mémoires (1697–1698 and again 1876–1879), which are highly praised by Ste Beuve as being a remarkable mirror of the life at Port Royal.

THOMAS, SIDNEY GILCHRIST (1850–1885), British inventor, was born on the 16th of April 1850 at Canonbury, London. His father, a Welshman, was in the civil service, and his mother was the daughter of the Rev. James Gilchrist. His father's death leaving his family with a considerably reduced income, he gave up his original idea of becoming a doctor and obtained an appointment as a police court clerk, which he held till May 1879. During these twelve years, besides the work of a busy police court, which brought him into intimate contact with social problems, he found time to study chemistry, and attended lectures at the Birkbeck Institute. He set himself to solve the problem of eliminating phosphorus from iron by means of the Bessemer converter, and by the end of 1875 was convinced that he had discovered a method. He communicated his theory to his cousin, P. C. Gilchrist, who was chemist to iron works in Wales, and experiments were made, which proved satisfactory. Edward Martin, manager of the Blaenavon Works, gave facilities for conducting the experiments on a larger scale and undertook to help in taking out a patent. In March 1878, the first public announcement of the discovery was made at the meeting of the Iron and Steel Institute, but without attracting much attention; and in September a paper was written by Thomas and Gilchrist on the "Elimination of Phosphorus in the Bessemer Converter" for the autumn meeting of this institute, but was not read till May 1879. Thomas, however, made the acquaintance of E. W. Richards, the manager of Bolckow Vaughan & Co.'s works at Cleveland, Yorkshire, whom he interested in the process, and from this time the success of the invention was assured and domestic and foreign patents were taken out. The "basic process" invented by Thomas was especially valuable on the continent of Europe, where the proportion of phosphoric iron is much larger than in England, and both in Belgium and in Germany the name of the inventor became more widely known than in his own country. In America, although non-phosphoric iron largely predominates, an immense interest was taken in the invention. But Thomas had been overworking for years, and his lungs became affected. A long sea voyage and a residence in Egypt proved unavailing to restore his health and he died in Paris on the 1st of February 1885. He had what W. E. Gladstone, in a review of the *Memoirs* published in 1891, described as an "enthusiasm of humanity," and he left his fortune to be used for the promotion of philanthropic work. A police court mission was endowed in his memory.

See *Memoirs and Letters of Sidney Gilchrist Thomas* (1891), ed. by R. W. Burnie.

THOMAS, THEODORE (1835–1905), American musician, was born in Esens, Germany, on the 11th of October 1835. His early musical training was received chiefly from his father. At the age of five he made his first public appearance as a violinist. In 1845 he was taken to America by his parents, and became first violin in the orchestra that accompanied Jenny Lind in 1850, Sontag in 1852 and Grisi and Mario in 1854. In 1862 he began to organize his own orchestra, and from 1864 to 1878 were performed a series of symphony concerts inaugurated by him in Irving Hall, which were regarded as one of the great musical institutions of New York City. His "summer night" concerts begun in 1866 in Terrace Garden were continued in Central Park. From 1855 to 1868 he took part in a series of chamber music concerts in New York. In the latter year his orchestra made its first tour, and continued to give concerts in various American cities until it was disbanded in 1888. To Theodore Thomas is largely due the popularization of Wagner's works in America, and it was he who founded the Wagner union in 1872. During most of the seasons from 1877 to 1891 he was conductor of the New York Philharmonic Society, and from 1862 to 1891, of the Brooklyn Philharmonic Society. He was director of the Cincinnati College of Music (1878–1879), conductor of the American Opera Company (1886–1887), and for more than thirty years (1873–1904) the conductor of the biennial May festivals at Cincinnati. In 1891 he removed to Chicago, and became the conductor of the Chicago Orchestra; in 1893 he was musical director of the Columbian Exposition. He died on the 4th of January 1905.

THOMAS, WILLIAM (d. 1554), English soldier and writer, was probably a native of Radnorshire and was educated at Oxford. In 1544 he went to Italy, where he spent the greater part of the next five years, and in April 1550, soon after his return to England, he was made one of the clerks of the privy council; he also taught the science of politics to the young king Edward VI., for whose instruction he wrote some treatises and some "commonplaces of state." Being a strong Protestant he took part in the rising against Queen Mary led by Sir Thomas Wyat in 1554, being captured and thrown into the Tower of London. Having whilst in prison tried to commit suicide and been tortured on the rack in the hope of incriminating the princess Elizabeth, he was found guilty and was hanged at Tyburn on the 18th of May 1554.

During his residence at Bologna Thomas, who was a very learned man, wrote *Il Pellegrino inglese*, published in 1552. This is a valuable and interesting defence of Henry VIII. by a contemporary and it originated in a discussion between the author and some Italian gentlemen. He also prepared an English version of this work, but this was not published during his lifetime. As *The Pilgrim: a dialogue of the life and actions of King Henry VIII.*, it was edited with notes by J. A. Froude and appeared in 1861. It had previously been edited by A. D'Aubant, who had added to it the six treatises written for Edward VI. and had called the whole *The Works of William Thomas* (1774). Of his other writings perhaps the most important is *The Historie of Italie* (1549), and his *Principal Rules of the Italian Grammar with a Dictionarie for the better understanding of Boccace, Petrarcha and Dante* (1550, 1560, 1562 and 1567) may also be mentioned. This was the first work of its kind in English. Thomas made an English translation of Josafat Barbaro's account of his voyages, Barbaro being a Venetian traveller who died in 1494. With an introduction by Lord Stanley of Alderley this was published by the Hakluyt Society in a volume of *Travels to Tana and Persia* (London, 1873). See John Strype, *Ecclesiastical Memorials* (Oxford, 1822).

Thomas has a namesake, William Thomas (1613–1689), bishop of St David's from 1677 to 1683 and bishop of Worcester from 1683 to 1689. He was one of the bishops who refused to take the oaths of allegiance to William and Mary in 1689 and was suspended, but in the midst of the dispute he died on the 25th of June 1689 (see NONJURORS). The bishop's grandson was William Thomas (1670–1738), the Worcestershire antiquary.

THOMASIUS, CHRISTIAN (1655–1728), German jurist and publicist, was born at Leipzig on the 1st of January 1655, and was educated by his father, Jakob Thomasius (1622–1684), at that time head master of the Thomasschule. Through his father's lectures Christian came under the influence of the political philosophy of Hugo Grotius and Samuel Pufendorf, and continued the study of law at Frankfort-on-Oder. In 1684 he commenced the career of professor of natural law at Leipzig, and soon attracted attention by his abilities, but particularly by his daring attack upon traditional prejudices, in theology and jurisprudence. In 1687 he made the daring innovation of lecturing in German instead of Latin, and in the following year published a monthly periodical (*Scherzhafte und ernsthafte, vernünftige und einfällige Gedanken über allerhand lustige und nützliche Bücher und Fragen*) in which he ridiculed the pedantic weaknesses of the learned, taking the side of the Pietists in their controversy with the orthodox, and defending mixed marriages of Lutherans and Calvinists. In consequence of these and other views, he was denounced from the pulpits, forbidden to lecture or to write (May 10, 1690), and his arrest was ordered. The latter he escaped by flight to Berlin, and the elector Frederick III. offered him a refuge in Halle, with a salary of 500 talers and the permission to lecture. He took part in founding the university of Halle (1694), where he became second and then first professor of law and rector of the university. He was one of the most esteemed university teachers and influential writers of his day. He died, after a successful and honourable career, on the 23rd of September 1728.

Though not a profound and systematic philosophical thinker, Thomasius prepared the way for great reforms in philosophy, and, above all, in law, literature, social life and theology. It was his mission to introduce a rational, common-sense point of view, and to bring the high matters of divine and human sciences into close and living contact with the everyday world. He thus created an epoch in German literature, philosophy and law, and Spittler opens with him the modern period of ecclesiastical history. He made it one of the aims of his life to free politics and jurisprudence from the control of theology, and fought bravely and consistently for freedom of thought and speech on religious matters. He is often spoken of in German works as the author of the "territorial system," or Erastian theory of ecclesiastical government. But he taught that the state may interfere with legal or public duties only, and not with moral or private ones. He would not have even atheists punished, though they should be expelled the country, and he came forward as an earnest opponent of the prosecution of witches and of the use of torture. In theology he was not a naturalist or a deist, but a believer in the necessity of revealed religion for salvation. He came strongly under the influence of the pietists, particularly of Spener, and there was a mystic vein in his thought; but other elements of his nature were too powerful to allow him to attach himself wholly to that party.

Thomasius's most popular and influential German publications were his periodical already referred to (1688–1689); *Einleitung zur Vernunftlehre* (1691, 5th ed. 1719); *Vernünftige Gedanken über allerhand auserlesene und juristische Händel* (1720–1721); *Historie der Weisheit und Torheit* (3 vols., 1693); *Kurze Lehrsätze von dem Laster der Zauberei mit dem Hexenprozess* (1704); *Weitere Erläuterungen der neueren Wissenschaft anderer Gedanken kennen zu lernen* (1711).

See Luden, *Christian Thomasius nach seinen Schicksalen und Schriften* (1805); H. Dernburg, *Thomasius und die Stiftung der Universität Halle* (1865); B. A. Wagner, *Thomasius, ein Beitrag zur Würdigung seiner Verdienste* (1872); Nicoladoni, *Christian Thomasius. Ein Beitrag zur Geschichte der Aufklärung* (Berlin, 1888); and E. Landsberg, *Zur Biographie von Christian Thomasius* (1894).

THOMASON, GEORGE (d. 1666), English book and tract collector, was a London bookseller, whose life contains few items of interest save the fact that he was concerned in a royalist plot in 1651. He is famous, however, as the man who brought together the great collection of books and tracts published during the time of the Civil War and the Commonwealth; this was formerly called the "King's Pamphlets," but is now known as the "Thomason Collection." During the years just before the outbreak of war a great number of writings covering every phase of the questions in dispute between king and people were issued, and in 1641 Thomason began to collect these. Working diligently at his task for about twenty years, he possessed nearly 23,000 separate publications in 1662, and having arranged these in chronological order he had them bound in 1983 volumes. After many vicissitudes the collection was bought in 1761 from his descendants by George III., who presented it to the British Museum, where it now is (see NEWSPAPERS). Thomason died in London in April (1666).

THOMASVILLE, a city and the county-seat of Thomas county, Georgia, U.S.A., about 200 m. S.W. of Savannah. Pop. (1900), 5322, of whom 3296 were negroes; (1910), 6727. Thomasville is served by the Atlanta, Birmingham & Atlantic, the Atlantic Coast Line and the Florida Central railways. The city is attractively situated (about 250 ft. above the sea) on a high plateau, is surrounded by pine forests, and is a well-known winter resort. There are fine drives in the vicinity. Thomasville has a city hospital, a public library (1876) and a good public school system, and is the seat of Young's College (for girls), which was founded by E. Remer Young, a wealthy planter of Thomas county, was incorporated in 1869 and was opened in 1871, and of the Vashti industrial school (1903) for girls, maintained by the Women's home mission society of the Methodist Episcopal Church, South. The city has a large trade in lumber, especially yellow pine; other products of the region are cotton, sugar-cane, tobacco, melons, fruits and vegetables. The municipality owns and operates the water-works and electric-lighting plant; the water supply is obtained in part from artesian wells 1900 ft.

deep. Thomasville was settled about 1825, was incorporated as a town in 1831, and was chartered as a city in 1889.

THOMOND, EARL AND MARQUESS OF, Irish titles borne by the great family of O'Brien, the earldom from 1543 to 1741 and the marquessate from 1800 to 1855. Thomond, or Tuaidh-Muin, was one of the three principalities of Munster, forming the northern part of the province. Its earls were descended from Turlough O'Brien (*c.* 1009–1086), king of Munster, and through him from the celebrated king of Ireland, Brian Boroimhe. Turlough's descendants, Conchobhar O'Brien (d. 1267) and Brian Ruadh O'Brien (d. 1276), kings of Thomond, were both typical Irish chieftains. Conchobhar's tomb and effigy with a crown are still to be seen in the ruined abbey of Corcomroe, Co. Clare. His descendant Conor O'Brien (d. 1539), prince of Thomond, took part in the feud between the great families of Fitzgerald and Butler and was the last independent prince of Thomond. It is interesting to learn that in 1534, when he was in some straits, he wrote to the emperor Charles V. offering to submit to his authority. Conor's brother, Murrough O'Brien (d. 1551), prince of Thomond, the succeeding chief of the race, gave up his "captainship, title, superiority and country" to Henry VIII. in 1543, when he was created earl of Thomond. By special arrangement the earldom descended, not to his son Dermod, but to his nephew, Donough, who became the 2nd earl. Dermod, however, inherited the barony of Inchiquin, which was conferred upon his father at the same time as the earldom.

Conor O'Brien, the 3rd earl (*c.* 1534–*c.* 1582), was for some years at the outset of his career, harassed by the attacks of his discontented kinsmen. Then in his turn he rose against the English, but was defeated and fled to France; in 1571, however, he was pardoned and formally surrendered his lands to Elizabeth. One of his younger sons was Daniel O'Brien (*c.* 1577–*c.* 1664) who, after loyally serving Charles I. and Charles II., was created Viscount Clare in 1663. His grandson Daniel, the 3rd viscount (d. 1691) served James II. in Ireland, being outlawed and deprived of his estates by the English parliament. The three succeeding viscounts Clare all distinguished themselves in the service of France. Daniel, the 4th viscount, was mortally wounded at the battle of Marsaglia in 1693; his brother Charles, the 5th viscount (d. 1706), was killed at the battle of Ramillies; and the latter's son Charles, the 6th viscount (1699–1761) after a brilliant military career, was made a marshal of France in 1757. When Charles, the 7th viscount, died in 1774 the title became extinct.

Donough O'Brien, the 4th earl (d. 1624), called the "great earl," was the son and successor of the 3rd earl. He served England well in her warfare with the rebellious Irish during the closing year of Elizabeth's reign and was made president of Munster in 1605. He had two sons, Henry, the 5th earl, (d. 1639) and Barnabas, the 6th earl (d. 1657). During the Irish rebellion of 1640–41 Barnabas showed a prudent neutrality, and then joined Charles I. at Oxford, where in 1645 he was created marquess of Billing, but the patent never passed the great seal and the title was never assumed. The succeeding earls were Barnabas's son Henry (*c.* 1621–1691) and Henry's grandson Henry (1688–1741) who was created an English peer as Viscount Tadcaster. When he died the earldom of Thomond became extinct.

The estates of the earldom descended to the last earl's nephew, Percy Wyndham (*c.* 1713–1774), a younger son of Sir William Wyndham, Bart. He took the additional name of O'Brien and was created earl of Thomond in 1756. When he died unmarried the title again became extinct.

In 1800 Murrough O'Brien, 5th earl of Inchiquin (*c.* 1724–1808), was created marquess of Thomond. He was succeeded by his nephew William (*c.* 1765–1846) who was created a British peer as Baron Tadcaster in 1826. His brother James, the 3rd marquess (*c.* 1768–1855), was an officer in the navy and became an admiral in 1853. When he died the marquessate became extinct.

See John O'Donoghue, *Historical Memoirs of the O'Briens* (Dublin, 1860).

THOMPSON, FRANCIS (1860–1907), English poet, was born at Ashton, Lancashire, in 1860. His father, a doctor, became a convert to Roman Catholicism, following his brother Edward Healy Thompson, a friend of Manning. The boy was accordingly educated at Ushaw College, near Durham, and subsequently studied medicine at Owens College, Manchester; but he took no real interest in the profession of a doctor and was bent on literary production. A period of friendlessness and failure (from the point of view of "practical life") followed, in which he became a solitary creature who yet turned his visions of beauty into unrecognized verse. It was not till 1893 that, after some five obscure years, in which he was brought to the lowest depths of destitution and ill health, his poetic genius became known to the public. Through his sending a poem to the magazine *Merrie England*, he was sought out by Mr and Mrs Wilfrid Meynell and rescued from the verge of starvation and self-destruction, and these friends of his own communion, recognizing the value of his work, gave him a home and procured the publication of his first volume of *Poems* (1893). His debt to Mrs Meynell was repaid by some of his finest verse. The volume quickly attracted the attention of sympathetic critics, in the *St James's Gazette* and other quarters, and Coventry Patmore wrote a eulogistic notice in the *Fortnightly Review* (Jan. 1894). An ardent Roman Catholic, much of Francis Thompson's verse reminded the critics of Crashaw, but the beauty and splendid though often strange inventiveness of his diction were immediately recognized as giving him a place by himself among contemporary poets, recalling Keats and Shelley rather than any of his own day. Persistent ill health limited his literary output, but *Sister Songs* (1895) and *New Poems* (1897) confirmed the opinion formed of his remarkable gifts. But his health was hopelessly broken down by tuberculosis. Cared for by the friends already mentioned, he lived a frail existence, chiefly at the Capuchin monastery at Tanlasapt, and later at Storrington; and on the 13th of November 1907 he died in London. He had done a little prose journalism, and in 1905 published a treatise on *Health and Holiness*, dealing with the ascetic life; but it is with his three volumes of poems that his name will be connected. Among his work there is a certain amount which can justly be called eccentric or unusual, especially in his usage of poetically compounded neologisms; but nothing can be purer or more simply beautiful than "The Daisy," nothing more intimate and reverent than his poems about children, or more magnificent than "The Hound of Heaven." For glory of inspiration and natural magnificence of utterance he is unique among the poets of his time. (H. Ch.)

THOMPSON, SIR HENRY, Bart. (1820–1904), English surgeon, was born at Framlingham, Suffolk, on the 6th of August 1820. His father wished him to enter business, but circumstances ultimately enabled him to follow his own desire of becoming a physician, and in 1848 he entered the medical school of University College, London. There he had a brilliant career, and obtained his degree at London University in 1851 with the highest honours in anatomy and surgery. In 1851 he married Miss Kate Loder, a talented pianist, who, though stricken with paralysis soon afterwards, was always a devoted helpmate to him. In 1853 he was appointed assistant surgeon at University College Hospital, becoming full surgeon in 1863, professor of clinical surgery in 1866, and consulting surgeon in 1874. In 1884 he became professor of surgery and pathology in the Royal College of Surgeons, which in 1852 had awarded him the Jacksonian prize for an essay on the *Pathology and Treatment of Stricture of the Urethra*, and again in 1860 for another on the *Health and Morbid Anatomy of the Prostate Gland*. These two memoirs indicate the department of medical practice to which he devoted his main attention. Specializing in the surgery of the genito-urinary tract, and in particular in that of the bladder, he went to Paris to study under Civiale, who in the first quarter of the 19th century proved that it is possible to crush a stone within the human bladder, and after his return he soon acquired a high reputation as a skilful operator in that class of disease. In 1863, when the king of the Belgians was suffering from stone, he was called to Brussels to consult in the case, and after some difficulties was allowed to perform the operation of lithotrity: this was quite successful, and in recognition of his skill Thompson was appointed surgeon-extraordinary to the king, an appointment which was continued by Leopold II. Nearly ten years later he carried out a similar operation on the emperor Napoleon, who, however, died four days after the second crushing, not from the surgical interference, as was proved by the post-mortem examination, but from uraemic poisoning. Besides devising various operative improvements in the treatment of the disorders which were his speciality, Sir Henry Thompson wrote various books and papers dealing with them, including *Clinical Lectures on Diseases of the Urinary Organs*, *Practical Lithotomy and Lithotrity*, *Tumours of the Bladder*, *Suprapubic Lothotomy*, and *Preventive Treatment of Calculous Disease*. Among other books of a medical character that came from his pen were *Food and Feeding*, and *Diet in Relation to Age and Activity*, both of which passed through a number of editions. In 1874 he took a foremost part in founding the Cremation Society of England, of which he was the first president; and not only was he active in urging the advantages of cremation as a means of disposing of the body after death, but also did much towards the removal of the legal restrictions by which it was at first sought to prevent its practice in England. On various occasions he denounced the slackness and inefficiency of the methods of death-certification prevalent in Great Britain, and in 1892 his agitation was instrumental in procuring the appointment of a select committee to inquire into the matter; its report, published in the following year, in great measure confirmed his criticisms and approved the remedies he suggested. But medicine and hygiene by no means exhaust the list of Sir Henry Thompson's activities. In art he was an accomplished sketcher and, moreover, an amateur of painting whose pictures were hung at the Royal Academy and the Paris Salon. About 1870 he began to get together his famous collection of china, in particular of old blue and white Nanking; this in time became so large that he could no longer find room for it, and most of it was sold. A catalogue of it, illustrated by himself and Mr James Whistler, was published in 1878. In his famous "octaves" he may be said to have elevated the giving of dinner parties into a fine art. The number of courses and of guests was alike eight, and both were selected with the utmost care and discrimination to promote the "feast of reason and the flow of soul." In literature, in addition to more serious works, he produced two novels—*Charley Kingston's Aunt* (1885) and *All But* (1886)—which met with considerable success. In science he became a devotee of astronomy, and for a time maintained a private observatory in his house at Molesey. He further did much to promote astronomical study in Great Britain by presenting Greenwich Observatory with some of the finest instruments now among its equipment, his gifts including a photoheliograph of 9-in. aperture; a 30-in. reflecting telescope, and a large refracting telescope having an object-glass of 26-in. diameter and a focal length of 22½ ft. The offer of the last instrument was made in 1894. Its manufacture was undertaken by Sir Howard Grubb of Dublin, and its erection was completed in 1897. It added greatly to the instrumental resources of Greenwich, especially for photographic work, and its importance may be gauged from the fact that both in aperture and focal length it is double the size of any instrument possessed by the observatory at the time it was put in place. That Sir Henry Thompson, who was knighted in 1867, received a baronetcy in 1899 was probably not unconnected with the presentation of this telescope to the national observatory. Thompson died on the 18th of April 1904. His family consisted of an only son, Herbert, a barrister and well-known egyptologist, who succeeded to the baronetcy, and two daughters, of whom the elder (author of a valuable *Handbook to the Public Picture Galleries of Europe*, first published in 1877), married Archdeacon Watkins of Durham, and the younger married the Rev. H. de Candole.

THOMPSON, SIR JOHN SPARROW (1844–1894), Canadian jurist and statesman, was born at Halifax, Nova Scotia, on the 10th of November 1844, of Irish descent. At fifteen he entered a lawyer's office, and in 1865 was called to the provincial bar. In 1871 he incurred much odium by leaving the Methodist Church, in which he had been prominent, and becoming a Roman Catholic, a change dictated solely by religious motives. In 1877 he was elected to the local legislature for Antigonish as a Conservative, and in 1878 became attorney-general. In May 1882 he became premier, but in June was defeated at the general election, though retaining his own seat, and in July was made a judge of the provincial Supreme Court. In September 1885, he was appointed minister of justice in the Federal cabinet, and soon after was elected member for Antigonish. In 1886 he successfully defended in the Federal parliament the hanging of Louis Riel (*q.v.*), which had greatly angered the French Roman Catholics; in 1887–1888, together with Mr Joseph Chamberlain and Sir Charles Tupper, he arranged a Fisheries Treaty with the American commissioners, which was afterwards thrown out by the United States Senate. During the following years he defended the government with great skill in various politico-religious disputes, and in November 1892 succeeded Sir John Abbott as premier of Canada. The length of time during which the Conservatives had held office had gathered around many parasites, and Thompson was compelled to face charges, some of them true, against prominent Conservatives. He promptly announced his intention to "lop the mouldering branches away," and would probably have reorganized his party, but on the 12th of December 1894 he dropped dead at Windsor Castle, a few minutes after having been sworn in by Queen Victoria as a member of the privy council.

Though a quiet man who did not advertise, few Canadian statesmen have done so much honest and solid work. In 1892 he finished the codification of the Canadian criminal code; in 1893 his firmness and knowledge as British arbitrator at Paris on the Bering Sea dispute between Great Britain and the United States were of great service.

His *Life* has been written by J. C. Hopkins (Toronto, 1895).

THOMPSON, LAUNT (1833–1894), American sculptor, was born at Abbeyleix, Ireland, on the 8th of February 1833. In 1847 he emigrated to the United States, and settled with his mother at Albany, New York. After studying anatomy in the office of a physician, Dr Armsby, he spent nine years in the studio of the sculptor, E. D. Palmer. In 1857 he opened a studio in New York, and in 1862 became a National Academician. He visited Rome in 1868–1869, and from 1875 to 1887 was again in Italy, living for most of the time at Florence. He died at Middletown, New York, on the 26th of September 1894. Among his important works are: "Napoleon the First," at the Metropolitan Museum, New York; "Abraham Pierson," first president of Yale University, New Haven, Connecticut; an equestrian statue of General A. E. Burnside, Providence, Rhode Island; "General Winfield Scott," Soldiers' Home, Washington, D.C.; "Admiral S. F. Du Pont" (Washington, D.C.); "General John Sedgwick" (West Point, N.Y.); a medallion portrait of General John A. Dix; and portrait busts of James Gordon Bennett, William Cullen Bryant, S. F. B. Morse, Edwin Booth as Hamlet, Stephen H. Tyng and Robert B. Minturn.

THOMPSON, THOMAS PERONNET (1783–1869), English political writer and mathematician, was born at Hull in 1783. He was educated at the Hull grammar school, and in October (1798) entered Queens' College, Cambridge. He entered the navy as midshipman in the "Isis" in 1803, but in 1806 exchanged to the army. Through his acquaintance with William Wilberforce, he was appointed governor of Sierra Leone in 1808, but was recalled on account of his hostility to the slave trade. In 1812 he returned to his military duties, and, after serving in the south of France, was in 1815 attached as Arabic interpreter to an expedition against the Wahabees of the Persian Gulf, with whom he negotiated a treaty (dated Jan. 1820) in which the slave trade was for the first time declared piracy. He was promoted major in 1825, lieutenant-colonel in 1829 and major-general in

1854. He entered parliament as member for Hull (1835–1837), and afterwards sat for Bradford (1847–1852, 1857–1859). He took a prominent part in the corn-law agitation, his *Catechism of the Corn Laws* (1827) being by far the most effective pamphlet published on the subject. In 1829 he became the proprietor of the *Westminster Review*, to which he contributed a large number of articles, republished in 1842 in six volumes, under the title *Exercises, Political and Others*. His mathematical publications were of a somewhat eccentric kind. He published a *Theory of Parallels* (1844), and was also the author of *Geometry without Axioms*, in which he endeavoured to "get rid" of axioms and postulates. His new *Theory of Just Intonation* (1850) was, however, a contribution of great value to the science of musical acoustics, and went through many editions. It may be said to have formed the basis of the tonic sol-fa system of music. He died at Blackheath, near London, on the 7th of September 1869.

See Colonel C. W. Thompson's memoir in the *Proc. Roy. Soc.* (1869).

THOMPSON, WILLIAM HEPWORTH (1810–1886), English classical scholar and master of Trinity College, Cambridge, was born at York on the 27th of March 1810. He was privately educated before entering the university. In 1834 he became a fellow of Trinity, in 1853 professor of Greek (to which a canonry in Ely Cathedral was then for the first time attached), and in 1866 master of his college. With the exception of the year 1836, when he acted as headmaster of a newly established school in Leicester, his life was divided between Cambridge and Ely. He died at the master's lodge on the 1st of October 1886. Thompson proved a worthy successor to Whewell; the twenty years of his mastership were years of progress, and he himself took an active part in the abolition of tests and the reform of university studies and of the college statutes. As a scholar he devoted his attention almost entirely to Plato; and his *Phaedrus* (1868) and *Gorgias* (1871), with especially valuable introductions, still remain the standard English editions of these two dialogues. He also edited (1856) from the author's MSS. *Lectures on the History of Ancient Philosophy* by William Archer Butler (1814–1848; lecturer on moral philosophy at Trinity College, Dublin), the value of which was greatly enhanced by Thompson's notes.

See article by J. W. Clark in *Dict. Nat. Biog.*; and J. E. Sandys, *History of Classical Scholarship* (1908), vol. iii.

THOMSEN, GRÍMUR (1820–1896), Icelandic poet and man of letters, was born in 1820. He came in 1837 to the university of Copenhagen, where he first studied law and philology, but later, philosophy and aesthetics. He became an enthusiastic follower of the Pan-Scandinavian movement, although this was not generally favoured by his countrymen. After some years of foreign travel, in 1848 he entered the Danish diplomatic service, and remained in it till 1851, when he returned to Copenhagen, where he became the chief of one of the departments of the Danish foreign office. He retired in 1866, and then went back to Iceland, where he passed the rest of his life, active in the politics and the literature of his native island. He died in 1896. He is the best ballad poet Iceland has produced. His poems are unaffected and mostly free from rhetoric, the besetting sin of Icelandic poets. His subjects are principally taken from Icelandic or Scandinavian history and mythology. He is very unlike most of his contemporaries, both in style and thought: he is Icelandic to the core, and on that account is perhaps the modern Icelandic poet most appreciated by foreigners Besides his poems (two separate collections, Reykjavík, 1880, and Copenhagen, 1895), he is the author of numerous critical and historical essays in Icelandic and Danish, and some larger works in Danish, of which his dissertation on Lord Byron (Copenhagen, 1845) deserves to be mentioned. Grímur Thomsen was a warm admirer of Greek literature, and translated a great number of poems from that language into Icelandic. (S. Bl.)

THOMSEN, HANS PETER JÖRGEN JULIUS (1826–1909), Danish chemist, was born in Copenhagen on the 16th of February 1826, and spent his life in that city. From 1847 to 1856 he was engaged in teaching chemistry at the Polytechnic, of which from 1883 to 1892 he acted as director, and from 1856 to 1866 he was on the staff of the military high school. In 1866 he was appointed professor of chemistry at the university, and retained that chair until his retirement from active work in 1891. His name is famous for his researches in thermochemistry, and, especially between 1869 and 1882, he carried out a great number of determinations of the heat evolved or absorbed in chemical reactions, such as the formation of salts, oxidation and reduction, and the combustion of organic compounds. His collected results were published in 1882–1886 in four volumes under the title *Thermochemische Untersuchungen*, and also a *résumé* in English under the title *Thermochemistry* in 1908. In 1857 he established in Copenhagen a process for manufacturing soda from cryolite, obtained from the west coast of Greenland. He died on the 13th of February 1909. His brother, Carl August Thomsen (1834–1894), was lecturer on technical chemistry at the Copenhagen Polytechnic, and a second brother, Thomas Gottfried Thomsen (1841–1901), was assistant in the chemical laboratory at the university till 1884, when he abandoned science for theology, subsequently becoming minister at Norup and Randers.

THOMSON, SIR CHARLES WYVILLE (1830–1882), Scottish naturalist, was born at Bonsyde, Linlithgowshire, on the 5th of March 1830, and was educated at Edinburgh University. In 1850 he was appointed lecturer in, and in 1851 professor of, botany at Aberdeen, and in 1853 he became professor of natural history in Queen's College, Cork. A year later he was nominated to the chair of mineralogy and geology at Queen's College, Belfast, and in 1860 was transferred to the chair of natural history in the same institution. In 1868 he assumed the duties of professor of botany at the Royal College of Science, Dublin, and finally in 1870 he received the natural history chair at Edinburgh. He will be specially remembered as a student of the biological conditions of the depths of the sea. Being interested in crinoids, and stimulated by the results of the dredgings of Michael Sars (1805–1869) in the deep sea off the Norwegian coasts, he succeeded, along with Dr W. B. Carpenter, in obtaining the loan of H.M.S. "Lightning" and "Porcupine," for successive deep-sea dredging expeditions in the summers of 1868 and 1869. It was thus shown that animal life exists in abundance down to depths of 650 fathoms, that all invertebrate groups are represented (largely by Tertiary forms previously believed to be extinct), and, moreover, that deep-sea temperatures are by no means so constant as was supposed, but vary considerably, and indicate an oceanic circulation. The results of these expeditions were described in *The Depths of the Sea*, which he published in 1873. The remarkable results gained for hydrography as well as zoology, in association with the practical needs of ocean telegraphy, soon led to the granting of H.M.S. "Challenger" for a circumnavigating expedition, and Thomson sailed at the end of 1872 as director of the scientific staff, the cruise lasting three years and a half (see Challenger Expedition). On his return he received many academic honours, and was knighted. In 1877 he published two volumes (*The Voyage of the Challenger in the Atlantic*), of a preliminary account of the results of the voyage, meanwhile carrying on his administrative labours in connexion with the disposition of the special collections and the publication of the monographs dealing with them. His health, never robust, was meanwhile giving way; from 1879 he ceased to perform the duties of his chair, and he died at Bonsyde on the 10th of March 1882.

See obituary notice in *Proc. Soc. Edin.* (1883); also Thomson and Murray, *Reports of the Voyage of H.M.S. "Challenger"* (Edinburgh, 1885).

THOMSON, JAMES (1700–1748), English poet, author of *The Seasons*, was born at Ednam, in Roxburghshire, on the 11th of September 1700—the third son and fourth child of Thomas Thomson, minister of that place. His mother, Beatrix, was the daughter of Mr Trotter of Fogo, whose wife, Margaret, was one of the Homes of Bassenden. About 1701 Thomas Thomson removed to Southdean near Jedburgh. Here James was educated at first by Robert Riccaltoun, to whose verses on

Winter he owed the suggestion of his own poem. In 1712 he attended a school at Jedburgh, held in the aisle of the parish church. He learnt there some Latin, but with difficulty, and the earliest recorded utterance of the future poet was "Confound the building of Babel." He began very soon to write verses, and we are told that every January he destroyed almost all the productions of the preceding year. And this was just as well, for the little that has escaped the fire contains no promise of his future powers. In 1715 he went to the university of Edinburgh. It is said that as soon as the servant who brought him thither had quitted him, he returned full speed to his father's house, declaring that he could read just as well at home; he went back, however, and had not been long at college before he lost his father, who died, according to one remarkable but highly improbable story, in the attempt to lay a ghost. The incident should have left more impression than we can trace upon the mind of the poet, at this date nervous and afraid of the dark; but in his *Winter* he writes of all such stories with a quiet contempt for "superstitious horror." He made friends at the university with David Mallock, who afterwards called himself Mallet, and with Patrick Murdoch, his future biographer. In 1719 he became a divinity student, and one of his exercises so enchanted a certain Auditor Benson, that he urged Thomson to go to London and there make himself a reputation as a preacher. It was partly with this object that Thomson left Edinburgh without a degree in March 1725. His mother saw him embark, and they never met again; she died on the 10th of May of that year. There is sufficient evidence that on his arrival in London he was not in the extreme destitution which Dr Johnson attributes to him; and in July 1725 we find him engaged, as a make-shift, in teaching "Lord Binning's son to read." This son was the grandson of Lady Grizel Baillie, a somewhat distant connexion of Thomson's mother. She was the daughter of Sir Patrick Home, whom, after the defeat of Argyll, she fed in his concealment near his own castle; she was also, like other Scottish ladies, a writer of pretty ballads. This heroine and poetess is supposed to have encouraged Thomson to come to England, and it is certain that she procured him a temporary home. But he had other friends, especially Duncan Forbes of Culloden, by whom he was recommended to the duke of Argyll, the earl of Burlington, Sir Robert Walpole, Arbuthnot, Pope and Gay. Some introductions to the literary world he may have owed to Mallet, then tutor in the family of the duke of Montrose.

Thomson's *Winter* appeared in March 1726. It was warmly praised by Aaron Hill, a man of various interests and projects, and in his day a sort of literary oracle. It was dedicated to Sir Spencer Compton, the Speaker, who rewarded the poet, to his great disgust, with a bare twenty guineas. By the 11th of June 1727 a second edition was called for. Meanwhile Thomson was residing at Mr Watts's academy in Tower Street as tutor to Lord George Graham, second son of the duke of Montrose, and previously a pupil of Mallet. *Summer* appeared in 1727. It was dedicated in prose, a compliment afterwards versified, to Bubb Dodington. In the same year Thomson published his *Poem to the Memory of Sir Isaac Newton*, with a fulsome dedication to Sir Robert Walpole, which was afterwards omitted, and the verses themselves remodelled when the poet began to inveigh against the ministry as he did in *Britannia*, published in 1729. *Spring* appeared in 1728, published by Andrew Millar, a man who, according to Johnson, dealt handsomely by authors and "raised the price of literature." It was dedicated to the countess of Hertford, afterwards duchess of Somerset, a lady devoted to letters and the patroness of the unhappy Savage. In 1729 Thomson produced *Sophonisba*, a tragedy now only remembered by the line "O Sophonisba, Sophonisba, O," and the parody "O Jemmy Thomson, Jemmy Thomson, O," which caused him to remodel the unhappy verse in the form, "O Sophonisba, I am wholly thine." A poem, anonymous but unquestionably Thomson's, to the memory of Congreve who had died in January 1729, appeared in that year. In 1730 *Autumn* was first published in a collected edition of *The Seasons*. It was dedicated to the Speaker, Onslow. In this year, at the suggestion of Rundle, bishop of Derry, one of his patrons, he accompanied the son of Sir Charles Talbot, solicitor-general, upon his travels. In the course of these he projected his *Liberty* as "a poetical landscape of countries, mixed with moral observations on their government and people." In December 1731 he returned with his pupil to London. He probably lived with his patrons the Talbots, leisurely meditating his new poem, the first part of which did not appear until the close of 1734 or the beginning of 1735. But meanwhile his pupil died, and in the opening lines of *Liberty* Thomson pays a tribute to his memory. Two months after his son's death Sir Charles Talbot became chancellor and gave Thomson a sinecure in the court of chancery. About this time the poet worked for the relief of Dennis, now old and in extreme poverty, and induced even Pope to give a half-contemptuous support to the bitter critic of the *Rape of the Lock*. *Liberty* was completed in five parts in 1736. The poem was a failure; its execution did not correspond with its design; in a sense indeed it is a survey of countries and might have anticipated Goldsmith's *Traveller*. It was not, however, the poem which readers were expecting from the author of *The Seasons*, who had taken them from the town to the country, and from social and political satire to the world of nature. It is in the main a set of wearisome declamations put in the mouth of the goddess, and Johnson rightly enough remarks that "an enumeration of examples to prove a position which nobody denied as it was from the beginning superfluous, must quickly grow disgusting." The truth is that Thomson's poetical gift was for many years perverted by the zeal of partisanship.

He was established in May 1736 in a small house at Richmond, but his patron died in February 1737 and he lost his sinecure; he then "whips and spurs" to finish his tragedy *Agamemnon*, which appeared in April 1738, not before he had been arrested for a debt of £70, from which, according to a story which has been discredited on quite insufficient grounds, Quin relieved him in the most generous and tactful manner. Quin, it is said, visited him in the sponging-house and "balanced accounts with him" by insisting on his accepting a hundred pounds as a return for the pleasure which the actor had received from the poet's works. The incident took place probably a little before the production of *Agamemnon*, in which Quin played the leading part. The play is of course modelled upon Aeschylus and owes whatever of dignity it possesses to that fact; the part of Cassandra, for instance, retains something of its original force, pathos and terror. But most of the other characters exist only for the purpose of political innuendo. Agamemnon is too long absent at Troy, as George is too long absent in Germany; the arts of Aegisthus are the arts of Walpole; the declamations of Arcus are the declamations of Wyndham or Pulteney; Melisander, consoling himself with the muses on his island in Cyclades, is Bolingbroke in exile. Thomson about this time was introduced to Lyttelton, and by him to the prince of Wales, and to one or the other of these, when he was questioned as to the state of his affairs, he made answer that they were "in a more poetical posture than formerly." *Agamemnon* was put upon the stage soon after the passing of Walpole's bill for licensing plays, and its obvious bias fixed the attention of the censorship and caused Thomson's next venture, *Edward and Eleanora*, which has the same covert aim, to be proscribed. The fact has very generally escaped notice that, like its predecessor, it follows a Greek original, the *Alcestis* of Euripides. It has also, what *Agamemnon* has not, some little place in the history of literature, for it suggested something to Lessing for *Nathan der Weise*, and to Scott for the *Talisman*. The rejection of the play was defended by one of the ministry on the ground that Thomson had taken a *Liberty* which was not agreeable to *Britannia* in any *Season*. These circumstances sufficiently account for the poet's next experiment, a preface to Milton's *Areopagitica*. He joined Mallet in composing the masque of *Alfred*, represented at Clieveden on the Thames before the prince of Wales, on the 1st of August 1740. There can be little question that "Rule

Britannia," a song in this drama, was the production of Thomson. The music of the song, as of the whole masque, was composed by Arne. In 1744 Thomson was appointed surveyor-general of the Leeward Islands by Lyttelton with an income of £300 a year; but his patron fell into disfavour with the prince of Wales, and in consequence Thomson lost, at the close of 1747, the pension he received from that quarter. For a while, however, he was in flourishing circumstances, and whilst completing at his leisure *The Castle of Indolence* produced *Tancred and Sigismunda* at Drury Lane in 1745. The story is found in *Gil Blas*, and is ultimately to be traced to *The Decameron*. It owes much to Le Sage in language, plot and sentiment, and the conflict of emotion, in depicting which Thomson had some little skill, is here effectively exhibited. He was assisted herein by his own experience. The "Amanda" of *The Seasons* is a Miss Elizabeth Young, a lady of Scottish parentage, whose mother was ambitious for her and forbade her to marry the poet, anticipating that she would be reduced to singing his ballads in the streets. The last years of his life were saddened by this disappointment.

The Castle of Indolence, after a gestation of fifteen years, appeared in May 1748. It is in the Spenserian stanza with the Spenserian archaism, and is the first and last long effort of Thomson in rhyme. It is not impossible that his general choice of blank verse was partly due to the fact that he had not the southron's ear and took many years to acquire it. The great and varied interest of the poem might well rescue it from the neglect into which even *The Seasons* has fallen. It was worthy of an age which was fertile in character-sketches, and like Gay's *Welcome to Pope* anticipates Goldsmith's *Retaliation* in the lifelike presentation of a noteworthy circle. There is in it the same strain of gentle burlesque which appears in Shenstone's *Schoolmistress*, whilst the tone and diction of the poem harmonize with the hazy landscape, the pleasant land of drowsyhead, in which it is set. It is the last work by Thomson which appeared in his lifetime. In walking from London to his house at Richmond he became heated and took a boat at Hammersmith; he thus caught a chill with fatal consequences and died on the 27th of August 1748. He was buried in Richmond churchyard. His tragedy *Coriolanus* was acted for the first time in January 1749. In itself a feeble performance, it is noteworthy for the prologue which his friend Lyttelton wrote for it, two lines of which—

> "He loved his friends—forgive the gushing tear!
> Alas! I feel I am no actor here"—

were recited by Quin with no simulated emotion.

It may be questioned whether Thomson himself ever quite realized the distinctive significance of his own achievement in *The Seasons*, or the place which criticism assigns him as the pioneer of a special literary movement and the precursor of Cowper and Wordsworth. His avowed preference was for great and worthy themes of which the world of nature was but one. Both the choice and the treatment of his next great subject, *Liberty*, indicate that he was imperfectly conscious of the gift that was in him, and might have neglected it but that his readers were wiser than himself. He has many audacities and many felicities of expression, and enriched the vocabulary even of the poets who have disparaged him. Yet it is difficult to believe that he was not the better for that training in refinement of style which he partly owed to Pope, who almost unquestionably contributed some passages to *The Seasons*. And, except in *The Castle of Indolence*, there is much that is conventional, much that is even vicious or vulgar in taste when Thomson's muse deals with that human life which must be the background of descriptive as of all other poetry; for example, his bumpkin who chases the rainbow is as unreal a being as Akenside's more sentimental rustic who has "the form of beauty smiling at his heart." But if Thomson sometimes lacks the true vision for things human, he retains it always for things mute and material, and whilst the critical estimate of his powers and influence will vary from age to age, all who have read him will concur in the colloquial judgment which only candour could have extorted from the prejudice of Dr Johnson—"Thomson had as much of the poet about him as most writers. Everything appeared to him through the medium of his favourite pursuit. He could not have viewed those two candles burning but with a poetical eye."

For the day of Thomson's birth see the Aldine edition of his poems (1897). In the same volume (pp. 189 seq.) is discussed the question of Pope's contributions to *The Seasons*. These Pope, if the handwriting be his, made in an interleaved edition of *The Seasons* dated 1738, and they were for the most part adopted by Thomson in the edition of 1744. The writer seldom makes more than verbal changes in passages of pure description, but sometimes strikingly enhances the scenes in which human character comes into play, adding, for example, the comparison, in *Autumn*, of the fair Lavinia to a myrtle in the Apennines, of which the first suggestion can be found in *The Rape of the Lock*. But whereas many years ago the opinion of experts at the British Museum pronounced the handwriting of these notes to be Pope's beyond a doubt, their successors at the present day are equally positive that it is not. Some account should be taken of the cramping of the hand, due to writing on a curved surface, and of the letters at Blenheim (see *Pall Mall Magazine* for August 1894), which bear a greater resemblance to the disputed handwriting than any specimens in the British Museum.

The first collected editions of *The Seasons* bear dates 1730, 1738, 1744, 1746. Lyttelton tampered both with *The Seasons* and with *Liberty* in editions after his friend's death. Among the numerous lives of the poet may be mentioned those by his friend Patrick Murdoch, by Dr Johnson in *Lives of the Poets*, by Sir Harris Nicolas (Ald. ed., 1860), by M. Morel, *James Thomson, sa vie et ses œuvres* (Paris, 1895), and *James Thomson*, in the English Men of Letters Series, by G. C. Macaulay (1908). See also Dr G. Schmeding's *Jacob Thomson, ein vergessener Dichter des achtzehnten Jahrhunderts*; the life prefixed to the Aldine edition of his works in 1897; and an excellent edition of *The Seasons* in the Clarendon Press Series by J. Logie Robertson. (D. C. To.)

THOMSON, JAMES (1834–1882), British poet, best known by his signature "B.V.", was born at Port-Glasgow, in Renfrewshire, on the 23rd of November 1834, the eldest child of a mate in the merchant shipping service. His mother was a deeply religious woman of the Irvingite sect. On her death, James, then in his seventh year, was procured admission into the Caledonian Orphan Asylum. In 1850 he entered the model school of the Military Asylum, Chelsea, from which he went out into the world as an assistant army schoolmaster. At the garrison at Ballincollig, near Cork, he encountered the one brief happiness of his life: he fell passionately in love with, and was in turn as ardently loved by, the daughter of the armourer-sergeant of a regiment in the garrison, a girl of very exceptional beauty and cultivated mind. Two years later he suddenly received news of her fatal illness and death. The blow prostrated him in mind and body. Henceforth his life was one of gloom, disappointment, misery and poverty, rarely alleviated by episodes of somewhat brighter fortune. While in Ireland he had made the acquaintance of Charles Bradlaugh, then a soldier stationed at Ballincollig, and it was under his auspices (as editor of the *London Investigator*) that Thomson first appealed to the public as an author, though actually his earliest publication was in *Tait's Edinburgh Magazine* for July 1858, under the signature "Crepusculus." In 1860 was established the paper with which Bradlaugh was so long identified, the *National Reformer*, and it was here, among other productions by James Thomson, that appeared (1863) the powerful and sonorous verses "To our Ladies of Death," and (1874) his chief work, the sombre and imaginative *City of Dreadful Night*. In October 1862 Thomson was dismissed the army, in company with other teachers, for some slight breach of discipline. Through Bradlaugh, with whom for some subsequent years he lived, he gained employment as a solicitor's clerk. From 1866 to the end of his life, except for two short absences from England, Thomson lived in a single room, first in Pimlico and then in Bloomsbury. He contracted habits of intemperance, aggravated by his pessimistic turn of mind to dipsomania, which made a successful career impossible for him. In 1869 he enjoyed what has been described as his "only reputable appearance in respectable literary society," in the acceptance of his long poem, "Sunday up the River," for *Fraser's Magazine*, on the advice, it is said, of Charles Kingsley.

In 1872 Thomson went to the western states of America, as the agent of the shareholders in what he ascertained to be a fraudulent silver mine; and the following year he received a commission from the *New York World* to go to Spain as its special correspondent with the Carlists. During the two months of his stay in that distracted country he saw little real fighting, and was himself prostrated by a sunstroke. On his return to England he continued to write in the *Secularist* and the *National Reformer*, under the initials "B.V."[1] In 1875 he severed his connexion with the *National Reformer*, owing to a disagreement with its editor; henceforth his chief source of income (1875–1881) was from the monthly periodical known as *Cope's Tobacco Plant*. Chiefly through the exertions of his friend and admirer, Bertram Dobell, Thomson's best-known book, *The City of Dreadful Night, and other Poems*, was published in April 1880, and at once attracted wide attention; it was succeeded in the autumn by *Vane's Story, and other Poems*, and in the following year by *Essays and Phantasies*. All his best work was produced between 1855 and 1875 ("The Doom of a City," 1857; "Our Ladies of Death," 1861; *Weddah and Om-el-Bonain*; "The Naked Goddess," 1866–1867; *The City of Dreadful Night*, 1870–1874). He died at University College Hospital, in Gower Street, on the 3rd of June 1882, and was buried at Highgate cemetery, in the same grave, in unconsecrated ground. as his friend Austin Holyoake.

To the productions of James Thomson already mentioned may be added the posthumous volume entitled *A Voice from the Nile, and other Poems* (1884), to which was prefixed a memoir by Bertram Dobell. This volume contained much that is interesting, but nothing to increase Thomson's reputation. If an attempt be made to point to the most apparent literary relationship of the author of *The City of Dreadful Night*, one might venture the suggestion that James Thomson was a younger brother of De Quincey. If he has distinct affinity to any writer it is to the author of *Suspiria de profundis*; if we look further afield, we might perhaps discern shadowy prototypes in Leopardi, Heine and Baudelaire. But, after all, Thomson holds so unique a place as a poet that the effort at classification may well be dispensed with. His was no literary pessimism, no assumed gloom. The poem "Insomnia" is a distinct chapter of biography; and in "Mater Tenebrarum" and elsewhere among his writings passages of self-revelation are frequent. The merits of Thomson's poetry are its imaginative power, its sombre intensity, its sonorous music; to these characteristics may be added, in his lighter pieces, a Heine-like admixture of strange gaiety, pathos and caustic irony. Much the same may be said of his best prose. His faults are a monotony of epithet, the not infrequent use of mere rhetoric and verbiage, and perhaps a prevailing lack of the sense of form; besides an occasional vulgar recklessness of expression, as in parts of *Vane's Story* and in some of his prose writings.

See the *Life*, by H. S. Salt (1905 edition).

THOMSON, JAMES (1822–1892), British physicist and engineer, was born in Belfast on the 16th of February 1822, and, like his younger brother, Lord Kelvin, at an unusually early age began to attend the classes at Glasgow University, where his father had been appointed professor of mathematics in 1832. After his graduation he decided to study civil engineering, and for that purpose became a pupil in several engineering offices and works successively; but ill-health obliged him to leave them all, and he had finally to accept the fact that an occupation involving physical exertion was out of the question. Accordingly, from about 1843, he devoted himself to theoretical work and to mechanical invention. To this period belong his well-known researches in thermodynamics, which enabled him to predict by the application of Carnot's theorem that the temperature of the freezing point of substances which expand on solidifying must be lowered by the application of pressure, the reverse being the case with substances which contract on solidification; and he was able to calculate the amount by which a given pressure lowers the freezing-point of water, a substance which expands on solidification. His results were experimentally verified in the physical laboratories of Glasgow University under Lord Kelvin's direction, and were afterwards applied to give the explanation of regelation. In 1861 he extended them in a paper on crystallization and liquefaction as influenced by stresses tending to change of form in the crystals, and in other studies on the change of state he continued Thomas Andrews's work on the continuity of the liquid and gaseous states of matter, constructing a thermodynamic model in three dimensions to show the relations of pressure, volume and temperature for a substance like carbonic acid. With regard to his inventions, he devised a clever feathering mechanism for the paddles of steamboats when only a boy of sixteen, and later turned his attention to water engines. In 1850 he patented his "vortex water-wheel," and during the next three or four years carried on inquiries into the properties of "whirling fluids," which resulted in improved forms of blowing-fans and water-turbines (see HYDRAULICS). Settling in Belfast in 1851, he was selected to be the resident engineer to the Belfast Water Commissioners in 1853, and four years later became professor of civil engineering and surveying in Queen's College, Belfast. Thence he removed in 1873 to Glasgow as successor to Macquorn Rankine in the chair of engineering in the university, and retained this position until 1889, when the failure of his eyesight compelled him to resign. He died on the 8th of May 1892 at Glasgow. His contributions to geological science included studies of the parallel roads of Glen Roy and of the prismatic jointing of basalt, as seen at the Giant's Causeway. In 1876 and following years he studied the origin of windings of rivers in alluvial plains and made many experiments with the aid of artificial streams; and the currents of atmospheric circulation afforded him the material for the Bakerian lecture of 1892.

THOMSON, JOHN (1778–1840), Scottish landscape painter—Thomson of Duddingston, as he is commonly styled—was born on the 1st of September 1778 at Dailly, Ayrshire. His father, grandfather and great-grandfather were clergymen of the Church of Scotland. He studied for the same vocation in the university of Edinburgh; and, residing with his elder brother, Thomas Thomson, afterwards celebrated as an antiquarian and feudal lawyer, he made the acquaintance of Francis Jeffrey and other young members of the Scottish bar afterwards notable. During the recess he sketched in the country, and, while attending his final college session, he studied art for a month under Alexander Nasmyth. After his father's death he became, in 1800, his successor as minister of Dailly; and in 1805 he was translated to the parish of Duddingston, close to Edinburgh. He continued, however, to practise art as an amateur, apparently without any detriment to his pastoral duties. Thomson's popularity as a painter increased with his increasing artistic skill; and, having mastered his initial scruples against receiving artistic fees, on being offered £15 for a landscape—reassured by "Grecian" Williams's stout assertion that the work was "worth thrice the amount"—the minister of Duddingston began to dispose of the productions of his brush in the usual manner. In 1830 he was made an honorary member of the Royal Scottish Academy. Thomson was also an accomplished performer on violin and flute, an exact and well-read student of physical science, and one of the writers on optics in the early numbers of the *Edinburgh Review*. He enjoyed a singularly wide and eminent circle of friends, including, among artists, Turner and Wilkie, and among men of letters, Wilson and Scott—the latter of whom desired that Thomson, instead of Turner, should have illustrated the collected edition of his works. He died at Duddingston on the 27th of October 1840 (not the 20th, as stated by some authorities). Thomson was twice married, and his second wife, the widow of Mr Dalrymple of Cleland, was herself also a skilful amateur artist.

Thomson is fairly represented in the Scottish National Gallery; and the "Aberlady Bay" of that collection, with the soft infinity of

[1] Bysshe Vanolis: "Bysshe," as the commonly used Christian name of Shelley, Thomson's favourite writer; and "Vanolis," an anagram of Novalis—(F. von Hardenberg).

its clouded grey sky, and its sea which leaps and falls again in waves of sparkling and of shadowed silver, is fit to rank among the triumphs of Scottish art.

THOMSON, JOSEPH (1858–1895), Scottish explorer in Africa, was born on the 14th of February 1858 at Penpont, Dumfriesshire, being the fifth son of William Thomson, originally a working stonemason, who had attained the position of a master builder. In 1868 his father removed to Gatelawbridge, where he rented a farm and a quarry. Joseph Thomson was soon attracted by the geological formation and historical associations of Nithsdale. For a short time he worked in his father's quarry. In 1875 he went to Edinburgh University, where he paid particular attention to geology and botany, and after completing his course in 1878 he was appointed geologist and naturalist to the Royal Geographical Society's expedition to East Central Africa under Keith Johnston. The latter died at Behobeho, between the coast and the north end of Lake Nyasa, on the 28th of June 1879, and Thomson then took command. Though only twenty-one his coolness and tact were remarkable, and he successfully conducted the expedition across the desolate region of Uhehè and Ubena to the north end of Lake Nyasa, and then by a hitherto unexplored track to Lake Tanganyika, where he investigated the moot question of the Lukuga outlet. From Tanganyika he started to reach the Congo, but troubles with his carriers, who dreaded the warlike Warua, obliged him to retrace his steps. Going round the south end of Tanganyika he discovered Lake Rukwa, whence he marched via Tabora to the coast at Bagamoyo, reaching London in August 1880. In the following year he published an account of his travels under the title *To the Central African Lakes and Back*. About this time the sultan of Zanzibar, being anxious to develop certain supposed coal beds on the river Rovuma, was advised to obtain independent expert opinion as to their value. Application was made to Thomson, who undertook to survey them, and started from Mikindani, on the 17th of July 1881. The coal, however, turned out to be merely bituminous shale, and Thomson, on his return to Zanzibar, had to endure much delay and vexation through the sultan's chagrin. For a considerable time the explorer had directed his attention to Masailand, a region of East Africa occupied by a powerful tribe of warriors who had a reputation for savagery and intractability somewhat greater than their actions warranted. Through their territory ran the shortest route from the sea to the headwaters of the Nile. In 1882 the Royal Geographical Society took up the question, and requested Thomson to report on the practicability of taking a caravan through the Masai country, which no European had yet been able to penetrate beyond Mt Kilimanjaro. By undaunted courage and great resourcefulness he succeeded in crossing the Njiri desert and exploring the eastern rift-valley. Thence he went with a picked company through Laikipia to Mt Kenya and Lake Baringo, afterwards traversing the unknown region lying between Baringo and Victoria Nyanza, reached on the 10th of December 1883. On his way back he visited Mt Elgon and discovered there a series of wonderful caves. The account of this adventurous journey appeared in 1884, under the title of *Through Masăiland*, and it is a classic in modern travel. The hardships and anxieties attendant on such a career began to tell upon Thomson's exceptionally hardy constitution, but in 1885 he undertook an expedition to Sokoto for the National African (afterwards the Royal Niger) Company, and succeeded in obtaining the signatures of the sultans of Sokoto and Gando to treaties with which he had been entrusted by the company, treaties which did much to secure British interests in Nigeria. In 1888, by way of recreation, he travelled through southern Morocco and explored a portion of the Atlas range, and published the results in the following year, under the title *Travels in the Atlas and Southern Morocco*. In 1890 he entered the service of the British South Africa Company and in that and the following year, starting from Quilimane he traversed the region between lakes Nyasa and Bangweulu and the Zambezi. It was a period of great tension between the Portuguese and the British, and Thomson's party on leaving the Portuguese frontier was fired on by the Portuguese who, too late, realized that they had allowed a treaty-making envoy to pass through their territory in the guise of a peaceful trader. Thomson concluded treaties with native potentates which gave to the Chartered Company political, trading and mining rights over a large part of the district since known as North-East Rhodesia. This journey, in which he covered nearly a thousand miles of hitherto unexplored country, proved disastrous to a constitution already undermined. In 1893 he visited South Africa in search of health, but unavailingly. He died in London on the 2nd of August 1895. The accounts of his travels not recorded in the books mentioned were published in magazines or in the *Proceedings of the Royal Geographical Society*. Thomson was the last, as he was one of the most successful, of the great geographical pioneers in Africa. He had an extraordinarily keen topographical instinct which enabled him to comprehend at a glance the natural features of the countries he traversed. To undaunted courage and promptness of decision he added a forbearing and patient disposition. "Joseph. Thomson," wrote Sir Clements Markham, "had the high and glorious distinction of never having caused the death of a native. This is a proof of very rare qualities in the leader of an expedition, and places him in the very first rank of explorers."

Besides the accounts of his own travels Thomson wrote, in collaboration with Miss E. Harris Smith, *Ulu* (London, 1888), a novel based on his insight into the working of the African mind, *Mungo Park and the Niger* (London, 1890), a sound critical biography and many magazine articles on African politics.

See *Joseph Thomson, African Explorer* (London, 1896), a biography by his brother, the Rev. J. B. Thomson, which contains a list of the published writings of the explorer.

THOMSON, THOMAS (1773–1852), Scottish chemist, was born at Crieff, Perthshire, on the 12th of April 1773. He was educated at the universities of St Andrews and Edinburgh, and after taking the degree of M.D. at the latter place in 1799 established himself there as a teacher of chemistry. From 1796 to 1800 he was sub-editor of the *Encyclopaedia Britannica*, in succession to his elder brother, James Thomson (1768–1855), who filled that position in 1795–1796, and who in 1805 was ordained to the parish of Eccles, Berwickshire; and the chemical and mineralogical articles which he contributed to the supplement to the third edition formed the basis of his *System of Chemistry*, the first edition of which was published in 1802 and the seventh in 1831. At first this work was merely a compilation, but in the later editions many of his original results were incorporated; the third edition (1807) is noteworthy as containing the first detailed account of the atomic theory, communicated to him by John Dalton himself. In 1811 he left Edinburgh, and after a visit to Sweden went to London, where in 1813 he began to edit the *Annals of Philosophy*, a monthly scientific journal which in 1827 was merged in the *Philosophical Magazine*. In 1817 he became lecturer in chemistry at Glasgow University, and in the following year was appointed to the regius professorship. This chair he retained until his death, which happened on the 2nd of July 1852 at Kilmun, Argyleshire; but from 1841 he was assisted by his nephew and son-in-law Robert Dundas Thomson (1810–1864), who subsequently became medical officer of health for St Marylebone, London, and after 1846 he ceased active work altogether. He was a most energetic professor, and, according to his colleague, but no relation, Lord Kelvin (Sir William Thomson), founded the first chemical laboratory for students at a time when practical work was scarcely recognized as a necessary part of chemical education. He did much to spread a knowledge of Dalton's atomic theory, and carried out many experiments in its support, but his strong predilections in favour of Prout's hypothesis tended to vitiate his results, many of which were sharply criticized by J. J. Berzelius and other chemists. In addition to various textbooks he published a *History of Chemistry* (1830–1831) which has provided material for many chemical biographers, but which, although it reads very plausibly, cannot be regarded as an authority of unimpeachable accuracy. His eldest son, Thomas Thomson (1817–1878) graduated as M.D. at Glasgow in 1839, accompanied

Sir J. D. Hooker on his travels in Sikkim in 1850, and collaborated with him in publishing his *Flora indica* in 1855 and in 1854 was appointed superintendent of the botanic gardens at Calcutta, also acting as professor of botany at the Calcutta medical college.

THOMSON, WILLIAM (1819–1890), English divine, archbishop of York, was born on the 11th of February 1819 at Whitehaven, Cumberland. He was educated at Shrewsbury and at Queen's College, Oxford, of which he became a scholar. He took his B.A. degree in 1840, and was soon afterwards made fellow of his college. He was ordained in 1842, and worked as a curate at Cuddesdon. In 1847 he was made tutor of his college, and in 1853 he delivered the Bampton lectures, his subject being "The Atoning Work of Christ viewed in Relation to some Ancient Theories." These thoughtful and learned lectures established his reputation and did much to clear the ground for subsequent discussions on the subject. Thomson's activity was not confined to theology. He was made fellow of the Royal and the Royal Geographical Societies. He also wrote a very popular *Outline of the Laws of Thought*. He sided with the party at Oxford which favoured university reform, but this did not prevent him from being appointed provost of his college in 1855. In 1858 he was made preacher at Lincoln's Inn and there preached some striking sermons, a volume of which he published in 1861. In the same year he edited *Aids to Faith*, a volume written in opposition to *Essays and Reviews*, the progressive sentiments of which had stirred up a great storm in the Church of England. In December 1861 he was rewarded with the see of Gloucester and Bristol, and within a twelvemonth he was elevated to the archiepiscopal see of York. In this position his moderate orthodoxy led him to join Archbishop Tait in supporting the Public Worship Regulation Act, and, as president of the northern convocation, he came frequently into sharp collision with the lower house of that body. But if he thus incurred the hostility of the High Church party among the clergy, he was admired by the laity for his strong sense, his clear and forcible reasoning, and his wide knowledge, and he remained to the last a power in the north of England. In his later years he published an address read before the members of the Edinburgh Philosophical Institution (1868), one on *Design in Nature*, for the Christian Evidence Society, which reached a fifth edition, various charges and pastoral addresses, and he was one of the projectors of *The Speaker's Commentary*, for which he wrote the "Introduction to the Synoptic Gospels." He died on the 25th of December 1890.

See the *Quarterly Review* (April 1892).

THOR, one of the chief deities of the heathen Scandinavians. He is represented as a middle-aged man of enormous strength, quick to anger, but benevolent towards mankind. To the harmful race of giants (demons), on the other hand, he was an implacable foe, and many stories are told in the poetic and prose Eddas of the destruction which he brought upon them at various times with his hammer. On the whole his figure is somewhat secondary in the mythology to that of Odin, who is represented as his father. But there is no doubt that in Iceland he was worshipped more than any other god, and the same seems to have been the case in Norway—indeed, perhaps, in all northern countries—except among the royal families. Even in the great temple at Upsala his figure is said to have occupied the chief place. There is evidence that a corresponding deity named Thunor or Thonar was worshipped in England and on the Continent, but little information is obtainable regarding him, except that he was identified with the Roman Jupiter. His name is identical with the Teutonic word for thunder, and even in Sweden the association of Thor with the thunder seems not to have been forgotten. Outside the Teutonic area he has close affinities not only with Jupiter or Zeus, but still more with the Lithuanian god Perkunas, whose name (which likewise means "thunder") appears to be connected with that of Thor's mother (Fiörgyn). The Varangian god Perun was probably Thor himself under a Slavonic name (Russian *perun*, "thunderbolt").

See H. Petersen, *Om Nordboernes Gudedyrkelse og Gudetro i Hedenold* (Copenhagen, 1876). For other references see TEUTONIC PEOPLES: *Religion* (*ad fin*). (H. M. C.)

THORAX (Gr. θώραξ, breastplate, also the part of the body covered by it), the anatomical term for the chest, that part of the body which contains the heart and lungs (see ANATOMY: *Superficial and Artistic*, and SKELETON: *Axial*). For the surgery of the thorax reference may be made to the headings HEART, LUNG and RESPIRATORY SYSTEM.

THORBECKE, JAN RUDOLF (1798–1872), Dutch statesman, was born at Zwolle, in the province of Overijssel, on the 14th of January 1798. Thorbecke was of German extraction, his grandfather, Heinrich Thorbecke, having settled in Overijssel towards the end of the 17th century. Little is known of his youth, beyond the fact that he was sent in the year of Waterloo to Amsterdam for his education. For two years he stayed with a Lutheran clergyman of the name of Sartorius, whilst attending the lectures of the Athenaeum Illustre. In 1817 he commenced his studies at Leiden University, proving a brilliant scholar, and twice obtaining a gold medal for his prize essays. In 1820 he obtained the degrees of Lit.D. and LL.D. In the following years Thorbecke undertook a journey of research and study in Germany, staying at most of her famous universities, and making the acquaintance of his best-known contemporaries in the fatherland. At Giessen he lectured as an extraordinary professor, and at Göttingen, in 1824, published his treatise, *Ueber das Wesen der Geschichte*. After his return to Amsterdam in 1824 Thorbecke wrote his first political work of any importance, *Bedenkingen aangaande het Recht en den Staat* ("Objections anent Law and the State"), which by its close reasoning and its legal acumen at once drew attention to the young barrister, and procured him in 1825 a chair as professor in Ghent University. Here he wrote two pamphlets of an educational character before 1830. The Belgian revolt of that year forced Thorbecke to resign his position at Ghent, and he subsequently went to Leiden. He did not approve of the Belgian movement, nor of the part that Europe played in it, and published his views in three pamphlets, which appeared in the years 1830 and 1831. In 1831 he was appointed professor of jurisprudence and political science at Leiden University. In that capacity, and, before his appointment at Leiden, as a lecturer on political science, history and economics at Amsterdam, he gained great reputation as a political reformer, particularly after the publication of his standard work, *Aanteekeningen op de Grondwet* ("Annotations on the Constitution," 1839; 2nd ed., Amsterdam, 1841–1843), which became the textbook and the groundwork for the new reform party in Holland, as whose leader Thorbecke was definitely recognized. Thorbecke's political career until his death, which occurred at the Hague on the 4th of June 1872, is sketched under HOLLAND: *History*. Thorbecke's speeches in the Dutch legislature were published at Deventer in six volumes (1867–1870), to which should be added a collection of his unpublished speeches, printed at Groningen in 1900. The first edition of his *Historische Schetsen* ("Historical Essays") was issued in 1860, the second in 1872. At Amsterdam there appeared in 1873 a highly interesting *Correspondence* with his academy friend and lifelong political adversary Groen van Prinsterer (*q.v.*), which, although dating back to the early 'thirties, throws much light on their subsequent relations and the political events that followed 1848. Of Dutch statesmen during the Napoleonic period, Thorbecke admired Falck and Van Hogendorp most, whose principles he strove to emulate. Of Van Hogendorp's *Essays* and *Speeches*, indeed, he published a standard edition, which is still highly valued. Thorbecke's speeches form a remarkable continuation of Van Hogendorp's orations, not only in their style, but also in their train of thought. Thorbecke's funeral furnished the occasion for an imposing national demonstration, which showed how deeply he was revered by all classes of his countrymen. In 1876 a statue of Thorbecke was unveiled in one of the squares of Amsterdam.

Thorbecke's gifts and public services as a statesman have been as fully recognized as his political genus has been. As an orator and writer his style was clear and forcible. His very dogmatism brought him many enemies, but at times, especially when he went in advance of his time, he was a much misunderstood man. These misunderstandings, frequently wilful, extended often beyond the domain of pure politics. Thus, by his enemies, Thorbecke was often held up to scorn as a pure materialist and no friend of the fine arts, because at a sitting of the states-general in 1862 he had said that it is not the duty of the state, nor in the true interest of art itself, for the government to "protect" art, since all state-aided art must be artificial, like any forced plant. This was popularly condensed into the aphorism, yet current in Holland, that "Art is not the business of the government," and Thorbecke was condemned as the author of it. Again, his adversaries used to call him a dangerous demagogue. As a matter of fact, there was no more ardent royalist than Thorbecke. He believed in constitutional monarchy, as offering the best guarantees both for sovereign and people, and he was bitterly opposed to all forms of state socialism. Long before his death he realized that he had outlived his own principles, and many of his former admirers had commenced to dub him a "rank conservative," whose political aims and reforms were no longer adequate. But Thorbecke's life-work will endure, and the Dutch constitution of 1887 practically embodied his principles, as laid down in the constitution of 1848. The former is the outcome of the latter and could not have been made without it.

The best biographical sketch of Thorbecke we owe to the late Professor Buys, his principal scholar and devoted friend, whose biography appeared in 1876 at Tiel. Another biography which deserves mention was issued in the same year at the Hague, from the pen of Dr J. A. Levy, an Amsterdam lawyer. (H. Tı.)

THOREAU, HENRY DAVID (1817–1862), American recluse, naturalist and writer, was born at Concord, Massachusetts, on the 12th of July 1817. To Thoreau this Concord country contained all of beauty and even grandeur that was necessary to the worshipper of nature: he once journeyed to Canada; he went west on one occasion; he sailed and explored a few rivers; for the rest, he haunted Concord and its neighbourhood as faithfully as the stork does its ancestral nest. John Thoreau, his father, who married the daughter of a New England clergyman, was the son of a John Thoreau of the isle of Jersey, who, in Boston, married a Scottish lady of the name of Burns. This last-named John was the son of Philippe Thoreau and his wife Marie le Gallais, persons of pure French blood, settled at St Helier, in Jersey. From his New England Puritan mother, from his Scottish grandmother, from his Jersey-American grandfather and from his remoter French ancestry Thoreau inherited distinctive traits: the Saxon element perhaps predominated, but the "hauntings of Celtism" were prevalent and potent. The stock of the Thoreaus was a robust one; and in Concord the family, though never wealthy nor officially influential, was ever held in peculiar respect. As a boy, Henry drove his mother's cow to the pastures, and thus early became enamoured of certain aspects of nature and of certain delights of solitude. At school and at Harvard University he in nowise distinguished himself, though he was an intelligently receptive student; he became, however, proficient enough in Greek, Latin, and the more general acquirements to enable him to act for a time as a master. But long before this he had become apprenticed to the learning of nature in preference to that of man: when only twelve years of age he had made collections for Agassiz, who had then just arrived in America, and already the meadows and the hedges and the stream-sides had become cabinets of rare knowledge to him. On the desertion of schoolmastering as a profession, Thoreau became a lecturer and author, though it was the labour of his hands which mainly supported him through many years of his life: professionally he was a surveyor. In the effort to reduce the practice of economy to a fine art he arrived at the conviction that the less labour a man did, over and above the positive demands of necessity, the better for him and for the community at large; he would have had the order of the week reversed—six days of rest for one of labour. It was in 1845 he made the now famous experiment of Walden. Desirous of proving to himself and others that man could be as independent of this kind as the nest-building bird, Thoreau retired to a hut of his own construction on the pine-slope over against the shores of Walden Pond—a hut which he built, furnished and kept in order entirely by the labour of his own hands. During the two years of his residence in Walden woods he lived by the exercise of a little surveying, a little job-work and the tillage of a few acres of ground which produced him his beans and potatoes. His absolute independence was as little gained as if he had camped out in Hyde Park; relatively he lived the life of a recluse. He read considerably, wrote abundantly, thought actively if not widely, and came to know beasts, birds and fishes with an intimacy more extraordinary than was the case with St Francis of Assisi. Birds came at his call, and forgot their hereditary fear of man; beasts lipped and caressed him; the very fish in lake and stream would glide, unfearful, between his hands. This exquisite familiarity with bird and beast would make us love the memory of Thoreau if his egotism were triply as arrogant, if his often meaningless paradoxes were even more absurd, if his sympathies were even less humanitarian than we know them to have been. His *Walden*, the record of this fascinating two years' experience, must always remain a production of great interest and considerable psychological value. Some years before Thoreau took to Walden woods he made the chief friendship of his life, that with Emerson. He became one of the famous circle of the transcendentalists, always keenly preserving his own individuality amongst such more or less potent natures as Emerson, Hawthorne and Margaret Fuller. From Emerson he gained more than from any man, alive or dead; and, though the older philosopher both enjoyed and learned from the association with the younger, it cannot be said that the gain was equal. There was nothing electrical in Thoreau's intercourse with his fellow men; he gave off no spiritual sparks. He absorbed intensely, but when called upon to illuminate in turn was found wanting. It is with a sense of relief that we read of his having really been stirred into active enthusiasm anent the wrongs done the ill-fated John Brown. With children he was affectionate and gentle, with old people and strangers considerate. In a word, he loved his kind as animals, but did not seem to find them as interesting as those furred and feathered. In 1847 Thoreau left Walden Lake abruptly, and for a time occupied himself with lead-pencil making, the parental trade. He never married, thus further fulfilling his policy of what one of his essayist-biographers has termed "indulgence in fine renouncements." At the comparatively early age of forty-five he died, on the 6th of May 1862. His grave is in the Sleepy Hollow cemetery at Concord, beside those of Hawthorne and Emerson.

Thoreau's fame will rest on *Walden; or, Life in the Woods* (Boston, 1854) and the *Excursions* (Boston, 1863), though he wrote nothing which is not deserving of notice. Up till his thirtieth year he dabbled in verse, but he had little ear for metrical music, and he lacked the spiritual impulsiveness of the true poet. His weakness as a philosopher is his tendency to base the laws of the universe on the experience-born, thought-produced convictions of one man—himself. His weakness as a writer is the too frequent striving after antithesis and paradox. If he had had all his own originality without the itch of appearing original, he would have made his fascination irresistible. As it is, Thoreau holds a unique place. He was a naturalist, but absolutely devoid of the pedantry of science; a keen observer, but no retailer of disjointed facts. He thus holds sway over two domains: he had the adherence of the lovers of fact and of the children of fancy. He must always be read, whether lovingly or interestedly, for he has all the variable charm, the strange saturninity, the contradictions, austerities and delightful surprises, of Nature herself.

After Thoreau's death were also published: *The Maine Woods* (Boston, 1863); *Cape Cod* (Boston, 1865); *A Yankee in Canada* (Boston, 1866). In the *Atlantic Monthly*, in 1862, appeared "Walking," "Autumn Tints" and "Wild Apples"; in 1863, "Night and

Moonlight." The standard editions of his works are *The Writings of Henry David Thoreau*, Riverside edition (11 vols., Boston, 1894–1895), and Manuscript edition (12 vols., ibid., 1907).

See also W. E. Channing, *Thoreau: The Poet Naturalist* (Boston, 1873); R. W. Emerson, an introductory note to *Excursions* (Boston, 1863); F. B. Sanborn, *Henry David Thoreau* (Boston, 1882), in the "American Men of Letters Series"; H. S. Salt, *Life of Henry David Thoreau* (London, 1890); *Some Unpublished Letters of H. D. and Sophia E. Thoreau* (Jamaica, New York, 1890); J. Russell Lowell, *My Study Windows*; R. L. Stevenson, *Familiar Studies in Men and Books*; and F. H. Allen, *Bibliography of H. D. Thoreau* (Boston, 1908). (W. Sh.)

THORFINN KARLSEFNI, or Karlsefne (*fl.* 1002–1007), Scandinavian explorer, leader of the chief medieval expedition for American colonization. Thorfinn belonged to a leading Icelandic family and had great success in trading voyages. In 1002 he came to Greenland, married Gudrid, widow of Red Eric's son Thorstein, and put himself at the head of a great expedition now undertaken from Ericsfiord for the further exploration and settlement of the western Vinland (south Nova Scotia?) lately discovered by Leif Ericsson (*q.v.*). Three vessels took part in the venture, with 160 men and some women, including Gudrid, and Freydis, a natural daughter of Red Eric. They first sailed north-west to the Vesterbygd or "Western Settlement" of Greenland, thence to Bear Island, and thence away to the south till they reached a country they named *Helluland* (some part of Labrador?) from its great flat slabs of stone (*hellur*). Two days' sail farther southward brought them to a thickly-wooded land they called *Markland* (*i.e.* Woodland, our Newfoundland?). Two days after this they sighted land to the right hand, and came to a cape, where they found the keel of a ship—perhaps a relic of some earlier, possibly Scandinavian explorer—and which they called therefore *Kialames* (Keelness; Cape Breton, or some adjacent point?); the long bleak sandy shores of this coast they called the *Wonderstrands* (on the east coast of Cape Breton Island?). After passing the *Wonderstrands* and reaching a coast indented with bays, Thorfinn put two fleet Gael runners ashore, with orders to explore southwards (see Leif Ericsson): they returned with grapes and wild wheat, proofs that the Northmen were not far from Vinland. The fleet now stood in to a bay called by the explorers *Streamfiord* or Firth of Currents, and wintered there (1003–1004), suffering some privations, and apparently getting no more news of the fruitful country desired. Thorfinn's son Snorri was born this first autumn in the new world. Next spring nine of the party, headed by the chief malcontent Thorhall, Red Eric's huntsman, sailed off northward, intending to come to Vinland by rounding Keelness and thence working round west (and south). Adverse weather drove them to Ireland, where they were enslaved. Meanwhile Thorfinn, with the rest of the venturers, sailed south "for a long time," till they reached a spot they called *Hop*, at the mouth of a river which flows from a lake into the sea (several estuaries near the southern extremity of Nova Scotia would do equally well here). Here they found the "self-sown" wheatfields and vines of Leif's Vinland, and here accordingly they settled and built their huts above the lake (1004–1005). After a fortnight natives, swarthy and ill-looking, with ugly hair, great eyes and broad cheeks (Beothuk or Micmac Indians?) appeared with many skin canoes; in the spring following these *Skraelings* came back and bartered with their visitors. Terrified by a bull belonging to the latter they fled, and after three weeks returned to fight. They were beaten off, but the Northmen narrowly escaped destruction, and two of their number (one a leading settler) were slain. The colony at Hop was therefore abandoned and the whole force returned to Streamfiord. Thence Thorfinn revisited Hop, staying two months; and also made a voyage northward in search of Thorhall, rounding Keelness and sailing westward (along the north coast of Cape Breton Island?), and apparently southward also, till they came to the mouth of a river flowing from east to west. Here Thorvald Ericsson was killed by a (Skraeling?) arrow, and the expedition came back to Streamfiord where they passed the next winter (1005–1006). Internal dissensions now broke out, mainly about the women of the colony, and in the next summer (1006) the entire project of Vinland settlement was abandoned and the fleet sailed to Markland. Two Skraeling children were captured here and the expedition divided, Thorfinn making Greenland and Ericsfiord in safety with his own vessel, while the other was lost in the Irish Sea, only half the crew escaping to Ireland in the ship's boat.

It may be noticed that the *Flatey Book* narrative gives a somewhat different but much slighter account of Thorfinn's expedition, making both Thorvald Ericsson and Freydis undertake separate Vinland ventures—one before, the other after, Karlsefni's enterprise—Thorvald being killed on his (as in *Red Eric Saga*, but with divergent details), and Freydis on her committing atrocities upon her comrades, the Icelanders Helgi and Finnbogi, which are unnoticed in *Red Eric*. The latter, however, in its mention of the domestic broils which arose over the women of the colony in its third winter, points to something which may have been the germ of the highly elaborated Freydis story in *Flatey*.

On *Flatey Book*, *Red Eric Saga* and the whole bibliography for the Vinland voyages, including that of Thorfinn, see Leif Ericsson and Vinland. The six Vinland voyages of *Flatey*, we may repeat, *Red Eric* reduces to three, wholly omitting the alleged voyage of Biarni Heriulfsson, and grouping those of Thorvald Ericsson and Freydis with Thorfinn Karlsefni's in one great colonizing venture. (C. R. B.)

THORIANITE, a rare mineral, discovered by W. D. Holland, and found in the gem-gravels of Ceylon, where it occurs as small, heavy, black, cubic crystals, usually much water-worn. It was so named by W. R. Dunstan, on account of its high percentage of thorium (about 70% ThO_2); it also contains the oxides of uranium, lanthanum, cerium and didymium. Helium is present, and the mineral is slightly less radio-active than pitchblende. It has been examined for new elements. Miss Evans (*Journ. Chem. Soc.*, 1908, 93, p. 666) obtained what is possibly a new element, whilst M. Ogawa (*Journ. Coll. Sci. Tokyo*, 1908, vol. 25) found indications of three new species: one which he called *nipponium*, with an equivalent weight of about 50 and atomic weight 100; the second with an equivalent of about 16·7; whilst the third yielded a radio-active oxide.

THORITE, a rare mineral consisting of thorium silicate, crystallizing in the tetragonal system and isomorphous with zircon. The theoretical formula, $ThSiO_4$, requires 81·5% of thoria, but analyses show only 50–70%, there being also some uranium, cerium, &c. The mineral is almost always altered by hydration and is then optically isotropic and amorphous. Owing to differences in composition and to alteration, the specific gravity varies from 4·4 to 5·4. The colour is usually light brown, but in the variety known as "orangite" it is orange-yellow. The mineral occurs as isolated crystals and small masses in the augite-syenite near Brevik in South Norway; also at Arendal, and in the gem-gravels of Ceylon. If found in larger amount it would be an important source of thoria for incandescent gas mantles. (L. J. S.)

THORIUM (symbol Th, atomic weight 232·42 [O=16]), a metallic chemical element. It belongs to the group of metals whose oxides are generally denominated "rare earths," and its history is bound up in the history of the group, which is especially interesting from the fact that it supplies the material for the manufacture of the mantles used in incandescent gas-lighting, and also that the radio-active substances are almost invariably associated with these oxides. The name *thoria* (after the Scandinavian god Thor) was first given in 1815 by Berzelius to a supposed new earth which he had extracted from several rare Swedish minerals. This "new earth" turned out to be nothing more nor less than a basis yttrium phosphate. In 1828 he gave the name thoria to an earth which he extracted from a mineral found at Lëvön. This mineral is the modern thorite. Thorium has proved to be very widely, although extremely sparingly, distributed: pyrochlor, orangite, monazite, euxenite, gadolonite, orthite, and in fact most of the rare minerals of this type contain it (see B. Szilard, *Le Radium*, 1909, 6, p. 233). The extraction of thorium salts from these minerals is a matter of much tedium. Metallic thorium is obtained by heating potassium thorium chloride or the tetrachloride with sodium (see W. von Bolton, R. J. Meyer and H. Karstens, *Journ. Chem. Soc.*, 1909, vol. 96). It forms microscopic hexagonal plates having a silver-white streak. It is very heavy, its density being about 11; it inflames when heated in air and is not attacked by alkalis; it readily dissolves in nitric acid and aqua regia, but with difficulty in hydrochloric acid.

In its salts, thorium is tetravalent, and in the periodic classification it occurs in the same sub-group as titanium, cerium and zirconium.

Thorium dioxide or *thoria*, ThO_2, is the most important compound, being manufactured commercially in comparatively large quantities from monazite sands, with a view to its utilization for gas mantles (see LIGHTING, GAS). It is an amorphous white powder; but it may also be obtained in crystals isomorphous with cassiterite by heating the amorphous form with borax to a very high temperature. An oxide Th_2O_5 is formed by heating the oxalate.

Thorium fluoride, ThF_4, is obtained as a heavy white insoluble powder by dissolving the hydrate in hydrofluoric acid and evaporating. By precipitating a thorium salt with a fluoride, a gelatinous hydrate, $ThF_4 \cdot 4H_2O$, is obtained. Acid potassium fluoride precipitates $K_2ThF_6 \cdot 4ThF_4 \cdot H_2O$ from a solution of thorium chloride. Potassium thorofluoride, $K_2ThF_6 \cdot 4H_2O$, is a heavy black powder formed by boiling the hydroxide with potassium fluoride and hydrofluoric acid. *Thorium chloride*, $ThCl_4$, is obtained as white shining crystals by heating a mixture of carbon and thoria in a current of chlorine. Baskerville (*Journ. Amer. Chem. Soc.*, 1904, 26, p. 922) divided the product into three fractions according to their volatility. He concluded that the first contained the chloride of *berzelium*, having an atomic weight of 212, the second contained thorium chloride, and the third the chloride of *carolinium*, having an atomic weight of 255·6. E. Chauvenet (*Compt. rend.*, 1908, 147, p. 1046) obtains it by heating thoria in a current of carbonyl chloride. Thorium chloride readily deliquesces on exposure and forms double salts with alkaline chlorides.

Thorium sulphate, $Th(SO_4)_2$, is obtained by dissolving the oxide in sulphuric acid. It forms several crystalline hydrates. Evaporation of a solution at ordinary temperatures gives colourless monoclinic prisms of $Th(SO_4)_2 \cdot 9H_2O$, which is isomorphous with uranium sulphate, $U(SO_4)_2 \cdot 9H_2O$. Above 43° $Th(SO_4)_2 \cdot 4H_2O$ is deposited. B. Roozeboom (*Zeit. phys. Chem.*, 1890, 5, p. 198) has described several other hydrates. Thorium sulphate forms double salts with the alkaline sulphates. *Thorium nitrate*, $Th(NO_3)_4 \cdot 12H_2O$, forms white deliquescent tables very soluble in water. It forms double salts such as $MgTh(NO_3)_6 \cdot 8H_2O$, which are isomorphous with the corresponding cerium compounds. *Thorium sulphide*, ThS_2, is obtained by burning the metal in sulphur. It cannot be produced by precipitation.

The atomic weight has been variously given. Berzelius found 235·5; Delafontaine, 229·7; Cleve, 232·6 by analyses of the sulphate, and 232·2 by analyses of the oxalate. Krüss and Nilson derived the value 230·7 ($H=1$) from analyses of the carefully purified sulphate.

For the so-called "disintegration of the thorium atom" and the relation of this element to the general subject of radio-active emanations, see RADIO-ACTIVITY.

A number of salts of thorium have been prepared for therapeutic use, including the hydroxide, nitrate, salicylate, oleate and lactate. The oleate has been used in chronic eczema and psoriasis and locally in cancer. Inhalations of thorium emanations produced from thorium nitrate through a wash-bottle inhaler are said to have a bactericidal action in diseases of the lungs. F. Soddy has used them in phthisis, and Louisa Chesney speaks favourably of the emanations in chronic and acute laryngitis and in tuberculous laryngeal ulcerations.

THORN (Polish *Torun*), a fortress town of Germany, in the Prussian province of West Prussia, situated on the right bank of the Vistula, near the point where the river enters Prussian territory, 85 m. by rail N.E. of Posen, 92 m. S. of Danzig and 12 m. from the Russian frontier at Alexandrovo. Pop. (1895), 30,314; (1906), 43,435. Its position as a bridge head commanding the passage of the Vistula makes it a point of strategic importance; it was strongly fortified in 1818, and in 1878 was converted into a fortress of the first class. The defensive works consist of a circle of outlying forts, about 2½ m. from the centre of the town—eight on the right and five on the left bank of the river. The "old town," founded in 1231, and the "new town," founded thirty-three years later, were united in 1454, and both retain a number of quaint buildings dating from the 15th and 16th centuries, when Thorn was a flourishing member of the Hanseatic League. The town-hall of the 14th and 16th centuries, the churches of St John of the Virgin, and of St James (all of the 13th–14th centuries), the ruined castle of the Teutonic order (a tower, the so-called "Dansker"), and a leaning tower, the sole remnant of the old environing walls, are among the most interesting of the ancient edifices. Among modern buildings may be mentioned the Artushof, containing concert and assembly halls, the new garrison church (1897), and the monument erected in 1853 to Copernicus, who was a native of Thorn. The ancient wooden bridge, now burned down, at one time the only permanent bridge across the lower Vistula, has been succeeded by a massive iron railway viaduct, 3300 ft. long. Thorn carries on an active trade in grain, timber, wine, groceries and minerals, and has ironworks, saw-mills, and various other manufactures. It is famous for its *Pfefferkuchen*, a kind of gingerbread. Part of the trade is carried on by passenger and cargo vessels on the Vistula, which ply as far as Warsaw.

Thorn, founded in 1231 by the Teutonic order as an outpost against the Poles, was colonized mainly from Westphalia. The first peace of Thorn, between the order and the Poles, was concluded in 1411. In 1454 the townspeople revolted from the knights of the order, destroyed their castle, and attached themselves to the king of Poland. This resulted in a war, which was terminated in 1466 by the second peace of Thorn. In the 15th and 16th centuries Thorn was a Hanse town of importance, and received the titles of "Queen of the Vistula" and "the beautiful." It embraced the Reformation in 1557, and in 1645 it was the scene of a *colloquium charitativum*, or discussion betwixt the doctors of the rival creeds, which, however, resulted in no agreement. In 1724 a riot between the Protestant and Roman Catholic inhabitants was seized upon by the Polish king as a pretext for beheading the burgomaster and nine other leading Protestant citizens, an act of oppression which is known as the "blood-bath of Thorn." The second partition of Poland (1793) conferred Thorn upon Prussia; by the treaty of Tilsit it was assigned to the duchy of Warsaw; but since the congress of Vienna (1815) it has again been Prussian.

See Wernicke, *Geschichte Thorns* (Thorn, 1839–1842); Hoburg, *Die Belagerungen der Stadt und Festung Thorn* (Thorn, 1850); and Steinbrecht, *Die Baukunst des deutschen Ritterordens in Preussen* (1st part, Berlin, 1884); Uebrick, *Thorn* (Danzig, 1903).

THORN (O. Eng. *þorn*, cf. Du. *doorn*, Ger. *Dorn*, &c), in botany, a hard pointed structure, also termed a "spine," generally representing a small branch, as in hawthorn, where a normal branch arising in the axil of a leaf is replaced by a sharply pointed thorn; accessory buds on each side of the thorn and developed in the same leaf-axil will grow in the next season into ordinary branches. The similarly developed thorns of the honey-locust (*Gleditschia*) are branched. In other cases, as the sloe or the wild pear, branches become spiny at the apex tapering into a stiff leafless point. On a cultivated tree these branches disappear owing to their more vigorous growth. Leaves may be modified into spines, as in barberry, the leaves of which show every gradation between a leaf with a spiny-toothed edge and those which have been reduced to simple or multiple spines. In some species of *Astragalus* the petiole of the pinnately compound leaf persists after the fall of the leaflets as a sharp spine. In the false acacia (*Robinia*) the stipules are represented by spines.

The reduction of the leaf-surface, of which the spinous habit is often an expression, is associated with growth in dry or exposed windy places. Thus, in the gorse, a characteristic plant of exposed localities such as open commons, the smaller branches, instead of being leaf-bearing shoots, are reduced to slender green spines, while the leaves on the main shoots are also more or less spinous in character. As the giving off of water from its surface is one of the chief functions of a leaf, this process is thus reduced to a minimum in situations where water is scarce or would be liable to be given off too rapidly. An extreme case is afforded by the cacti and cactus-like euphorbias, which are a characteristic type of desert vegetation where water is extremely scarce. The whole plant is reduced to a simple or branching succulent, leafless, columnar or flattened stem, the branches of which are represented by small clusters of thorns. Incidentally the thorns protect the plant which bears them from the attacks of animals seeking food.

Prickles are structures of less importance from the morphological point of view, being mere superficial outgrowths which may occur anywhere on stem or leaf, or even fruit.

THORNABY-ON-TEES, a municipal borough in the North Riding of Yorkshire, England, 3 m. S.W. of Middlesbrough, on the North-Eastern railway. Pop. (1901), 16,054. It lies opposite Stockton-on-Tees, with which it is connected by a bridge, on the river Tees. There are blast furnaces, iron foundries, engineering works, iron ship-building yards, extensive saw-mills, flour-mills and a manufactory of "blue and white" pottery. The town was formerly known as South Stockton, and is still included in the parliamentary borough of Stockton (it is within the Cleveland division of the county), but was incorporated as a separate municipal borough in 1892. It is under a mayor, 6 aldermen and 18 councillors. Area, 1927 acres.

THORNE, a market town in the Doncaster parliamentary division of the West Riding of Yorkshire, 10 m. N.E. of Doncaster by the North-Eastern railway, served also by a branch of the Great Central railway. Pop. (1901), 3818. It lies near the river Don, in a low, flat district, which was formerly a marshy waste, resembling the fens of the eastern counties. Hatfield Chase, a portion of this tract south of Thorne, was partly drained by the Dutch engineer Vermuyden in the 17th century, and there were in the district numerous Dutch settlers. The Chase is generally considered to have been the scene of the battle of Heathfield in 633, when King Edwin of Northumbria fell before the heathen King Penda of Mercia. The Levels, as this district is generally named, are of remarkable fertility, and Thorne, having water communication with Goole and the Humber, is consequently an agricultural centre of importance; while some barge-building and a trade in peat fibre are also carried on. The church of St Nicholas is a fine building of various periods from the 12th century.

THORNHILL, SIR JAMES (1676–1734), English historical painter, was born at Melcombe Regis, Dorset, in 1676, of an ancient but impoverished county family. His father died while he was young, but he was befriended by his maternal uncle, the celebrated Dr Sydenham, and apprenticed to Thomas Highmore, serjeant-painter to King William III., a connexion of the Thornhill family. Little is known regarding his early career. About 1715 he visited Holland, Flanders and France; and, having obtained the patronage of Queen Anne, he was in 1719–1720 appointed her serjeant-painter in succession to Highmore, and was ordered to decorate the interior of the dome of St Paul's with a series of eight designs, in chiaroscuro heightened with gold, illustrative of the life of that apostle—a commission for which Louis Laguerre had previously been selected by the commissioners for the repair of the cathedral. He also designed and decorated the saloon and hall of Moor Park, Herts, and painted the great hall at Blenheim, the princesses' apartments at Hampton Court, the hall and staircase of the South Sea Company, the chapel at Wimpole, the staircase at Easton-Neston, Northamptonshire, and the hall at Greenwich Hospital, usually considered his most important and successful work, upon which he was engaged from 1708 to 1727. Among his easel pictures are the altar-pieces of All Souls and Queen's College chapels, Oxford, and that in Melcombe Regis church; and he executed such portrait subjects as that of Sir Isaac Newton, in Trinity College, Cambridge, and the picture of the House of Commons in 1730, in the possession of the earl of Hardwicke, in which he was assisted by Hogarth, who married Jane, his only daughter. He also produced a few etchings in a slight and sketchy but effective manner, and executed careful full-size copies of Raphael's cartoons, which now belong to the Royal Academy. About 1724 he drew up a proposal for the establishment of a royal academy of the arts, and his scheme had the support of the lord treasurer Halifax, but government declined to furnish the needful funds. Thornhill then opened a drawing-school in his own house in James Street, Covent Garden, where instruction continued to be given till the time of his death. He acquired a considerable fortune by his art, and was enabled to repurchase his family estate of Thornhill, Dorsetshire. In 1715 he was knighted by George I., and in 1719 he represented Melcombe Regis in parliament, a borough for which Sir Christopher Wren had previously been member. Having been removed from his office by some court intrigue, and suffering from broken health and repeated attacks of gout, he retired to his country seat, where he died on the 4th of May 1734. His son James, also an artist, succeeded his father as serjeant-painter to George II. and was appointed "painter to the navy."

The high contemporary estimate of Sir James Thornhill's works has not since been confirmed; in spite of Dr Young, "late times" do *not*

"Understand
How Raphael's pencil lives in Thornhill's hands."

He is weak in drawing—indeed, when dealing with complicated figures he was assisted by Thomas Gibson; and, ignorant of the great monumental art of Italy, he formed himself upon the lower model of Le Brun.

THORNHILL, an urban district in the Morley parliamentary division of the West Riding of Yorkshire, England, 2 m. S. of Dewsbury, on the Great Northern, Lancashire & Yorkshire, and London & North-Western railways. Pop. (1901), 10,290. The church of St Michael has a modern nave, but the chancel with aisles are of good Decorated work, and the tower is Perpendicular. There are interesting monuments of the ancient family of Savile, the site of whose mansion, Thornhill Hall, may be traced near the church. The east window of the church contains fine fragments of stained glass of the 15th century. The large industrial population is employed in the woollen mills and manufactures of shoddy, carpets, &c., which are numerous in this locality.

THORNHILL, a village of the parish of Morton, Nithsdale, Dumfriesshire, Scotland, 14 m. N.N.W. of Dumfries by the Glasgow & South-Western railway. Pop. (1901), 1132. It is beautifully situated in the midst of tree-clad hills and watered by the bountiful Nith and such streams as the Carron, Cample and Crichope. Morton parish church lies in the village, and among other buildings are the library and the natural history museum, in the grounds of which there is a statue of Richard Cameron, the covenanter (1680). The weekly sales of livestock are important, and an agricultural show is held every September. Three miles N.N.W. stands Drumlanrig Castle, a seat of the duke of Buccleuch. It is built of red sandstone in the form of a hollow square, and has 145 ft. of outer walls, which are surmounted with turrets, and capped and spired at the angles. The castle was begun in 1679 and finished in 1689, and cost the first duke of Queensberry an immense sum. He is believed to have spent but a single night under its roof. The fourth duke of Queensberry, Old "Q.," incurred the wrath of Robert Burns and Wordsworth by his wanton destruction of the magnificent woods. On the death of "Old Q." without issue in 1810, Henry, third duke of Buccleuch, succeeded to the dukedom of Queensberry, and the property has since been adequately cared for. Trees, planted on the most extensive scale, have repaired the ravages of the former owner; the gardens have been laid out with exquisite taste; and the vast policy, intersected by the Nith, is one of the finest parks in Scotland. The ruins of Tibber's Castle, dismantled in 1311 by Robert Bruce, stand in the grounds, about 1 m. from the ducal mansion. Two miles and a half N.N.E. of Thornhill is found another ruined fortress, that of Morton Castle, interesting as the residence of Thomas Randolph, earl of Moray, regent during the early years of the minority of David II., and as belonging afterwards to a branch of the Douglases, who derived from it the title of earl. About 3 m. south-east of Thornhill stands the ruined castle of Closeburn, once a stronghold of the Kirkpatricks. It was Sir Roger of that ilk who helped "mak sikker" the death of John, "Red" Comyn, of Badenoch (1306). In Closeburn parish (pop. 1275) occur cairns, tumuli and a stone circle, besides Roman and prehistoric remains. Two mineral wells give the place the promise of some degree of popular favour, likely to be enhanced by the romantic beauty of its surroundings.

THORNTON, HENRY (1760–1815), English banker and economist, was born on the 10th of March 1760. In 1784 he became a member of the banking firm of Downie, Free & Thornton, with which he was associated till his death on the 16th of January 1815. In 1783 he was elected member of parliament for Southwark, a constituency which he represented for the rest of his life. Although an indifferent speaker, he soon acquired a high reputation as an authority on financial matters. This reputation he confirmed by *An Inquiry into the Nature and Effects of the Paper Currency of England* (1802), defending the legislature in suspending cash payments. He strongly supported the income tax on its original imposition in 1798, but was in favour of a graduated system, and indeed paid his own income tax "on the scale of his ideal, not his legal debt." He was one of the founders of the Sierra Leone Company (see SIERRA LEONE) and its chairman until the colony was taken over by the English government.

THORNTON, WILLIAM THOMAS (1813–1880), English economist, was born at Burnham, Buckinghamshire, on the 14th of February 1813. In 1836 he obtained a clerkship in the London house of the East India Company. In 1858 he became secretary for public works in the India office, a post which he held till his death. He was created a C.B. in 1873. His works include *Over-population and its Remedy* (1846), in which he put forward a plan for colonizing Irish wastes by Irish peasants; *A Plea for Peasant Proprietors* (1848), in which his views were developed in greater detail; *On Labour* (1869); and *Old-fashioned Ethics and Commonsense Metaphysics*, a volume of essays, published in 1873.

THORNYCROFT, WILLIAM HAMO (1850–), British sculptor. A pupil of his father, Thomas Thornycroft, and of the Royal Academy schools, he was still a student when he was called upon to assist his father in carrying out the important fountain in Park Lane, London. He accordingly returned in 1871 to England from Italy, where he was studying, and modelled the figures of Shakespeare, Fame and Clio, which were rendered in marble and in bronze. In the following year he exhibited at the Royal Academy "Professor Sharpley," in marble, for the memorial in University College; and "Mrs Mordant," a relief—a form of art to which he has since devoted much attention. The "Fame," already mentioned, was shown in 1873. Believing that the pendulum had overshot its swing from conventional classicality towards pictorial realism, he turned from the "fleshy" school towards the Greek, while realizing the artistic necessity for modern feeling. In 1875 his "Warrior Bearing a Wounded Youth from the Field of Battle" gained the gold medal at the Royal Academy schools, and when exhibited in 1876 it divided public attention with the "Tennyson" of Woolner and "Wellington monument" sculptures of Alfred Stevens, now in St Paul's Cathedral. Then followed the dramatic "Lot's Wife," in marble (1878), and "Artemis" (1880), which for grace, elegance and purity of taste the sculptor never surpassed. He was thereupon elected an associate of the Royal Academy, and more than justified the selection by his "Teucer" of the following year, a bronze figure of extraordinary distinction which, bought for the Chantrey collection, is now in the National (Tate) Gallery of British Art. It is simple and severe, classic yet instinct with life and noble in form; and in it he touched the high-water mark of his career. Turning to the ideal, in works entirely modern in motive and treatment, Hamo Thornycroft produced "The Mower" (1884) and "A Sower" (1886); the "Stanley Memorial" in the old church at Holyhead partakes of the same character. Among the sculptor's principal statues are "The Bishop of Carlisle" (1895; Carlisle Cathedral), "General Charles Gordon" (Trafalgar Square, London), "Oliver Cromwell" (Westminster), "Dean Colet" (a bronze group—early Italianate in feeling—outside St Paul's School, Hammersmith), "King Alfred" (a colossal memorial for Winchester), the "Gladstone Monument" (in the Strand, London) and "Dr Mandell Creighton, Bishop of London" (bronze, erected in St Paul's Cathedral). Mr Thornycroft's other memorials, such as the "Queen Victoria Memorial" (Karachi), the "War Memorial" (at Durban) and the "Armstrong Memorial" (at Newcastle), are well known, and his portrait statuary and medallions are numerous. He was elected a full academician in 1888, and an honorary member of the Royal Academy of Munich. He was awarded a medal of honour at the Paris Exhibition, 1900.

See M. H. Spielmann, *British Sculpture and Sculptors of To-day* (London, 1901). (M. H. S.)

THÓRODDSEN, JÓN ÞOR ÐARSON (1819–1868), Icelandic poet and novelist, was born in 1819 at Reykhólar in western Iceland. He studied law at the university of Copenhagen, entered the Danish army as volunteer in 1848 in the war against the insurgents of Schleswig and Holstein, who were aided by Prussia and the other German States. He went back to Iceland in 1850, became sheriff (*sýslumaður*) of Barðastrandarsýsla, and later in Borgarfjarðarsýsla, where he died in 1868. He is the first novel writer of Iceland. Jónas Hallgrímsson had led the way by his short stories, but the earliest veritable Icelandic novel was Jón Thóroddsen's *Piltur og stúlka* ("Lad and Lass"), a charming picture of Icelandic country life. Still better is *Maður og kona* ("Man and Wife"), published after his death by the Icelandic Literary Society. He had a great fund of delicate humour, and his novels are so essentially Icelandic in their character, and so true in their descriptions, that he is justly considered by most of his countrymen not only as the father of the Icelandic novel, but as the best novelist Iceland has produced. His poems, mostly satirical, are deservedly popular; he follows Jónas Hallgrímsson closely in his style, although he cannot reach him in lyrical genius. (S. BL.)

THOROTON, ROBERT (1623–1678), English antiquary, belonged to an old Nottinghamshire family, which took its name from Thoroton, near Newark. He resided mainly at another village in the same neighbourhood, Car Colston, where he practised as a physician and where he lived the life of a country gentleman. He took very little part in the Civil War, although his sympathies were with the royalists, but as a magistrate he was very active in taking proceedings against the Quakers. In 1667 Thoroton, aided by a band of helpers, began to work upon his elaborate *Antiquities of Nottinghamshire*. This was published in London in 1677; it was dedicated to Gilbert Sheldon, archbishop of Canterbury, and was illustrated by engravings by W. Hollar.

In 1797 a new edition of the *Antiquities* was published by John Throsby (1740–1803), who added an additional volume. In 1897 the Thoroton Society was founded in honour of the antiquarian, its object being to promote the study of the history and antiquities of Nottinghamshire. Under its auspices annual volumes of *Transactions* and several volumes of *Records* have been published and much valuable work has been done. A brass tablet to the memory of Thoroton has been placed in Car Colston church. See J. T. Godfrey, *Robert Thoroton, Physician and Antiquary* (1890).

THORPE, BENJAMIN (1782–1870), English Anglo-Saxon scholar, was born in 1782. After studying for four years at Copenhagen University, under the Danish philologist Rasmus Christian Rask, he returned to England in 1830, and in 1832 published an English version of Cædmon's metrical paraphrase of portions of the Holy Scriptures, which at once established his reputation as an Anglo-Saxon scholar. In 1834 he published *Analecta Anglo-Saxonica*, which was for many years the standard textbook of Anglo-Saxon in English, but his best-known work is a *Northern Mythology* in three volumes (1851). His was the first complete good translation of the elder *Edda* (1866). His other works include *Ancient Laws and Institutes of England* (1840), an English translation of the laws enacted under the Anglo-Saxon kings; *The Holy Gospels in Anglo-Saxon* (1842); *Codex Exoniensis* (1842), a collection of Anglo-Saxon poetry with English translation; an English translation of Dr Lappenburg's *History of England under the Anglo-Saxon Kings* (1845); *Anglo-Saxon Poems of Beowulf* (1855), a translation; an edition for the "Rolls" series of the *Anglo-Saxon Chronicle* (1861); and *Diplomatarium Anglicum aevi saxonici* (1865), a collection of early English charters. Thorpe died at Chiswick on the 19th of July 1870. The value of his work was recognized by the grant to him, in 1835, of a civil list pension.

THORPE [or Thorp], **JOHN** (*fl.* 1570–1618), English architect. Little is known of his life, and his work is dubiously inferred, rather than accurately known, from a folio of drawings in the Soane Museum, to which Horace Walpole called attention, in 1780, in his *Anecdotes of Painting*; but how far these were his own is uncertain. He was engaged on a number of important English houses of his time, and several, such as Longleat, have been attributed to him on grounds which cannot be sustained. He was probably the designer of Kirby Hall, Northamptonshire; the original Longford Castle, Wiltshire; and the original Holland House, Kensington; and he is said to have been engaged on Rushton Hall, Northamptonshire, and Audley End, Essex (with Bernard Janssens).

See J. A. Gotch, *Architecture of the Renaissance in England* (1891–1894).

THORWALDSEN, BERTEL (1770–1844), Danish sculptor, the son of an Icelander who had settled in Denmark, and there carried on the trade of a wood-carver, was born in Copenhagen on the 19th of November 1770. While very young he learnt to assist his father; at the age of eleven he entered the Copenhagen school of art, and soon began to show his exceptional talents. In 1792 he won the highest prize, the travelling studentship, and in 1796 he started for Italy in a Danish man-of-war. On the 8th of March 1797 he arrived in Rome, where Canova was at the height of his popularity. Thorwaldsen's first success was the model for a statue of Jason, which was highly praised by Canova, and he received the commission to execute it in marble from Thomas Hope, a wealthy English art-patron. From that time Thorwaldsen's success was assured, and he did not leave Italy for twenty-three years. In 1819 he returned to Denmark, where he was commissioned to make the colossal series of statues of Christ and the twelve apostles which are now in the Fruenkirche in Copenhagen. These were executed after his return to Rome, and were not completed till 1838, when Thorwaldsen again returned to Denmark. He died suddenly in the Copenhagen theatre on the 24th of March 1844 and bequeathed a great part of his fortune for the building and endowment of a museum in Copenhagen, and also left to fill it all his collection of works of art and the models for all his sculpture—a very large collection, exhibited to the greatest possible advantage. Thorwaldsen is buried in the courtyard of this museum, under a bed of roses, by his own special wish.

On the whole Thorwaldsen was the most successful of all the imitators of classical sculpture, and many of his statues of pagan deities are modelled with much of the antique feeling for breadth and purity of design. His attempts at Christian sculpture, such as the tomb of Pius VII. in St Peter's and the "Christ and Apostles" at Copenhagen, are less successful, and were not in accordance with the sculptor's real sympathies, which were purely classic. Thorwaldsen worked sometimes with feverish eagerness; at other times he was idle for many months together. A great number of his best works exist in private collections in England. His not very successful statue of Lord Byron, after being refused a place in Westminster Abbey, was finally deposited in the library of Trinity College, Cambridge. The most widely popular among Thorwaldsen's works have been some of his bas-reliefs, such as the "Night" and the "Morning," which he is said to have modelled in one day.

See Eugène Plon, *Thorwaldsen, sa vie*, &c. (Paris, 1880); Andersen, *B. Thorwaldsen* (Berlin, 1845); Killerup, *Thorwaldsen's Arbeiten*, &c. (Copenhagen, 1852); Thiele, *Thorwaldsen's Leben* (Leipzig, 1852–1856); C. A. Rosenberg, *Thorwaldsen . . . mit 146 Abbildungen* (1896; "Künstlermonographien," No. 16); S. Trier, *Thorvaldsen* (1903); A. Wilde, *Erindringer om Jerichau og Thorvaldsen* (1884).

THOTH, the Greek name of the Egyptian god of letters, invention and wisdom (*e.g.* Thowt, *Zḥwty*), the mouthpiece and recorder of the gods, and arbiter of their disputes. Thoth is found on the earliest monuments symbolized by an ibis (*Ibis aethiopica*, still not uncommon in Nubia), which bird was sacred to him. In the Pyramid texts Thoth is already closely associated with the Osiris myth, having aided the god by his science and knowledge of magic, and demonstrated the justice of his claims in the contest with Set. Thoth presided over writing, measuring and calculation, and is prominent in the scene of the weighing of the soul. He was often identified with the moon as a divider of time, and in this connexion, during the New Empire, the ape first appears as his sacred animal. Thoth was identified by the Greeks with Hermes, and Hermes Trismegistus (*q.v.*) is a late development of the Egyptian god. Geographically the worship of Thoth in Lower Egypt centred in the Hermopolite nome, contiguous to the Busirite and Mendesian nomes. This was the district anciently called *Zḥwt*, and the god's name *Zḥwty* means simply "him of *Zḥwt*." But Hermopolis Magna in Upper Egypt, now Eshmunain, was a city of greater political importance than Hermopolis in Lower Egypt.

See E. A. W. Budge, *The Gods of the Egyptians*; and specially Egypt: *Ancient*, § *Religion*. (F. Ll. G.)

THOU, JACQUES AUGUSTE DE [Thuanus] (1553–1617), French historian, was the grandson of Augustin de Thou, president of the parlement of Paris (d. 1544), younger son of Christophe de Thou, "first president" of the same parlement, who began to collect a number of books and notes for a history of France which he was never to write (d. 1582), and nephew of Nicolas de Thou, who was bishop of Chartres (1573–1598). In these family surroundings he imbibed a love of letters, a firm and orthodox, though enlightened and tolerant piety, and an attachment to the traditional power of the Crown. At the age of seventeen he began his studies in law, first at Orleans, later at Bourges, where he made the acquaintance of Hotman, and finally at Valence, where he had Cujas for his master and Scaliger as a friend. He was at first intended for the Church; he received the minor orders, and on the appointment of his uncle Nicolas to the episcopate succeeded him as a canon of Notre-Dame. But his tastes led him in a different direction; not content with a knowledge of books, he wished to know the world and men. During a period of ten years he seized every opportunity for profitable travel. In 1573 he accompanied Paul de Foix on an embassy, which enabled him to visit most of the Italian courts; he formed a friendship with Arnaud d'Ossat (afterwards bishop of Rennes and Bayeux and cardinal, d. 1604), who was secretary to the ambassador. In the following year he formed part of the brilliant *cortège* which brought King Henry III. back to France, after his flight from his Polish kingdom. He also visited several parts of France, and at Bordeaux met Montaigne. On the death, however, of his elder brother Jean (April 5, 1579), who was *maître des requêtes* to the parlement, his relations prevailed on him to leave the Church, and he entered the parlement and married (1588). In the same year he was appointed *conseiller d'état*. He served faithfully both the effeminate, bigoted and cruel Henry III. and Henry IV., a sceptic and given to love-intrigues, because they were both the representatives of legitimate authority. He succeeded his uncle Augustin as *président à mortier* (1595), and used his new authority in the interests of religious peace, negotiating, on the one hand, the Edict of Nantes with the Protestants, while in the name of the principals of the Gallican Church he opposed the recognition of the Council of Trent. This attitude exposed him to the animosity of the League party and of the Holy See, and to their persecution when the first edition of his history appeared. This history was the work of his whole life. In a letter of the 31st of March 1611 addressed to the president Jeannin, he himself describes his long labours in preparation of it. His materials for writing it were drawn from his rich library, which he established in the Rue des Poitevins in the year 1587, with the two brothers, Pierre and Jacques Dupuy, as librarians. His object was to produce a purely scientific and unbiassed work, and for this reason he wrote it in Latin, giving it as title *Historia sui temporis*. The first 18 books, embracing the period from 1545–1560, appeared in 1604 (1 vol. folio), and the work was at once attacked by those whom the author himself calls *les envieux et les factieux*. The second part, dealing with the first wars of religion (1560–1572), was put on the *Index librorum prohibitorum*

(Nov. 9, 1609). The third part (up to 1574), and the fourth (up to 1584), which appeared in 1607 and 1608, caused a similar outcry, in spite of de Thou's efforts to remain just and impartial. He carried his scruples to the point of forbidding any translation of his book into French, because in the process there might, to use his own words, "be committed great faults and errors against the intention of the author"; this, however, did not prevent the Jesuit Father Machault from accusing him of being "a false Catholic, and worse than an open heretic" (1614); de Thou, we may say, was a member of the third order of St Francis. As an answer to his detractors, he wrote his *Mémoires*, which are a useful complement to the *History of his own Times*. After the death of Henry IV., de Thou met with another disappointment; the queen-regent refused him the position of first president of the parlement, appointing him instead as a member of the *Conseil des finances* intended to take the place of Sully. This was to him a distinct downfall; he continued, however, to serve under Marie de Medicis, and took part in the negotiations of the treaties concluded at Ste Menehould (1614) and Loudun (1616). He died at Paris on the 7th of May 1617.

Three years after the death of de Thou, Pierre Dupuy and Nicolas Rigault brought out, with pt. v., the first complete edition of the *Historia sui temporis*, comprising 138 books; they appended to it the *Mémoires*, also given in Latin (1620). A hundred years later, an Englishman, Samuel Buckley, published a critical edition, the material for which had been collected in France itself by Thomas Carte (1733). De Thou was treated as a classic, an honour which he deserved. His history is a model of exact research, drawn from the best sources, and presented in a style both elegant and animated; unfortunately, even for the men of the Renaissance, Latin was a dead language; it was impossible for de Thou, for example, to find exact equivalents for technical terms of geography or of administration. As the reasons which had led de Thou to forbid the translation of his monumental history disappeared with his death, there soon arose a desire to make it accessible to a wider public. It was translated first into German. A Protestant pastor, G. Boule, who was afterwards converted to Catholicism, translated it into French, but could not find a publisher. The first translation printed was that of Pierre Du Ryer (1657), but it is mediocre and incomplete. In the following century the abbé Prévost, who was a conscientious collaborator with the Benedictines of Saint-Maur before he became the author of the more profane work *Manon Lescaut*, was in treaty with a Dutch publisher for a translation which was to consist of ten volumes; only the first volume appeared (1733). But competition, perhaps of an unfair character, sprang up. A group of translators, who had the good fortune of being able to avail themselves of Buckley's fine edition, succeeded in bringing out all at the same time a translation in sixteen volumes (De Thou, *Histoire universelle*, Fr. trans. by Le Beau, Le Mascrier, the Abbé Des Fontaines, 1734). As to the *Mémoires* they had already been translated by Le Petit and Des Ifs (1711); in this form they have been reprinted in the collections of Petitot, Michaud and Buchon. To de Thou we also owe certain other works: a treatise *De re accipitraria* (1784), a *Life*, in Latin, of Papyre Masson, some *Poemata sacra*, &c.

For his life may be consulted the recollections of him collected by the brothers Dupuy (*Thvana, sive Excerpta J. A. Thuani per ff. P. P.*, 1669; reprinted in the edition of 1733), and the biographies by J. A. M. Collinson (*The Life of Thuanus*, 1807), and Duntzer, (*De Thou's Leben*, 1837). Finally, see Henry Harrisse, *Le Président de Thou et ses descendants, leur célèbre bibliothèque, leurs armoiries et la traduction française de J.A. Thuani Historiarum sui Temporis* [*sic*] (1905). (C. B.*)

THOUARS, a town of western France, in the department of Deux-Sèvres, on the right bank of the Thouet, 24 m. S. by W. of Saumur on the railway to Bordeaux. Pop. (1906), 5321. A massive stronghold built in the first half of the 17th century by the La Trémoille family, and now used as a prison, stands on a rocky eminence overlooking the river, towards which it has a frontage of nearly 400 ft. The adjoining Sainte-Chapelle dating from the early years of the 16th century is in the Gothic style with Renaissance details, and was built by Gabrielle de Bourbon, wife of Louis II. of La Trémoille. The church of St Médard, rebuilt in the 15th century, preserves a doorway of a previous Romanesque building. That of St Laon (12th and 15th centuries) was formerly attached to an abbey, the buildings (17th century) of which serve as town-hall. It has a fine square tower in the Romanesque style and contains the sculptured tomb of the abbot Nicholas. Remains of the ramparts of the town dating from the 13th century and flanked by huge towers are still to be seen, and a bridge of the same period crosses the Thouet. The manufacture of furniture and wooden shoes, and the preparation of veterinary medicine and lime, are carried on. Wine, livestock and agricultural produce are the chief articles of trade.

Thouars, which probably existed in the Gallo-Roman period, became in the 9th century the seat of powerful viscounts, who in later times were zealous supporters of the English. In 1372 the latter were expelled from the town by Bertrand du Guesclin. In 1563 Charles IX. created Louis III., the head of the family of La Trémoille, duke of Thouars. In 1793 the Vendeans took the town by assault.

THOURET, JACQUES GUILLAUME (1746–1794), French revolutionist, was born at Pont l'Évêque. He was the son of a notary, and became an avocat at the parlement of Rouen. In 1789 he was elected deputy to the states-general by the third estate of Rouen, and in the Constituent Assembly his eloquence gained him great influence. Like so many lawyers of his time, he was violently opposed to the clergy, and strongly supported the secularization of church property. He also obtained the suppression of the religious orders and of all ecclesiastical privileges, and actively contributed to the change of the judiciary and administrative system. He was one of the promoters of the decree of 1790 by which France was divided into departments, and was four times president of the Constituent Assembly. After its dissolution he became president of the court of cassation. He was included in the proscription of the Girondists, whose political opinions he shared, and was executed in Paris. Besides his speeches and reports he wrote an *Abrégé des révolutions de l'ancien gouvernement français* and *Tableau chronologique de l'histoire ancienne et moderne.*

His brother, MICHEL AUGUSTIN THOURET (1748–1810), a physician, was a keen opponent of the ideas of Mesmer and a promoter of vaccination in France.

See F. Aulard, *Les Orateurs de l'assemblée constituante* (2nd ed., Paris, 1905); E. Carette and A. Sanson, *Thouret . . . sa vie, ses œuvres* (1890).

THOUSAND AND ONE NIGHTS. The *Thousand and One Nights*, commonly known in English as *The Arabian Nights' Entertainments*, is a collection of tales written in Arabic, which first became generally known in Europe in the early part of the 18th century through the French translation by Antoine Galland, and rapidly attained universal popularity. In the *Journal asiatique* for 1827, p. 253, von Hammer (J. von Hammer-Purgstall) drew attention to a passage in the *Golden Meadows* of Mas'ūdī (ed. Barbier de Meynard, iv. 89 seq.), written in A.D. 943, in which certain stories current among the old Arabs are compared with "the books which have reached us in translations from Persian, Indian and Greek, such as the book of *Hezār Afsāne*, a title which, translated from Persian into Arabic, means 'the thousand tales.' This book is popularly called The *Thousand and One Nights*, and contains the story of the king and his vizier and of his daughter Shīrazād and her slave girl Dīnāzād. Other books of the same kind are the book of *Ferza and Sīmās*, containing stories of Indian kings and viziers, the book of Sindibād, &c." Von Hammer concluded that the *Thousand and One Nights* were of Persian or Indian origin. Against this conclusion Silvestre De Sacy protested in a memoir (*Mém. de l'acad. des inscr.*, 1833, x. 30 seq.), demonstrating that the character of the book we know is genuinely Arabian, and that it must have been written in Egypt at a comparatively recent date. Von Hammer in reply adduced, in *Journ. as.* (1839), ii. 175 seq., a passage in the *Fihrist* (A.D. 987), which is to the following effect:—

"The ancient Persians were the first to invent tales and make books of them, and some of their tales were put in the mouths of animals. The Ashghanians, or third dynasty of Persian kings, and after them the Sāsānians, had a special part in the development of this literature, which found Arabic translators, and was taken up by accomplished Arabic literati, who edited it and imitated it. The earliest book of the kind was the *Hezār afsāne* or *Thousand Tales*, which had the following origin. A certain Persian king was accustomed to kill his wives on the morning after the consummation of the marriage. But once he married a clever princess called Shahrazād, who spent the marriage night in telling a story which in the morning reached a point so interesting that the king spared her, and asked next night for the sequel. This went on for a thousand nights till Shahrazād had a son, and ventured to tell the king of her device. He admired her intelligence, loved her, and spared her life. In all this the princess was assisted by the king's stewardess Dīnāzād. This book is said to have been written for the princess Ḥomāi (MSS. Ḥomānī), daughter of Bahman. . . . It contains nearly two hundred stories, one story often occupying several nights. I have repeatedly seen the complete book, but it is really a meagre and uninteresting production" (*Fihrist*, ed. Flügel, p. 304).

Persian tradition (in Firdousī) makes Princess Ḥomāi the daughter and wife of Bahman Ardashīr, *i.e.* Artaxerxes I. Longimanus. She is depicted as a great builder, a kind of Persian Semiramis, and is a half-mythical personage already mentioned in the Avesta, but her legend seems to be founded on the history of Atossa and of Parysatis. Firdousī says that she was also called Shahrazād (Mohl v. 11). This name and that of Dīnāzād both occur in what Mas'ūdī tells of her. According to him, Shahrazād was Ḥomāi's mother (ii. 129), a Jewess (ii. 123). Bahman had married a Jewess (i. 118), who was instrumental in delivering her nation from captivity. In ii. 122 this Jewish maiden who did her people this service is called Dīnāzād, but "the accounts," says our author, "vary." Plainly she is the Esther of Jewish story. Tabarī (i. 688) calls Esther the mother of Bahman, and, like Firdousī, gives to Ḥomāi the name of Shahrazād. The story of Esther and that of the original *Nights* have in fact one main feature in common. In the former the king is offended with his wife, and divorces her; in the *Arabian Nights* he finds her unfaithful, and kills her. But both stories agree that thereafter a new wife was brought to him every night, and on the morrow passed into the second house of the women (Esther), or was slain (*Nights*). At length Esther or Shahrazād wins his heart and becomes queen. The issue in the Jewish story is that Esther saves her people; in the *Nights* the gainers are "the daughters of the Moslems," but the old story had, of course, some other word than "Moslems." Esther's foster-father becomes vizier, and Shahrazād's father is also vizier. Shahrazād's plan is helped forward in the *Nights* by Dīnāzād, who is, according to Mas'ūdī, her slave girl, or, according to other MSS., her nurse, and, according to the *Fihrist*, the king's stewardess. The last account comes nearest to Esther ii. 15, where Esther gains the favour of the king's chamberlain, keeper of the women. It is also to be noted that Ahasuerus is read to at night when he cannot sleep (Esther vi. 1). And it is just possible that it is worth notice that, though the name of Ahasuerus corresponds to Xerxes, Josephus identifies him with Artaxerxes I.

Now it may be taken as admitted that the book of Esther was written in Persia, or by one who had lived in Persia, and not earlier than the 3rd century B.C. If now there is real weight in the points of contact between this story and the *Arabian Nights*—and the points of difference cannot be held to outweigh the resemblances between two legends, each of which is necessarily so far removed from the hypothetical common source—the inference is important for both stories. On the one hand, it appears that (at least in part) the book of Esther draws on a Persian source; on the other hand, it becomes probable that the *Nights* are older than the Sāsānian period, to which Lane (iii. 677) refers them.

It is a piece of good fortune that Mas'ūdī and the *Fihrist* give us the information cited above. For in general the Moslems, though very fond of stories, are ashamed to recognize them as objects of literary curiosity. In fact, the next mention of the *Nights* is found only after a lapse of three centuries. Maqrīzī, describing the capital of Egypt, quotes from a work of Ibn Sa'īd (*c.* A.D. 1250), who again cites an older author (Al-Ḳorṭobī), who, in speaking of a love affair at the court of the caliph Al-Āmir (1097–1130), says "what is told about it resembles the romance of Al-Bāṭṭal, or the *Thousand and One Nights*" (*Ḥiṭaṭ*, Būlāq ed., i. 485, ii. 181).

That the *Nights* which we have are not the original translation of the *Hezār Afsāne* is certain, for the greater part of the stories are of Arabian origin, and the whole is so thoroughly Mahommedan that even the princes of remote ages who are introduced speak and act as Moslems. It might be conceived that this is due to a gradual process of modernization by successive generations of story-tellers. But against this notion, which has been entertained by some scholars, Lane has remarked with justice that, much as MSS. of the *Nights* differ from one another in points of language and style, in the order of the tales, and the division into nights, they are all so much at one in essentials that they must be regarded as derived from a single original. There is no trace of a recension of the text that can be looked on as standing nearer to the *Hezār Afsāne*. And the whole local colour of the work, in point of dialect and also as regards the manners and customs described, clearly belongs to Egypt as it was from the 14th to the 16th century. Some points, as De Sacy and Lane have shown, forbid us to place the book earlier than the second half of the 15th century. Galland's MS. copy, again, was in existence in 1548. Lane accordingly dates the work from the close of the 15th century or the beginning of the 16th, but this date appears to be too late. For Abu'l-Maḥāsin, an Egyptian historian who died in 1470, writing of Ḥamdi, a famous highwayman of Bagdad in the 10th century, remarks that he is probably the figure who used to be popularly spoken of as Aḥmad al-Danaf (ed. Juynboll ii. 305). Now in the *Nights* Aḥmad al-Danaf really plays a part corresponding to that of the historical Ḥamdi, being now a robber (Lane ii. 404) and again a captain of the guard (Lane ii. 249). It would seem that Abu'l-Maḥāsin had read or heard the stories in the *Nights*, and was thus led to compare the historical with the fictitious character. And, if this be so, the *Nights* must have been composed very soon after 1450.[1]

No doubt the *Nights* have borrowed much from the *Hezār Afsāne*, and it is not improbable that even in the original Arabic translation of that work some of the Persian stories were replaced by Arab ones. But that our *Nights* differ very much from the *Hezār Afsāne* is further manifest from the circumstance that, even of those stories in the *Nights* which are not Arabian in origin, some are borrowed from books mentioned by Mas'ūdī as distinct from the *Hezār Afsāne*. Thus the story of the king and his son and the damsel and the seven viziers (Lane, ch. xxi. note 51) is in fact a version of the *Book of Sindbād*,[2] while the story of Jalī'ād and his son and the vizier Shammās (M'Naghten iv. 366 seq.; cf. Lane iii. 530) corresponds to the book of *Ferza and Sīmās*.[3]

Not a few of the tales are unmistakably of Indian or Persian origin, and in these poetical passages are rarely inserted. In other stories the scene lies in Persia or India, and the source is foreign, but the treatment thoroughly Arabian and Mahommedan. Sometimes, indeed, traces of Indian origin are perceptible, even in stories in which Hārūn al-Rashīd figures and the scene is Bagdad or Baṣra.[4] But most of the tales, in substance and form alike, are Arabian, and so many of them have the capital of the caliphs as the scene of action that it may be guessed that the author used as one of his sources a book of tales taken from the era of Bagdad's prosperity.

The late date of the *Nights* appears from sundry anachronisms. In the story of the men transformed into fish—white, blue, yellow or red according as they were Moslems, Christians, Jews or Magians (Lane i. 99)—the first three colours are those of

[1] The hypothesis of gradual and complete modernization is also opposed to the fact that the other romances used by Cairene story-tellers (such as those of 'Antar and of Saïf) retain their original local colour through all variations of language and style.

[2] The Syriac *Sindibān*, the Greek *Syntipas*, and the *Seven Sages* of the European West.

[3] De Sacy and Lane suppose that the original title of the Arabic translation of the *Hezār Afsāne* was *The Thousand Nights*. But most MSS. of Mas'ūdī already have *The Thousand and One Nights*, which is also the name given by Maqrīzī. Both ciphers perhaps mean only "a very great number," and Fleischer (*De glossis Habichtianis*, p. 4) has shown that 1001 is certainly used in this sense.

[4] Gildemeister, *De rebus indicis*, p. 89 seq.

the turbans which, in 1301, Mahommed b. Kala'un of Egypt commanded his Moslem, Christian and Jewish subjects respectively to wear.[1] Again, in the story of the humpback, whose scene is laid in the 9th century, the talkative barber says, "this is the year 653" (= A.D. 1255; Lane, i. 332, writes 263, but see his note), and mentions the caliph Mostanṣir (d. 1242), who is incorrectly called son of Mostaḍī.[2] In the same story several places in Cairo are mentioned which did not exist till long after the 9th century (see Lane i. 379).[3] The very rare edition of the first 200 nights published at Calcutta in 1814 speaks of cannon, which are first mentioned in Egypt in 1383; and all editions sometimes speak of coffee, which was discovered towards the end of the 14th century, but not generally used till 200 years later. In this and other points, *e.g.* in the mention of a mosque founded in 1501 (Lane iii. 608), we detect the hand of later interpolators, but the extent of such interpolations can hardly perhaps be determined even by a collation of all copies. For the nature and causes of the variations between different copies the reader may consult Lane, iii. 678, who explains how transpositions actually arise by transcribers trying to make up a complete set of the tales from several imperfect copies.

Many of the tales in the *Nights* have an historical basis, as Lane has shown in his notes. Other cases in point might be added: thus the chronicle of Ibn al-Jauzī (d. A.D. 1200) contains a narrative of Ḳamar, slave girl of Shaghb, the mother of Moqtadir, which is the source of the tale in Lane i. 310 seq., and of another to be found in M'Naghten iv. 557 seq.; the latter is the better story, but departs so far from the original that the author must have had no more than a general recollection of the narrative he drew on.[4] There are other cases in the *Nights* of two tales which are only variations of a single theme, or even in certain parts agree almost word for word. Some tales are mere compounds of different stories put together without any art, but these perhaps are, as Lane conjectures, later additions to the book; yet the collector himself was no great literary artist. We must picture him as a professional story-teller equipped with a mass of miscellaneous reading, a fluent power of narration, and a ready faculty for quoting, or at a push improvising, verses. His stories became popular, and were written down as he told them—hardly written by himself, else we should not have so many variations in the text, and such insertions of "the narrator says," "my noble sirs," and the like. The frequent coarseness of tone is proper to the condition of Egyptian society under the Mameluke sultans, and would not have been tolerated in Bagdad in the age to which so many of the tales refer. Yet with all their faults the *Nights* have beauties enough to deserve their popularity, and to us their merit is enhanced by the pleasure we feel in being transported into so entirely novel a state of society.

The *Thousand and One Nights* became known in Europe through A. Galland's French version (12 vols. 12mo, Paris, 1704–1712); the publication was an event in literary history, the influence of which can be traced far and wide. This translation, however, left much to be desired in point of accuracy, and especially failed to reproduce the colour of the original with the exactness which those who do not read merely for amusement must desire. It was with a special view to the remedying of these defects that E. W. Lane produced in 1840 his admirably accurate, if somewhat stilted, translation, enriched with most valuable notes and a discussion of the origin of the work (new edition, with some additional notes, 3 vols. 8vo, London, 1859). Lane's translation omits the tales which he deemed uninteresting or unfit for a European public. Sir Richard Burton's unexpurgated English translation, with elaborate notes, was issued in 10 vols., 1885–1886, with six supplementary vols., 1887–1888. A new French version (1899 seq.) was undertaken by J. C. Mardrus. Of the Arabic text of the *Nights* the principal editions are—(1) M'Naghten's edition (4 vols. 8vo, Calcutta, 1839–1842); (2) the Breslau edition (12 vols., 12mo, 1835–1843), the first 8 vols. by Habicht, the rest by Fleischer (compare as to the defects of Habicht's work, Fleischer, *De glossis Habichtianis.* Leipzig, 1836); (3) the first Būlāq edition (4 vols., 1862–1863). See the *Bibliographie des ouvr. arabes* (1901), vol. iv., by V. Chauvin, (M. J. DE G.)

[1] Quatremère, *Sultans Mamloucs*, ii. 2, p. 177 seq.
[2] Lane, i. 342, arbitrarily writes "Montaṣir" for "Mostanṣir."
[3] See also *Edin. Review* (July 1886), p. 191 seq.
[4] See De Goeje in *Gids* (1876), ii. 397–411.

THRACE, a name which was applied at various periods to areas of different extent. For the purposes of this article it will be taken in its most restricted sense, as signifying the Roman province which was so called after the district that intervened between the river Ister (Danube) and the Haemus Mountains (Balkan) had been formed into the separate provinces of Moesia, and the region between the rivers Strymon and Nestus, which included Philippi, had been added to Macedonia. The boundaries of this were—towards the N. the Haemus, on the E. the Euxine Sea, on the S. the Propontis, the Hellespont and the Aegean, and towards the W. the Nestus. The most distinguishing features of the country were the chain of Rhodope (Despoto-dagh) and the river Hebrus (Maritza). The former separates at its northernmost point from the Haemus, at right angles, and runs southward at first, nearly parallel to the Nestus, until it approaches the sea, when it takes an easterly direction (See Virg. *Georg.* iii. 351). Several of the summits of this chain are over 7000 ft. in height. The Hebrus, together with its tributaries which flow into it from the north, east and west, drains almost the whole of Thrace. It starts from near the point of junction of Haemus and Rhodope, and at first takes an easterly direction, the chief town which lies on its banks in the earlier part of its course being Philippopolis; but when it reaches the still more important city of Hadrianopolis it makes a sharp bend towards the south, and enters the sea nearly opposite the island of Samothrace. The greater part of the country is hilly and irregular, though there are considerable plains; but besides Rhodope two other tolerably definite chains intersect it, one of which descends from Haemus to Adrianople, while the other follows the coast of the Euxine at no great distance inland. One district in the extreme north-west of Thrace lay beyond the watershed separating the streams that flow into the Aegean from those that reach the Danube: this was the territory of Sardica, the modern Sophia. In the later Roman period two main lines of road passed through the country. One of these skirted the southern coast, being a continuation of the Via Egnatia, which ran from Dyrrhachium to Thessalonica, thus connecting the Adriatic and the Aegean; it became of the first importance after the foundation of Constantinople, because it was the direct line of communication between that city and Rome. The other followed a north-westerly course through the interior, from Constantinople by Hadrianopolis and Philippopolis to the Haemus, and thence by Naissus (Nish) through Moesia in the direction of Pannonia, taking the same route by which the railway now runs from Constantinople to Belgrade. The climate of Thrace was regarded by the Greeks as very severe, and that country was spoken of as the home of the north wind, Boreas. The coast in the direction of the Euxine also was greatly feared by sailors, as the harbours were few and the sea proverbially tempestuous; but the southern shore was more attractive to navigators, and here we find the Greek colonies of Abdera and Mesambria on the Aegean, Perinthus on the Propontis, and, the most famous of all, Byzantium, at the meeting-point of that sea and the Bosporus. Another place which proved attractive to colonists of that race was the curious narrow strip of ground, called the Thracian Chersonese, that intervened between the Hellespont and the Bay of Melas, which penetrates far into the land on its northern side. Among the cities that occupied it the most important were Sestos and Callipolis (Gallipoli). In order to prevent the incursions of the Thracians, a wall was built across its isthmus, which was less than 5 m. in breadth. The north-eastern portion of the Aegean, owing to its proximity to the coast of Thrace, was known as the Thracian Sea, and in this were situated the islands of Thasos, Samothrace and Imbros.

History.—The most striking archaeological monuments of the prehistoric period are the sepulchral mounds, which are found by thousands in various parts of the country, especially in the neighbourhood of the ancient towns. As Roman implements and ornaments have been found in some of them, it is plain that this mode of burial continued to be practised until a late period. The country was overrun several times by Darius and his generals, and the Thracian Greeks contributed 120 ships to the armament of Xerxes (Herod. vii. 185). The most powerful Thracian tribe was that of the Odrysae, whose king, Teres, in the middle of the 5th century B.C. extended his dominion so as to include the greater part of Thrace. During the Peloponnesian War his son Sitalces was an ally of some importance to the Athenians, because he kept in check the Macedonian monarch, who opposed the interests of the Athenians in the Chalcidic peninsula. Again, in the time of Philip of Macedon we find Cersobleptes, who ruled the south-eastern portion of the country, exercising an important influence on the policy of Athens. During the early period of the Roman Empire the Thracian kings were allowed to maintain an independent sovereignty, while acknowledging the suzerainty of Rome, and it was not until the reign of Vespasian that the country was reduced to the form of a province (Kalopathakas, *De Thracia, provincia romana*, 1894; Mommsen, *Roman Provinces*, Eng. trans., 1886). From its outlying position in the northern part of the Balkan peninsula it was much exposed to the inroads of barbarian invaders. It was overrun by the Goths on several occasions, and subsequently by the Huns; but its proximity to Constantinople caused its fortunes to be closely connected with those of that city, from the time when it became the capital of the Eastern Empire. In the course of the middle ages the northern parts of Thrace and some other districts of that country were occupied by a Bulgarian population; and in 1361 the Turks made themselves masters of Adrianople, which for a time became the Turkish capital. When Constantinople fell in 1453 the whole country passed into the hands of the Turks, and in their possession it remained until 1878, when, in accordance with the provisions of the Treaty of Berlin, the northern portion of it was placed under a separate administration, with the title of Eastern Rumelia; this province has now become, to all intents and purposes, a part of the principality of Bulgaria. The population is composed of Turks, Greeks and Bulgarians. (H. F. T.)

Ancient Peoples.—The name "Thracians," from being used both ethnically and geographically, has led to confusion. There were the true indigenous Thracians and also Celtic tribes such as the Treres in the early period, the Getae and Trausi later, and the Gallic Scordisci in Roman days. These were the "red" Thracians of Greek writers, and they differed not merely in physique and complexion, but also in their customs and religion from the native Thracians (Herod. v. 14). The native Thracians were inferior in morals, allowing their girls complete licence till marriage. The chief native deities were Dionysus, Ares and Bendis (Artemis), but many of these tribes had Celtic chiefs, who traced their descent from and worshipped a god called Hermes by the Greeks, but possibly Odin. The substantial features of the ancient Dionysiac rites, including a ritual play by "goat-men" carrying a wooden phallus, may still be seen at Bizye, the old residence of the Thracian kings (see R. M. Dawkins in *Hellenic Journal*, 1906, p. 191). The true Thracians were part of that dark-complexioned, long-skulled race, which had been in the Balkan peninsula from the Stone Age, closely akin to the Pelasgians (*q.v.*), the aborigines of Greece, to the Ligurians, the aborigines of Italy, and to the Iberians. The name "Illyrian" (see ILLYRIA) was applied to all the tribes of this stock who dwelt west of the northern extensions of the Pindus range and in what was termed Upper Macedonia in later times, and who extended right up to the head of the Adriatic. In Homer the name Macedonia is not yet known, and the term Thracian is applied to all the tribes dwelling from Pieria to the Euxine. There is no well-defined difference between aboriginal Thracians and Illyrians. Thus there was an Illyrian tribe Brygi, a Thracian one Bryges; some of the latter had passed into Asia and settled in the land called from them Phrygia, whence some of them later passed into Armenia; some of the Mysians (regarded by Strabo as Thracians) had also crossed into what was later known as Mysia: closely connected with the Mysians were the Dardanii, of Trojan fame, who had a city Dardania or Dardanus. In Strabo's time a tribe called Dardanii, then reckoned Illyrian, living next the Thracian Bessi (in whose land was the oldest oracle of Dionysus), were probably as much Thracian as Illyrian. All the Thracian and Illyrian tribes tattooed, thus being distinguished from the Celtic tribes who had conquered many of them. The Thracians differed only dialectically from the Illyrians (Strabo), their tongue being closely allied to Greek. The Thracians of the region from Olympus to the Pangaean district, usually regarded as rude tribes, had from a very early time worked the gold and silver of that region, had begun to strike coins almost as early as the Greeks, and displayed on them much artistic skill and originality of types. The most famous were the Bisaltae, the Orrescii, Odomantes and Edoni. Alexander I. of Macedon on his conquest of the Bisaltae adopted the native coinage, merely placing on it his own name (see, further, NUMISMATICS: *Greek*, §§ *Thrace* and *Macedonia*). They were famous for their skill in music and literature. Orpheus, Linus, Thamyris and Eumolpus were theirs, and in later days the Dardanii were noted for their love of music as well as for their uncleanliness.

See Herodotus v. 3–8; H. Kiepert, *Lehrbuch der alten Geographie* (Berlin, 1878); A. Boué, *La Turquie d'Europe* (4 vols., Paris, 1840); G. Finlay, *History of Greece*, vols. i.–iv. (Oxford, 1877); W. Ridgeway, *Early Age of Greece*, i. 351 seq. (Cambridge, 1902); Tomaschek, *Die alten Thraker* (1893–1895); Hiller von Gaertringen, *De Graecorum fabulis ad Thraces pertinentibus* (1886). (W. RI.)

THRALL, a slave, a captive or bondman, a term especially applied to the serfs (Lat. *servi*) of the early northern Teutonic peoples. It only occurs in Old English as a word borrowed from the Norse, the proper term in Old English being "theow" (*þeow*); the Icel. *þraell* (Dan. *trael*, Swed. *träl*) is probably represented by O. H. Ger. *dregil*, *trigil*, *trikil*, a slave, and would therefore be derived from the root meaning "to run," seen in O. Eng. *þraegian*, Goth. *thagjan*, cf. Gr. τρέχειν; Skeat (*Etym. Dict.*, 1898) compares the "trochilus" (Gr. τροχίλος), the small bird that according to Herodotus waits or attends on the crocodile and picks insects out of his teeth.

THRASEA PAETUS, PUBLIUS CLODIUS, Roman senator and Stoic philosopher, lived during the reign of Nero. He was the husband of Arria the daughter of Arria (*q.v.*), father-in-law of Helvidius Priscus, and a friend and kinsman of the poet Persius. He was born at Patavium, and belonged to a distinguished and wealthy family. The circumstances under which he came to settle in Rome are unknown. At first he was treated with great consideration by Nero, probably owing to the influence of Seneca, and became consul in A.D. 56 and one of the keepers of the Sibylline books. In 57 he supported in the senate the cause of the Cilician envoys, who came to Rome to accuse their late governor, Cossutianus Capito, of extortion. In 59 Thrasea first openly showed his disgust at the behaviour of Nero and the obsequiousness of the senate by retiring without voting after the emperor's letter justifying the murder of Agrippina had been read. In 62 he prevented the execution of the praetor Antistius, who had written a libel upon the emperor, and persuaded the senate to pass a milder sentence. Nero showed his displeasure by refusing to receive Thrasea when the senate went in a body to offer its congratulations on the birth of a princess. From this time (63) till his death in 66 Thrasea retired into private life and did not enter the senate-house again. But his death had been decided upon. The simplicity of his life and his adherence to Stoic principles were looked upon as a reproach to the frivolity and debaucheries of Nero, who "at last yearned to put Virtue itself to death in the persons of Thrasea and Soranus" (Tacitus). Cossutianus Capito, the son-in-law of Tigellinus, who had never forgiven Thrasea for securing his condemnation, and Eprius Marcellus undertook to conduct the prosecution. Various charges were brought against him, and the senate, awed by the presence of large bodies of troops, had no alternative but to condemn him to death. When the news was brought to Thrasea at his house, where he was entertaining a number of friends, he retired to his chamber, and had the veins of both his arms opened. The narrative of Tacitus breaks off at the moment when Thrasea was about to address Demetrius, the Cynic philosopher, with whom he had previously on the fatal day held a conversation on the nature of the soul. Thrasea was the subject of a panegyric by Arulenus Rusticus, one of the tribunes, who had offered to put his veto on the decree of the senate, but Thrasea refused to allow him to throw his life away uselessly. Thrasea's own model of life and conduct was Cato of Utica, on whom he had written a panegyric, one of Plutarch's chief authorities in his biography of Cato.

See Tacitus, *Annals* (ed. Furneaux), xiii. 49, xiv. 12, 48, xv. 20–22, xvi. 21–35, containing a full account of his trial and condemnation, *Hist.* ii. 91, iv. 5; Dio Cassius lxi. 15, lxii. 26; Juvenal v. 36; W. A. Schmidt, *Geschichte der Denk- und Glaubensfreiheit* (Berlin, 1847); Merivale, *Hist. of the Romans under the Empire*, ch. 53; F. Hersche, *Zwei Characterbilder*, on Diogenes of Sinope and Paetus (Lucerne, 1865); monographs by A. S. Hoitsema (Groningen, 1852); and G. Joachim (Lahr, 1858); see also Pauly-Wissowa's *Realencyclopädie der classischen Altertumswissenschaft* (1900), iv. pt. 1.

THRASHING, or Threshing (from "to thrash," O. Eng. *þerscan*, cf. Ger. *dreschen*, Du. *dorschen*, &c.), the process by which the grain or seed of cultivated plants is separated from the husk or pod which contains it.

Historical.—It is probable that in the earliest times the little grain that was raised was shelled by hand, but as the quantity increased doubtless the grain was beaten out with a stick or the sheaf beaten upon the ground. An improvement on this, as the quantity further increased, was the practice of the ancient Egyptians and Israelites of spreading out the loosened sheaves on a circular enclosure of hard ground 50 to 100 ft. in diameter, and driving oxen, sheep or other animals round and round over it so as to tread out the grain. This enclosure was placed on an elevated piece of ground so that when the straw was removed the wind blew away the chaff and left the corn. This method, however, damaged part of the grain, and as civilization advanced it was partially superseded by the thrashing sledge—the *charatz* of Egypt and the *morag* of the Hebrews—a heavy frame mounted with three or more rollers, sometimes spiked, which revolved as it was drawn over the spread out corn by two oxen. A common sledge with a ridged or grooved bottom was also used. Similar methods to these were used by the Greeks and are still employed in backward countries. In Italy a tapering roller fastened to an upright shaft in the centre of the thrashing floor and pulled round from the outer end by oxen is still in vogue and would seem to be a descendant of the Roman *tribulum* or roller sledge.

Doubtless the flail was evolved from the early method of using the stick. It seems to have been the thrashing implement in general use in all Northern European countries, and was the chief means of thrashing grain as late as 1860. It was known to the Japanese from the earliest times, and was probably used in conjunction with the stripper, an implement fashioned very much like a large comb, with the teeth made of hard wood and pointing upwards. The straw after being reaped was brought to this and combed through by hand, the heads being drawn off and afterwards thrashed on the thrashing floor by the flail. At the present day just such an implement, known as a "heckle," is used for combing the bolls or heads off flax or for straightening the fibre in the after treatment.

The flail consisted of two pieces of wood, the handstaff or helve and the beater, fastened together loosely at one end by a thong of raw hide or eelskin, which made a very durable join. The handstaff is a light rod of ash about 5 ft. long, slightly increasing in girth at the farther end to allow for the hole for the thong to bind it to the beater. The length of the handstaff enabled the operator to stand in an upright position while working. The beater is a wooden rod about 30 in. long, made of ash, though a more compact wood such as thorn is less likely to split. This also has a hole at one end for the thong to bind it to the handstaff. The shape of the beater was cylindrical, of about $1\frac{1}{2}$ in. diameter and constructed so that the edge of the grain of the wood received the force of the blow; 30 to 40 blows or strokes per minute was the average speed.

After the grain had been beaten out by the flail or ground out by other means the straw was carefully raked away and the corn and chaff collected to be separated by winnowing when there was a wind blowing. This consisted of tossing the mixture of corn and chaff into the air so that the wind carried away the chaff while the grain fell back on the thrashing floor. The best grain fell nearest while the lightest grain was carried some distance before falling, thus a very rough-and-ready grading of the grain was obtained. It was also performed when there was no wind by fanning while pouring the mixture from a vessel. Later on a fanning or winnowing mill was invented. All ancient barns were constructed with large doors giving on to the thrashing floor and opening in the direction of the prevailing winds so that the wind could blow right through the barn and across the thrashing floor for the purpose of winnowing the corn. The flail is still in use for special purposes such as flower seeds and also where the quantity grown is so small as to render it not worth while to use a thrashing mill.

With regard to the amount of grain thrashed in a day by the flail, a fair average quantity was 8 bushels of wheat, 30 bushels of oats, 16 bushels of barley, 20 bushels of beans, 8 bushels of rye and 20 bushels of buckwheat.

There seem to have been many attempts to devise some form of power-driven machinery for thrashing. In 1732 Michael Menzies, a Scotsman, obtained a patent for a power-driven machine. This was a contrivance arranged to drive a large number of flails operated by water power, but though worked for a time it was not particularly successful. The first practical effort leading in the right direction was made by a Scottish farmer named Leckie about 1758. He invented what was described as a "rotary machine consisting of a set of cross arms attached to a horizontal shaft and enclosed in a cylindrical case." This machine did not work very well, but it demonstrated the superiority of the rotary motion and pointed out the lines on which thrashing machines should be constructed.

The first really successful thrashing machine—the type which is embodied in modern thrashers—was invented by another Scotsman named Andrew Meikle in 1786 In this the loosened sheaves were fed, ears first, from a feeding board between two fluted revolving rollers to the beating cylinder. This cylinder or "drum" was armed with four iron-shod beaters or spars of wood parallel to its axle, and these striking the ears of corn as they protruded from the rollers knocked out the grain. The drum revolved at 200 to 250 revolutions per minute and carried the loose grain and straw on to a concave sieve beneath another revolving drum or rake with pegs which rubbed the straw on to the concave and caused the grain and chaff to fall through. Another revolving rake tossed the straw out of the machine. The straw thus passing under one peg drum and over the next was subjected to a thorough rubbing and tossing which separated the grain and chaff from it. These fell on to the floor beneath, ready for winnowing.

A later development of the beater-drum was to fix iron pegs on the framework, and thus was evolved the Scottish "peg-mill," which remained the standard type for nearly a hundred years and is found at nearly every farmstead in Scotland as a fixed machine in the barn to the present day, though in many cases unused since the advent of the portable thrasher. Further, it is the type adopted in America, and all "separators" in use on the great wheat lands of "the West" are simply modifications of the peg-mill principle. In Great Britain, however, a reversion has been made to the beating or rubbing principle, where the arms of the "drum" rub the straw against an encircling concave framework and thus shell the grain out, and the portable thrashing machines now taken from farm to farm are all constructed on this principle. It was not till about 1800 that a machine for winnowing was invented to work as part of Meikle's peg-drum thrasher, and this made a complete separator or thrasher which thrashed, cleaned and delivered the grain at one operation. Still, these machines were stationary, being generally built up in homesteads and operated by water power, and the unthrashed corn had to be brought to them. Portable thrashing machines operated by horse power were used to a small extent, but the work was very hard on the horses and took them away when their services were otherwise required on the farm. When steam was developed as a motive power the portable thrashing machine became more general.

When Meikle had brought together the peg-drum and concave he had solved the difficulty of mechanical thrashing. The development of the machine to the efficiency of the modern thrasher was very gradual, and was in the direction of greater speed to the drum and more beaters on it, and improved arrangements to ensure a clean sample of grain. It is generally supposed that each part was invented and perfected singly, but in reality the early experimenters had tried to make a complete separating machine. In fact they covered the whole ground in theory before any main features were made practical.

The Modern Thrashing Machine.—The present-day thrashing machine embodies the main features of Meikle's machine and will thrash up to 16 quarters of oats per hour, depending on the size of the same. There are no fluted rollers at the feed, the sheaves are fed straight to the drum; but as the working of these high-speed drums was attended with considerable risk, the Threshing Machine Act 1878 now provides for some sort of guard or safety feed.

In the most modern thrashing machine the ordinary routine is as follows: The loosened sheaf is fed in at the feed mouth under the drum guard and passes between the drum beaters and the concave; most of the corn falls through the concave on to the corn and chaff receiving board, but some of the corn and chaff remain among the straw; as the "cavings" (the short broken straw and leaf) need to be separated from the straw it is given a thorough tossing up on the shakers, which have an upwards and onwards peristaltic action, and deliver the straw at the end of the machine. The corn, chaff and cavings fall on to a reciprocating board or "upper shoe," which carries them back to the middle

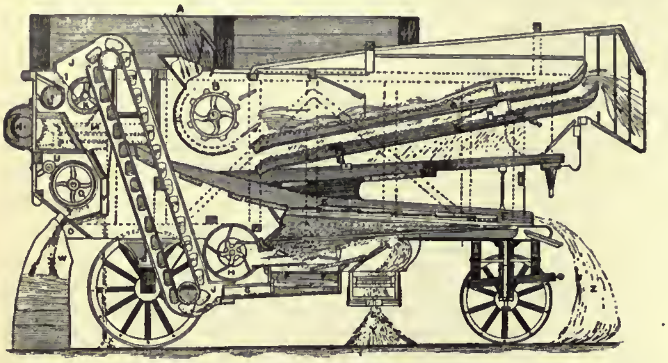


FIG. 1.—The internal construction and arrangement of the "Ruston" double crank finishing Thrashing Machine. (Ruston, Proctor & Co., Lincoln.)

A, Corn feed opening.	O, Grain passage.
B, Thrashing drum.	P, Spout.
CC, Straw shakers.	Q, Rotary screen.
D, Collecting board of top shoe.	R, Grain passage.
EE, Caving riddle.	T, Classified grain.
FF, Dressing riddles.	U, Rotary screen brush.
G, Grain spout.	V, Dust spout.
H, Large blower.	W, Grain delivery to sacks.
I, Shut off lid.	X, Dust.
JJ, Elevator.	Z, Cavings delivery.
K, Smutter.	Y, Chaff delivery or chaff collector may be fitted here to deliver chaff upon either side of machine, as desired.
L, Creeper.	
MM, Riddle.	
N, Second blower.	

of the machine, where they meet the corn that fell through the concave. The upper shoe passes the cavings, &c., over the end into a "lower shoe," which thoroughly sifts the corn and chaff from the cavings. The cavings are then carried along to the outside of the machine and emerge at an opening beneath the point where the straw passes out. The corn and chaff fall through the lower shoe or caving riddle on to a receiving board

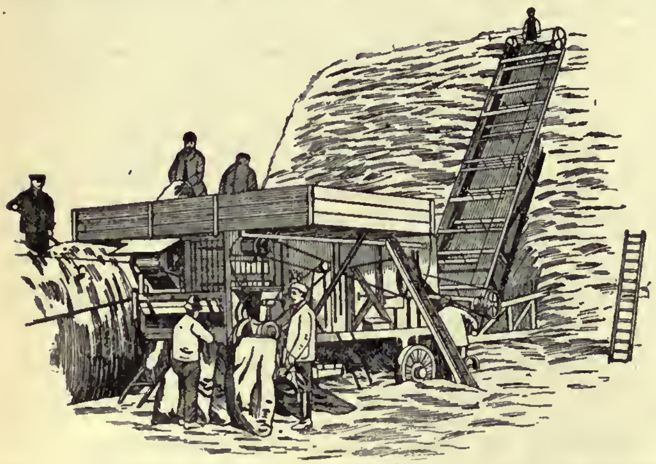


FIG. 2.—Thrashing Machine at work with stacking elevator behind. (Clayton & Shuttleworth, Lincoln.)

which takes them back to the middle of the machine, where they fall, meeting with a strong blast of wind from the first fan, which blows out the chaff and light matter, the small seeds and light dust being sifted out through finely perforated sieves, while larger débris such as thistle heads and "chobs" (broken heads) are taken off by a coarse sieve. The corn then passes into the shaker shoe, which is fitted with sieves to take off the larger seed, and thence to the elevator, which carries it to the top of the machine in a roughly dressed condition. The elevator delivers the corn into the awner or "hummeller," which is fitted with helical blades to rub off the awns or beards which may still adhere to the grain. From here the grain falls on to a second series of sieves, where it meets the blast of air from the second fan, which blows and sifts the light and coarse foreign matter from the grain, delivering this débris on the first corn and chaff receiving board to undergo separation again along with that just fallen from the concave. The corn falls from the sieve of this second dresser into a rotary screen where separations are made producing the clean sample and the tail corn, which are delivered at separate openings below. There are modifications on the machine described—such as single fan-blast instead of double, &c.—but the general principles are the same.

The concave which surrounds the drum is made adjustable, so that it can be regulated according to the nature of the crop to be thrashed. An ordinary machine will thrash all usual farm crops, but great care has to be taken in adjusting the concave or the seed will be injured. Clover, however, is twice

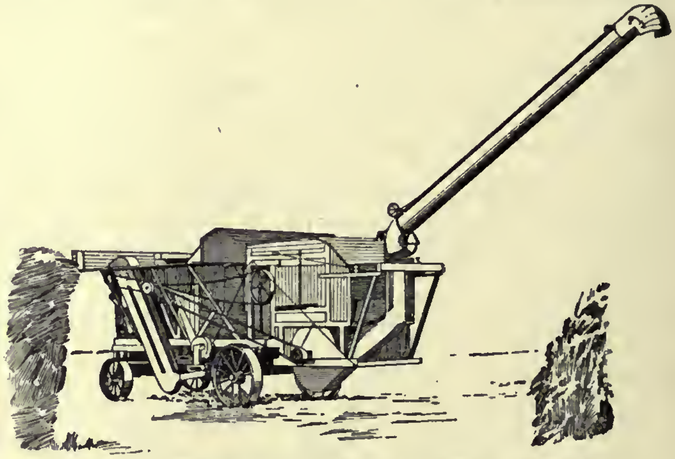


FIG. 3.—Thrashing Machine with fan-blast straw-stacker. (Clayton & Shuttleworth, Lincoln.)

passed through a machine of this description, to free the seed from the haulm and afterwards to rub the seed clear from the chaff, but special machines to thrash it all in one operation are made.

The drum is carried on the main shaft and all other pulleys take their motion from it directly or indirectly. Sometimes the main shaft is lengthened to accommodate another pulley and so drive a chaff-cutter behind and chaff up the straw as it leaves the thresher. In some districts an elevator is driven behind to stack the straw. Others use a trusser, which ties the straw into large bundles before delivering it for stacking.

American Machines.—In American machines the straw, cavings, &c., are caught in a blast at the rear end of the machine and blown up in a light iron pipe of about 18 in. diameter on to the top of the stack, and the grain is delivered loose at the side through a spout into a box wagon. As the payment for thrashing is per bushel the grain is usually passed through a self-registering weighing apparatus, so that accurate account is kept of the bushels thrashed. In Great Britain payment is per quarter of 8 bushels, and as the machine delivers into 4-bushel

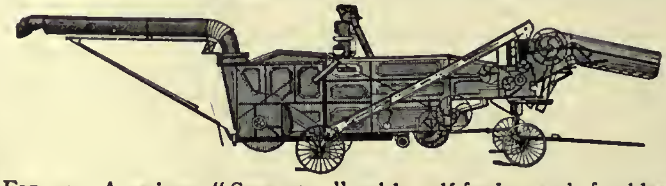


FIG. 4.—American "Separator" with self-feeder and fan-blast delivery-pipe for straw. (Avery Manufacturing Co., Peoria, Illinois.)

sacks this rough-and-ready measure is accepted. On American machines self-feeders are adopted, in which the sheaves are thrown on to a travelling web which carries them under revolving knives to cut the bands and deliver them loose into the drum, so that while many more bushels of grain are passed per day through an American machine than is done in Great Britain, only about half the men are required at the work.

Thrashing Work.—The minimum number of hands required in Great Britain are: An engine-driver, a feeder, a sackman, and ten other men to handle the sheaves, straw, chaff, grain, &c., while half as many more may be needed where the grain has to be carted, as when the thrashing is done in the field in harvest time. An 8-h.p. steam engine is the usual motive power, but the development of the oil engine has provided a very satisfactory substitute. The engine is usually of the "traction" type, so that it can move the thrashing machine or "barn work" (as it is sometimes called) and elevator from place to place. The usual quantities thrashed with a "double blast finishing machine," as described, in the United Kingdom are, with a 5 ft. wide drum, from 60 to 80 bushels per hour of wheat, and one-third to one-half more of oats and barley.

Sometimes the straw is stacked loose, while sometimes it is tied up with twine by a tier exactly like that on a "string binder" and then stacked up. Where all the straw is used at the farm for fodder, &c., the fixed thrashing machine set up in the barn is the most convenient. The sheafed corn has to be carried to it, but, on the other hand, everything is under cover, the work can be done on a wet day, and all the products of thrashing in the shape of grain, straw, cavings, chaff, &c., are kept dry. In the great corn districts, however, the portable thrasher is most convenient; it is set alongside the stack and only the grain and chaff are carried under cover, while the thrashed straw, &c., is restacked up on the spot as the work goes on. The farmer finds the coal and the men and horses to cart water to the engine and corn to the barn and pays the proprietor of the thrashing outfit, who finds all the other men, about the following rates: wheat, 1s. 10d., oats and barley, 1s. 6d. per quarter. (P. McC.)

THRASYBULUS, an Athenian general, whose public career began in 411 B.C., when by his resolute behaviour he frustrated the oligarchic rising in Samos (see PELOPONNESIAN WAR), and secured the Athenian armament to the cause of democracy. Elected general by the troops, he effected the recall of Alcibiades and assisted him in the ensuing naval campaigns. By his brave defence at Cynossema (411) he won the battle for Athens, and in 410 contributed towards the brilliant victory of Cyzicus. In 406 he fought at Arginusae as a simple ship's captain, but after the engagement was commissioned with Theramenes (*q.v.*) to rescue some drowning crews. In the subsequent inquiry Thrasybulus successfully disclaimed responsibility for the failure.

In 404, when exiled by the Thirty Tyrants for his services to the democracy, he retired to Thebes and there prepared for a desperate attempt to recover his country. Late in the year, with seventy men, he seized Phyle, a hill fort on Mt Parnes. A force sent by the Thirty was repulsed and routed by a surprise attack. Thrasybulus now gained the Peiraeus, 1000 strong, and successfully held the steep hill of Munychia against the oligarchs' full force. After this repulse the Thirty gave way to a provisional government of moderate oligarchs. Meanwhile a Spartan fleet, which the latter had summoned, blockaded the Peiraeus, but king Pausanias, commanding the land forces, after some skirmishes effected a general reconciliation by which the democracy was restored (October 403). Thrasybulus was now the hero of the people; but a decree by which he secured the franchise for all his followers, including many slaves, was rescinded as illegal.

In 395 Thrasybulus induced Athens to join the Theban league against Sparta, but did not himself take the field till 389, when he led a new fleet of 40 ships against the Spartans at Rhodes. Sailing first to the Bosporus he effected a democratic revolution at Byzantium and renewed the corn-toll. After a successful descent on Lesbos and the renewal of the 5% import tax at Thasos and Clazomenae he sailed south in quest of further contributions, but met his death in a night surprise by the people of Aspendus. By his exactions he had forfeited the confidence both of the allies and of Athens; but after his death the ill-feeling subsided, and he was ever remembered as one of the saviours of his country.

See Thucydides, viii. 75–105; Xenophon, *Hellenica*; Lysias, *c. Eratosth.* 55–61 and *c. Ergocl.* 5, 8; and *Const. ath.* xl. Diodorus xiii., xiv., Justin v. 9, 10, and Nepos depend almost wholly on Xenophon. *Corpus inscr. att.* ii. 11b and 14b. (M. O. B. C.)

THRASYMEDES, of Paros, a Greek sculptor. Formerly he was regarded as a pupil of Pheidias, because he set up in the temple of Asclepius at Epidaurus a seated statue of that deity made of ivory and gold, which was evidently a copy of the Zeus of Pheidias. But an inscription recently found at Epidaurus proves that the temple and the statue belong to the fourth century. (See EPIDAURUS.)

THREAD (O. Eng. *þræd*, literally, that which is twisted, *þrawan*, to twist, to throw, cf. "throwster," a silk-winder, Ger. *drehen*, to twist, turn, Du. *draad*, Ger. *Draht*, thread, wire), a thin or fine cord of two or more yarns of fibrous substance, such as cotton, silk, wool or flax, tightly twisted together (see SPINNING and COTTON AND COTTON MANUFACTURE). Thread, whether as silk or cotton thread, is particularly used for sewing, but it is also used in weaving. Lisle thread, a hard-twisted linen thread, originally made at Lille in France, is specially used in the manufacture of stockings (see HOSIERY). Apart from the figurative sense of that which runs through the course of a subject, narrative or speech, as a connecting thought, idea or purpose, the term is also applied specifically to the spiral part of a screw (*q.v.*).

THREAT, a menace or intimidation. At common law the employment of threats or other forms of intimidation to induce a person to enter into a contract will give the right to sue for its recision or avoidance, or to plead the special form of intimidation in answer to any action brought, or to sue for damages occasioned by entering into the contract. (See such headings as COERCION; CONTRACT; EXTORTION, &c.)

In criminal law the sending of threatening letters (or causing them to be received), demanding with menaces and without reasonable cause money or other valuable thing, is a felony. So is the sending a letter threatening to burn or destroy any house, barn or other building or to kill or maim cattle. It is also a felony to threaten to accuse a person of a crime for the purpose of extorting money, or merely to demand money or other property, without having any claim to it, by means of a threat.

THREE BODIES, PROBLEM OF, the problem of determining the motion of three bodies moving under no influence but that of their mutual gravitation. No general solution of this problem is possible. As practically attacked it consists in the problem of determining the perturbations or disturbances in the motion of one of the bodies around the principal or central body, produced by the attraction of the third. Examples are the motion of the moon around the earth as disturbed by the action of the sun, and of one planet around the sun as disturbed by the action of another planet.

THREE RIVERS, or TROIS RIVIÈRES, a city and port of entry of Quebec, Canada, and capital of St Maurice county, situated at the confluence of the rivers St Maurice and St Lawrence. The St Maurice flows in from the north, and, being divided at its mouth by two islands, the channels give the town its name. It is on the line of the Canadian Pacific railway, 78 m. S.W. of Quebec and 92 m. N.E. of Montreal. Founded in 1634 by Champlain, Three Rivers is one of the oldest towns in Quebec. It is the centre of a large lumber trade, which is carried on along the St Maurice and its tributaries. Some miles from the city are the St Maurice forges, where iron wares were manufactured as early as the 17th century. Other industries are furniture- and cabinet-making, boot and shoe making, and those carried on in the brass and lead foundries, saw-mills, and carriage factories. The city is the seat of a Roman Catholic bishopric. A large trade is carried on in lumber, grain, cattle, &c., which are shipped to South America, the West Indies, Great Britain and the United States, and a great development has been caused by the utilization of the water-power of the St Maurice at Shawanegan, Grand Meré and other falls, for the manufacture of wood pulp. As a result, the population, long stationary or slightly declining, increased from 8334 (1891) to 9981 (1901), and 12,730 (1906). The city was almost destroyed by fire on the 23rd of June 1908, but it was quickly rebuilt.

THRENODY, a lament written in verse, a dirge, a funeral ode composed in honour of a dead personage. The word is an adaptation of the Greek *θρηνῳδία*, a funeral dirge, from *θρῆνος*, lamentation, wailing, *θρέομαι*, I cry aloud, and *ᾠδή*, a song, ode, *ᾄδειν*, to sing.

THRESHOLD, the door-sill, the piece of stone or wood which is placed at the bottom of a door, gate, or entrance to a house or other building. The word is used in psychology as the equivalent of Ger. *Schwelle* and of Lat. *limen*, *i.e.* the lowest limit of sensation, the point at which the intensity of sensation becomes just noticeable. Etymologically threshold (O. Eng. *þerscold*, M. Eng. þreswold) has usually been divided "thresh," *i.e.* thrash, beat, and *wold*, *wald*, wood; the word meaning the pieces of wood beaten or trampled by the feet. The termination, as is shown by the Old English form, has probably no connexion with *wald*, but is merely a suffix, as in O. H. Ger. *driscūfli*, threshold. The first part is certainly "thrash," beat; some have supposed that in early times the entrance to a house was used as a threshing-floor.

THRIFT, economy in personal or domestic expenditure, the habit and practice of saving, careful or frugal management in money matters. The word, which is borrowed from Scandinavian languages, meant the condition of one who thrives or prospers (M. Eng. *thriven*, Icel. *thrifa*, to clutch, seize, Norw. *triva*, seize). There are several species of plants, such as the sea-pink, *Armeria maritima*, or March rosemary (*Statice*) which from their vigorous growth are often termed "thrift."

THRING, EDWARD (1821–1887), English schoolmaster, was the son of John Gale Dalton Thring, rector of Alford, Somerset, and was born on the 19th of November 1821. His elder brother was Henry, afterwards Lord, Thring (1818–1907) the distinguished Parliamentary counsel (1868–1886), who was made a peer in 1886. Edward was educated first at Ilminster grammar school and afterwards at Eton, where he became head of the school, and Captain of Montem in 1841, the last occasion on which that ancient festival was celebrated. He then entered King's College, Cambridge, won the Porson Prize for Greek Verse, and was elected fellow. At that time King's College scholars retained the privilege of proceeding to a degree without examination, but Thring thought the maintenance of this usage inexpedient in the interests of learning and wholly indefensible in principle, and his vigorous protests against it aroused lively academic controversy, and became effective in 1851, when it was abolished. On leaving the university in 1846 he was ordained, and served for a short time as curate in Gloucester. Here he took remarkable interest in the elementary school of the parish, and ever afterwards attributed much of his professional success and his insight into educational principles and methods to the experience he had acquired in imparting the humble rudiments of learning to the children of the poor. After an interval of two or three years, spent partly in private tuition and partly as curate at Cookham Dean, he married in 1853 a daughter of Carl Koch, commissioner of customs at Bonn, and was elected to the mastership of Uppingham School, a post which he retained until his death in 1887. That school had been founded in 1584, was slenderly endowed, poorly housed, and little known. Thring found only twenty-five boys in it, but he succeeded in raising it, both in numbers and repute, to a position in the first rank among English public schools. He had a strong conviction that there should be a limit to the number of pupils entrusted to the care of one head master, and he fixed that limit at 300, although, owing to the increasing popularity of the school, he was under strong temptation to exceed it. Little by little he surrounded himself with a loyal staff of masters, raised money for the building and equipment of a noble schoolroom and chapel, besides class-rooms and eleven boarding-houses. Among the distinctive features of his plans and achievements were: (1) his strong sense of the need for a closer study of the characteristics of individual boys than is generally found possible in large public schools; (2) his resolute adherence to the discipline of the ancient languages, in connexion with English, as the staple of a liberal education; (3) his careful provision of a great variety of additional employments and interests, in studies and in games, to suit the aptitudes of different pupils; (4) the value he attached to the aesthetic side of school training, as evinced in the encouragement he gave to music and to drawing and to the artistic decoration of the schoolrooms; and above all (5) his rebellion against mere routine, and his constant insistence on the moral purpose of a school as a training-ground for character, rather than as a place solely concerning itself with the acquisition of knowledge. The vigour and intrepidity of his character were conspicuously shown in 1875, when an outbreak of fever made Uppingham for a time untenable, and when, at a few days' notice, he took a disused hotel and some boarding-houses at Borth, on the Cardiganshire coast, and transported the whole 300 boys, with 30 masters and their households, to it as to a city of refuge. Here the school was carried on with undiminished and even fresh zest and efficiency for fourteen months, during which needful sanitary measures were taken in the town.

Unlike Arnold, with whose moral earnestness and lofty educational aims he was in strong sympathy, he took little or no part in outside controversies, political or ecclesiastical. All the activity of his life centred round the school. His was the first public school to establish a gymnasium, and the first to found a town mission in a district of South London, with a view to interest the boys in an effort to improve the social condition of the poor. He took the first step in 1869 in the formation of the Head Masters' Conference, an institution which has ever since done much to suggest improvements in method and to cultivate a sense of corporate life and mutual helpfulness among the teachers in the great schools. And in 1887 he took the bold and unprecedented step of inviting the Association of Head Mistresses to Uppingham, and giving to them a sympathetic address. He also formed an association in Uppingham, with lectures, cookery classes, concerts, and other aids to the intellectual and social improvement of the residents of the little town. He gave valuable evidence before the Schools Inquiry Commission of Lord Taunton in 1866, but it was very characteristic of him that he dreaded the intrusion of public authority, whether that of royal commissioners or of the legislature, into the domain of the school, wherein he thought it indispensable that the liberty and personal inventiveness and enthusiasm of teachers should have full scope and be hindered by no official regulations.

His contributions to literature were not numerous, but were all closely connected with his work as a schoolmaster. They were: *Thoughts on Life Science* (1869), written under the assumed name of Benjamin Place; *Education and School* (1864); *The Theory and Practice of Teaching* (1883); *Uppingham School Sermons* (1858); *The Child's Grammar* (1852); *The Principles of Grammar* (1868); *Exercises in Grammatical Analysis* (1868); *School Songs* (1858); *Borth Lyrics*, poems and translations (1887); and a volume of *Miscellaneous Addresses*, published after his death in 1887.

The fullest account of his life is that written by G. R. Parkin (1898), containing copious extracts from his diary and letters, *A Memory of Edward Thring*; and *Uppingham by the Sea*, written by J. H. Skrine, the warden of Glenalmond, who was first a pupil and afterwards an assistant master at the school, presents a vivid and attractive picture of Thring's active life, and an affectionate and yet discriminating estimate of his character. Other particulars may be found in the chapter devoted to his biography in Sir Joshua Fitch's *Educational Aims and Methods*, and in *Edward Thring, Teacher and Poet*, by Canon H. D. Rawnsley. (J. G. F.)

THROAT (O. Eng. *þrotu*, *þrote* or *þrota*, possibly from *þreōtan*, to press, whence threat, or, with loss of initial *s*, connected with strut, to swell), the term applied to the front external part of the neck from below the chin to the collar-bone in human and animal anatomy, and to the internal parts, which include the gullet, viz. the fauces, pharynx and oesophagus, and the windpipe, viz. the larynx and trachea (see PHARYNX, ALIMENTARY CANAL, and RESPIRATORY SYSTEM: *Anatomy*; and for diseases see PHARYNGITIS, LARYNGITIS, DIPHTHERIA, TONSILITIS and OESOPHAGUS).

THROCKMORTON (or THROGMORTON), **FRANCIS** (1554–1584), English conspirator, was the son of Sir John Throckmorton of Feckenham in Warwickshire, and his wife Margery Puttenham. Sir John had been concerned in Wyat's rebellion against Queen Mary Tudor, but was afterwards known as a sympathizer with the Roman Catholic party in the reign of Queen Elizabeth, and in 1580 was removed from his office of chief justice of Chester for irregularities in his office, but probably because he was suspected of disloyalty by the government. Francis was educated at Hart Hall, Oxford, which he entered in 1572. In 1576 he was enrolled in the Inner Temple. At Oxford he had come under the influence of the Roman Catholics, whose power was still great in the university, and must have heard of Edmund Campian (*q.v.*) who had left shortly before he himself entered the university. When Campian and Parsons came to England in 1580 to conduct the Jesuit propaganda against Queen Elizabeth, Francis Throckmorton was one of a society of members of the Inner Temple who united to hide and help them. In that year he went abroad, first to join his brother Thomas, who was engaged with the exiled Roman Catholics in Paris, and then to travel in Italy and Spain. While abroad he consorted with exiled papists, and was undoubtedly engaged in treasonable intrigues. In 1583 he returned to act as the confidential agent of an elaborate conspiracy which had for its object the invasion of England by a French force under command of the duke of Guise, or by Spaniards and Italians sent by Philip II. for the purpose of releasing the imprisoned Mary Queen of Scots and restoring the authority of the pope. Throckmorton possessed, or occupied, a house on Paul's wharf, London, which served as a meeting-place for the conspirators. Many plots were being carried on alongside of the chief one, and the suspicions of the government were aroused. Throckmorton's constant visits to the Spanish ambassador, Bernardino de Mendoza, attracted attention, and he was arrested in October 1583. He was ciphering a letter to Queen Mary when the constables came upon him suddenly, but he found time to send a casket of compromising papers by a trustworthy maidservant to Mendoza, and a card in cipher in which he promised to reveal nothing. As he refused to confess when brought before the council, he was put on the rack in the Tower. He resisted a first application of the torture, but his strength and courage failed when he was threatened with a second, and he made a full confession. At a later period he retracted and asserted that his avowals were false and had been extorted from him by pain, or had been put in his mouth by the examiners. His confession agreed, however, fully with what is known from other sources of the plot, and there can be no doubt that when his house was searched the constables found lists of his confederates, plans of harbours meant for use by foreign invaders, treatises in defence of the title of the Queen of Scots to the throne of England, and "infamous libels on Queen Elizabeth printed beyond seas." His trial, which in the circumstances was a mere formality, took place on the 21st of May 1584, and he was executed at Tyburn on the 10th of July. The arrest and confession of Throckmorton were events of great importance. They terrified the conspirators, who fled abroad in large numbers, and led to the expulsion of the Spanish ambassador and so to war with Spain.

THROCKMORTON (or THROGMORTON), **SIR NICHOLAS** (1515–1571), English diplomatist and politician, was the fourth of eight sons of Sir George Throckmorton of Congleton in Warwickshire, and uncle of the conspirator Francis Throckmorton (see above). He was brought up in the household of Catherine Parr, the last wife of Henry VIII. In his youth he was favourable to the reformers in religion. He sat in parliament from 1545 to 1567. During the reign of Edward VI. he was in high favour with the regents. In 1547 he was present at the battle of Pinkie during the invasion of Scotland. When on the death of Edward VI. an attempt was made to place Lady Jane Grey on the throne, he contrived to appear as the friend of both parties, and secured the favour of Queen Mary Tudor. He was, however, suspected of complicity in Wyat's rebellion in 1554, and was brought to trial at the Guildhall on the 17th of April of that year. By eloquence, readiness of wit, and adroit flattery of the jury he contrived to secure his acquittal in the face of the open hostility of the judge—a unique achievement at a time when the condemnation of prisoners whom the authorities wished to convict was a mere matter of course. The jurymen were fined and sent to prison, and Throckmorton was detained in the Tower till the following year. There was some talk of bringing him to trial again, but he made his peace, and was employed by Queen Mary. After the accession of Elizabeth he rose rapidly into favour. He became chamberlain of the exchequer, and from May 1559 to April 1564 he was ambassador in France. During the latter part of this period he was associated with Sir Thomas Smith, whose function was at least partly to watch and check his fellow-ambassador. It was in these years that Throckmorton became acquainted with Mary Queen of Scots. He had to conduct the delicate negotiations which accompanied her return to Scotland, and though he was a supporter of the reformers on political grounds, he became her personal friend and was always willing to do her service. As ambassador in France he exerted himself to induce Elizabeth to aid the Huguenots, and took a part in the war of religion. He was taken prisoner by the Catholic leader, the duke of Guise. After his return to England he was sent as ambassador to Scotland in May 1565. The mission entrusted to him was to prevent Queen Mary's marriage with Darnley, which however he was unable to do. After the murder of Darnley he was again sent to Scotland in June 1567 on a still more hopeless mission than the first. He was instructed to persuade the Scottish barons who had just imprisoned the queen to restore her to her authority. His known friendship for Queen Mary and his constant support of her claim to be recognized as Elizabeth's successor, made him a very unwelcome representative of England in that crisis. Moreover, the queen of England increased his difficulties by making him the bearer of offensive messages to the barons, and by contradictory instructions. He cannot have undertaken his task with much zeal, for his own opinion was that Elizabeth would consult her interests best by supporting the barons. In Edinburgh Throckmorton could effect little, but he exerted himself to secure the personal safety of the queen. He offended his mistress by showing his instructions to the Scottish barons, and was recalled in August. In 1569 he fell under suspicion during the duke of Norfolk's conspiracy in favour of Mary, and was imprisoned for a time at Windsor, but was not further proceeded against. He died on the 12th of February 1571. Sir Nicholas married Anne Carew, and his daughter Elizabeth became the wife of Sir Walter Raleigh.

THRONE, a royal, viceregal, or episcopal chair of state standing upon a dais or platform. Formerly the platform, with the steps leading up to it, was comprised in the significance of the word—hence the familiar expression to "mount the throne." The ceremonial induction of a sovereign into his throne is one of the usual solemnities of a coronation, while enthronization of the bishop in his cathedral is the final observance in the making of a diocesan. The throne, which is of immemorial antiquity, is the universal ancestor of all chairs, which were for long symbols of authority and rule. In early days and in Oriental countries thrones were of barbaric magnificence. Solomon's was of ivory "overlaid with the best gold." There were two figures of lions at the sides, with two other lions on each of the six steps. The remains of a throne in rock-crystal were found in the ruins of Sennacherib's palace. The Persian throne made for Abbas the Great was of white marble. This monarch appears to have had a nice taste in thrones, for in 1605 he presented one to the Russian tsar Boris which is covered with sheets of gold and decorated with precious stones and pearls. Tsar Michael Feodorovitch, grandfather of Peter the Great, outdid even this magnificence, for his "golden throne" is set with eight thousand turquoises, fifteen hundred rubies, four great amethysts and two large topazes. One of the glories of Delhi, until it was sacked by Nadir Shah, was the "peacock throne," the value of which was estimated, perhaps with some Eastern exuberance, at twelve millions sterling. It was ascended by silver steps and stood on golden feet set with jewels. It obtained its name from the two open peacocks' tails composed of magnificent diamonds, rubies, and other stones which formed part of its appurtenances. Apparently it was made for Shah Jahan by the French designer of the Taj Mahal. According to that veracious chronicler, Sir John Mandeville, the seven steps of the throne of Prester John were respectively of onyx, crystal, green jasper, amethyst, sardonyx, cornelian and chrysolite. They were bordered with gold and set with pearls. The throne itself was of gold enriched with jewels. Ranjit Singh's golden throne—it is of wood covered with plates of gold—is in the possession of the British Crown. European thrones were usually more modest in conception and less barbaric in execution than those, real or legendary, of the East. The medieval emperors of Byzantium had, however, imbibed a good deal of the Orient, and their famous throne, which is supposed to have been imitated from, as well as named after, that of Solomon, was guarded by golden lions, which rose to their feet and roared when some artful mechanism was set in motion. An exceedingly ancient chair of state is the so-called throne of Dagobert (see CHAIR). The most recent writers on this remarkable relic suggest that it is a bronze copy of Dagobert's golden throne. However that may be, there can be no doubt that it possesses at least one illustrious modern association, for Napoleon sat in it when he distributed the first decorations of the Legion of Honour in his camp at Boulogne in 1804. The throne which Napoleon had made for himself was a heavy gilded chair with an abundance of Egyptian ornament, lions' heads and imperial eagles. One of the many curiosities of a conclave for the electing of a Pope is that every cardinal present occupies a throne, since, during the vacancy of the Holy See, each member of the Sacred College is a potential sovereign. When the election has taken place the canopy of every throne is lowered, with the exception of that occupied by the new pontiff. The palaces of the great Roman nobles contained—and still in some cases contain—a throne for use in the event of a visit from the pope. The papal throne itself is an antique bronze chair which stands in St Peter's. Embassies frequently contain a throne for the use of the sovereign in whose territory the building technically stands. No ancient throne-chair pertains to the British monarchy; the coronation chair is not, properly speaking, a throne, since it is used only during a portion of the coronation ceremonies. The actual throne of Great Britain is the oaken Gothic chair in the House of Lords occupied by the sovereign at the opening and prorogation of parliament.

THRUM-EYED, a botanical term for flowers which occur in two forms, one of which shows the stamens in the mouth of the corolla, as in the primrose, contrasted with pin-eyed (*q.v.*).

THRUSH (A. S. *Þrysce*, Icel. *Þröstr*, Norw. *Trast*, O. H. Ger. *Drosce*, whence the mod. Ger. *Drossel*, to be compared with the analogous English form Throstle,[1] now almost obsolete, both being apparently diminutives), the name that in England seems to have been common to two species of birds, the first now generally distinguished as the song-thrush, but known in many districts as the mavis,[2] the second called the mistletoe-thrush, but having many other local designations, of which more presently.

The former of these is one of the finest songsters in Europe, but it is almost everywhere so common that its merits in this respect are often disregarded, and not unfrequently its melody, when noticed, is ascribed to the prince of feathered vocalists, the nightingale (*q.v.*). In the spring and summer there is hardly a field, a copse or a garden that is not the resort of a pair or more of song-thrushes; and the brown-backed bird with its spotted breast, hopping over the grass for a few yards, then pausing to detect the movement of a worm, and vigorously seizing the same a moment after, is one of the most familiar sights. Hardly less well-known is the singular nest built by this bird—a deep cup, lined with a thin but stiff coating of fragments of rotten wood, ingeniously spread, and plastered so as to present a smooth interior—in which its sea-green eggs spotted with black are laid. An early breeder, it builds nest after nest during the season, and there can be few birds more prolific. Its ravages on ripening fruits, especially strawberries and gooseberries, excite the enmity of the imprudent gardener who leaves his crops unprotected by nets, but he would do well to stay the hand of revenge, for no bird can or does destroy so many snails, as is testified to the curious observer on inspection of the stones that it selects against which to dash its captures—stones that are besmeared with the slime of the victims and bestrewn with the fragments of their shattered shells. Nearly all the young thrushes reared in the British Islands—and this expression includes the storm-swept isles of the Outer Hebrides, though not those of Shetland—seem to emigrate as soon as they are fit to journey, and at a later period they are followed by most of their parents, so that many parts of the kingdom are absolutely bereft of this species from October to the end of January. On the continent of Europe the autumnal influx of the birds bred in the North is regarded with much interest, for they are easily ensnared and justly esteemed for the table, while their numbers make their appearance in certain districts a matter of great importance.

The second species to which the name applies is distinguished as the mistletoe-thrush, or, by corrupt abbreviation, the missel-thrush.[3] It is known also in many districts as the "storm-cock," from its habit of singing in squally weather that silences almost all other birds, and "holm-(*i.e.* holly-) thrush"; while the harsh cries it utters when angry or alarmed have given it other local names, as "screech," "shrite" and "skrike," all traceable to the Anglo-Saxon *Scric*.[4] This is a larger species than the last, of paler tints, and conspicuous in flight by the white patches on its outer tail-feathers. Of bold disposition, and fearless of the sleety storms of spring, as of predatory birds, the cock will take his stand on a tall tree, "like an enchanter calling up the gale" (as Knapp happily wrote), and thence with loud voice proclaim in wild and discontinuous notes the fervour of his love for his mate; nor does that love cease when the breeding-season is past, since this species is one of those that appear to pair for life, and even when, later in the year, it gathers in small flocks, husband and wife may be seen in close company. In defence of nest and offspring, too, few birds are more resolute, and the daw, pie or jay that approaches with an ill intent speedily receives treatment that causes a rapid retreat, while even the marauding cat finds the precincts of the "master of the coppice," (*Pen y llwyn*), as the Welsh name this thrush, unsuitable for its stealthy operations. The connexion of this bird with the mistletoe, which is as old as the days of Aristotle, is no figment, as some have tried to maintain. Not only is it exceedingly fond of the luscious viscid berries, but it seems to be almost the only bird that will touch them.

The thrushes form a distinct family, Turdidae, of the Oscines division of perching birds, and are now divided into five subfamilies: (1) Turdinae, or true thrushes and their immediate allies, the ousel (*q.v.*), the fieldfare (*q.v.*), the redwing (*q.v.*), the rock-thrushes (*Monticola*), the wheatears, stonechats, whinchats (see WHEATEAR), the redstarts (*q.v.*), robins (see REDBREAST), and

[1] For many interesting facts connected with the words "thrush" and "throstle" which cannot be entered upon here, the reader should consult Professor Skeat's *Etymological Dictionary*.

[2] Cognate with the French *mauvis*, though that is nowadays almost restricted to the redwing. Its diminutive is *mauviette*, the modern table-name of the skylark, and perhaps *mavis* was in English originally the table-name of the thrush.

[3] There is no doubt of the bird taking its name from the plant mistletoe (*Viscum album*), about the spelling of which there can be no uncertainty—A. S. *Misteltan*, the final syllable originally signifying "twig," and surviving in the modern "tine," as of a fork or of a deer's antler.

[4] It seems quite possible that the word shrike, though now commonly accepted as the equivalent, in an ornithological sense, of *Lanius*, may have been originally applied to the mistletoe-thrush. In several of the Anglo-Saxon *Vocabularies* dating from the 8th to the 11th century, as printed by Thomas Wright, the word *Scric*, which can be hardly anything else than the early form of "shrike," is glossed *Turdus*.

hedge-sparrows (see SPARROW). In these, as opposed to the warblers, the young are spotted. (2) Myiodectinae, a small group, chiefly South American, with strong bristles round the gape. (3) Sylviinae (see WARBLERS). (4) Polioptilinae or gnat-catchers of North and South America. (5) Miminae or mocking-birds (*q.v.*). The so-called "babbling-thrushes" which occur throughout the Old World are usually referred to a distinct family, the Timeliidae, characterized by strong bills and feet, and short, rounded and incurved wings. The "ant thrushes" belong to a different family (see PITTA). (A. N.)

THUCYDIDES (Θουκυδίδης), Athenian historian. Materials for his biography are scanty, and the facts are of interest chiefly as aids to the appreciation of his life's labour, the *History of the Peloponnesian War*. The older view that he was probably born in or about 471 B.C., is based on a passage of Aulus Gellius, who says that in 431 Hellanicus "seems to have been" sixty-five years of age, Herodotus fifty-three and Thucydides forty (*Noct. att.* xv. 23). The authority for this statement was Pamphila, a woman of Greek extraction, who compiled biographical and historical notices in the reign of Nero. The value of her testimony is, however, negligible, and modern criticism inclines to a later date, about 460[1] (see Busolt, *Gr. Gesch.* iii., pt. 2, p. 621). Thucydides' father Olorus, a citizen of Athens, belonged to a family which derived wealth and influence from the possession of gold-mines at Scaptē Hylē, on the Thracian coast opposite Thasos, and was a relative of his elder namesake, the Thracian prince, whose daughter Hegesipyle married the great Miltiades, so that Cimon, son of Miltiades, was possibly a connexion of Thucydides (see Busolt, ibid., p. 618). It was in the vault of the Cimonian family at Athens, and near the remains of Cimon's sister Elpinice, that Plutarch saw the grave of Thucydides. Thus the fortune of birth secured three signal advantages to the future historian: he was rich; he had two homes—one at Athens, the other in Thrace—no small aid to a comprehensive study of the conditions under which the Peloponnesian War was waged; and his family connexions were likely to bring him from his early years into personal intercourse with the men who were shaping the history of his time.

The development of Athens during the middle of the 5th century was, in itself, the best education which such a mind as that of Thucydides could have received. The expansion and consolidation of Athenian power was completed, and the inner resources of the city were being applied to the embellishment and ennoblement of Athenian life (see CIMON; PERICLES). Yet the *History* tells us nothing of the literature, the art or the social life under whose influences its author had grown up. The "Funeral Oration" contains, indeed, his general testimony to the value and the charm of those influences. But he leaves us to supply all examples and details for ourselves. Beyond a passing reference to public "festivals," and to "beautiful surroundings in private life," he makes no attempt to define those "recreations for the spirit" which the Athenian genius had provided in such abundance. He alludes to the newly-built Parthenon only as containing the treasury; to the statue of Athena Parthenos which it enshrined, only on account of the gold which, at extreme need, could be detached from the image; to the Propylaea and other buildings with which Athens had been adorned under Pericles, only as works which had reduced the surplus of funds available for the war. He makes no reference to Aeschylus, Sophocles, Euripides, Aristophanes; the architect Ictinus; the sculptor Pheidias; the physician Hippocrates; the philosophers Anaxagoras and Socrates. Herodotus, if he had dealt with this period, would have found countless occasions for invaluable digressions on men and manners, on letters and art; and we might almost be tempted to ask whether his more genial, if laxer, method does not indeed correspond better with a liberal conception of the historian's office. No one can do full justice to Thucydides, or appreciate the true completeness of his work, who has not faced this question, and found the answer to it.

It would be a hasty judgment which inferred from the omissions of the *History* that its author's interests were exclusively political. Thucydides was not writing the history of a period. His subject was an event—the Peloponnesian War—a war, as he believed, of unequalled importance, alike in its direct results and in its political significance for all time. To his task, thus defined, he brought an intense concentration of all his faculties. He worked with a constant desire to make each successive incident of the war as clear as possible. To take only two instances: there is nothing in literature more graphic than his description of the plague at Athens, or than the whole narrative of the Sicilian expedition. But the same temper made him resolute in excluding irrelevant topics. The social life of the time, the literature and the art did not belong to his subject.

The biography which bears the name of Marcellinus states that Thucydides was the disciple of Anaxagoras in philosophy and of Antiphon in rhetoric. There is no evidence to confirm this tradition. But Thucydides and Antiphon at least belong to the same rhetorical school and represent the same early stage of Attic prose. Both writers used words of an antique or decidedly poetical cast; both point verbal contrasts by insisting on the precise difference between terms of similar import; and both use metaphors somewhat bolder than were congenial to Greek prose in its riper age. The differences, on the other hand, between the style of Thucydides and that of Antiphon arise chiefly from two general causes. First, Antiphon wrote for hearers, Thucydides for readers; the latter, consequently, can use a degree of condensation and a freedom in the arrangement of words which would have been hardly possible for the former. Again, the thought of Thucydides is often more complex than any which Antiphon undertook to interpret; and the greater intricacy of the historian's style exhibits the endeavour to express each thought.[2] Few things in the history of literary prose are more interesting than to watch that vigorous mind in its struggle to mould a language of magnificent but immature capabilities. The obscurity with which Thucydides has sometimes been reproached often arises from the very clearness with which a complex idea is present to his mind, and his strenuous effort to present it in its entirety. He never sacrifices thought to language, but he will sometimes sacrifice language to thought. A student may always be consoled by the reflection that he is not engaged in unravelling a mere rhetorical tangle. Every light on the sense will be a light on the words; and when, as is not seldom the case, Thucydides comes victoriously out of this struggle of thought and language, having achieved perfect expression of his meaning in a sufficiently lucid form, then his style rises into an intellectual brilliancy—thoroughly manly, and also penetrated with intense feeling—which nothing in Greek prose literature surpasses.

The uncertainty as to the date of Thucydides' birth renders futile any discussion of the fact that before 431 he took no prominent part in Athenian politics. If he was born in 455, the fact needs no explanation; if in 471, it is possible that his opportunities were modified by the necessity of frequent visits to Thrace, where the management of such an important property as the gold-mines must have claimed his presence. The manner in which he refers to his personal influence in that region is such as to suggest that he had sometimes resided there (iv. 105, 1). He was at Athens in the spring of 430, when the plague broke out. If his account of the symptoms has not enabled physicians to agree on a diagnosis of the malady, it is at least singularly full and vivid. He had himself been attacked by the plague; and, as he briefly adds, "he had seen others suffer." The tenor of his narrative would warrant the inference that he had been one of a few who were active in ministering to the sufferers.

The turning-point in the life of Thucydides came in the winter of 424. He was then forty seven (or, according to Busolt, about thirty-six), and for the first time he is found holding an official position. He was one of two generals entrusted with the command of the regions towards Thrace (τὰ ἐπὶ Θρᾴκης), a phrase which denotes the whole Thracian seaboard from Macedonia

[1] Christ (*Gesch. der griech. Litt.*) gives the date of birth as "about 455."

[2] See Jebb's *Attic Orators*, i. 35.

eastward to the vicinity of the Thracian Chersonese, though often used with more special reference to the Chalcidic peninsula. His colleague in the command was Eucles. About the end of November 424 Eucles was in Amphipolis, the stronghold of Athenian power in the north-west. To guard it with all possible vigilance was a matter of peculiar urgency at that moment. The ablest of Spartan leaders, Brasidas (*q.v.*), was in the Chalcidic peninsula, where he had already gained rapid success; and part of the population between that peninsula and Amphipolis was known to be disaffected to Athens. Under such circumstances we might have expected that Thucydides, who had seven ships of war with him, would have been ready to co-operate with Eucles. It appears, however, that, with his ships, he was at the island of Thasos when Brasidas suddenly appeared before Amphipolis. Eucles sent in all haste for Thucydides, who arrived with his ships from Thasos just in time to beat off the enemy from Eion at the mouth of the Strymon, but not in time to save Amphipolis. The profound vexation and dismay felt at Athens found expression in the punishment of Thucydides, who was exiled. Cleon is said to have been the prime mover in his condemnation; and this is likely enough.

From 423 to 404 Thucydides lived on his property in Thrace, but much of his time appears to have been spent in travel. He visited the countries of the Peloponnesian allies—recommended to them by his quality as an exile from Athens; and he thus enjoyed the rare advantage of contemplating the war from various points of view. He speaks of the increased leisure which his banishment secured to his study of events. He refers partly, doubtless, to detachment from Athenian politics, partly also, we may suppose, to the opportunity of visiting places signalized by recent events and of examining their topography. The local knowledge which is often apparent in his Sicilian books may have been acquired at this period. The mind of Thucydides was naturally judicial, and his impartiality—which seems almost superhuman by contrast with Xenophon's *Hellenica*—was in some degree a result of temperament. But it cannot be doubted that the evenness with which he holds the scales was greatly assisted by his experience during these years of exile.

His own words make it clear that he returned to Athens, at least for a time, in 404, though the precise date is uncertain. The older view (cf. Classen) was that he returned some six months after Athens surrendered to Lysander. More probably he was recalled by the special resolution carried by Oenobius prior to the acceptance of Lysander's terms (Busolt, ibid., p. 628). He remained at Athens only a short time, and retired to his property in Thrace, where he lived till his death, working at his *History*. The preponderance of testimony certainly goes to show that he died in Thrace, and by violence. It would seem that, when he wrote chapter 116 of his third book, he was ignorant of an eruption of Etna which took place in 396. There is, indeed, strong reason for thinking that he did not live later than 399. His remains were brought to Athens and laid in the vault of Cimon's family, where Plutarch (*Cimon*, 4) saw their resting-place. The abruptness with which the *History* breaks off agrees with the story of a sudden death. The historian's daughter is said to have saved the unfinished work and to have placed it in the hands of an editor. This editor, according to one account, was Xenophon, to whom Diogenes Laërtius (ii. 6, 13) assigns the credit of having "brought the work into reputation, when he might have suppressed it." The tradition is, however, very doubtful; it may have been suggested by a feeling that no one then living could more appropriately have discharged the office of literary executor than the writer who, in his *Hellenica*, continued the narrative.

The History.—At the outset of the *History* Thucydides indicates his general conception of his work, and states the principles which governed its composition. His purpose had been formed at the very beginning of the war, in the conviction that it would prove more important than any event of which Greeks had record. The leading belligerents, Athens and Sparta, were both in the highest condition of effective equipment. The whole Hellenic world—including Greek settlements outside of Greece proper—was divided into two parties, either actively helping one of the two combatants or meditating such action. Nor was the movement confined within even the widest limits of Hellas; the "barbarian" world also was affected by it—the non-Hellenic populations of Thrace, Macedonia, Epirus, Sicily and, finally, the Persian kingdom itself. The aim of Thucydides was to preserve an accurate record of this war, not only in view of the intrinsic interest and importance of the facts, but also in order that these facts might be permanent sources of political teaching to posterity. His hope was, as he says, that his *History* would be found profitable by "those who desire an exact knowledge of the past as a key to the future, which in all probability will repeat or resemble the past. The work is meant to be a possession for ever, not the rhetorical triumph of an hour." As this context shows, the oft-quoted phrase, "a possession for ever," had, in its author's meaning, a more definite import than any mere anticipation of abiding fame for his *History*. It referred to the permanent value of the lessons which his *History* contained.

Thucydides stands alone among the men of his own days, and has no superior of any age, in the width of mental grasp which could seize the general significance of particular events. The political education of mankind began in Greece, and in the time of Thucydides their political life was still young. Thucydides knew only the small city-commonwealth on the one hand, and on the other the vast barbaric kingdom; and yet, as has been well said of him, "there is hardly a problem in the science of government which the statesman will not find, if not solved, at any rate handled, in the pages of this universal master."[1]

Such being the spirit in which he approached his task, it is interesting to inquire what were the points which he himself considered to be distinctive in his method of executing it.

His Predecessors.

His Greek predecessors in the recording of events had been, he conceived, of two classes. First, there were the epic poets, with Homer at their head, whose characteristic tendency, in the eyes of Thucydides, is to exaggerate the greatness or splendour of things past. Secondly, there were the Ionian prose writers whom he calls "chroniclers" (see LOGOGRAPHI), whose general object was to diffuse a knowledge of legends preserved by oral tradition and of written documents—usually lists of officials or genealogies—preserved in public archives; and they published their materials as they found them, without criticism. Thucydides describes their work by the word ξυντιθέναι, but his own by ξυγγράφειν—the difference between the terms answering to that between compilation of a somewhat mechanical kind and historical composition in a higher sense. The vice of the "chroniclers," in his view, is that they cared only for popularity, and took no pains to make their narratives trustworthy. Herodotus was presumably regarded by him as in the same general category.

Distinctive Aim of Thucydides.

In contrast with these predecessors Thucydides has subjected his materials to the most searching scrutiny. The ruling principle of his work has been strict adherence to carefully verified facts. "As to the deeds done in the war, I have not thought myself at liberty to record them on hearsay from the first informant or on arbitrary conjecture. My account rests either on personal knowledge or on the closest possible scrutiny of each statement made by others. The process of research was laborious, because conflicting accounts were given by those who had witnessed the several events, as partiality swayed or memory served them."

The Speeches.

It might be supposed that the speeches which Thucydides has introduced into his *History* conflict with this standard of scientific accuracy; it is, therefore, well to consider their nature and purpose rather closely. The speeches constitute between a fourth and a fifth part of the *History*. If they were eliminated, an admirable narrative would indeed remain, with a few comments, usually brief, on the more striking characters and events. But we should lose all the most vivid light on the inner workings of the Greek political mind, on the motives of the actors and the arguments which they used—in a word, on the whole play of contemporary feeling and opinion. To the speeches is due in no small measure the imperishable intellectual interest of the *History*, since it is chiefly by the speeches that the facts of the Peloponnesian War are so lit up with keen thought as to become illustrations of general laws, and to acquire a permanent suggestiveness for the student of politics. When Herodotus made his persons hold conversations or deliver speeches, he was following the precedent of epic poetry; his tone is usually colloquial rather than rhetorical; he is merely making thought and motive vivid in the way natural to a simple age. Thucydides is the real founder of the tradition by which historians were so long held to be warranted in introducing set speeches of their own composition. His own account of his practice is given in the following words: "As to the speeches made on the eve of the war, or in its course, I have found it difficult to retain a memory of the precise words which I had heard spoken; and so it was with those who brought me reports

[1] Freeman, *Historical Essays*, 2nd series, vol. iii.; on the general questions of the structure of the work and the view of the war which it represents see PELOPONNESIAN WAR; and GREECE: *Ancient History*, § Authorities.

But I have made the persons say what it seemed to me most opportune for them to say in view of each situation; at the same time I have adhered as closely as possible to the general sense of what was actually said." So far as the language of the speeches is concerned, then, Thucydides plainly avows that it is mainly or wholly his own. As a general rule, there is little attempt to mark different styles. The case of Pericles, whom Thucydides must have repeatedly heard, is probably an exception; the Thucydidean speeches of Pericles offer several examples of that bold imagery which Aristotle and Plutarch agree in ascribing to him, while the "Funeral Oration," especially, has a certain majesty of rhythm, a certain union of impetuous movement with lofty grandeur, which the historian has given to no other speaker. Such strongly marked characteristics as the curt bluntness of the Spartan ephor Sthenelaïdas, or the insolent vehemence of Alcibiades, are also indicated. But the dramatic truth of the speeches generally resides in the matter, not in the form. In regard to those speeches which were delivered at Athens before his banishment in 424—and seven such speeches are contained in the *History*—Thucydides could rely either on his own recollection or on the sources accessible to a resident citizen. In these cases there is good reason to believe that he has reproduced the substance of what was actually said. In other cases he had to trust to more or less imperfect reports of the "general sense"; and in some instances, no doubt, the speech represents simply his own conception of what it would have been "most opportune" to say. The most evident of such instances occur in the addresses of leaders to their troops. The historian's aim in these military harangues—which are usually short—is to bring out the points of a strategical situation; a modern writer would have attained the object by comments prefixed or subjoined to his account of the battle. The comparative indifference of Thucydides to dramatic verisimilitude in these military orations is curiously shown by the fact that the speech of the general on the one side is sometimes as distinctly a reply to the speech of the general on the other as if they had been delivered in debate. We may be sure, however, that, wherever Thucydides had any authentic clue to the actual tenor of a speech, he preferred to follow that clue rather than to draw on his own invention.

The Greek View.

Why, however, did he not content himself with simply stating, in his own person, the arguments and opinions which he conceived to have been prevalent? The question must be viewed from the standpoint of a Greek in the 5th century B.C. Epic poetry had then for many generations exercised a powerful influence over the Greek mind. Homer had accustomed Greeks to look for two elements in any complete expression of human energy—first, an account of a man's deeds, then an image of his mind in the report of his words. The Homeric heroes are exhibited both in action and in speech. Further, the contemporary readers of Thucydides were men habituated to a civic life in which public speech played an all-important part. Every adult citizen of a Greek democracy was a member of the assembly which debated and decided great issues. The law courts, the festivals, the drama, the market-place itself, ministered to the Greek love of animated description. To a Greek of that age a written history of political events would have seemed strangely insipid if speech "in the first person" had been absent from it, especially if it did not offer some mirror of those debates which were inseparably associated with the central interests and the decisive moments of political life. In making historical persons say what they might have said, Thucydides confined that oratorical licence to the purpose which is its best justification: with him it is strictly dramatic, an aid to the complete presentment of action, by the vivid expression of ideas and arguments which were really current at the time. Among later historians who continued the practice, Polybius, Sallust and Tacitus most resemble Thucydides in this particular; while in the Byzantine historians, as in some moderns who followed classical precedent, the speeches were usually mere occasions for rhetorical display. Botta's *History of Italy* from 1780 to 1814 affords one of the latest examples of the practice, which was peculiarly suited to the Italian genius.

The Eight Books.

The present division of the *History* into eight books is one which might well have proceeded from the author himself, as being a natural and convenient disposition of the contents. The first book, after a general introduction, sets forth the causes of the Peloponnesian War. The first nine years of the war are contained in the second, third and fourth books—three years in each. The fifth book contains the tenth year, followed by the interval of the "insecure peace." The Sicilian expedition fills the sixth and seventh books The eighth books opens that last chapter of the struggle which is known as the "Decelean" or "Ionian" War, and breaks off abruptly—in the middle of a sentence, indeed—in the year 411.

Origin of that Division.

The principal reason against believing that the division into eight books was made by Thucydides himself is the fact that a different division, into thirteen books, was also current in antiquity, as appears from Marcellinus (§ 58). It is very improbable—indeed hardly conceivable—that this should have been the case if the eight-book division had come down from the hand of the author. We may infer, then, that the division of the work into eight books was introduced at Alexandria—perhaps in the 3rd or 2nd century B.C. That division was already familiar to the grammarians of the Augustan age. Dionysius of Halicarnassus, who recognizes it, has also another mode of indicating portions of the work, viz. by *stichometria*, or the number of lines which they contained. Thus, in the MS. which he used, the first 87 chapters of book i. contained about 2000 lines (equivalent to about 1700 lines in Bekker's stereotyped 8vo text). (On the order of composition, see PELOPONNESIAN WAR, *ad init.*; and GREECE: *Ancient History*, § Authorities).

Mode of Reckoning Time.

The division of the war by summers and winters (κατὰ θέρος καὶ χειμῶνα)—the end of the winter being considered as the end of the year—is perhaps the only one which Thucydides himself used, for there is no indication that he made any division of the *History* into books. His "summer" includes spring and autumn and extends, generally speaking, from March or the beginning of April to the end of October. His "winter"—November to February inclusive—means practically the period during which military operations, by land and sea, are wholly or partly suspended. When he speaks of "summer" and "winter" as answering respectively to "half" the year (v. 20, 3), the phrase is not to be pressed: it means merely that he divides his year into these two parts. The mode of reckoning is essentially a rough one, and is not to be viewed as if the commencement of summer or of winter could be precisely fixed to constant dates. For chronology, besides the festivals, he uses the Athenian list of archons, the Spartan list of ephors and the Argive list of priestesses of Hera.

There is no reference to the *History* of Thucydides in the extant Greek writers of the 4th century B.C.; but Lucian has preserved a tradition of the enthusiasm with which it was studied by Demosthenes. The great orator is said to have copied it out eight times, or even to have learnt it by heart. The Alexandrian critics acknowledged Thucydides as a great master of Attic. Sallust, Cornelius Nepos, Cicero and Quintilian are among the Roman writers whose admiration for him can be traced in their work, or has been expressly recorded. The most elaborate ancient criticism on the diction and composition of Thucydides is contained in three essays by Dionysius of Halicarnassus.

MSS., &c.

Among the best MSS. of Thucydides, the Codex vaticanus 126 (11th century) represents a recension made in the Alexandrian or Roman age. In the first six books the number of passages in which the Vaticanus alone has preserved a true reading is comparatively small; in book vii. it is somewhat larger; in book viii. it is so large that here the Vaticanus, as compared with the other MSS., acquires the character of a revised text. Other important MSS. are the Palatinus 252 (11th century); the Casselanus (A.D. 1252); the Augustanus monacensis 430 (A.D. 1301). A collation, in books i., ii., of two Cambridge MSS. of the 15th century (NN. 3, 18; KK. 5, 19) has been published by Shilleto. Several Parisian MSS. (H. C. A. F.), and a Venetian MSS. (V.) collated by Arnold, also deserve mention. The Aldine edition was published in 1502. It was formerly supposed that there had been two Juntine editions. Shilleto, in the "Notice" prefixed to book i., first pointed out that the only Juntine edition was that of 1526, and that the belief in an earlier Juntine, of 1506, arose merely from the accidental omission of the word *vicesimo* in the Latin version of the imprint. Some papyrus fragments were published in Grenfell and Hunt's *Oxyrhynchus papyri* (1908), vi., which also contains an anonymous commentary (pub. 1st century) on Thuc. ii.

The most generally useful edition is Classen's, in the Weidmann Series (1862–1878; new ed. by Steup, 1882–1892); each book can be obtained separately. Arnold's edition (1848–1851) contains much that is still valuable. For books i. and ii. Shilleto's edition (1872–1876) furnishes a commentary which, though not full, deals admirably with many difficult points. Among other important complete editions, it is enough to name those of Duker, Bekker, Goeller, Poppo and Krüger. For editions of separate books and selections (up to 1895) see J. B. Mayor's *Guide to the Choice of Classical Books.* Special mention may be made of those by E. C. Marchant. Later editions of the text are by H. Stuart Jones (1900–1901), in the Oxford *Scriptorum classicorum bibliotheca*, and C. Hude ("Teubner Series," 1901; ed. minor, 1903). Bétant's lexicon to Thucydides (1843) is well executed. Jowett's translation (1883) is supplemented by a volume of notes. Dale's version (Bohn) also deserves mention for its fidelity, as Crawley's (1876) for its vigour. *Hellenica* (1880) contains an essay on "The Speeches of Thucydides," which has been translated into German (see Eduard Meyer, *Forschungen zur alten Geschichte*, Bd. ii. pp. 269–436). The best clue to Thucydidean bibliography is in Engelmann's *Scriptores graeci* (1880), supplemented by the articles by G. Meyer, in Bursian's *Jahresbericht*, (1895) lxxix., (1897) lxxxviii. Busolt, *Griechische Geschichte*, iii. 616–693, is invaluable. For the life of Thucydides, U. von Wilamowitz-Moellendorff, "Die Thukydides-Legende," *Hermes*, (1878) xii., is all important. All works on ancient Greek History contain discussions of Thucydides, and an interesting criticism is that of J. B. Bury, *Ancient Greek Historians* (1909). F. M. Cornford, *Thucydides mythistoricus* (1907), sought to prove that the *History* is really only an historical tragedy, *i.e.* a dramatized version of the facts, but this view has not been adopted. (R. C. J.; J. M. M.)

THUGS. That the Sanskrit root *sthag* (Pali, *ṭhak*), to cover, to conceal, was mainly applied to fraudulent concealment, appears from the noun *sthaga*, a cheat, which has retained this signification in the modern vernaculars, in all of which it has assumed the form *ṭhag* (commonly written *thug*), with a specific meaning. The Thugs were a well-organized confederacy of professional assassins, who in gangs of whom 10 to 200 travelled in various guises through India, wormed themselves into the confidence of wayfarers of the wealthier class, and, when a favourable opportunity occurred, strangled them by throwing a handkerchief or noose round their necks, and then plundered and buried them. All this was done according to certain ancient and rigidly prescribed forms and after the performance of special religious rites, in which the consecration of the pickaxe and the sacrifice of sugar formed a prominent part. From their using the noose as an instrument of murder they were also frequently called *Phansigars*, or "noose-operators." Though they themselves trace their origin to seven Mahommedan tribes, Hindus appear to have been associated with them at an early period; at any rate, their religious creed and practices as stanch worshippers of Kali (Devi, Durga), the Hindu goddess of destruction, had certainly no flavour of Islam in them. Assassination for gain was with them a religious duty, and was considered a holy and honourable profession. They had, in fact, no idea of doing wrong, and their moral feelings did not come into play. The will of the goddess by whose command and in whose honour they followed their calling was revealed to them through a very complicated system of omens. In obedience to these they often travelled hundreds of miles in company with, or in the wake of, their intended victims before a safe opportunity presented itself for executing their design; and, when the deed was done, rites were performed in honour of that tutelary deity, and a goodly portion of the spoil was set apart for her. The fraternity possessed also a jargon of their own (*Ramasi*), as well as certain signs by which its members recognized each other in the remotest parts of India. Even those who from age or infirmities could no longer take an active part in the operations continued to aid the cause as watchers, spies, or dressers of food. It was owing to their thorough organization, the secrecy and security with which they went to work, but chiefly to the religious garb in which they shrouded their murders, that they could, unmolested by Hindu or Mahommedan rulers, recognized as a regular profession and paying taxes as such, continue for centuries to practise their craft. Both the fractions into which they were divided by the Nerbudda river laid claim to antiquity: while the northern, however, did not trace their origin further back than the period of the early Mahommedan kings of Delhi, the southern fraction not only claimed an earlier and purer descent, but adhered also with greater strictness to the rules of their profession.

The earliest authenticated mention of the Thugs is found in the following passage of Ziau-d din Barni's *History of Firoz Shah* (written about 1356): "In the reign of that sultan," that is, about 1290, "some Thugs were taken in Delhi, and a man belonging to that fraternity was the means of about a thousand being captured. But not one of these did the sultan have killed. He gave orders for them to be put into boats and to be conveyed into the lower country, to the neighbourhood of Lakhnauti, where they were to be set free. The Thugs would thus have to dwell about Lakhnauti and would not trouble the neighbourhood of Delhi any more" (Sir H. M. Elliot's *History of India*, iii. 141). The first European travellers who speak of them without mentioning their name are Thévenot (1665) and Fryer (1673). Though instances of Thagi (Thuggee) had been known to the English rulers in India for many years, and sporadic efforts had been made by them towards the extinction of the gangs, it was not till Lord W. Bentinck (1828–1835) took vigorous steps in this matter that the system was gradually unmasked, and finally all but stamped out. His chief agent, Captain (afterwards Sir William) Sleeman, with several competent assistants, and the co-operation of a number of native states, succeeded in completely grappling with the evil, so that up to October 1835 no fewer than 1562 Thugs had been committed, of which number 382 were hanged and 986 transported or imprisoned for life. According to the *Thuggee and Dacoity Report for 1879*, the number of registered Punjabi and Hindustani Thugs then still amounted to 344; but all of these had already been registered as such before 1852, and the whole fraternity may now be considered as extinct. The Thuggee and Dacoity department continued to exist until 1904, though its operations had long been confined to the suppression of organized robbery in native states. Its place is now taken by the Central Criminal Intelligence department.

Full particulars concerning the system of Thagi are given by Dr Sherwood, "On the Murderers called Phansigars," and J. Shakespear, "Observations regarding Bradheks and Thegs" (both treatises in vol. xiii. (1820), of the *Asiatic Researches*); W. N. Sleeman, *Ramaseeana, or a Vocabulary of the Language used by the Thugs, with an Introduction and Appendix* (Calcutta, 1836); the *Edinburgh Review* for January 1837; E. Thornton, *Illustrations of the History and Practices of the Thugs* (London, 1837); Meadows Taylor, *Confessions of a Thug* (London, 1839; new ed. 1879); Major Sleeman, *Report on the Depredations committed by the Thug Gangs* (Calcutta, 1840); J. Hutton, *Popular Account of the Thugs and Dacoits* (London, 1857). (R. R.)

THUGUT, JOHANN AMADEUS FRANCIS DE PAULA, BARON (1736–1818), Austrian diplomatist, was born at Linz on the 24th of May 1736. His origin and name have been the subject of legends more or less malicious and probably the inventions of enemies. It has been said that the correct form of his name was Thunichtgut, or Thenitguet (do no good), and was altered to Thugut (do good) by Maria Theresa. Tunicotta has been given as a variation. But Thugut was the name of his great-grandfather, who belonged to Budweiss in southern Bohemia. He was the legitimate son of Johann Thugut, an army paymaster, who married Eva Maria Mösbauer, daughter of a miller near Vienna. The paymaster, who died about 1760, left his widow and children in distress, and Maria Theresa took charge of them. Johann Amadeus was sent to the school of Oriental languages. He entered the Austrian foreign office as an interpreter and was appointed dragoman to the embassy at Constantinople. In 1769 he was appointed chargé d'affaires, and in that capacity secured a grant of money and a promise of the territory of Little Wallachia from the Turks during the negotiations connected with the first partition of Poland (see POLAND: *History*). In 1771 he was appointed internuncio at Constantinople and was actively engaged, under the direction of Prince Kaunitz, in all the diplomacy of Austria in Turkey and Poland until he secured the cession of the Bukovina on the 7th of May 1775. During these years Thugut was engaged in a mean intrigue. His salary as dragoman was small, and his needs great. He therefore agreed to receive a pension of 13,000 livres, a brevet of lieutenant-colonel, and a promise of a safe refuge in case of necessity from the king of France, Louis XV. The condition on which the pension was granted was that he took advantage of his position as an Austrian official to render secret services to France. The only excuses to be made for him are that such hidden arrangements were not uncommon before and in his time, and that as a matter of fact he never did render France any real service, or betray his masters at Vienna. Yet the terror of discovery disturbed him at several periods of his life, and when Louis XV. died in 1774 he showed a strong disposition to take refuge in France, and would have done so if Louis XVI. would have given him a promise of employment. His pension was continued. It seems to be tolerably certain that at a later period he made a clean breast to the emperor Francis II. His services at Constantinople were approved by Prince Kaunitz (*q.v.*), who may possibly have been informed of the arrangement with the French secret diplomatic fund. It is never safe to decide whether these treasons were single or double. When Thugut was appointed internuncio he was also ennobled, being raised to the *Ritterstand*. After 1775 he travelled in France and Italy, partly on diplomatic service. In 1778 he was the agent through whom Maria Theresa entered into direct negotiations with Frederick the Great, in order to stop the Bavarian War. In 1780 he was Austrian envoy in

Warsaw, but in 1783 he applied for leave and satisfied his hankering after France by living for four years in Paris. It was in this time that his savings, made during his years of service at Constantinople, by means which would probably not bear investigation, were invested in France. Thugut became acquainted with many of the leaders in the Revolution. From 1787 to 1789 he was minister at Naples, and showed great tact in managing the queen, Maria Carolina, a daughter of Maria Theresa. In 1790 he was sent by the emperor Joseph II. to Bucharest, nominally as commissioner with the hospodar of Wallachia, but in reality in order that he might open negotiations for peace with the Turks. Until 1792 he was much in France and Belgium, partly as a diplomatic agent, but largely because he was anxious to rescue his investments, which were ultimately lost. His personal grievances may have had some share in creating the hatred of the Revolution and the Jacobins, for which he was afterwards famous. In 1792 he was associated with Mercy Argenteau, formerly Austrian ambassador in France, as diplomatic agent at the headquarters of the allied army. The mismanagement of the invasion of France excited his anger. He came back to Vienna to report the facts to Francis II., to whom he presented a statement on the 27th of December. On the 19th of January 1793 he was appointed *armée-diplomat* at headquarters, largely, it is said, by the intrigues of Philip Cobenzl and Spielmann, who wished to have him out of the way. But he never went, for at this time Russia and Prussia annexed large parts of Poland. Austria, entangled in the war with France, was left empty-handed (see POLAND: *History*). The emperor, dissatisfied with the ministers who had not prevented this misfortune, dismissed them, and after some delay Thugut was named "director of the foreign affairs of Austria" on the 25th of March 1793. When Prince Kaunitz died in the following year Thugut was appointed to "discharge the duties of the office of house, court, and state chancellor." His promotion to the foremost place in the Austrian administration met with much opposition, and is known to have been largely due to the empress Maria Theresa of Naples. The Austrian government was by tradition very aristocratic. The empress Maria Theresa, mother of Francis II., though she valued the services of Thugut, had consented with reluctance to make him commander of the order of St Stephen, and had only yielded to the urgent requests of Kaunitz and of her son Joseph II. She thought the promotion excessive for a man of his plebeian origin. The nobles, who thought that the great offices of state should go to themselves, were of the same opinion. Thugut, who had a large fund of vanity, resented their insolence, and did nothing to disarm their hostility. He was unmarried, and he avoided all society. In the discharge of his duties he took counsel with nobody. All the confidential work of his department was done by himself with the help of two clerks he could trust, and he took all important papers directly to the emperor, keeping no copies in his own office. He had his own experience to teach him how easy it was to bribe the officials of Austria. The nobles, who regarded themselves with good cause as the supporters of the Crown, and who expected to be consulted, resented his indifference and secrecy as the arrogance of an upstart. They were his constant enemies and critics. A few of them who admired his abilities supported him on personal grounds, but with these exceptions Thugut had no friends in Austria. Out of it, he was commonly regarded as the representative of all that was most unscrupulous and self-seeking in the methods of the Austrian government. He had inherited from his master Prince Kaunitz the firm conviction that Prussia was the worst enemy of Austria. From him, too, he had learnt that the first duty of an Austrian minister was to be an increaser of the empire, even at the expense of allies, and that excuses for annexation were to be made when they could not be found. His hatred of France, and of the Revolution, was no doubt sincere. But while prepared to defend Europe from French aggression, it was with the implied intention that Austria should be rewarded for her exertions by increases of territory, and should be made the absolute mistress of Germany. The history of his policy from 1793 to 1800 is the history of Europe. The conflicting objects which he kept before him, resistance to French aggression on the west, and to Russian and Prussian aggressions on the east, and the pursuit of more territory for Austria, compelled him to divide his exertions and his forces. Thus in 1793–94 he recalled troops from the west to participate in a partition of Poland, thereby taking pressure off France, and doing much to smooth the way for her subsequent victories. Some of his actions cannot be described as other than criminal. He was certainly responsible for the murderous attack on the French envoys at Rastadt in April 1799. He may have intended that they should only be robbed, but he must be held responsible for the acts of his agents. So again he has to answer for the perverse policy of Austria in 1799 when Suvarov (*q.v.*) and the Russians were recalled from northern Italy for no visible reason except that Austria should be left in sole possession of the dominions of the king of Sardinia, with a good excuse for keeping them. The correspondence of Joseph de Maistre shows how bitterly the continental allies of Austria resented her selfishness, and how firmly they were persuaded that she was fighting for her own hand. That Thugut believed that he was doing his duty, and that he was carrying on the traditional policy of Austria, may be true. Yet his methods were so extreme, and his attitude so provocative as to justify the judgment passed on him by Kaunitz —namely, that he required the control of a strong hand if good results were to be obtained from his ability. After the defeats of Austria in Italy in 1796–97 and the peace of Campo Formio, it became a fixed object with the French, and with a growing party in Austria who held him responsible for the disasters of the war, to secure the removal of Thugut. He found no support, except from the British government, which considered him as a sure ally and had great influence at Vienna as paymaster of subsidies. The death of the empress Catherine of Russia deprived him of a friend at court. During the campaigns of 1799 and 1800 Thugut was the advocate of war "to the knife." At the end he was kept in office only by the vigorous support of England. The battle of Hohenlinden on the 3rd of December 1800 made his position untenable. He retired from public life, and left Vienna for Pressburg on the 27th of March 1801. At a later period he returned to Vienna and lived quietly on a pension of 7000 florins till his death on the 28th of May 1818. In personal appearance Thugut is described as looking like "a faunish Mephistopheles," a favourite of Louis XI., an Italian tyrant of the worst type, and by the prince de Ligne as what Henry IV. of France would have been if he had been king of the Jews, and if his mouth had worn a constant expression of derision, hate and malignity. The only known portrait of him appears to bear out these unpleasant descriptions.

See A. von Vivenot, *Thugut und sein politisches System*, a strong defence of his policy in 1793–1794 (Vienna, 1870); and *Quellen z. Geschichte d. deutschen Kaiserpolitik Oesterreichs während d. französ. Revolutions-Krieg* (Vienna, 1873–1885).

THUIN, a town of Belgium, in that part of the province of Hainaut called "entre Sambre et Meuse." Pop. (1904), 6198. It is situated on the Sambre about 9 m. S.W. of Charleroi. The old part of the town, which dates back to the 10th century, occupies a narrow promontory between the Sambre and a small stream called the Biesmelle. The ruined tower called after him is all that remains of the fortress constructed by Bishop Notger of Liége. It was successfully defended against the Normans and long afterwards against the French under Marshal de Lorges in 1654. Although the town itself retains something of its medieval appearance it is the centre of a great manufacturing and mining district, the banks of the Sambre being lined with factories and coal-yards.

THULE, the Greek and Roman name for the most northerly known land in the north Atlantic. The first to use the name was the Greek navigator Pytheas (about 300 B.C. probably). He calls it the most northerly of the British Isles and says that he reached it after six days' sail from Britain: it was inhabited, but produced little; corn grew there sparingly and ripened ill; in summer the nights were long and bright. This account of his travels is lost save for fragments, and the few surviving fragments

do not determine where his Thule was, but Müllenhoff is probably right in thinking it was the Shetlands. The Faeroes, Iceland and Norway have also been suggested, but are for various reasons much less likely. After Pytheas, the name is used loosely for the farthest north. Thus Agricola's fleet in A.D. 84 sailing up the east coast of Scotland is said to have espied but not to have reached Thule ("dispecta est Thule") but the phrase is merely literary. The actual point meant may be the Orkneys or the Shetlands, or even some fragment of Scotland seen across the water. In some later writers (Procopius, &c.) Thule seems sometimes used to denote Scandinavia. The phrase "ultima Thule" is commonly used to describe the farthest limit possible.
(F. J. H.)

THÜMMEL, MORITZ AUGUST VON (1738–1817), German humorist and satirical author, was born on the 27th of May 1738 at Schönefeld near Leipzig. Educated at Rossleben and the university of Leipzig, where he studied law, he held from 1761 till 1783 various offices in the ducal court of Saxe-Coburg, where he became privy councillor and minister of state. He retired in 1783 and died at Coburg on the 26th of October 1817. He wrote a comic prose epic, *Wilhelmine, oder der vermählte Pedant* (1764); and *Die Inoculation der Liebe* (1771), a tale in verse. His most famous work is his *Reise in die mittäglichen Provinzen von Frankreich im Jahre 1785–1786* (1791–1805), a "sentimental journey" in ten volumes, in which the influence of Wieland is unmistakable. Schiller, who found this work wanting in aesthetic dignity, yet allowed that the keen knowledge of men and things it displays makes it a valuable contribution to literature. Thümmel's other writings are unimportant.

His collected works were published at Leipzig in six volumes (1812), and again in 1820 (7 vols.), with a biography by J. E. von Gruner. The most recent edition is that of 1855 (8 vols.). See also F. Bobertag, *Erzählende Prosa der klassischen Periode* vol. i. (Kürschner's *Deutsche Nationalliteratur*, vol. cxxxvi., 1886). *Wilhelmine* has also been edited by R. Rosenbaum (1894).

THUN (Fr. *Thoune*), a picturesque little town in the Swiss canton of Bern, built on the banks of the Aar, just as it issues from the Lake of Thun, and by rail 19 m. S.E. of Bern, or 17½ m. N.W. of Interlaken. It is the capital of the Bernese Oberland, the snowy peaks of which are well seen from it. It has 6030 inhabitants, mostly German-speaking and Protestants. The 18th-century parish church and the 15th-century castle rise in a striking fashion above the town, in the chief street of which are arcades (locally called *Lauben*) as in Bern. There is a museum in the tower of the castle, while in and near the town (in the Heimberg valley) are several potteries of local ware. From its local lords it passed by 1127 to the house of Zähringen, and on its extinction (1218) to the counts of Kyburg. The heiress of that family brought Thun (and Burgdorf) in 1273 to the cadet or Laufenburg line of the Habsburg family, her mother having (1264) granted the town a charter of liberties that confirmed an earlier grant of 1256. In 1375 the town was mortgaged to Bern, to which it was sold outright in 1384. From 1798 to 1802 Thun was the capital of the canton Oberland of the Helvetic Republic. (W. A. B. C.)

THUN, LAKE OF, in the Swiss canton of Bern, the second lake (the first being that of Brienz) into which the river Aar (*q.v.*) expands. It lies in a deep hollow between (N.W.) the town of Thun (*q.v.*) and (E.) the plain on which Interlaken (*q.v.*) is built between this lake and that of Brienz. It is 11½ m. in length, 2 m. in width, and its maximum depth is 712 ft., while its area is 18½ sq. m., and its surface is 1837 ft. above sea-level. Most splendid views of the great snowy peaks of the Bernese Oberland range are obtained from the lake, while the beauty of its shores renders it a formidable rival in point of picturesqueness to the Lake of Lucerne. Its chief feeder is the Kander (swollen shortly before by the Simme), which in 1714 was diverted by a canal into the lake (south-western end). On or above the south-western shore (along which runs the railway from Thun to Interlaken, 17½ m.) are Spiez (a picturesque village with an ancient castle, and the starting-point of railways towards the Gemmi and Montreux) and Aeschi (admirably situated on a high ridge). On the other shore of the lake are Oberhofen and Gunten (above which is Sigriswil), and Merligen, while above the lake, near its east end, are the wooded heights of St Beatenberg, well known to summer visitors. The first steamer was placed on the lake in 1835. (W. A. B. C.)

THUNBERG, KARL PETER (1743–1828), Swedish naturalist, was born at Jönköping on the 11th of November 1743, and became a pupil of Linnaeus at the university of Upsala. After graduating in medicine there in 1770 he obtained an appointment as surgeon in the Dutch East India Company, and sailed to the Cape of Good Hope in 1772. He spent three years there, and then went to Japan, where he remained till 1778, engaged in making collections of plants. On his return in 1779 he visited England, and made the acquaintance of Sir Joseph Banks. In 1781 he was appointed demonstrator of botany at Upsala, and he succeeded the younger Linnaeus as professor of botany in 1784. He published his *Flora japonica* in 1784, and in 1788 he began to publish his travels. He completed his *Prodomus plantarum* in 1800, his *Icones plantarum japonicarum* in 1805, and his *Flora capensis* in 1813. He published numerous memoirs in the transactions of many Swedish and other scientific societies, of sixty-six of which he was an honorary member. He died near Upsala on the 8th of August 1828. A genus of tropical plants (*Thunbergia*), of the natural order Acanthaceae, which are cultivated as evergreen climbers, is named after him.

THUNDER, the noise which accompanies or follows a flash of lightning, due to the disturbance of air by a discharge of electricity (see LIGHTNING; ATMOSPHERIC ELECTRICITY and METEOROLOGY). The Old English word is *þunor*, also the name of the Scandinavian god Thor (*q.v.*), which is cognate with Dutch *donder*, German *Donner*. The root is *than*,- Indo-European *tan*-, cf. Latin *tonare*, *tonitru*. This root is apparently another form of *stan*-, as in Skr. *stan*, to sound, thunder, Gr. *στένειν*, to groan, Eng. "stun."

THUN-HOHENSTEIN. The family of Thun-Hohenstein, one of the wealthiest of the Austrian nobility, which has for more than 200 years settled at Tetschen, in Bohemia, has given several distinguished members to the Austrian public service. Of the three sons of Count Franz, the eldest, FRIEDRICH (1810–1881), entered the diplomatic service; after holding other posts he was in 1850 appointed president of the restored German Diet at Frankfort, where he represented the anti-Prussian policy of Schwarzenberg, and often came into conflict with Bismarck, who was Prussian envoy. He was afterwards ambassador at Berlin and St Petersburg. After his retirement from the public service in 1863 he supported in the Bohemian *Landtag* and the Austrian *Reichsrat* the federal policy of his brother Leo. In 1879 he was made hereditary member of the Upper House. In this position he was on his death, on the 24th of September 1881, succeeded by his eldest son FRANZ ANTON (b. 1847). Like the rest of his family, he belonged to the Federalist party, and his appointment in 1889 as governor of Bohemia was the cause of grave dissatisfaction to the German Austrians. He took a leading part in the negotiation of 1890 for the Bohemian settlement, but the elections of 1891, in which the young Czechs who were opposed to the feudal party gained a decisive victory, made his position a very difficult one. Contrary to expectation, he showed great energy in suppressing disorder; but after the proclamation of a state of siege his position became untenable, and in 1895 he had to resign. On the resignation of Badeni in 1898 he was made minister president, an office which he held for little more than a year, for, though he succeeded in bringing to a conclusion the negotiations with Hungary, the support he gave to the Czechs and Slovenians increased the opposition of the Germans to such a degree that parliamentary government became impossible, and at the end of 1899 he was dismissed.

The third son of Count Franz, LEOPOLD OR LEO (1811–1888), was one of the leading Austrian statesmen. After studying at the university of Prague he travelled through Europe, and among other countries he visited England, where he became acquainted with James Hope (afterwards Hope-Scott) and other leaders of the Tractarian party. He was much affected by the romantic movement and the Ultramontane revival, and after his return home interested himself greatly in the revival of Czech language and literature and the growth of the Bohemian national feeling. He formed a personal friendship with Palacky and others of the Czech leaders; he helped in the foundation of schools in which Czech should be taught, and set himself to acquire some knowledge of the language. He was also interested in prison reform, on which he wrote, and other philanthropic work. After serving under Stadion in Galicia, he was in 1848, after the outbreak of the revolution, appointed president of the administration and acting Stadthalter in Bohemia. He had scarcely entered on his duties when the rebellion of June broke out in Prague. In order to avoid bloodshed, he went down to the insurgents on the barricade, but was seized by them, imprisoned, and for some time his life was in danger. On his release he vigorously supported Windischgrätz, who was in command of the troops, in the restoration of order, but thereby lost his popularity and was superseded. He still defended the Bohemian national movement, and in one of his writings laid down the principle that nationality was one of the interests outside the control of the state. Notwithstanding this, in 1849 he accepted the office of minister of religion and education, which he held in 1860 under the autocratic and centralizing administration of Schwarzenberg and Bach. At first he threw himself with great energy into the task of building up an adequate system of schools. He summoned experienced teachers, Protestant as well as Catholic, from Germany, established middle and higher schools in all parts of the empire, superseded the antiquated textbooks and methods of instruction, and encouraged the formation of learned societies and the growth of a professional spirit and independence among the teachers. It is noticeable that at this time he insisted on the use of German in all schools of higher education. As minister of religion he was to a certain extent responsible for the concordat which again subjected the schools to the control of the Church: to a certain extent he thereby undid some of his work for the extension of education, and it was of him that Grillparzar said, "I have to announce a suicide. The minister of religion has murdered the minister of education." But during his administration the influence of the church over the schools was really much less than, by the theory of the concordat, it would have appeared to be. The crisis of 1860, by which the office he held was abolished, was the end of his official career; for the rest of his life he was very prominent as the leader of the Federalist party in Bohemia. His high social position, his influence at court, his character, as well as his undoubted abilities and learning, not often in Austria found in a man of his rank, gave him great influence. He supported the claims of Bohemia to a full autonomy; he strongly attacked both the February constitution and the *Ausgleich* with Hungary; what he desired was a common parliament for the whole empire based on a settlement with each one of the territories. With the old Czechs he refused to recognise the constitution of 1867; he helped to draft the declaration of 1868 and the fundamental articles of 1871, and took a leading part in the negotiations during the ministry of Potocki and Hohenwart. In order to found a strong Conservative party he established a paper, the *Vaterland*, which was the organ of the Clerical and Federalist party. It is needless to say that he protested against the ecclesiastical legislation of 1867 and 1873. He married in 1847 the countess Clàm-Martinic, but there was no issue of the marriage. He died in Vienna on the 17th of December 1888.

See the very full article by Frankfurter in the *Allgemeine deutsche Biographie*, which supersedes his earlier biography. (J. W. He.)

THURET, GUSTAVE ADOLPHE (1817–1875), French botanist, was born in Paris on the 23rd of May 1817. He came of an old Huguenot family, which had sought refuge for a time in Holland after the revocation of the Edict of Nantes. A trace of Dutch influence still persists in the pronunciation of the family name in which the final *t* is sounded. Thuret's mother was brought up in England; English was the first language that he learnt, and he appears to have retained strong sympathies with Great Britain throughout life. As a young man he studied for the law; in his leisure time he was an ardent musician, and it was from a musical friend, de Villers, that he received, in 1837, his first initiation into botany. Beginning simply as a collector, he soon came under the influence of Joseph Decaisne (1809-1882), whose pupil he became. It was Decaisne who first encouraged him to undertake those algological studies which were to become the chief work of his life. Thuret twice visited Constantinople in company with the French ambassador, M. de Pontois, and was for a time attaché to the French embassy there. His diplomatic career, though of short duration, gave him a valuable opportunity of studying the Oriental flora. After travelling in Syria and Egypt in the autumn of 1841, he returned to France. Giving up his intention of entering the civil service, he retired to his father's country house at Rentilly, and thenceforth devoted himself to scientific research. He had already, in 1840, published his first scientific paper, "Notes sur l'anthère de *Chara* et les animalcules qu'elle renferme," in which he first accurately described the organs of motion of the "animalcules" or spermatozoids of these plants. He continued his studies of the zoospores and male cells of Algae and other Cryptogams, and our exact knowledge of these remarkable motile stages in vegetable life is largely due to his labours. He spent a great part of his time, up to 1857, on the Atlantic coast of France, assiduously observing the marine Algae in their natural habitat and at all seasons. In conjunction with his friend Édouard Bornet, he became the recognized authority on this important group of plants, of which the two colleagues acquired an unrivalled knowledge. Their work, while remarkable for taxonomic accuracy, was more especially concentrated on the natural history, development and modes of reproduction of the plants investigated. The discovery of sexual reproduction in seaweeds is almost wholly the work of these two men. The researches on the fecundation of the Fucaceae were published by Thuret in 1853 and 1855; the complicated and difficult question of the sexual reproduction in Floridae was solved by the joint work of Thuret and Bornet (1867). These great discoveries—of far-reaching biological significance—stand out as the chief, but every group of marine Algae was elucidated by the researches of Thuret and his colleague. There are few scientific authors whose work has so completely stood the test of subsequent investigation and criticism. Thuret's style in expounding his results was singularly clear and concise; he was a man of wide education, and possessed the power of expressing his ideas with literary skill. Unfortunately, much of his best work remained unpublished during his life. A portion of the material accumulated by himself and his colleague was embodied in two magnificent works published after his death—the *Notes algologiques* (1876–1880), and the still finer *Études phycologiques* (1878). These volumes, as well as earlier memoirs, are illustrated by drawings of unequalled accuracy and beauty from the hand of the artist Riocreux, whom Thuret employed. In 1857 Thuret removed to Antibes on the Mediterranean coast, where, on a once barren promontory, he established a botanic garden which became famous throughout the scientific world. Since his death the Antibes establishment has been placed at the disposal of botanical workers as an institute for research. Thuret died suddenly, while on a visit to Nice, on the 10th of May 1875, when he had scarcely completed his fifty-eighth year. He was a man of considerable wealth, who devoted his money as freely as his time and labour to the advancement of science, but his high reputation rests on the brilliancy of his personal investigations.

The best and fullest account of Thuret's career is that by his friend and fellow worker Bornet, published in the *Annales des sciences naturelles* for 1876. An English notice of his life, by Professor W. G. Farlow, will be found in the *Journal of Botany* for the same year. (D. H. S.)

THURGAU (Fr. *Thurgovie*), one of the cantons of north-eastern Switzerland, bordering on the Lake of Constance and the Rhine as it issues from that lake. Its total area is 390·4 sq. m., of which 326·9 sq. m. are reckoned as "productive" (forests covering 69·3 sq. m. and vineyards 4·4 sq. m.); of the "unproductive" portion most ($59\frac{3}{4}$ sq. m.) consists of the cantonal share of the Lake of Constance. The canton is partly made up of the central portion of the valley of the Thur (which rises in the Toggenburg), with its affluent the Murg, and partly of the level stretch along the west shore of the Lake of Constance and left bank of the Rhine. Low ranges of wooded hills separate the lake from the Thur valley and the latter from that of the Murg, as well as from the cantons of Zürich and of St Gall, the highest point in the canton being situated at its southern extremity, and forming the northern slope (3271 ft.) of the Hörnli (3727 ft.), itself wholly in Zürich. The small outlying district of Horn is an "enclave" in the canton of St Gall, because it was acquired in 1463 by the bishop of Constance, who incorporated it with the bailiwick of Arbon, the fate of which it has followed. In 1798 the lower portion of the Stammheim glen was given to Zürich, as well as the Diessenhofen region to Schaffhausen, but the latter region came back to Thurgau in 1800. The main railway line from Winterthur to Romanshorn (with a branch to St Gall) runs right through the canton, while on its north edge is the direct line along the left bank of the Rhine from Constance to Schaffhausen. A network of well-made roads traverses the canton in every direction, some of them being now served by public motor cars. It is a prosperous region, the population being mainly engaged in agriculture, and in cotton-spinning, which is often combined with it at home. The orchards are so splendid that Thurgau has been called "the garden of Helvetia." The vineyards produce a number of highly esteemed wines (the best known is the red Bachtobler), which are said to retain their strength for eight or ten years, this being attributed to the influence of the east wind to which the vines are much exposed. In 1900 the population was 113,221, of whom 110,845 were German-speaking, 1867 Italian-speaking and 332 French-speaking, while there were 77,210 Protestants, 35,824 Romanists and 113 Jews. Its capital is Frauenfeld (*q.v.*), while other important places are Arbon (pop. 5677), Kreuzlingen (4732), practically a suburb of Constance, and Romanshorn (*q.v.*), the chief port of the canton on the Lake of Constance. Till 1814 it was in the diocese of Constance, and since 1828 in that of Basel. The canton is divided into eight administrative districts, which comprise 212 communes. In 1869 the very advanced existing constitution was adopted, by which the "initiative" (or right of 2500 electors to compel the cantonal assembly to take any subject into consideration), and the "obligatory referendum," taking place twice a year (by which all laws passed by the cantonal assembly, and all financial resolutions involving a capital expenditure of 50,000 francs or an annual one of 10,000, must be submitted to a popular vote), were introduced. The cantonal government consists of a legislative assembly or *Grossvat* (one member to every 250 electors, or fraction over 125) and a *Regierungsvat* or executive council of five members, both elected directly by the people and holding office for three years; 5000 electors can at any time call for a popular vote on the question of the dismissal of either one or the other. Further, to show the very democratic character of the (1869) constitution, it may be added that members of both houses of the Federal assembly are in Thurgau elected direct by the people, and hold office for three years. The "communes" in Thurgau are of no less than eleven or twelve varieties. The division of the lands, &c., of the old "burgher communes" between them and the new communes, consisting of all residents (with whom political power rests), was carried out (1872) in all the 212 communes; but there are still 38 gilds or corporations with special rights over certain forests, &c.

The Thurgau originally took in all the country, roughly speaking, between the Reuss, the Lake of Lucerne, the Rhine and the Lake of Constance; but many smaller districts (Zürichgau, Toggenburg, Appenzell, St Gall) were gradually carved out of it, and the county was reduced to about the size of the present canton when in 1264 it passed by the gift of the last count of Kyburg to his nephew Rudolph of Habsburg, chosen emperor in 1273. In 1415 the count, Duke Frederick of Austria (a Habsburg), was put under the ban of the empire by the emperor Sigismund for having aided Pope John XXIII. to escape from Constance, and the county was overrun, Sigismund in 1417 mortgaging to the city of Constance the appellate jurisdiction in all civil and criminal matters ("Landgericht" and "Blutbann") arising within the county, which he had declared to be forfeited in consequence of Frederick's conduct. In 1460 some of the Confederates, now becoming very eager for conquests, overran and seized the county. Winterthur was saved, but in 1461 Frederick's son, Duke Sigismund, had perforce to cede the county to the Confederates. Henceforth it was ruled as a "subject district" by seven members of the League—Bern occupied in the west, not being admitted to a share in the government till 1712, after one of the wars of religion. It was only in 1499 that the Confederation (then consisting of ten members) obtained from the emperor (the claims of Constance being passed over in silence) the supreme jurisdiction, through the mediation of the duke of Milan, but there were still 103 minor jurisdictions belonging to various lords spiritual (particularly the bishop of Constance, the abbot of St Gall and the abbot of Reichenau) and temporal, which went on till 1798 and greatly limited the power of the Confederates. Thurgau had hoped, but in vain, to be admitted in 1499 a full member of the Confederation.

At the time of the Reformation many of the inhabitants became Protestants, and bitter quarrels ensued between the Protestant and Catholic (the latter having a large majority) members of the Confederation who had rights over Thurgau, with regard to the toleration of the new doctrines in the "subject districts" such as Thurgau. By the first peace of Kappel (1529) the majority in each "commune" was to settle the religion of that "commune," but by the second (1531, after Zwingli's death) both religions were to be allowed side by side in each "commune." Thurgau thus became a "canton of parity," as it is to this day. Its rulers, however, continued to watch each other very closely, and Kilian Kesselring, one of the chief military commanders in Thurgau, was in 1633, on suspicion of having connived at the advance of the Swedes through Thurgau on Constance, seized by the Catholic cantons and severely punished. In 1798 Thurgau became free, and was one of the nineteen cantons of the Helvetic republic, being formally received (like the other "subject lands") as a full member of the Swiss Confederation in 1803 by the Act of Mediation. It was one of the very first cantons to revise, in 1830, after the July revolution in Paris, its constitution in a very liberal sense, and in 1831 proposed a revision of the Federal Pact of 1815. This failed, but the new Federal constitutions of 1848 (of which one of the two drafters was Kern of Thurgau) and 1874 were approved by very large majorities. In 1848 almost all of the convents in the canton were suppressed, one only (that of the Dominican nuns at St Katharinenthal) surviving till extinguished in 1869 by the new cantonal constitution, which also forbade the erection of any new religious houses. In 1849 the cantonal constitution was revised and the veto introduced, by which the people might reject a bill passed by the cantonal assembly. The castle (modern) of Arenenberg, above the western arm of the Lake of Constance, belonged to the Napoleonic family from 1817 to 1843, and was repurchased by them in 1855. It contains many relics of Napoleon III., whose widow, the ex-empress Eugénie, in 1906 presented it (with provision for annual masses in the chapel) to the canton of Thurgau, which has converted it into an agricultural college.

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THURIBLE (Lat. *thuribulum* or *turibulum*, *thus* or *tus*, incense, Gr. θυός, from θυέιν, to offer a burnt sacrifice, cf. Skr. *dhūma* and Lat. *fumus*, smoke), the ecclesiastical term for a censer, a portable vessel in which burning incense (*q.v.*) can be carried. The censer, to use the more general term, is a vessel which contains burning charcoal on which the aromatic substances to be burned are sprinkled. The early Jewish portable censer would seem to have been a bowl with a handle, resembling a ladle. A similar form was used by the ancient Egyptians long prior to the Jewish use. There are very numerous representations on the monuments; in some the censer appears as a small cup or bowl held by a human hand to which a long handle is attached on which is a small box to hold the incense. The Greek and Roman censers (*θυμιατήριον* and *turibulum* or *thuribulum*) are of quite different shape. They are small portable braziers (*foculi*) of bronze or sometimes of silver and of highly ornate design. One type took the form of a candelabrum with a small flat brazier on the top. They were carried in processions and were lifted by cords. Terra cotta censers have also been found of a similar shape. The censers or thuribles in Christian usage have been specially adapted to be swung, though there are in existence many early specimens of heavy weight and made of gold or silver which were obviously not meant to be used in this way and have handles and not chains. The thurible, the proper ecclesiastical term for the vessel in the Western Church, is usually spherical in form, though often square or polygonal, containing a small receptacle for the charcoal and covered by a perforated lid; it is carried and swung by three chains, a fourth being attached to the lid, thus allowing it to be raised at intervals for the volume of smoke to be increased. The early thuribles were usually simple in design; but in the medieval period an architectural form was given to the lids by ornamenting them with towers, battlements and traceries, varying according to the prevalent Gothic style of the period. A censer lid with a late Saxon tower upon it, now in the British Museum, dates from the 12th century or earlier.

THURII, or THURIUM, a city of Magna Graecia on the Gulf of Tarentum, near the site of the older Sybaris (*q.v.*). It owed its origin to an attempt made in 452 B.C. by Sybarite exiles and their descendants to repeople their old home. The new settlement was crushed by Crotona, but the Athenians lent aid to the fugitives and in 443 Pericles sent out to Thurii a mixed body of colonists from various parts of Greece, among whom were Herodotus and the orator Lysias. The pretensions of the Sybarite colonists led to dissensions and ultimately to their expulsion; peace was made with Crotona, and also, after a period of war, with Tarentum, and Thurii rose rapidly in power and drew settlers from all parts of Greece, especially from Peloponnesus, so that the tie to Athens was not always acknowledged. The oracle of Delphi determined that the city had no founder but Apollo, and in the Athenian War in Sicily Thurii was at first neutral, though it finally helped the Athenians. Thurii had a democratic constitution and good laws, and, though we hear little of its history till in 390 it received a severe defeat from the rising power of the Lucanians, many beautiful coins testify to the wealth and splendour of its days of prosperity. In the 4th century it continued to decline, and at length called in the help of the Romans against the Lucanians, and then in 282 against Tarentum. Thenceforward its position was dependent, and in the Second Punic War, after several vicissitudes, it was depopulated and plundered by Hannibal (204). In 194 a Roman colony was founded, with Latin rights, known for a time as Copiae, but afterwards by the old name of Thurii. It continued to be a place of some importance, the situation being favourable and the region fertile, and does not seem to have been wholly abandoned till the middle ages. The site of the original Greek city is not accurately known, though that of the Roman town, which probably though not certainly occupied the same site, is fixed by insignificant ruins as being 4 m. to the east of Terranova di Sibari, and as occupying an area some 4 m. in circuit. The tombs found in 1879–1880 (see SYBARIS) lie a little to the east of the site.

See F. Lenormant, *La Grande-Grèce* i. 317 (Paris, 1881). (T. As.)

THURINGIA (German *Thüringen*), an historical division of Germany, but now a territorial term without political significance. It strictly designates only that district in upper Saxony that is bounded by the Werra, the Harz Mountains, the Saale and the Thuringian Forest; in common parlance, however, it is frequently used as equivalent to the Thuringian states, *i.e.* the group of small duchies and principalities lying between Prussia, Hesse-Nassau, Bavaria and the kingdom of Saxony. Such Thuringian states are Saxe-Weimar-Eisenach, Saxe-Coburg-Gotha, Saxe-Meiningen, Saxe-Altenburg, Schwarzburg-Rudolstadt, Schwarzburg-Sondershausen, and the two principalities of Reuss, all of which are separately described. Besides these, the term Thuringia also, of course, includes the various "exclaves" of Prussia, Saxony, Bavaria and Bohemia which lie embedded among them.

The Thuringians are first mentioned by Vegetius Renatus about A.D. 420 when they occupied the district between the Harz Mountains and the Thuringian Forest. They were probably descended from the Hermunduri, a Suevic people referred to by Tacitus as living in this region during the 1st century. They were tributary to Attila the Hun, under whom they served at the battle of Châlons in 451. They were governed by kings, whose realm in the early 6th century touched both the Danube and the lower Elbe. At this time King Basin divided Thuringia among his three sons. The eldest, Hermannfried, eventually obtained sole possession by the help of Theuderich I., king of Austrasia, but having refused to pay the price he had promised for this assistance, was defeated by Theuderich in a series of battles and murdered by him in 531. The northern portion of the kingdom was given to the Saxons who had joined him against Hermannfried; the southern part was added to Austrasia; and the name of Thuringia was confined to the district bounded by the Harz Mountains, the Werra, the Thuringian Forest and the Saale. It remained under the direct rule of the Frankish kings until 634, when Radulf was appointed duke of the Thuringians by King Dagobert I. Radulf made himself practically independent of the Franks, in spite of an attack made on him by Sigebert III., king of Austrasia. About this time the conversion of the Thuringians to Christianity was begun by British missionaries and continued by St Boniface, who founded a bishopric at Erfurt. They were again reduced to dependence on the Franks by Charles Martel, who abolished the office of duke and divided the country among Frankish counts. About 804 Charlemagne, in order to defend the line of the Saale against the Slavs, founded the Thuringian mark, which soon became practically coextensive with the former duchy. In 849 King Louis the German recognized Thakulf as duke (*dux Sorabici limitis*), and some of his successors bore the title of margrave until the death of Burkhard in 908, when the country was seized by Otto the Illustrious, duke of Saxony. Thuringia was retained by Otto's son and successor, Henry I. the Fowler, in spite of the opposition of the German king, Conrad I., and ceased for a time to enjoy a separate political existence. It appears to have been united with Meissen for some time, and this was certainly the case from 1046 to 1067, when both countries were ruled by William and Otto, counts of Weimar. During the 11th century the Thuringians refused to pay tithes to Siegfried, archbishop of Mainz, and this was probably one reason why they joined the rising of the Saxons against the emperor Henry IV. in 1073.

About this time a new dominion was founded by Louis the Bearded, who by purchase, gift or marriage obtained several counties in Thuringia. These passed on his death in 1056 to his son Louis the Springer (d. 1123), who took part in the Saxon risings against the emperors Henry IV. and Henry V., built the castle of the Wartburg near Eisenach, which was the residence of his family for nearly 200 years, and founded the monastery of Reinhardsbrunn, where as a monk he passed his last days. His son Louis was appointed landgrave of Thuringia in 1130 by the emperor Lothair II.; by his marriage with Hedwig of Gudensberg in 1137 he obtained a large part of Hesse. He was succeeded in 1140 by his son Louis II. the Hard, who married Judith, a sister of the emperor Frederick I., and on his behalf took a leading part in the opposition to his powerful neighbour Henry the Lion, duke of Saxony. In 1172 he was succeeded by his son Louis III. the Pious. He acquired the Saxon palatinate in 1179, on the death of Adalbert, count of Sommerschenburg, went to Italy to assist Frederick I. in 1157, joined in the war against Henry the Lion in 1180, and distinguished himself at the siege of Acre in the Third Crusade, on the return from which he died at Cyprus in 1190. He was succeeded by his brother Hermann I., during whose reign Thuringia suffered greatly from the ravages of the adherents of Philip, duke of Swabia, and also from those of his rival Otto of Brunswick. The next landgrave (1217–1227) was his son Louis IV. the Saint, who married St Elizabeth, daughter of Andrew II., king of Hungary, and acted as guardian for his kinsman Henry III. the Illustrious, margrave of Meissen. This Louis, who is celebrated in story, destroyed many robber-castles in Thuringia and died at Otranto while accompanying the emperor Frederick II. on crusade. The next ruler was Henry Raspe, who made himself regent on behalf of his nephew Hermann II. from 1227 to 1238 and in 1241 succeeded his former ward as landgrave. Henry was appointed regent for King Conrad IV., but he soon transferred his allegiance from the emperor to Pope Innocent IV., and in 1246 was chosen German king at Beitshochheim. He defeated Conrad near Frankfort in August 1246, but died in the following year at the Wartburg, when the male line of the family became extinct.

In 1242 Thuringia had been promised by Frederick II. to Henry III. the Illustrious, margrave of Meissen, a maternal grandson of the landgrave Hermann I. Henry, however, found himself obliged to defend his title against Sophia, wife of Henry II., duke of Brabant, who was a daughter of the landgrave Louis IV., and it was not till 1263 that an arrangement was made by which Thuringia and the Saxon palatinate fell to Henry. Two years later Henry apportioned Thuringia to his son Albert the Degenerate, who sold it in 1293 to the German king Adolph of Nassau for 12,000 marks of silver. Albert's sons Frederick the Undaunted and Dietrich contested this transaction, and the attempts of Adolph and his successor Albert I. to enforce it led to the infliction of great hardships upon the Thuringians. Frederick defeated Albert decisively and in 1314 was formally invested with Thuringia by the emperor Henry VII. His son Frederick II. the Grave (1323–1349) consolidated the power of his dynasty against rebellious vassals and the neighbouring counts of Weimar and Schwarzburg. His son Frederick III. the Strong (1349–1381) and his grandson Balthasar (1381–1406) further extended their dominion by marriage and conquest, and the latter of these founded the university at Erfurt (1392). Balthasar's son, Frederick the Peaceful, became landgrave in 1406 but left the government largely to his father-in-law Günther, count of Schwarzburg. He died childless in 1440, and Thuringia then passed to the electoral dynasty of Saxony. After a joint rule by Frederick II. and his brother William, the latter in 1445 became sole landgrave as William III. and died without sons in 1482. In 1485 his nephews and heirs Albert and Ernest made a division of their lands, and Thuringia was given to the Ernestine branch of the family of Wettin, with which its subsequent history is identified (see SAXONY).

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THURINGIAN FOREST (*Thüringerwald*), a range of hills in Germany, extending in an irregular line from the neighbourhood of Eisenach in the N.W. to the Lobensteiner Kulm on the Bavarian frontier on the S.E. On the S.E. it is continued directly by the Frankenwald Mountains to the Fichtelgebirge, while on the N.E. it approaches the Harz Mountains, and thus takes its place in the great Sudetic chain of central Germany. The length of the Thuringian chain is 70 m., and its breadth varies from 6 to 22 m. It nowhere rises into peaks, and only a few of its rounded summits reach 3000 ft.; the successive hills form a continuous comb; the north-west slopes are precipitous and seamed with winding gorges. This range encloses many charming valleys and glens; the most prominent feature of its scenery is formed by the forests, chiefly of pines and firs. The north-west part of the system is the loftier and the more densely wooded as well as the more beautiful; the highest summits here are the Grosser Beerberg (3225 ft.), Schneekopf (3203) and the Finsterberg (3104), all in the duchy of Gotha. The south-east part of the Thuringian Forest is the more populous and industrial; the chief summits are the Kieferle (2848 ft.), the Blessberg (2834 ft.), the Wurzelberg (2841 ft.) and the Wetzstein (2575 ft.). The crest of the Thuringian Forest, from the Werra to the Saale, is traversed by the Rennsteig or Rainsteig, a broad path of unknown antiquity, perhaps referred to in a letter of Pope Gregory III. dated 738. The name means probably "frontier-path"; and the path marks in fact the boundary between Thuringia and Franconia. It may be also regarded as part of the boundary line between north and south Germany, for dialect, customs, local names and costume are different on the two sides. The rocks are largely volcanic, the stratification being complex. The mineral resources have been nearly exhausted, but the district is an important centre of small industries (glassware, earthenware, meerschaum-ware, iron castings and toys being among its principal products) and a favourite resort for tourists.

See Regel, *Thüringen, ein landeskundlicher Grundriss* (Jena, 1897); Trinius, *Thüringer Wanderbuch* (8 vols., Minden, 1896–1902); Pröscholdt, "Der Thüringer Wald und seine nächste Umgebung," in *Forschungen zur deutschen Landes- und Volkskunde*, vol. v. (Stuttgart, 1891); Walther, *Geologische Heimatskunde von Thüringen* (Jena, 1906); and Meyer's *Reisebuch*, "Thüringen" (18th ed., Leipzig, 1906).

THURLES, a market town of Co. Tipperary, Ireland, pleasantly situated on the Suir, and on the main line of the Great Southern & Western railway, 87 m. S.W. of Dublin. Pop. (1901), 4411. Thurles is the seat of the Roman Catholic archdiocese of Cashel; and the cathedral of St Patrick is a beautiful building. The town is the seat of other important Catholic establishments, including an Ursuline convent; a Presentation convent; St Patrick's Catholic College (1829) for ecclesiastical students, where was held in 1850 the synod of Thurles; and an establishment of Christian Brothers, who devote themselves to the instruction of boys on the Lancasterian method. The town has a considerable agricultural and retail trade, and there is a monthly horse fair largely attended by English and continental buyers. Thurles is governed by an urban district council.

Originally the town was called Durlas O'Fogarty. In the 10th century it was the scene of a defeat of the Irish by the Danes. A preceptory was founded here by the Knights Templars, who possessed themselves of a castle, of which there are remains, erected early in the 13th century. A castle was subsequently erected by James Butler, first lord palatine of Tipperary, of which the keep collapsed in 1868. There were several other strongholds in the vicinity. South-west of the town, at a distance of $3\frac{1}{2}$ m., stands the Cistercian abbey of Holy Cross, one of the finest ruins in Ireland. It was founded by Donnell O'Brien, king of Thomond (1168–1194); and owes its foundation and name to the presentation to his family of a portion of the true Cross, which attracted numerous pilgrims. The shrine of this relic is in the Ursuline convent at Blackrock, Co. Cork. The ruins, beautifully placed on the bank of the river, embody a cruciform church, transitional Norman in style, and exhibiting the carving of the period in its highest development. There is a fine Perpendicular tomb in the choir. A large portion remains of the adjoining buildings, including chapter-house, sacristy, cloisters and dormitory.

THURLOE, JOHN (1616–1668), English politician, son of Thomas Thurloe, rector of Abbot's Roding in Essex, was baptized on the 12th of June 1616. He studied law, entered the service of Oliver St John, through whose interest he was appointed a secretary to the parliamentary commissioners at Uxbridge in January 1645. He was admitted to Lincoln's Inn in 1647, and in March 1648 he received the appointment of receiver of the cursitor's fines, worth £350 a year. He took no part in the subsequent historical events or in the king's death. In March 1651 he attended St John and Sir Walter Strickland as secretary in their mission to Holland, and on the 29th of March 1652 he was appointed secretary to the council of state, being apparently also elected a member thereof about the same time. His duties included the control of the intelligence department and of the posts, and his perfect system of collecting information and success in discovering the plans of the enemies of the administration astonished his contemporaries. By his means, it was said, "Cromwell carried the secrets of all the princes of Europe at his girdle." On the 10th of February 1654 he was made a bencher of Lincoln's Inn. In the parliaments of 1654 and of 1656 he represented Ely; he was appointed a member of Cromwell's second council in 1657; was elected a governor of the Charterhouse in the same year; and in 1658 became chancellor of Glasgow University. Thurloe was attached to Cromwell as a man and admired him as a ruler, and Cromwell probably placed more confidence in the secretary than in any one of those who surrounded him. Thurloe, however, by no means directed Cromwell's policy. He was in favour of the protector's assumption of the royal title, and was opposed to the military party who obtained the ascendancy. After Oliver's death he supported Richard Cromwell's succession and took a prominent part in the administration, sitting in the parliament of January 1659 as member for Cambridge University. Attacked by the republicans on the ground of arbitrary imprisonments and transportations during the Protectorate, he succeeded in vindicating his conduct; but the breach between the army and the parliament, and the ascendancy obtained by the former, caused his own as well as Richard's downfall. Nevertheless, being indispensable, he was reappointed secretary of state on the 27th of February 1660. He appears to have steadily resisted the Restoration, and his promises of support to Hyde in April inspired little confidence. On the 15th of May 1660 he was arrested on the charge of high treason, but was set free on the 29th of June, subject to the obligation of attending the secretaries of state "for the service of the state whenever they should require." He subsequently wrote several papers on the subject of foreign affairs for Clarendon's information. He died on the 21st of February 1668 at his chambers in Lincoln's Inn, and is buried under the chapel there. Thurloe was twice married, and by his second wife Anne, daughter of Sir John Lytcote of East Moulsey in Surrey, he had four sons and two daughters.

His extensive correspondence, the originals of which are in the Bodleian Library at Oxford and the British Museum (*Add. MSS.* 4156, 4157, 4158), is one of the chief sources of information for the period. A portion was published with a memoir by T. Birch in 1742, and other correspondence is printed in R. Vaughan's *Protectorate of Oliver Cromwell* (1836). See also *Die Politik des Protectors Oliver Cromwell in der Auffassung und Thätigkeit . . . des Staatssecretärs John Thurloe*, by Sigismund, Freiherr von Bishoffshausen (1899); *Eng. Hist. Review*, xiii. 527 (Thurloe and the post office); *Notes and Queries*, 11th series, vol. viii. p. 83 (account of his death); *A Letter to a Friend . . . on the Publication of Thurloe's State Papers* (1742); Clarendon's *History of the Rebellion*; Gardiner's *History of the Commonwealth.*

THURLOW, EDWARD THURLOW, 1ST BARON (1731–1806), English lord chancellor, was born at Bracon Ash, in the county of Norfolk, on the 9th of December 1731. He was the eldest son of the Rev. Thomas Thurlow. He was educated at a private school and at the grammar school of Canterbury, where he was considered a bold, refractory, clever boy. In 1748 Thurlow entered Caius College, Cambridge, but an act of insubordination necessitated his leaving Cambridge without a degree (1751). He was for some time articled to a solicitor in Lincoln's Inn along with the poet Cowper, but in 1754 was called to the bar at the Inner Temple, and subsequently went on the western circuit—at first with little success. But in the case of *Luke Robinson* v. *The Earl of Winchelsea* (1758) Thurlow came into collision with Sir Fletcher Norton, afterwards 1st Baron Grantley (1716–1789), then the terror of solicitors and the tyrant of the bar, and put down his arrogance with dignity and success. From this time his practice increased rapidly. In 1761 he was made a king's counsel, through the influence of the duchess of Queensberry. In 1762 he was elected a bencher of the Inner Temple. Thurlow now with some hesitation entered himself into the ranks of the Tory party. In 1768 he became member for Tamworth. In 1769 the Douglas peerage case came on for hearing in the House of Lords, and Thurlow, who had drawn the pleadings some years before (*Notes and Queries*, 3rd series, vol. iii. p. 122), led for the appellant in a speech of great analytic power. In 1770, as a recognition of his defence in the previous January of the expulsion of Wilkes, Thurlow was made solicitor-general on the resignation of Dunning, and in the following year, after he had enhanced his reputation with the government by attacking the rights of juries in cases of libel (*Rex* v. *Miller*, 20 *St. Tr.* 870–896) and the liberty of the press (16 *Parly. Hist.* 1144), was raised to the attorney-generalship. Thurlow's public life was as factious as his youth had been daring. His hatred of the American colonists, and his imprudent assertion that as attorney-general he might set aside by *scire facias* as forfeited every charter in America (debate on the American Prohibitory Bill, 18 *P.H.* 999); his speech in aggravation of punishment in the case of Horne Tooke (20 *St. Tr.* 777–783), when he argued that the prisoner ought to be pilloried, because imprisonment was no penalty to a man of sedentary habits and a fine would be paid by seditious subscription; and his opposition to all interference with the slave trade—are characteristic. In 1778 Thurlow became lord chancellor and Baron Thurlow of Ashfield, and took his seat in the House of Lords, where he soon acquired an almost dictatorial power. He opposed the economical and constitutional reforms proposed by Burke and Dunning. Under Rockingham he clung to the chancellorship, while conducting himself like a leader of the opposition. To the short-lived ministry of Shelburne he gave consistent support. Under the coalition of Fox and North (April to December 1783) the great seal was placed in commission, and Lord Loughborough was made first commissioner. But Thurlow, acting as the king's adviser, and in acccordance with his wishes, harassed the new ministry, and ultimately secured the rejection of Fox's India Bill (24 *P.H.* 226). The coalition was at once dissolved. Pitt accepted office, and Thurlow again became lord chancellor (Dec. 23, 1783). At first he supported the government, but soon his overbearing temper asserted itself. Imprudently relying on the friendship of the king, and actuated by scarcely disguised enmity to Pitt, Thurlow passed rapidly from occasional acts of hostility to secret disaffection, and finally to open revolt. He delivered himself strongly against a bill, introduced without his privity, for the restoration to the heirs of attainted owners of estates forfeited in the Jacobite rebellion of 1745. Partly to please the king and queen, partly from dislike to Burke, and partly perhaps from a real belief in the groundlessness of the accusation, he supported Warren Hastings on every occasion "with indecorous violence." His negotiations with the Whigs during the discussion of the Regency Bill (1788–Feb. 19, 1789) were designed to secure his seat on the woolsack in the event of Fox being called to power. The climax was reached in 1792, when he attacked Pitt's bill "to establish a sinking fund for the redemption of the national debt," not on account of the economic objections to which it was liable, but on the trivial ground that it was an unconstitutional attempt to bind further parliaments. The bill was carried, but only by a narrow majority, and Pitt, feeling that co-operation with such a colleague was impossible, insisted successfully on his dismissal (June 15, 1792). The ex-chancellor, who had a few days before been created Baron Thurlow of Thurlow, with remainder to his brothers and their male descendants, now retired into private life, and, with the exception of a futile intrigue, under the auspices of the prince of Wales, for the formation of a ministry from which Pitt and Fox should be excluded, and in which the earl of Moira should be premier and Thurlow chancellor (1797), finally abandoned hope of office. In 1795 he opposed the Treason and Sedition bills without success. In 1801 he spoke on behalf of Horne Tooke—now his friend—when a bill was introduced to render a priest in orders ineligible for a seat in the House of Commons. His last recorded appearance in the House of Lords was in 1802. He now spent his time between his villa at Dulwich and various seaside resorts. He died at Brighton on the 12th of September 1806, and was buried in the Temple church. Thurlow was never married, but left three natural daughters, for whom he made a handsome provision. The title descended to his nephew, son of the bishop of Durham.

Lord Thurlow was a master of a coarse caustic wit, which habitually in his private and too frequently in his public life displayed itself in profanity. He was a good classical scholar and made occasional translations in verse from Homer and Euripides. His judicial and his ecclesiastical patronage were wisely exercised; he was the patron of Dr Johnson and of Crabbe, and was the first to detect the great legal merits of Eldon. Thurlow's personal appearance was striking. His dark complexion, harsh but regular features, severe and dignified demeanour, piercing black eyes and bushy eyebrows, doubtless contributed to his professional and political eminence and provoked the sarcasm of Fox that he *looked* wiser than any man ever *was*. Yet he was far from being an impostor. By intense though irregular application he had acquired a wide if not a profound knowledge of law. Clear-headed, self-confident and fluent, able at once to reason temperately and to assert strongly, capable of grasping, rapidly assimilating, and forcibly reproducing minute and complicated details, he possessed all the qualities which command success. His speeches in the trial of the duchess of Kingston for bigamy (20 *St. Tr.* 355–651) are vigorous and effective, while his famous opening in the Douglas peerage case and his argument for the Crown in *Campbell* v. *Hall* (20 *St. Tr.* 312–316) show that he might have rendered high service to the judicial literature of his country had he relied more upon his own industry and less upon the learning of Hargrave and Kenyon.

See Lord Campbell's *Lives of the Chancellors*, vii. 153–333; Foss's *Judges of England*, viii. 374–385; *Public Characters* (1798); *Notes and Queries*, 2nd series, vol. iii. p. 283; 3rd series, vol. iii. p. 122; *Reports* of his decisions by Brown, Dickens and Vesey (jun.); Brougham's *Statesmen of the Time of George III.* (A. W. R.)

THURMAN, ALLEN GRANBERY (1813–1895), American jurist and statesman, was born at Lynchburg, Virginia, on the 13th of November 1813. In 1819 he removed with his parents to Chillicothe, Ohio, where he attended the local academy for two years, studied law in the office of his uncle, William Allen,[1] and in 1835 was admitted to the bar, becoming his uncle's law partner. He began to take an active part in politics in 1844, and in 1845–1847 was a Democratic representative in Congress, where he advocated the Wilmot Proviso. From 1851 to February 1856 he was an associate justice of the state supreme court, and from December 1854 was chief justice. He was Democratic candidate for governor of Ohio in 1867, and was defeated by Rutherford B. Hayes by a majority of less than 3000 votes; but the Democrats gained a majority in both branches of the state legislature, and Thurman was elected to the United States Senate, where he served from 1869 until 1881—during the 46th Congress (1879–1881) as president *pro tempore*. Here he became the recognized Democratic leader and in 1879–1881 was chairman of the judiciary committee. He contested the constitutionality of the Civil Rights Bill, opposed the resumption of specie payments, advocated the payment of the public debt in silver and supported the Bland-Allison Act. He introduced the Thurman Bill, for which he was chiefly responsible, which became law in May 1878, and readjusted the government's relations with the bond-aided Pacific railways. Thurman was a member of the Electoral Commission of 1877, and was one of the American delegates to the international monetary conference at Paris in 1881. In 1876, 1880 and 1884 he was a candidate for the presidential nomination, and in 1888 was nominated for vice-president on the ticket with Grover Cleveland, but was defeated in the election. He died at Columbus, Ohio, on the 12th of December 1895.

THURSDAY ISLAND, one of the smallest of the Prince of Wales group, N. of Cape York, in the Torres Strait, attached to Somerset county, Queensland, Australia. Pop. (1901), 1534. It has an excellent harbour, Port Kennedy, and is a port of call for mail steamers and the centre of the bêche-de-mer and pearl fisheries of the Torres Strait. It is a fortified coaling station for the British navy. The neighbouring Friday Island is the quarantine and leper station for Queensland.

THURSO, a municipal and police burgh, and seaport of Caithness, Scotland. Pop. (1901), 3723. It is situated at the mouth of the Thurso, on Thurso Bay, 21 m. N.W. of Wick, and 319 m. N. of Edinburgh by the North British and Highland railways, the most northerly town in Scotland. Coaches run daily to Mey and Wick and every day a mail-car goes to Tongue, in Sutherlandshire, about 40 m. west.

In Macdonald Square, laid out with ornamental walks, there is a statue of Sir John Sinclair. A promenade along the sands was opened in 1882. The town-hall contains a public library and museum, which possesses the geological and botanical specimens of Robert Dick (1811–1866), the "Thurso baker," as well as a large collection of northern birds. In the neighbourhood are quarries for Caithness flags, which are cut and dressed in the town. They constitute the leading export, but the trade of the port is hindered by the inconvenience of the harbour. There is, however, communication daily from Scrabster pier, 2 m. north-west, with Scapa and Stromness in Pomona (Orkneys), calling at Hoxa; once a week with Wick, Aberdeen and Leith; and occasionally in summer with Liverpool. To the east is Thurso Castle, the residence of the Ulbster branch of the Sinclairs, and near it is Harold's Tower, built over the grave of Earl Harold, once owner of half of Caithness, and half of the Orkneys and Shetlands, who fell in battle with Earl Harold the Wicked in 1190. About three-quarters of a mile west stand the ruins of the bishop's palace, which was destroyed by fire in 1222. Thurso was the centre of the Norse power on the mainland when at its height under Thorfinn (1014), and afterwards till the battle of Largs (1263). Count Modach, nephew of King Duncan, quartered his army for a time at Thurso and despoiled it till he was surprised and slain by Thorfinn in 1040. In the time of Malcolm II. Earl Erlend resided in the town. In 1633 it was created a burgh of barony, and was the seat of the sheriff courts of the county till they were removed to Wick in 1828.

THURSTAN, or TURSTIN (d. 1140), archbishop of York, was the son of a certain Anger, or Auger, prebendary of St Paul's, London, and a brother of Audoen (d. 1139), bishop of Evreux. He himself was a prebendary of St Paul's, and was also a clerk in the service of William II. and then of Henry I., who secured his election as archbishop of York in August 1114. He now entered upon the great controversy which occupied him during a large part of his subsequent life and made him for several years an exile from England. Archbishop Ralph of Canterbury refused to consecrate him unless he made a profession of obedience to the southern see; this Thurstan refused and asked the king for permission to go to Rome to consult Pope Paschal II. Henry I. declined to allow him to make the journey, while Paschal declared against Archbishop Ralph. At the Council of Salisbury in 1116 the English king ordered Thurstan to submit, but instead he resigned his archbishopric, although this did not take effect. The new pope, Gelasius II., and also his successor, Calixtus II., espoused the cause of the stubborn archbishop, and in October 1119, in spite of promises made to Henry I., he was consecrated by Calixtus at Reims. Enraged at this the king refused to allow him to enter England, and he remained for some time in the company of the pope. At length, however, his friends succeeded in reconciling him with Henry; and, after serving the king in Normandy, he was recalled to England, which he entered early in 1121. Refusing to recognize the new archbishop of Canterbury, William of Corbeil, as his superior, Thurstan took no part in his consecration, and on two occasions both archbishops carried their complaints in person to Rome. In 1138 he made a truce at Roxburgh between England and Scotland, and took active part in gathering together the army which defeated the Scots at the Battle of the Standard

[1] William Allen (1806–1879), a native of North Carolina, removed in 1822 to Chillicothe, Ohio, was admitted to the bar in 1827, was a representative in Congress in 1833–1835, served in the United States Senate in 1837–1849, and was governor of Ohio in 1874–1875.

in August 1138. Early in 1140 he entered the order of the Cluniacs at Pontefract and here he died on the 6th of February 1140. Thurstan was generous to the churches of his diocese and was the founder of several religious houses.

See his life in the *Fasti eboracenses*, edited by J. Raine (1863).

THYLACINE (*Thylacinus cynocephalus*). The only known living species of this genus, though smaller than a common wolf, is the largest predaceous marsupial existing. It is confined to the island of Tasmania, although fragments of bones and teeth found in caves afford evidence that a closely allied species once inhabited the Australian mainland. The general colour of the thylacine is grey-brown, but it has a series of transverse black bands on the hinder part of the back and loins, whence the name of "tiger" frequently applied to it by the colonists. It is also called "wolf," and sometimes, though less appropriately, "hyena." Owing to the havoc it commits among the sheep-folds, it has been nearly exterminated in all the more settled parts of Tasmania, but still finds shelter in the more mountainous regions of the island. The female produces four young at a time. (See MARSUPIALIA.)

THYME. The genus *Thymus* (nat. ord. Labiatae) comprises a number of fragrant aromatic undershrubs, with very small leaves and whorls of small purple honey-bearing flowers in the axils of the leaves or at the ends of the branches. The common garden thyme, a native of the Mediterranean region, is *Thymus vulgaris*; the wild thyme of English banks is *T. serpyllum*. Marjoram (*Origanum*) is also closely allied. All these plants are remarkable for their essential oil, to which their fragrance is due. From this oil is produced by distillation the substance known as thymol.

THYMOL, $C_{10}H_{14}O$ or $C_6H_3(OH)(CH_3)(C_3H_7)$ [1:3:6], a methylisopropylphenol isomeric with carvacrol (*q.v.*), is an aromatic substance found with the hydrocarbons cymene, $C_{10}H_{14}$, and thymene, $C_{10}H_{16}$, in oil of thyme (from *Thymus vulgaris*) and in other essential oils, *e.g. Carum copticum*, from which it may be extracted by shaking with potassium hydroxide, filtering and precipitating the phenol with hydrochloric acid. It can be prepared from dibrom-menthone (obtained by brominating menthone in chloroform solution) by eliminating two molecules of hydrobromic acid. Thymol crystallizes in large colourless plates, which melt at 44° and boil at 230°. On distillation with phosphorus sulphide it gives cymene.

Thymol has a strong odour of thyme and a pungent taste, and is freely soluble in alcohol, ether, chloroform or olive oil, but almost insoluble in cold water. It is a more powerful antiseptic than carbolic acid, but its insolubility prevents its being used for the same purposes. A saturated solution (1 in 1000 of warm water), thymol gauze and an ointment are used. Externally it is anti-parasitic, and is used in certain stages of eczema and psoriasis, and the alcoholic solution has been used in ringworm; internally it has been employed as an intestinal antiseptic in typhoid fever. Its chief use is as an anthelmintic to destroy the *Ankylostoma duodenale*. Thymol may colour the urine green. Thymol iodide, official in the United States, is a compound of iodine and thymol; it is also known as aristol or annidalin. It was introduced as a substitute for iodoform and is stated to be less toxic. *Glycothymolin* is a proprietary preparation, used in the treatment of catarrhal conditions of mucous membranes, while a mixture of naphthalene, camphor and thymol is sold under the name of thymolin.

THYROID (Gr. θυροειδής, shield-shaped, from θυρεός, a large oblong shield, shaped like a door, θύρα, and εἶδος, form), in anatomy, a term applied (1) to the largest of the cartilages of the larynx (see RESPIRATORY SYSTEM), (2) to one of two arteries which lie near the thyroid cartilage and gland (see ARTERIES), and (3) to a vascular ductless gland, which rests on the larynx and upper part of the trachea (see DUCTLESS GLANDS). The thyroid gland is used in medicine in two forms. *Thyroideum siccum* is a light dull brown powder, prepared by drying the thyroid gland of a sheep. Its chief constituent is a proteid known as thyreoglobulin, the active principle of which contains 9·3% of iodine and 0·5% of phosphorus, and is known as iodothyrin or thyroiodin. The dried gland easily becomes damp and deteriorates. *Liquor thyroidei* is a pink turbid liquid made by macerating the fresh gland of a sheep with glycerin and phenol.

Thyroid gland administered to man increases the pulse rate, causes increased and enfeebled cardiac beat and leads to increased metabolism, consequently excess of urea, uric acid and phosphates are excreted in the urine; it therefore reduces the body weight. Glycosuria develops from the inability of the body to ingest glucose. Overdoses of thyroid cause rapid pulse, headache and vomiting, together with diarrhoea and pruritus, emaciation and weakness. These symptoms are known as *thyroidism*.

Thyroid gland was introduced for the treatment of patients suffering from goitre, myxoedema and cretinism, in which diseases it has been remarkably successful, cretins growing rapidly under the thyroid treatment and developing intelligence. It has also been used in dwarfism, excessive obesity, psoriasis and scleroderma. When used in obesity an excess of nitrogenous food should be taken to balance the destruction of proteid. In certain forms of insanity, melancholia and climacteric insanities it has given good results. Full doses of thyroid are valuable in the prevention and relief of eclampsia. It should not be given to patients suffering from exophthalmic goitre, for which an anti-thyroid serum (anti-thyreoidin of Moebius), which is the serum of thyroidectomized animals, has been introduced.

Rodagen is a white powder consisting of the dried milk of thyroidectomized goats, mixed with 50% of milk sugar. In exophthalmic goitre this preparation causes a reduction of the swelling and of the pulse rate, and an increase of body weight.

THYROSTRACA, an order of Crustacea, comprising barnacles, acorn shells and some allied degenerate parasites. The embryos are free-swimming, active forms, but in adult life the animals are fixed head downwards, and are very degenerate. The body is indistinctly segmented, and is enveloped in a fold of the integument, usually with calcareous plates. The anterior antennae are fused with the anchoring attachment, whilst the posterior pair is vestigial, and the appendages of the mouth and body present various degrees of degeneration and specialization. In most cases the adults are hermaphrodite, but unisexual forms also occur, whilst the hermaphrodite adults may carry with them minute "complementary" males. In strong contrast with the condition in most Crustacea, the spermatozoa are mobile. As shown by Burmeister in his historical review (1834), these animals, comprised by Linnaeus in the genus *Lepas*, first received a more comprehensive title from Cuvier, who called them Cirrhopoda, a word strictly meaning tawny-footed. Lamarck in 1809 altered this into the hybrid form Cirrhipoda, meaning curl-footed, which was subsequently improved into Cirripedia or Cirrhipedia. So long as the group was held to be a subordinate member of the Entomostraca, this term, though not the earliest, was generally accepted. The name Thyrostraca, meaning doorshells or valve-shells, is preferred as agreeing in termination with the titles of the other two divisions, the Malacostraca and Entomostraca. The group may conveniently be arranged in two principal sections—the Genuina with cirrhiform feet, and the Anomala without them.

Thyrostraca genuina.—It is with these that Darwin's classical treatises (*Ray Soc.* and *Palaeont. Soc.*, 1851–1854) are almost exclusively concerned. Therein an order Thoracica comprehends the pedunculate Lepadidae, together with the operculate and sessile Balanidae and Verrucidae; a single species without cirrhi constitutes the order Apoda, and a single species with only three pairs of cirrhi the order Abdominalia. Within the last *Kochlorine* (Noll, 1872) with two species, and *Lithoglyptes* (Aurivillius, 1892) with three species, have since been included. But H. J. Hansen (*Die Cirripedien der Plankton-Expedition*, 1899) states that *Cryptophialus minutus*, for which the order Abdominalia was founded, has, like *Alcippe* and other Genuina, its cirrhi on the thorax, not, as Darwin wrongly supposed, on the abdomen. In place, therefore, of the Abdominalia, it will be right to accept the family Cryptophialidae, v. Martens, side by side with the Lithoglyptidae of Aurivillius and the Alcippidae of Gerstaecker. These, with Darwin's three families above mentioned, complete the section of genuine cirripedes now existing. Gruvel submitted to the Linnaean Society a rearrangement of the Lepadidae, unfortunately using for the first of his new families the preoccupied name Anaspidae. It is confusing, but not uninstructive, to find that within the Balanid group such generic titles as *Stephanolepas* and *Platylepas* have been coined. The vernacular name barnacle, traceable to the fable of pedunculate cirripedes hatching out into bernicle geese, has also been transferred to the sessile cirripedes, which are popularly known as acorn barnacles. A complete list of all the recent species of Thyrostraca in both sections, down to the year 1897, was published by Weltner (*Arch. Naturg.*, 1898, § 63. pt. i. pp. 227–280). For fossil species, Woodward's *Catalogue of Brit. Foss. Crust.* (1877), pp. 137–144, should be consulted. Hoek

(" *Challenger* " *Reports*, " Cirripedia," 1883, viii. 8–11), gives a brief geological summary down to 1882. In that year J. M. Clarke (*Amer. Journ. Sci. and Arts*, 3rd series, vol. xxiv., p. 55) added a new species to *Plumulites* (Barrande, 1872), remarking that the species in question, *P. devonicus*, " is interesting in being the first representative of fossil barnacles from the Devonian, Barrande's species of *Plumulites* and *Anatifopsis*, as well as the *Turrilepis* of Woodward, being from the Upper and Lower Silurian, and *Plumulites jamesi* (Hall and Whitf., *Pal. Ohio*, vol. ii.) from the Hudson River group." Since *Plumulites* appears to be a synonym of *Turrilepas* (not *Turrilepis*), the species *Turrilepas wrightii* (Woodward, 1865), from the Upper Silurian of Dudley, did not long enjoy an isolated eminence as the oldest known cirripede. As pointed out by Dr Bather (*Geol. Mag.* 1901, decade 4, vol. viii. p. 521), palaeontologists themselves have in this branch not very closely followed the progress of their own science, since Dr Ruedemann, in regard to his new *Pollicipes siluricus*, 1901, speaks of " the enormous gap existing between the appearance of this Lower Siluric type and the next Upper Triassic (Rhaetic) representatives of the genera *Pollicipes* and *Scalpellum*." Many species of *Scalpellum* from the Wenlock shale of Gotland were described in 1892 by C. W. S. Aurivillius, who at the same time founded the species *Pollicipes signatus* on an almost perfect specimen from the Lower Ludlow of Wisby in Sweden. Aurivillius considered that *Pollicipes signatus* showed a closer approach to the Balanidae than any other of the Lepadidae, but he, too, in ignorance of the Devonian *Protobalanus* (Whitf.), discoursed needlessly about the gap in the distribution. Dr Bather justifiably anticipates further discoveries, but if, already in Silurian as in modern times, the members of these families had to pass through nauplius and cypris stages to maturity, there is one " enormous gap " between them and the common ancestor of the crustacean class that will not be easily filled. To later phylogenetic links an addition is offered by Dr Woodward (*Geol. Mag.*, 1901, p. 145), who transfers his *Pyrgoma cretaceum*, 1865, to a new genus *Brachylepas* (fig. 1), and a new family Brachylepadidae, intermediate between the Rhaetic *Pollicipes* and the modern *Balanus*. Among other fossil genera of recent institution, *Archaeolepas*, *Lepidocoleus*, *Squama*, *Stramentum* can only be mentioned as incentives to research. Among living forms, added since Weltner's catalogue, may be noticed *Koleolepas willeyi*, from the Loyalty Islands (Stebbing, in Willey's *Zool. Results* (1900) pt. v., p. 677. This was found in a Turbo shell, occupied also by a Pagurid, and coated with Actinians. The cirripede, which has an elastic peduncle, a crested capitulum, but no valves, and the first cirrhi longer than the rest, should stand near *Eremolepas*, the name given by Weltner in place of the preoccupied *Gymnolepas* (Aurivillius). In the genus *Scalpellum*, *S. giganteum*, Gruvel (*Trans. Linn. Soc.*, 1901) disputes with *S. stearnsii* (fig. 2), Pilsbury, 1890, which shall be accounted the greater. The latter is threatened with a new generic name (Chun, *Aus den Tiefen des Weltmeeres*, 1900, p. 502).

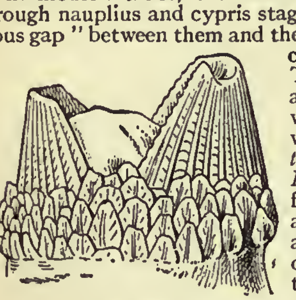


Fig. 1.—*Brachylepas cretacea* (Woodward), from Margate chalk.

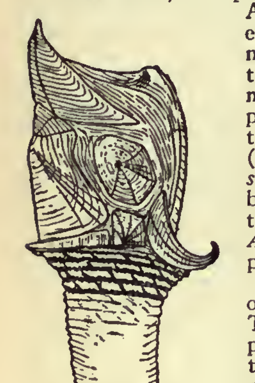


Fig. 2.—*Scalpellum stearnsii.* (Two-thirds nat. size.)

The horizontal distribution of barnacles over all seas is fully explained by Darwin. The bathymetric range of sessile as well as pedunculate forms down to such depths as twelve or eighteen thousand feet—*Verruca quadrangularis*, Hoek, 1900 fathoms; *Scalpellum regium*, Wyville Thomson, 2850 fathoms—is a more recent discovery. Gruvel (*Contribution à l'étude des Cirrhipèdes*, 1894) found that the species frequenting sea surface or shallow water, notwithstanding their feeble powers of vision, cannot live long when entirely debarred from light. It must, therefore, be supposed that abyssal forms have gradually acquired such tolerance of darkness as makes their health independent of the sun. Among other singularities of habitat, not the least curious is the freedom with which some small species, especially in the genus *Dichelaspis*, occupy the very jaws of large crustaceans. It is generally stated that cirripedes are confined to salt water, and, generally speaking, that is true. But *Platylepas bissexlobata* (De Blainville), from the west coast of Africa, is sometimes found entirely buried, except its operculum, in the skin of the manatee. Now, since it seems this *Manatus senegalensis* ascends rivers, we may infer that its parasite travels with it. Studer (*Crustacea of the Gazelle*, 1882) records *Balanus amphitrite* (Darwin?) from roots and stems of mangroves in the Congo, where, he says, " it follows the mangroves as far as their vegetation extends along the stream, to six sea-miles from the mouth." Darwin notes *B. improvisus* as quite tolerant of water not saline. Why the Thyrostraca, so hardy, so widely dispersed and multitudinous, and with a history so prolonged, should not have made more extended and more independent incursions into fresh water remains a problem. Though the *Ornitholepas australis* (Targioni Tozzetti, 1872), found on the tail feathers of a bird, represents only the cypris-larva of a cirripede, it still shows one of the many facilities for dispersion which these creatures enjoy. A striking instance of their abundance is cited by Aurivillius (1894) from a report by Captain G. C. Eckman, who late in the summer observed great masses of *Lepas fascicularis* forming broad belts in the North Sea. Aurivillius himself examined a humpback whale which had as many as fifty specimens of *Coronula diadema* on each side of its head. He believes that the cetacean approaches not only rocks, but ships, in the hope of freeing itself from its lodgers. Yet the fact that the long, soft *Conchoderma auritum* stands exposed on the *Coronula*, sometimes ten on one, indicates that the whale can have little chance of evicting its tenants, even at the expense of rubbing off the eighteen flattened horns of its own skin embedded in cavities round the domed base of the *Coronula* shell. The fecundity in the genus *Lepas* has struck many observers. Hoek (" *Challenger* " *Reports*, " Cirripedia," 1884, vol. x.) notes that, while in *Scalpellum* the number of eggs may be less than a hundred, " in *Lepas anatifera* it amounts, on the contrary, to many thousands and tens of thousands." In the same treatise Dr Hoek has useful chapters on the anatomy, development and sexes of the group, with references to the important researches since Darwin by Krohn, Claus, Kossmann and others. Francis Darwin, in the life of his father (1888, iii. 2), says, " Krohn stated that the structures described by my father as ovaries were in reality salivary glands, also that the oviduct runs down to the orifice described in the *Monograph of the Cirripedia* as the auditory meatus." Hoek, however, observes that the interpretation of the glands as salivary is not given by Krohn as his own opinion, but only quoted from Cuvier. Hoek himself proposes to call them pancreatic glands.

On the absorbing question of the development, T. T. Groom (*Phil. Trans.*, 1894, vol. clxxxv.) supplies a full bibliography, beginning with the pioneers Slabber (1778; properly 1769) and J. Vaughan Thomson (1830). Groom's monograph was almost immediately supplemented by Chun's chapters on the same subject (*Bibliotheca Zoologica*, 1895, Heft 19, Lieferung 2), to which an important discussion is contributed by H. J. Hansen (*Die Cirripedien der Plankton-Exp.*, 1899). He insists on the value of the upper lip or labrum for generic distinction, and as an aid in affiliating larval forms of different stages to their several species. He cites Groom's evidence that larvae obtained from the egg readily go through one moult in the aquarium, and the known fact that the last larval stage is marked by a longitudinal series of six pairs of immovable spines or processes. He considers, then, that by a judicious comparison of larval forms with these two easily determinable stages the poverty of existing information on the subject may be gradually, if laboriously, diminished. The large and peculiar *Archizoea gigas* of Dohrn must, he thinks, belong to the Lepadidae as a larva in the last stage, but not, as v. Willemoes Suhm supposed, to *Lepas australis*, or even to the genus *Lepas* at all.

Thyrostraca anomala.—This section comprises Darwin's Apoda, the footless, Lilljeborg's Suctoria, called by Fritz Müller the Rhizocephala or rootlet-headed, and the group to which Lacaze-Duthiers gave the alternative names Ascothoracida, sac-bodied or Rhizothoracida, rootlet-bodied. For the present these names may be dispensed with in favour of their equivalents, the three families Proteolepadidae, Sacculinidae and Lauridae. The first is still limited to the single genus and species *Proteolepas bivincta* (Darwin), parasitic within the sac of another cirripede. Nothing is certainly known of its development, except that the ova are extremely small, but H. J. Hansen (*Die Cirripedien der Plankton-Exp.*, 1899, p. 53) argues that various nauplii of a type not previously described may probably be referred to this group or family. The second family, discussed by Delage, Giard, Kossmann and others, has no dearth of genera and species, though about several of them the information is scanty. Almost all of them are parasitic on other crustaceans. *Sphaerothylacus polycarpus* (Sluiter, 1884) has an ascidian for its host. *Sarcotaces* (Olsson, 1872) has two species parasitic in fishes. But these exceptional and dubious forms do not obtain nutriment by sending rootlets in a rhizocephalous manner into their patrons. The family Peltogastridae is sometimes separated from the Sacculinidae, and sometimes made to do duty for both, the latter course being improper, since *Sacculina* (J. Vaughan Thompson, 1836) is not, as has been supposed, preoccupied, and must, therefore, take precedence of *Peltogaster* (Rathke, 1843). In the same family stands the genus *Sylon*, noted by Kröyer without a name in 1842, named by him without a description in 1855, described by Michael Sars in 1869, and published by G. O. Sars in 1870. Hoek (" *Challenger* " *Reports*, 1888, vol. xxiv. app. A) will orientate the English reader on this genus. For the complicated parasitism of isopods and Sacculinidae on the same hosts Giard and Bonnier (*Bopyriens*, 1887, p. 197) should be consulted.

The remaining family may, till further knowledge, be allowed to cover four remarkable species, three of them resident on Anthozoa, one on an echinoderm. Only the first, the celebrated *Laura* *gerardiae* (Lacaze-Duthiers, 1865), sends such rootlets into its host as would justify the term Rhizothoracida. The small sinuous segmented body is enclosed, except for one small opening, in an enormous sac-like carapace, between the lamellae of which are protruded from the body the ovary and "liver," both large, bifurcate and ramified. It is this sac-like and not valvular carapace, therefore, that justifies the term Ascothoracida. But *Synagoga mira*, Norman, 1888 (*Brit. Assoc. Report* for 1887), has the body covered by two nearly circular valves instead of a sac. *Petrarca bathyactidis*, G. H. Fowler (*Quart. Journ. Mic. Sci.*, 1889, vol. xxx. pt. ii. p. 115), has a bilobed carapace, ventrally open; *Dendrogaster astericola*, Knipovitch (*Biologisches Centralblatt*, 1891, x. 707), is a multilobular sac, with apparently indistinct segmentation of the body proper on the dorsal side. For this highly problematic group the original authorities should by all means be consulted. The student may then be asked to compare the account of *Synagoga mira* both with the figure of the cypris-stage of *Dendrogaster astericola* and with the figure of the "indeterminate animal found on Gerardia," about which Lacaze-Duthiers asks, "Is it the cypris-stage of Laura?" (*Mém. Acad. Sci.*, 1883, xlii. 160, pl. 1, fig. 102). *S. mira* was found, like *Laura gerardiae* (fig. 3), in the Mediterranean, and found like it attached

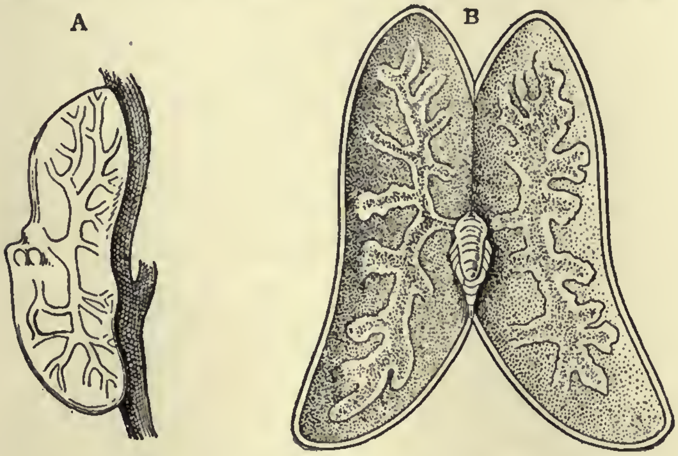


FIG. 3.—A, *Laura gerardiae*; B, Carapace slit open to show the body proper.

to an antipatharian. Its six pairs of limbs are not like the bare and simple feet of the *Laura*, but two-branched and setose as in the ordinary cypris-stage of the cirripede. The conclusion, therefore, from these facts and from the suggested comparisons, seems at least extremely probable that the question asked by H. Lacaze-Duthiers should be answered in the affirmative, and that *S. mira* is either the cypris-stage of *Laura gerardiae* or of some congeneric species. In Lacaze-Duthiers's highly-elaborated memoir it should be noticed that he uses the term "cirrhes" rather misleadingly, not for cirrhiform feet, but as the equivalent of setae. Also he gives two different reckonings of the segmentation, counting first eleven body segments without the caudal furca (p. 40), and then the caudal furca as itself the eleventh segment (p. 41). Of *Petrarca* the development is not yet known. The points of agreement and difference between it and *Laura* are carefully drawn out in the essay by Dr G. H. Fowler, who inclines to favour a close relationship between the Thyrostraca and Ostracoda. To the extreme development of the carapace in *Laura*, as compared with the segmented body, it would be difficult to find among crustaceans any analogy more striking than that of the great ovarial expansions in *Nicothoe astaci*, the little copepod parasite of the common lobster. The compactness of the class Crustacea is generally admitted; of the precise affinities of its subdivisions there is still much to learn.

(T. R. R. S.)

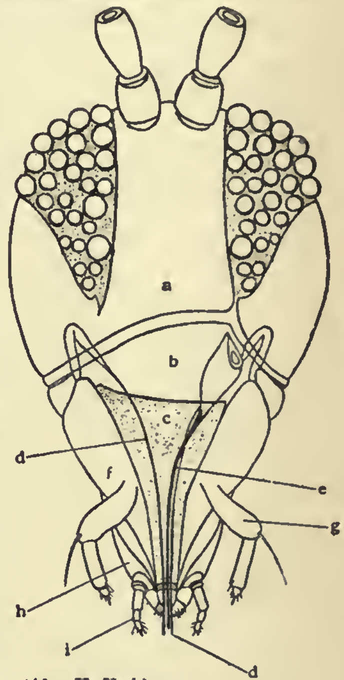
THYRSUS (the latinized form of Gr. θύρσος, a stem or stalk) the wand or staff of Dionysus (Bacchus), the Bacchants and Maenads and the votaries taking part in his orgiastic rites. As commonly represented on the monuments it was a straight staff terminating in a pine cone, a ribbon or fillet being attached to the head below it. Another form terminated in a bunch of grapes and vine leaves, or ivy-berries and leaves. The pine-cone or bunch of leaves was sometimes supposed to cover the head of a spear, and the thyrsus was termed θυρσόλογχος (see DIONYSUS and MYSTERY).

THYSANOPTERA (θύσανος, a fringe, and πτερόν, a wing), a term used in zoological classification for a small order of the class Hexapoda (*q.v.*). The minute insects included in it, which haunt blossoms and leaves, are fairly well known to gardeners by the name Thrips, a generic term used by Linnaeus for the four species of the group which he had examined and relegated to the order Hemiptera. The term Thysanoptera was first used by the Irish entomologist A. H. Haliday (1836), who made a careful study of the British species and recognized that their structural peculiarities required ordinal separation. H. Burmeister in 1838 also considered that these insects should form a distinct order, for which he proposed the name Physopoda, with reference to the bladder-like outgrowths (fig. 3) on the feet. Since then various authors have incorporated the Thysanoptera with one of the large orders, some, following Linnaeus, regarding them as Hemiptera, others grouping with them the Orthoptera or "Pseudoneuroptera." But all recent students agree with Haliday and Burmeister in allowing the Thysanoptera to rank as a distinct order, showing affinities on the one hand with the Corrodentia (book-lice and biting lice) and on the other with the Hemiptera (cicads, bugs, &c.).

(The illustrations in this article are all after H. Uzel, *Monographie der Ordnung Thysanoptera*, and are used with his permission.)

FIG. 1.—*Limothrips denticornis*, female, Europe. (× 20.)

Characters.—The Thysanoptera, small insects with firmly chitinized cuticle, are recognized by the combination of imperfectly suctorial jaws—the mandibles acting as piercers and maxillae retaining their palps (see fig. 2)—with the presence of two pairs of excessively narrow wings (fig. 1), which are partly or completely surrounded by elongate delicate bristles forming a fringe. Other important structural features are mentioned below. In their life-history the Thysanoptera belong to the Exopterygote division of the Hexapoda (*q.v.*). The newly hatched insect closely resembles the parent, and the wing-rudiments appear externally on the second and third thoracic segments; but before the final moult the nymph remains quiescent, taking no food. Its condition thus recalls the pupal instar of the higher (Endopterygote) Hexapoda; and the Thysanoptera, though few in number, are seen to be of great interest to the student, exhibiting at once a transition between the biting and the suctorial mouth, and the passage from "incomplete" to "complete" metamorphosis.



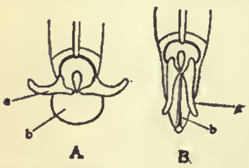
(After H. Uzel.)

FIG. 2.—Head of *Aeolothrips fasciata*, face view, showing eyes, bases of feelers and jaws. (× 120.)

a, Clypeus.
b, Membrane between clypeus and labrum.
c, Labrum.
d, Mandible.
e, Unpaired piercer (? inner lobe of left maxilla).
f, Maxilla.
g, Its palp.
h, Second maxillae, forming labium.
i, Labial palp.

Structure.—The head is usually quadrangular in form with small but prominent compound eyes (fig. 2), whose facets are relatively large and convex; three ocelli may also be present on the vertex. The feelers are inserted close together (fig. 2) on the extreme front of the head; they exceed the head in length, but they are composed of only from six to nine segments, which are beset with prominent spines, some of the latter appearing to be organs of special sense. The mouth, with its jaws, forms a conical outgrowth which projects backwards, so that its apex lies beneath the prothorax. The labrum (fig. 2 *c*), which encloses the cone in front, is irregularly triangular in shape. Behind the mouth the two maxillae of the second pair are intimately associated to form the labium (fig. 2 *h*), whose appendicular nature is shown only by a median furrow and by short, cylindrical palps (fig. 2 *i*) with two or four segments. The maxillae of the first pair (fig. 2 *f*) enclose the mouth at either side. They are broad at the base, but taper towards the tip and carry palps (fig. 2 *g*) with two or three segments. Within the mouth lie a pair of slender piercers (fig. 2 *d*), while a single piercer (fig. 2 *e*) is situated asymmetrically on the left side. The nature of these structures has been much disputed. H. Uzel, with the majority of students, regards the paired organs as mandibles and the unpaired as an epipharynx. H. Garman and W. E. Hinds believe that the paired piercers are the inner lobes of the maxillae, and the unpaired piercer the left mandible, the right mandible being absent. C. Börner has stated that the unpaired piercer is attached directly to the base of the left maxilla. He therefore regards it as the inner lobe (*lacinia*) of that maxilla, comparing it with the remarkable "pick" of the maxilla of a book-louse (see Copeognatha in article NEUROPTERA). The paired piercers, connected by muscles with the base of the maxillae, but attached directly to the head skeleton, into which they can be withdrawn, are regarded by Börner as true mandibles.

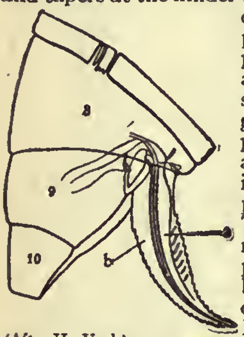
Turning to the thorax we find that the first segment (prothorax) is distinct and free, with a wide dorsal sclerite. The mesothorax and metathorax are rather intimately fused together. Most remarkable in this order is the structure of the feet; there are never more than two tarsal segments, and the claws, usually so conspicuous in insect feet, are reduced (fig. 3 *a*) or absent. But the legs carry peculiar spines, and the terminal tarsal segment is cup-shaped at the end; from this hollow a delicate bladder (fig. 3 *b*) can be protruded, apparently by the force of the blood-pressure, and by means of this bladder—acting as a sucker—the insect obtains firm hold on any surface which the foot touches. The narrow, delicate, fringed wings have already been described; each wing may be surrounded by a nervure and traversed by two longitudinal nervures, or the nervuration may be altogether degenerated. A fair number of species are wingless (fig. 5), either in one or both sexes, and the occurrence of winged females with wingless males is noteworthy.



(After H. Uzel.)

FIG. 3.—Foot of young *Trichothrips* (under surface). (× 300.)
A, With "bladder," *b*, protruded; B, retracted, *a*, Claws.

Ten segments are recognizable in the abdomen, which is elongated and tapers at the hinder end. In two of the three families of Thysanoptera the female has a conspicuous ovipositor (fig. 4) with serrate processes, projecting from the ventral surface of the abdomen between the eighth and ninth segments. The number of spiracles is greatly reduced; in the adult a pair is present on the mesothorax, sometimes also a pair on the metathorax, and there is always a pair on the first and another pair on the eighth abdominal segment. These spiracles, according to Hinds, are remarkable honeycomb-like structures, and perforations to the tracheal tubes have not been demonstrated. The internal structure of the Thysanoptera has been studied by K. Jordan. They possess a long, tubular gullet and a highly concentrated nervous system; in addition to the suboesophageal ganglion, there are two thoracic ganglia and a single abdominal nerve-mass which is situated far forward. In this condensation of the nervous system and in the presence of four Malpighian (excretory) tubes the Thysanoptera resemble the Hemiptera.



(After H. Uzel.)

FIG. 4.—Ovipositor (side view) of *Physopus*. (× 100.)
8, 9, 10, Abdominal segments.
a, Anterior; *b*, posterior process of ovipositor.

Development and Habits.—Many species of Thysanoptera are known to be habitually parthenogenetic. The eggs are laid on the food-plant, those females possessed of an ovipositor cutting through the epidermis and placing their eggs singly within the plant-tissues; a single female may take five or six weeks to deposit all her eggs. The young insect resembles its parent in most points, but the head is disproportionately large; the anterior abdominal spiracles are on the second segment instead of on the first, and the foot has only a single segment. At first the eyes consist of a few distinct facets on either side of the head; they increase in number as growth proceeds, and become aggregated to form the curious compound eye of the adult. From two to four moults occur, after which the "pronymph" stage is reached, which in the insect is moderately active and possesses wing-rudiments reaching to the second abdominal segment. After another moult the insect passes into the passive nymphal or "pupal" stage, during which it takes no food and rests in some safe hiding-place, such as the soil at the base of its food-plant or the hollow of a leaf-stalk. During this stage the cuticle draws away from the imaginal cuticle which is forming beneath, ultimately becoming separated as a thin transparent pellicle through which the form of the adult can be seen.

Thysanoptera are found on the leaves and in the blossoms of plants. According to Hinds they feed chiefly on the green tissues, which "are punctured by the piercing mouth-parts and the sap withdrawn by suction. The traces of their feeding are left in irregular streaks of dry, whitened cells." It has been stated that when present in blossoms they feed on nectar, but it is more probable that there—as on the green parts—they suck sap. In any case, their presence in apple blossoms has been known to prevent the formation of fruit through injury to the essential organs of the flower, and some species do considerable damage to ears of corn. Some Thysanoptera habitually dwell on the under-surface of leaves, and others periodically migrate to roots. While the majority of the Thysanoptera are thus vegetarian in their diet, and are frequently injurious in farm and garden, some species, at least occasionally, adopt a predaceous habit, killing aphids and small mites (so-called "red-spiders") and sucking their juices. There are even records of an *Anaphothrips*, when cut off from its normal vegetable food-supply, becoming cannibalistic and feeding on its own species. The usual variations in habit that characterize plant-feeding insects are exhibited by the Thysanoptera some species being found only on one particular food-plant, while others thrive indifferently on a large assortment. Some members of this order spend the winter in the adult state, others in the "larval" or "pupal" condition. They shelter in crevices of the bark of trees, in the dried stems of herbaceous plants, or among moss and fallen leaves on the ground. Hinds states that the hibernating individuals live for more than six months. During summer there may be eight or nine successive generations when conditions are favourable and food abundant.

Distribution and Fossil History.—The Thysanoptera are probably world-wide in their range, but they have hardly been studied outside Europe and North America. Fossil insects referable to the order have been found in Tertiary beds as old as the White River Oligocene of North America, and the Baltic amber, but nothing is known as to the previous history of the group.

Classification.—Only about 150 species of Thysanoptera are known; the European species with a few exotic forms have been described by Uzel, the North American by Hinds. These writers both follow the classification of Haliday, who divided the order into two groups or sub-orders.

1. *Terebrantia*: In this division (figs. 1, 4) the abdomen is cylindrical, the female is provided with a ventral ovipositor and has the terminal abdominal segment conical; the corresponding segment in the male is usually bluntly rounded. The forewings have at least a single longitudinal nervure—often two—reaching from base to tip of the wing. The maxillary palps have usually three, the labial either two or four segments. There are two families of Terebrantia: (*a*) the Aeolothripidae, whose feelers have nine segments; whose wings, relatively broad and rounded at the tip, have a few cross nervules, and whose ovipositor is curved backwards; and (*b*) the Thripidae, whose feelers have six to eight segments, whose narrow acuminate wings have no cross nervules, and whose ovipositor (fig. 4) is curved downwards. This latter family contains the great majority of the order.

2. *Tubulifera*: This division comprises but a single family — the Phloeothripidae; the species are not numerous, but some of them are of large size for Thysanoptera, as much as 8 mm. (one-third inch) in length. These insects have the abdomen flattened, with its terminal segment (see fig. 5) narrow and cylindrical. The palps, both maxillary and labial, have two segments. There is no ovipositor, and the wings are either without nervures or have only a single degraded longitudinal nervure which does not reach to the tip. While the Terebrantia are often rapid in their movements, the Tubulifera are slow and deliberate. According to Hinds, "they never run or spring."

(After H. Uzel.)

FIG. 5.—*Megalothrips lativentris*, female, Europe. (× 16.)

BIBLIOGRAPHY.—The number of important writings on the Thysanoptera is not large. A. H. Haliday's papers in *Entom. Mag.*, 1836–1837, vols. iii. and iv., are still valuable and contain nearly all that is known of the fifty British species. K. Jordan's anatomical studies (*Zeits. wiss. Zool.*, 1888, vol. xlvii.) are valuable and the descriptions of the jaws by H. Garman (*Amer. Nat.*, 1896, vol., xxx.) and C. Börner (*Zool. Anz.*, 1904, vol. xxvii.) should also be consulted. Indispensable to the student are H. Uzel's *Monographie der Ordnung Thysanoptera* (Königgratz, 1895; in the Czech language, but with a German summary), and W. E. Hinds's *Monograph* of the North American species (*Proc. U. S. Nat. Mus.*, 1903, vol. xxvi.). (G. H. C.)

THYSANURA, the name applied by P. A. Latreille to the primitive wingless insects known as springtails and bristletails. Sir J. Lubbock (Lord Avebury) separated the springtails as a distinct order, the Collembola, and by many students this separation has been maintained. It is better, on the whole, to regard the Thysanura and Collembola as sub-orders of a single order, the Aptera (*q.v.*). The Thysanura are recognizable by their elongate feelers and tail-processes (*cerci*). *Campodea* (*q.v.*) *Machilis* and *Lepisma*—to which belongs the "silver-fish" (*q.v.*)—are the best known genera. (See also HEXAPODA and APTERA.)

THYSSAGETAE, an ancient tribe described by Herodotus (iv. 22, 123) as occupying a district to the north-east of Scythia separated from the Budini by a desert seven days' journey broad—perhaps the Voguls. From their land four rivers flowed into the Maeotis, but as one of them, the Oarus, is almost certainly the Volga, there must be some mistake about this. They seem to have held the southern end of the Urals about Ufa and Orenburg. (E. H. M.)

TIAN-SHAN, or CELESTIAL MOUNTAINS, one of the most extensive mountain systems of Asia. In the widest acceptation, the system extends from the E. edge (in about 67° E.) of the Aral-Caspian depression in the W. to the great bend of the Hwang-ho (about 103° E.) in the E. The Chinese geographers, however, appear to have confined the term to that part of the system which falls between the conspicuous mountain-knot of Khan-tengri (80° 11′ E. and 42° 13′ N.) and the Otun-koza or Barkul depression in 92°-93° E., where the northern ranges of the system abut upon the Ek-tagh Altai; and this conception and limitation of the term are more or less accepted by some European geographers, *e.g.* Dr Max Friedrichsen and G. E. Grum-Grshimailo. On the other hand P. P. Semenov (or Semyonov), one of the earliest scientific explorers of the system, applies the name to the ranges which lie immediately west of Khan-tengri, including Khan-tengri itself. The Tarbagatai Mountains and their north-western continuation, the Chinghiz-tau, are sometimes considered to belong orographically to the Altai system; but there are good reasons for regarding them as an independent range. Excluding these mountains, the northernmost member of the Tian-shan system is the Dzungarian Ala-tau in 45°–45° 30′ N. The southernmost range is the Trans-Alai, or rather its W.S.W. prolongation, Peter the Great Mountains in Karateghin (Bokhara), though some geographers (*e.g.* Max Friedrichsen) assign both the Alai and the Trans-Alai Mountains to the Pamirs.

General Orographical Description.—The Tian-shan consists almost everywhere of "sheaves" of parallel ranges, having their strike predominantly east and west, with deflexions to the W.S.W., west of Khan-tengri and to the E.S.E., east of 92° E., thus describing as it were a wide flattened arc open to the south. The principal constituent ranges are accompanied by another set of ranges which break away from the main axes in a westerly or even in a north-westerly direction. In the east, where the system is narrowest, the predominant feature, at least as far west as 87° E., the longitude of the Bagrash-kul, is the Pe-shan swelling, with its flanking ranges, the Chol-tagh on the north and the Kuruk-tagh on the south. North of the Chol-tagh and west of Barkul and the depression of Otun-koza (alt. 2390 ft.) the principal constituent ranges are the Bogdo-ola, continued west and north-west in the Iren-khabirga, the Talki Mountains and the Boro-khoro, flanking in succession the great depression of Dzungaria on the south. South of this last line of elevations comes the depression of Kulja or Ili, cutting deep and far into the outer edge of the great plateau of central Asia. This again is bordered on the south by another series of ranges, the Narat Mountains and the Tömurlik-tau. The last bifurcates into the Trans-Ili Ala-tau and the Kunghei Ala-tau, skirting the north shore of Lake Issyk-kul. The west continuation of the Kunghei Ala-tau is the Alexander range, which in its turn bifurcates into the Talas-tau and the Kara-tau, this last stretching far out into the desert beside the Syr-darya. South of Lake Issyk-kul, which appears to be a hollow of tectonic origin, runs the Terskei Ala-tau, separating the lake from the high valley of the Naryn. On the south side of the Naryn valley comes the Kokshal-tau, called also in part the Boz-adyr, striking south-west from the Khan-tengri knot and terminating in the Terek-tau (40° 30′ N. and 74°–76° E.), at which point the system again bifurcates, the Ferghana Mountains running away from it towards the north-west until it, or rather its prolongation the Uzun-tau, strikes against the Talas-tau. From this latter point, again, the Chotkal-tau strikes away to the south-west, screening the valley of Ferghana against the Aralo-Caspian desert. The other arm of the bifurcation, situated farther south, and beginning at the Terek-tau, is double; it consists of the Alai and Trans-Alai ranges, continued westwards in the Karateghin, Zarafshan, Hissar and Turkestan ranges, though orographically the Trans-Alai ought probably to be described as the border-ridge of the Pamir plateau. Thus the Tian-shan is as a whole narrowest in the east and spreads out fan-like in the west.

Khan-tengri and the Central Tian-shan.—The peak of Khan-tengri, which according to Max Friedrichsen's observations is not so high as had generally been supposed, being 22,800 ft. instead of 24,000 ft., stands, not on the main watershed of the central Tian-shan, but on a spur which projects from the watershed towards the south-west. The loftiest summit on the actual watershed, according to G. Merzbacher, is a peak to which he has given the name of Nicholas Mikhailovich; its altitude he puts at 20,670 ft. But the general altitude of the crest of the watershed he estimates at about 16,500 ft., and it is overtopped by peaks (*e.g.* Dr von Almasy's peak Edward VII.) rising 3000–3500 ft. higher.

Closely connected with the Khan-tengri knot are the Khalyk-tau on the east, and on the west three diverging lines of elevation, namely the Terskei Ala-tau or Kirghiz Ala-tau, overhanging the south shore of Issyk-kul; the Kokshal-tau, stretching away south-west as far as the Terez Mountains between Kashgar and Ferghana; and, intermediate between these two, the successive ranges of the Sary-jas, Kulu-tau, and Ak-shiryak. The snowy chain of Khalyk-tau is highest in the north and west and sinks gradually towards the south and east. The highest parts of the range have generally an east-west strike and the range itself is continued east in the Kokteke (12,300 ft.), with the Kui-kuleh pass at an altitude of 11,500 ft.

From Issyk-kul there is a sharp rise of 6000–9000 ft. to the snow-capped ridge of the Terskei Ala-tau, the peaks of which ascend to 15,000–16,500 ft. and even reach 18,000 ft. At this part the system as a whole has a breadth of 150 m. The Terskei Ala-tau forms a sharply accentuated, continuous, snow-clad range. According to I. V. Mushketov it is continued westwards in the Son-kul (alt. 9,500 ft.) of Baron Kaulbars, the Kara-kol, and the Suzamir-tau, until it abuts upon the Talas-tau. The country immediately south of the Terskei Ala-tau consists "of broad, shallow basins running east and west in *en echelon* pattern, and lying at 10,000 ft. Between them and bordering them run from five to seven ridges as broad as the basins and rising by gentle slopes to 13,000–16,000 ft. The ridges rise by long, gentle slopes to flat summits, where often for many miles the sky-line is an almost straight crest, from which the rounded slopes of pure white snowfields descend towards the basins. The crest line is notched by high passes only 1000–2000 ft. below the top of the crest. Oftener the summit of the ridge is broken into individual mountains, broadly flat-topped and of nearly equal elevation. . . . (Since late Tertiary times) erosion has had but little effect in altering the country from the state to which it was brought by the uplifting and warping of the old peneplain. The result of these geological changes is that, although the internal structure of the Tian-shan region is highly mountainous, its external appearance, or in other words its geographical aspect, is that of a plateau."[1] The passes over the Terskei Ala-tau and the plateau country to the south lie at great altitudes—at 13,560 ft. in the Kulu-tau; at 13,800 in the Bedel pass, 12,400 in the Kubergenty, at 12,600 in the Terekty, and at 14,440 in the Jan-art pass—all in the Kokshal-tau; the Terek pass at 12,800 ft., and the Turugurt at 12,730 ft., both in the Terek range; the Barskoun at 12,000 ft., the Suka or Sauka at 11,650 ft., and the Jauku at 14,000 ft. in the Terskei Ala-tau; and the Tez at 11,800 and the Akbel at 12,000 ft., both in the Sary-jas; while the pass of Muz-art, on the east shoulder of the Khan-tengri, necessitates a climb of 12,000 ft. or more. The snow-line on the Terskei Ala-tau runs at 11,500 ft. The summits of the Kulu-tau or Kyulyu-tau reach 13,700 to 14,750 ft.; those of the Ak-skiryak 15,000–16,000 ft., overtopping by some 2000–3000 ft. the plateau or highland region which forms the water-parting between the Tarim basin on the east and the Syr-darya catchment area on the west. The Kokshal-tau, which consists of several parallel ranges, is truly alpine in character and bears large glaciers, which send out polyp-like arms into U-shaped valleys, behind which the mountain peaks tower up into sharp-cut, angular "matterhorns." The loftiest range is that to the north, which exceeds 16,000 ft., and the altitude increases generally from west to east as far as the Bedel pass in 78° 30′ E., where the road crosses from Ak-su and Uch-Turfan to the valley of the Naryn and Ferghana. At its south-western extremity the Kokshal-tau merges in the Kokiya Mountains (16,000–18,000 ft.), which at their other end are met by the Alai Mountains and the Terek-tau.

Eastern and Northern Tian-shan.—The mutual relations and exact orographical connexions of several of the ranges east and north of the Khan-tengri group are not yet elucidated. The region east of the Barkul-Hami route was in part explored in the closing years of the 19th century, by P. K. Kozlov, V. A. Obruchev, the brothers G. E. and M. E. Grshimailo, V. I. Roborovsky and Sven Hedin. The system is known there locally as the Barkul Mountains and the

[1] Ellsworth Huntington, in *Geog. Journ.* (1905), pp. 28 seq.

Karlyk-tagh,[1] which stretch from W.N.W. to E.S.E. Its middle parts are snow-clad, the snow lying down to 12,000 ft. on the north side, while the peaks reach altitudes of 14,000–15,000 ft., but so far as is known the range is not crossed by any pass except in the east, where there are passes at 9600 ft. and 10,600 ft. (Belu-daban). Towards the east, the Karlyk-tagh radiates outwards, at the same time decreasing in altitude, though it rises again in the rocky Emir-tagh. From the Karlyk-tagh a stony desert slopes south to the Chol-tagh. The Chol-tagh marks the northern escarpment, as the Kuruk-tagh, farther south, marks the southern escarpment, of the great Pe-shan swelling of the desert of Gobi. These two ranges (described under GOBI) are apparently eastern prolongations, the former of the Khaidyk-tagh or Khaidu-tagh, and the latter of the Kok-teke Mountains, which enclose on north and south respectively the Yulduz valley and the Lake of Bagrash-kul. Thus the Kuruk-tagh are linked, by the Kok-teke, on to the Khalyk-tau of the Khan-tengri group. The Khaidyk-tau, which are crossed by the passes of Tash-againyn (7610 ft.) and Kotyl (9900 ft.), are not improbably connected orographically with the Trans-Ili Ala-tau, or its twin parallel range, the Kunghei Ala-tau, in the west, in that they are an eastern prolongation of the latter. The Narat-tau appear to form a diagonal (E.N.E. to W.S.W.) link between the Khaidyk-tau and the Khalyk-tau and are crossed by passes which V. I. Roborovsky estimates at 10,800 ft. (Sary-tyur) and 11,800 ft. (Mukhurdai). The Jambi pass in this same range lies at an altitude of 11,415 ft. and the Dundeh-keldeh pass at 11,710 ft.

At the west end of the Barkul range is the gap of Otunkoza (2390 ft.), by which the Hami-Barkul caravan road crosses into the valley of Dzungaria, and at Urumchi (87°30′ E.), over 200 m. farther west, is a similar gap (2800 ft.) which facilitates communication between the oasis of Turfan and Dzungaria. Between these two gaps stretches the snow-clad range of the Bogdo-ola, which runs at an average altitude of some 13,000 ft., and rises to an altitude of 17,000–18,000 ft. in the conspicuous double peak of Turpanat-tagh or Topotar-aulie, a mountain which the Mongols regard with religious veneration. On the north side of this range the snow-line runs at an altitude of 9500 ft. At the foot of the same slopes lies the broad, deep valley of Dzungaria (2500–1000 ft.). On the south the Bogdo-ola is flanked by the nearly parallel range of the Jargöz, a range which, in contrast to most of the Tian-shan ranges, carries no perpetual snow. But its altitude does not exceed 10,000 ft., and its steep rocky slopes meet in a sharp, denticulated crest. West of the Urumchi gap, the Bogdo-ola is continued in the double range of the Iren-khabirga Mountains (11,500 ft.), which curve to the north-west and finally, under the name of the Talki Mountains, merge into the Boro-khoro range. The Iren-khabirga, like the Bogdo-ola and the Terskei Ala-tau, are capped with perpetual snow. They culminate in the peak of Dös-megen-ora at an altitude of 20,000 ft. The more southerly of the twin ranges, the Avral-tau, in which is the Arystan-daban pass at an altitude of 10,800 ft., terminates in 82° E., over against the confluence of the Kash and the Kunghez (Ili) rivers. The Boro-khoro Mountains, with an average elevation of at least 11,500 ft., have all the characteristics of a border-ridge. This range, the slopes of which are clothed with Coniferae between the altitudes of 6000 and 9000 ft., separates the valley of Kulja (Ili) on the south from the depressions of Zairam-nor (6820 ft.) and Ebi-nor (670 ft.) in the valley of the Borotala on the north, the said valley opening out eastwards into the wider valley of Dzungaria. The passes in the Boro-khoro lie at lower altitudes than is usual in the Tian-shan ranges, namely at 7000–7415 ft.

On its northern side the valley of Borotala is skirted by the important orographic system of the Dzungarian Ala-tau, the northernmost member of the Tian-shan. Its constituent ranges run from E.N.E. to W.S.W., though some of them have a W.N.W. and E.S.E. strike. The two principal series of parallel ranges possess no common names, but are made up as follows: The northern series (going from east to west) of the Baskan-tau, Sarkan-tau, Karazryk-tau, Bionyn-tau, and Koranyn-tau, running at an average elevation of 11,000–13,000 ft., and the southern series of the Urtak-saryk, Bejin-tau and Kok-su (Semenov's Labazy chain), at altitudes of 12,000–14,000 ft.

Western and Southern Tian-shan.—On the north side of the Issyk-kul, and separated from the Terskei Ala-tau by that lake, are the twin ranges of the Trans-Ili Ala-tau and Kunghei Ala-tau, parallel to one another and also to the lake and to the Terskei Ala-tau. The two chains are connected by the lofty transverse ridge of Almaty, Almata or Almatinka. The more northerly range, the Trans-Ili Ala-tau, swings away to the north-west, and is continued in the echeloned ranges of Kandyk-tau, Kulja-bashi, Khan-tau and the Chu-Ili Mountains, the general altitudes of which lie between 4000 ft. and 9000 ft. These latter ranges separate the Muyun-kum desert on the west from the Balkash deserts on the east. The Trans-Ili itself culminates in Mt Talgar at an altitude of 14,990 ft. The Kunghei Ala-tau rises nearly 8000 ft. above the Issyk-kul and lifts its summits higher than 13,000 ft. The passes across the twin ranges lie at 8000–11,000 ft. (Almaty pass) in the Trans-Ili Ala-tau and at 9000–10,885 ft. (Kurmenty pass) in the Kunghei Ala-tau. This last is continued without a break past the western end of Issyk-kul, being directly prolonged by the Alexander Mountains, although parted from them by the gorge of Buam or Bom, through which the Issyk-kul probably once drained. On neither of these ranges are there any true glaciers.

The Alexander Mountains terminate over against the town of Aulie-ata (71° 20′ E.) at the relatively low altitude of 2460 ft., though farther east they rise to 13,000–14,000 ft., and even reach 15,350 ft. in Mt Semenov. On the north their declivities are steep and rugged. They are crossed by passes at 6550–11,825 ft. (Shamsi).

From the middle of the Alexander range, in about 74° E., a chain known as the Talas-tau breaks away from its south flank in a W.S.W. direction, and from near the western extremity of this latter two parallel ranges, the Chotkal or Chatkal (14,000 ft.), and the Ala-tau, break away in a south-westerly direction, and running parallel to one another and to the river Naryn, or upper Syr-darya, terminate at right angles to the middle Syr-darya, after it has made its sweeping turn to the north-west. The Talas-tau, sometimes known as the Urtak-tau, while the name of Ala-tau is also extended to cover it, has an average elevation of 14,000–15,000 ft., but lifts its snow-capped summits to 15,750 ft.; it is crossed by passes at 8000–10,650 ft.

From near the west end of the Alexander range, in about 71° E., the Kara-tau stretches some 270 m. to the north-west, between the Syr-darya and the Chu. It belongs to the later series of transverse upheavals, and consists almost entirely of sedimentary rocks. It is not clear, however, whether orographically it is connected with the Alexander range or with the Talas-tau. Its average elevation is 5000 ft., but in places it reaches up to 7000–8000 ft. In the same north-westerly to south-easterly direction and belonging to the same series of later transverse upheavals are the Ferghana Mountains, which shut in the plain of Ferghana on the north-east, thus running athwart the radiating ranges of the central Tian-shan. The Ferghana Mountains, which are cleft by the Naryn (upper Syr-darya) river, have a mean altitude of 10,000 ft., but attain elevations of 12,740 ft. (Suyuk) and are crossed by the Terek pass (distinct from the Terek pass in the Terek Mountains) at an altitude of 9140 ft.

On the south the Ferghana valley is fenced in by the lofty range of the Alai, backed by the parallel range of the Trans-Alai. Both ranges abut at their eastern or E.N.E. extremity upon the Pamir plateau, and both extend in their respective continuations a long way out into the desert. The Alai is a well-defined ridge with steep slopes, and both it and the Terek-tau, which prolongs it towards the Kokshal-tau, are flanked next the Ferghana valley by what appear to be the old uplifted strata both of the old Palaeozoic series of metamorphic limestones and of the newer Tertiary series of softer conglomerates and sandstones. The general altitude of both ranges is 16,000–19,000 ft., but the Trans-Alai culminates in peak Kaufmann (23,000 ft.). The Trans-Alai is a true border range, the ascent to it from the Pamir plateau (13,000 ft.) on the south-east being gentle and relatively short, while both it and the Alai tower up steeply to a height of 11,000–14,000 ft. above the valley of the Alai. This valley, which runs up at its eastern end to the Muz-tagh-tau, is about 75 m. long and is continued towards the south-west by the valley of Karateghin. Its breadth varies from 3 to 12 m. and its altitude decreases from 10,500 ft. in the north-east to 8200 ft. in the south-west. It is drained by the Kyzyl-su, which, under the name of Vakhish, finally enters the Amu-darya. The Alai valley is in ill repute because of the enormous masses of snow which fall in it in the winter. Despite that it is an important highway of communication between Bokhara and the Pamirs on the one hand and Kashgar and Ferghana on the other. The principal passes over it into the valley of Ferghana are Taldyk, 11,605 ft.; Jiptyk, 13,605 ft.; Saryk-mogal, 14,110 ft.; Tenghiz-bai, 12,630 ft.; and Kara-kasyk, 14,305 ft. The first-named has been made practicable for artillery and wheeled carriages. The Pamir plateau is reached by means of the Kyzyl-art pass at an altitude of 14,015 ft.

The Alai Mountains are continued westwards in the radiating ranges of the Karateghin Mountains, Zarafshan Mountains, the Hissar Mountains and the Turkestan range, which reach altitudes of 18,500–22,000 ft., though peak Baba in the Zarafshan range reaches nearly 20,000 ft. The Trans-Alai are continued in the Peter the Great range, which culminates in the Sandal group at close upon 25,000 ft. (see further BOKHARA). The passes across these ranges are as a rule difficult and lie at altitudes of some 10,000–13,000 ft. The last outlying range of the Tian-shan system in this direction is the Nura-tau, which, like the Kara-tau farther north, belongs to the more recent series of upheavals having a W.N.W to E.S.E. axis. It rises abruptly from the desert and lifts its snowy peaks to altitudes of 15,000–16,000 ft., separating the river Syr-darya from the river Zarafshan. The passes over it lie at altitudes of 10,000–13,000 ft.

Glaciation.—In the central and western parts of the Tian-shan there exist numerous indications of former glaciation on an extensive scale, *e.g.* in the Sary-jas, the Terskei Ala-tau, Khan-tengri, Alai, Trans-Alai, Terek range, Trans-Ili Ala-tau, Kunghei Ala-tau, Kokshal-tau, Dzungarian Ala-tau, Alexander Mountains and Talas-tau.

[1] It may however eventually turn out that these ranges, together with the Mechin-ola, farther to the north-east and intimately connected with the Karlyk-tau, belong to the Altai system.

Indeed, the evidences, so far as they have been examined, appear to warrant the conclusion that the region of the western Tian-shan, from Lake Issyk-kul southwards, was in great part the scene of probably five successive glacial periods, each being less severe than the period which immediately preceded it. At the present day four or five large glaciers stream down the shoulders and embed themselves in the hollow flanks of Khan-tengri—the Semenov at altitudes of 12,410–11,100 ft., the Mushketov at 11,910–10,920 ft., the Inylchik at 11,320–10,890 ft., and the Kaindy at 10,810–10,040 ft. The Inylchik glacier is computed to have a length of about 45 m. Glaciers occur also on Manas mount to the south of the town of Aulie-ata. In the Alai region there are other extensive glaciers, *e.g.* the Fedchenko and Shurovsky glaciers south of peak Kauffmann. Generally speaking, the snow-line runs at 11,500–12,800 ft. above sea-level, and all ranges the peaks of which shoot up above 12,000 ft. are snow-clad, and all ranges which are snow-clad rise to higher altitudes than 11,500 ft. A feature generally characteristic of the Tian-shan as a whole is that the absolute elevation of the ranges increases gradually from north to south, and from the centre decreases towards both the east and the west. At the same time the relative altitudes, or the heights of the mountain ranges above the valleys which flank them, decrease from north to south. For instance, in the Dzungarian Ala-tau, the valleys going south lie successively at altitudes of 4300 ft. in the Borotala, at 5600 ft. in the Urtaksaryk and at 6820 beside the Zairam-nor. Again, while the Ili (Kulja) valley lies at 1300 ft., the Issyk-kul has an altitude of 5300 ft., the Koshkar basin, in which the river Chu has its source, reaches 6070 ft., the Son-kul valley 9430 ft., the Ak-sai valley, farther east, 10,000 to 11,150 ft., and the Chatyr-kul on the north side of the Terek Mountains 11,200 ft. In the elevated regions of this part of the system, between the Kokshal-tau and the Pamir plateau, the snow-line runs at a higher level than is usual elsewhere, namely at 12,500 ft. and even at 13,000–13,800 ft. on the Kokiya Mountains.

Climatic Conditions.—As a rule on all the Tian-shan ranges the ascent from the north is steep and from the south relatively gentle. But the deep lateral indentations (*e.g.* Kulja) provide a more or less easy access up to the loftier tablelands and plateaus of the interior. Broadly speaking, the climate on the north and west of the main ranges is both milder and moister than on the south and east, and accordingly the precipitation in the former is relatively heavier, namely 10 to 20 in. annually. It used to be supposed that the Tian-shan confronted the basin of the Tarim with a steep, wall-like versant. But this is not the case. G. Merzbacher, speaking of the slopes of the Khalyk-tau and other neighbouring ranges of the central Tian-shan, says that " nearly everywhere the Tian-shan slopes away gradually towards the high plain at its southern base, in places...subsiding gradually in ranges of transverse spurs, whose cape-like ends project far into the desert, or in other places in the step-like tailing off of longitudinal ranges.... In some places limestones appear as projections from the range; at others conglomerates and Tertiary clay marls form the outermost fold."[1] On the north versant of the ranges the rainfall increases from the foot of the mountains upwards, and at 9000–10,000 ft. the vegetation becomes luxuriant. According to P. P. Semenov, the following vegetable zones may be distinguished on the northern slopes: altitudes of 525–1575 ft. are steppe lands, of 1575–4300 ft. are the zone of cultivation, 4300–8100 ft. the zone of coniferous trees, 8100–9500 ft. alpine pastures, 9500–11,900 ft., the higher alpine regions, and above the last limit is the region of perpetual snow. The south versant, on the other hand, is barren and desolate below the 10,000 ft. limit and above that it is dotted with scanty patches of grass and bush vegetation. Its general aspect is that of rugged slopes of bare rock, seamed with the beds of dry torrents choked with gravel (see further TURKESTAN, WEST).

Routes.—The traditional routes between China on the one side and West Turkestan and Persia on the other have from time immemorial crossed the Tian-shan system at some half a dozen points. After traversing the desert of Gobi from Sa-chou to Hami, the great northern route crossed over into the Dzungarian valley either by the Otun-koza depression or by the gap at Urumchi, or else it proceeded over the Muz-art pass on the east side of Khan-tengri or over the Bedel pass in the Kokshal-tau and so down into the valley of Kulja. The shortest route, though not the easiest, between Kashgar and East Turkestan in the east and Ferghana and West Turkestan in the west is over the Terek pass or the pass at the head of the Alai valley, a dangerous route in winter by reason of the vast quantity of snow which usually accumulates there.

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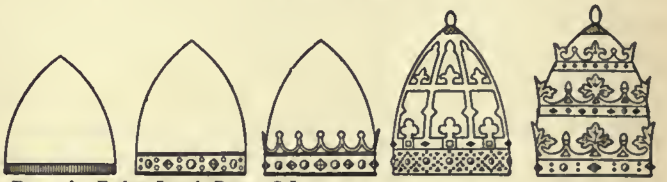
[1] G. Merzbacher, *The Central Tian-shan Mountains*, pp. 139–140 (London, 1905).

TIARA (Gr. τιάρα), also called *regnum*, *triregnum* and *corona*, the papal crown, a bee-hive shaped, somewhat bulging head-covering, ornamented with three crowns (whence *triregnum* or "triple crown"). It has no sacral character, being solely the ensign of sovereign power (cf. Innocent III. Serm. vii. *in S. Silvest*: " Pontifex romanus in signum imperii utitur regno "), and is therefore never worn at liturgical functions, when the pope always wears the mitre. The tiara is first mentioned, under the name of *camelaucum*, in the *Vita* of Pope Constantine (d. 715), and next under the name of *pileus phrygius* or *phrygium*, or the *Constitutum Constantini*, the so-called " Donation of Constantine." In the 9th century it appears in the 9th *Ordo* of Mabillon in connexion with the description of the consecration of the pope. On papal coins it first appears on those of Sergius III. (d. 911) and then on those of Benedict VII. (d. 983). At



Drawn by Father Joseph Braun, S.J.

Figure to illustrate the development of the Tiara.

this period it was, according to the *Ordo* above mentioned, a sort of cap of white stuff, and helmet-shaped. Before the 9th century the tiara was certainly without any crown; any such ornament would not have been in keeping with the circumstances of the time, and seems also to be excluded by the terms of the *Constitutum Constantini*. It is quite uncertain when the crown was first added. It is true that Mabillon's 9th *Ordo* calls this head-gear *regnum*, but it appears to know nothing of a crown. The papal coins and a few pictures of the 10th and 11th centuries leave it doubtful whether the ornamental band at the lower edge of the tiara is intended to represent a crown or merely a decorative orphrey (*aurifrisium*). At the beginning of the 12th century, however, the papal tiara was already decorated with a circlet, as the *Ordo* of Benedict (*c.* 1140) and statements made by Bruno of Segni and Suger, abbot of St Denys, prove; but it is only in representations of the tiara dating from the late 13th century that the circlet appears as a regular spiked crown. The two pendants at the back of the tiara (*caudae*, *infulae*) are likewise only traceable to this period. The second circlet was added by Boniface VIII., as is proved by three statues executed during his lifetime (one in the Lateran church and two in the crypt of St Peter's). Perhaps this was due only to the pope's love of display, but possibly the two crowns were intended to symbolize Boniface's views as to the twofold nature of the papal authority. In the inventory of the papal treasury made in 1316 the tiara is described as having three crowns; the third must therefore have been added under Benedict XI. or Clement V. The monumental effigy of Benedict XI. in S. Domenico at Perugia still has a tiara with one circlet in the antique fashion of the 13th century; that of John XXII. showed only two crowns. The earliest monumental effigy of a pope giving an example of a triple-crowned tiara is now, therefore, that of Benedict XII. (d. 1342), of which the head is preserved in the museum at Avignon, while an effigy of the same pope in the crypt of St Peter's at Rome has a tiara with only two crowns. Since Benedict XII. the triple-crowned tiara has appeared regularly on the monuments of the popes. The crowns are essentially uniform, though the ornament varies (leaves or spikes).

Outside Rome it was still a considerable time before the triple-crowned tiara appeared in representations of the popes, and as late as the 15th century they are sometimes pictured with the single-crowned tiara. The reason for the addition of the third crown is unknown. The symbolism now attached to the triple crown (authority over heaven, earth and hell, or the temporal power and the powers of binding and loosing) is certainly not the original explanation.

Several baseless hypotheses have been advanced as to the origin of the papal tiara. In all probability the *camelaucum*, the oldest form of the tiara, came into use under the Greek and Syrian popes of the 7th, or the beginning of the 8th century, perhaps even under Pope Constantine himself. The prototype of the *camelaucum* must undoubtedly be sought at Constantinople in the head-ornament forming part of the Byzantine court costume. (J. Bra.)

TIARET (*Tahert*), a town of Algeria, in the Tell Atlas, department of Oran, 122 m. S.E. of Mostaganem by rail. It occupies an important strategic position on a pass through the mountains at an elevation of 3552 ft. Pop. (1906), 5778, of whom 3433 were Europeans. The Wadi Tiaret flows through the town in a series of cascades. The upper town, the residential quarter, is on the right bank of this stream. The citadel occupies a separate hill on the other side of the wadi. The chief business centre is the lower town where are also the principal public buildings. On another hill opposite the citadel is the native town.

The citadel occupies the site of a Roman station believed to be that of Tingurtia. Tiaret (Berber for "station") was a town of note at the time of the Arab invasion of North Africa in the 7th century and is stated by Ibn Khaldun to have offered a stubborn resistance to Sidi-Okba. In 761 it was taken by Abdurrahman ibn Rostem, the founder of the dynasty of the Beni Rustām (Rostem). Their empire, which during the reign of Abdurrahman (761–784) and his son Abdul Wahab (784–823) extended over the greater part of the modern Algeria, was known as the Ibadite Empire from Abdallah ibn Ibad, the founder of the heretical sect to which Abdurrahman belonged. The Ibadites represented the moderate section of the Kharijites (see Mahommedan Religion). Seven princes of the Rustamite house succeeded Abdul Wahab at Tiaret, but in 909 the dynasty was overthrown by the Fatimite general al Shi'i. Two years later Tiaret was captured by Massala ibn Habbus of the Miknasa dynasty of Morocco, and after his death in 924 two other princes of the same house maintained their independence, but in 933 the Fatimites again gained the mastery. The Ibadites, after being expelled from the Tell, took refuge in Wargla. They were driven thence in the 11th century and migrated to Mzab, where their descendants still profess the Ibadite doctrines (see Mzabites). After its second capture by the Fatimites, Tiaret ceased to be the capital of a separate state. For a long period it was included in the sultanate of Tlemçen, and in the 16th century fell to the Turks. It was one of the chief towns of Abd el Kader, but was occupied by the French in 1843. At Takdempt, 6 m. west of Tiaret, Abd el Kader had his principal arsenal. About a mile from Takdempt are ruins of a town supposed to be the remains of the Ibadite capital. Eighteen miles S.S.W. of Tiaret are the sepulchral monuments known as the Jedars (see Algeria: § *Archaeology*).

TIBBU, or Tebu ("Men of Tu," *i.e.* "of the rocks"), a nomad negro-Berber race of the eastern Sahara, their territory being conterminous westward with that of the Tuareg Berbers. Roughly, their domain is some 200,000 sq. m. Their westernmost settlements are the oases of Agram, Kawar and Jebādo, their northernmost the district of Gatron (Qatrūn) within the Fezzan frontier, while south and south-east they merge gradually in the negroid populations of Kanem, Bornu (Chad basin), Wadai and north-west Darfur. But the bulk of the nation is concentrated in the region of Tibesti or Tu, hence their name. There are two main divisions—the northern Teda, or less negroid Tibbu, and the southern Daza, or more negroid Tibbu. Somewhat more distantly connected with the same family are the Baele of the eastern and south-eastern oases and the Zoghāwa (Zaghwa) of Darfur. The Tibbu are variously estimated as numbering from 60,000 to 100,000, but their districts are so little known that these figures are not to be relied on.

The Tibbu are usually identified with the Garamantes of Herodotus (iv. 183), whose capital was Garama (Idrisi's Germa) in Phazania (Fezzan), and of whom Ptolemy already spoke doubtfully as Ethiopians (Negroes ?): Ὄντων δὲ καὶ αὐτῶν ἤδη μᾶλλον Αἰθιόπων (i. 8). But Leo Africanus transfers them to the Berber connexion, whose fifth great division he deals with under the names of Gumeri (Garamantes?) and Bardaei or Bardoa, that is, the Teda of the Bardai oasis, Tibesti.[1] Lastly Heinrich Barth on linguistic grounds grouped them with the Kanuri of Bornu, who are undoubtedly negroes; and since his time (1852–1853) the Tibbu have been regarded by most ethnologists as a negroid people.[2] Gustav Nachtigal, who studied them carefully (1870–1873), although his own inferences are somewhat vague, supplies sufficient evidence for a solution of this difficult ethnological problem. There can be little doubt that the Teda, or true Tibbu, probably identical with the Tedamansii, a branch of the Garamantes, placed by Ptolemy south of the Samamycii in Tripolitana,[3] physically resemble their western Tuareg neighbours. They are a pure homogeneous race, who have for ages undergone no perceptible change in their rocky homes, and are still distinguished by the regular features, long black ringlety hair, haughty bearing and fierce expression common to so many of the Berber peoples. Mostly of middle size, they are finely proportioned, except the somewhat too small hands and feet, with lighter complexion than that of the southern Daza, and no trace of the flat nose, thick tumid lips, or other marked characteristics of the true negro. "Their women are charming while still in the bloom of youth" (Keane's *Reclus*, xxii. 429). But there has been a general displacement of the race southwards; and, while a few linger in the northern Gatron and Kufara districts, large numbers have since medieval times penetrated into the Kanem, Bornu, Wadai and Darfur regions of central Sudan. Here they have everywhere merged in the natives, so that in the Daza, Kanembu, Kanuri, Baele and Zoghāwa groups the Tibbu race presents all the shades of transition between the true negro and the true Berber.

The same transitional stages are observed in the Tibbu forms of speech, which constitute a wide-spread linguistic family, whose most archaic and purest branch is the Tedaga of Tibesti (Nachtigal). Through the southern Dazaga the Tedaga merges in the more highly developed and more recent Kanem, Bornu (Kanuri), Ennedi (Baele) and Darfur (Zoghāwa) dialects, which, owing to the absence of grammatical gender and some other structural features, are usually classed as negro languages. But a negro tongue could not have arisen among the people of Hamitic speech of the Tibesti uplands, and the explanation of this linguistic difficulty is obviously the same as that of the physical puzzle. The negro affinities of the southern members of the group have arisen through assimilation with the original and now partly displaced negro idioms of central Sudan. There remains the final difficulty that Tedaga itself has nothing in common with the Berber or any Hamitic tongue. If, therefore, it is neither Hamitic nor negro, the only two stock languages recognized by Lepsius in Africa, how is it to be placed? Lepsius's generalization, inconsistent as it is with the conditions occurring in other parts of the continent, must be rejected. Room having thus been found for other linguistic families, the Tedaga of Tibesti may be explained as an independent evolution from a primeval Tibbu-Berber germ, analogous to other linguistic evolutions in other isolated or inaccessible highland regions, such as the Caucasus, the Pyrenees and the Anahuac table-land. The common germ has long since perished, or can no longer be detected, and the Tibbu and Berber languages stand side by side as fundamentally distinct, while the two races remain physically one. The Tibbu are therefore a Berber people, who in their secluded homes have had time to evolve an independent form of speech, which southwards has become largely assimilated to the Sudanese negro dialects.

Lying on the tract of the great caravan route between Fezzan and Lake Chad, the Tibbu have always been a predatory race, levying blackmail on the convoys passing through their territory, maintaining inter-tribal feuds and carrying on constant

[1] See Vater, *Mithradates*, ii. p. 45 of Berlin ed. 1812, and Nachtigal, *Sāhara und Sudan* (1881), ii. 189.

[2] "Ursprünglich ein Negervolk," Lepsius, *Nubische Grammatik* (*Einleitung*) (Berlin, 1880).

[3] The original inhabitants of the Kufara (Kufra) oases were Teda, some of whom survive in a settlement south of Jebel Nari. Since the beginning of the 18th century they have been replaced elsewhere in Kufara by the Zwiya Arabs from the Leshkerreh oases.

warfare with the surrounding Berber and Sudanese populations. The tribal organization embraces *dardai* or headmen, *maina* or nobles, and the common folk, while the unwritten law of custom rules supreme over all classes. Their customs are partly negroid, partly Arab. They scar their faces like the negroes and wear the veil like the Tuareg.

See G. F. Lyon, *Narrative of Travels in Northern Africa* (London, 1821); Gustav Nachtigal, *Sahara und Sudan* (Berlin and Leipzig, 1879–1889); Gerhard Rohlfs, *Quer durch Africa* (1874–1875).

TIBER (anc. *Tiberis*; Ital. *Tevere*), a river of central Italy. It traverses the Tuscan Apennines—in which it rises at a point some 12 m. N. of Pieve San Stefano, 4160 ft. above sea-level—in a series of picturesque ravines, skirts the west foot of the Sabine Mountains in a broad shallow valley, then crosses the Roman Campagna, cutting its way through Rome, and finally enters the Tyrrhenian (Mediterranean) Sea by two arms at Ostia and Fiumicino, the latter artificial. Its principal tributaries are the Paglia, the Nera and the Anio or Teverone, and it is generally navigable by boats up to the confluence of the Nera, a distance of 104 m., though, owing to the rapidity of the current, there is very little navigation above Rome. The total length of the river is 240 m., of which 21 m. lie between Rome and the sea. This latter portion of the river's course is tortuous, but in spite of this, and although the depth varies from only 7 to 20 ft., and in places at low water does not exceed 4 ft., it is nevertheless navigated by vessels up to 180 tons burden and proposals have been made to embank and dredge it so as to increase this depth to 8 ft. at least, or to build a ship canal up to Rome. The area of the Tiber basin is 6845 sq. m. The stream is heavily charged with sediment, and from that circumstance got its ancient epithet of *flavus* (tawny). It does not, however, form a delta proportionate to the volume of its water, owing to a strong sea current flowing northwards close to the shore, to the sudden sinking of the sea to a great depth immediately off the mouth of the river, and possibly also to the permanent subsidence of the Italian coast from the Tiber mouth southwards to Terracina. Still it has advanced at each mouth about 2 m. since Roman times, while the effect of the sediment it brings down is seen on the north-west almost as far as Palo (anc. *Alsium*), and on the south-east beyond Tor Paterno (see LAURENTINA VIA) in the gradual advance of the coast. The rate of advance at Fiumicino is estimated at 13 ft. per annum. From Rome to the sea the fall is only 6·5.: 1000. The arm which reaches the sea at Fiumicino is a canal, dug by Claudius and improved by Trajan (see PORTUS), which partially silted up in the middle ages, and was reopened for navigation by Paul V. in 1612, 2½ m. long, 80-130 ft. wide, and with a minimum depth of 5 ft. The lower course of the Tiber has been from the earliest ages subject to frequent and severe inundations; of more recent ones, those of 1598, 1870 and 1900 have been especially destructive, but since the year 1876 the municipality of Rome, assisted by the Italian Government, has taken steps to check, and possibly to prevent these calamities within the city by constructing embankments of stone, resting on caissons, for a total distance (counting in both sides of the river) of 6 miles. The flood of 1900 carried away about ¼ m. of the new embankment on the right bank of the right arm opposite the island owing to the faulty planning of the course of the river at that point, which threw the whole of the water into the right arm, and except in flood time, left the left arm dry—a fault which has since been corrected.

In the prehistoric period the mouth of the Tiber must have been situated at the point where the hills which follow it on each side cease, about 12 m. below Rome. On the right bank they are of pliocene gravel, on the left of tufa; and on the latter, on a cliff above the river (the ancient *Puilia saxa*) stood Ficana (marked by the farmhouse of Dragoncello), which is said to have owed its origin to Ancus Martius. Beyond these hills the low coast belt formed by the solid matter brought down by the river begins; and on each side of the mouth in the flat ground were salt marshes (see OSTIA, PORTUS). The flood of 1900, when the river both above and below Rome extended over the whole width of its valley, from hill to hill, and over most of the low ground at its mouth, gave an idea of the conditions which must have existed in prehistoric days.

TIBERIAS, a town on the western shore of the sea of Galilee (to which it gives its modern Arabic name, *Baḥr Tubariya, i.e.* Sea of Tiberias). It has a population of about 4000, more than half of whom are Jews (principally Polish immigrants). It stands in a fertile but fever-stricken strip of plain between the Galilee hills and the sea-shore. It is the seat of a ḳaimmaḳam or sub-governor, subordinate to the governor of 'Akka. There are Latin and Greek hospices here, as well as an important mission, with hospital and schools, under the United Free Church of Scotland. The pre-Herodian history of the city is not certain. There is a rabbinical tradition that it stands on the site of a city called Rakka, but this is wholly imaginary. Josephus (*Ant.* xviii. 2, 3) describes the building of Tiberias by Herod Antipas near a village called Emmaus, where are hot springs. This is probably the Hammath of Jos. xix. 35. The probability is that Herod built an entirely new city; in fact, the circumstance that it was necessary to disturb an ancient graveyard proves that there were here no buildings previously. The graveyard was probably the cemetery of Hammath. Owing to this necessity Herod had a difficulty in peopling his city, and, indeed, was compelled to use force (Jos. *Ant., loc. cit.*) to cause any but the dregs of the populace to incur defilement by living in a place thus unclean. On this account Tiberias was long regarded with aversion by Jews, but after the fall of Jerusalem it was settled by them and rose to be the chief centre of rabbinic learning.

The building of the city falls between A.D. 16 and A.D. 22. It was named in honour of the emperor Tiberius, and rapidly increased in luxury and art, on entirely Greek models. Probably because it was so completely exotic in character it is passed over in almost total silence in the Gospels—the city (as opposed to the lake) is mentioned but once, as the place from which came boats with sight-seers to the scene of the feeding the five thousand, John vi. 23. There is no reason to suppose that Christ ever visited it. The city surrendered to Vespasian, who restored it to Agrippa. It now became a famous rabbinic school. Here lived Rabbi Judah haḳ-Ḳadōsh, editor of the *Mishnah*; here was edited the Jerusalem Talmud, and here are the tombs of Rabbi Aqiba and Maimonides. Christianity never succeeded in establishing itself here in the Byzantine period, though there was a bishopric of Tiberias, and a church built by Constantine. In 637 the Arabs captured the town. The crusaders under Tancred retook it, but lost it to Saladin in 1187. In the 16th century the city was rebuilt by Joseph ben Ardut, subvented by Doña Gracia and Sultan Suleiman. An attempt was made to introduce the silk industry. In the 18th century it was fortified and occupied by the famous independent sheikh Dhahir el-Amir.

Tiberias is notoriously dirty and proverbial for its fleas, whose king is said by the Arabs to hold his court here. Most of the town was ruined by the earthquake of 1837. The most interesting buildings are the ruins of a fortress, perhaps Herodian, south of the town, and an ancient synagogue on the sea-coast. The hot springs mentioned by Josephus (and also by Pliny) are about half an hour's journey to the south. (R. A. S. M.)

TIBERIUS [TIBERIUS CLAUDIUS NERO] (42 B.C.–A.D. 37), Roman emperor, was born on the 16th of November, 42 B.C. His father, who bore the same name, was an officer of Julius Caesar, who afterwards proposed to confer honours on the assassins, then joined Mark Antony's brother in his mad attack on Octavian, took refuge with Mark Antony, and returned to Rome when the general amnesty was proclaimed in 39 B.C. Livia, the mother of Tiberius, was also of the Claudian family, out of which her father had passed by adoption into that of the Livii Drusi. Early in 38 Livia was amicably ceded to Octavian (the future Augustus), and three months after her new marriage Drusus, brother to Tiberius, was born. Livia had no children by Augustus, and therefore devoted all her remarkable gifts to the advancement of her sons. Tiberius passed through the list of state offices in the usual princely fashion, beginning with the quaestorship at the age of eighteen, and attaining the consulate for the first time at twenty-nine. From the great capacity for civil affairs which he displayed as emperor it may be inferred that he applied himself with determination to learn the business of government.

But from 22 to 6 B.C. and again from A.D. 4 to 10 by far the greater part of Tiberius's time was spent in the camp. His first service was as legionary tribune in one of the desperate and arduous wars which led to peace in the Spanish peninsula through the decimation, or rather the extermination, of the rebellious tribes. In 20 B.C. Augustus sent Tiberius with an army to seat Tigranes of Armenia on the throne as a Roman vassal. When Tiberius approached the frontier of Armenia, he found its throne vacant through the assassination of the king, and Tigranes stepped into his place without a blow being struck. Tiberius crowned Tigranes king with his own hand. Then the Parthian monarch grew alarmed, and surrendered " the spoils and the standards of three Roman armies." The senate ordered a thanksgiving such as was usually celebrated in honour of a great victory. The following year was passed by Tiberius as governor of Transalpine Gaul. In the next year (15) he was despatched to aid his brother Drusus in subjugating the Raeti and Vindelici, peoples dwelling in the mountainous region whence the Rhine, Rhone and Danube take their rise.[1] Drusus attacked from the eastern side, while Tiberius operated from the upper waters of the Rhine, and by stern measures the mountaineers were reduced to a state of quietude, and could no longer cut communications between northern Italy and Gaul, nor prosecute their raids in both countries. In 12 B.C. Agrippa, the great general of Augustus, died at the age of fifty-one, leaving Julia, the emperor's only child, a widow. Agrippina, daughter of Agrippa by an earlier marriage, was wife of Tiberius, and had borne him a son, Drusus, afterwards father of Germanicus. Livia, with great difficulty, prevailed upon Augustus to replace Agrippa by Tiberius, who was compelled to exchange Agrippina for Julia, to his bitter grief. During the year of mourning for Agrippa, which delayed his new marriage, Tiberius was occupied with a victorious campaign against the Pannonians, followed by successful expeditions in the three succeeding summers. For his victories in the Danube regions, the emperor conferred on him the distinctions which flowed from a military triumph in republican times (now first separated from the actual triumph), and he enjoyed the " ovation " or lesser form of triumphal entry into the capital. On the death of Drusus in the autumn of 9 B.C. Tiberius, whose reputation had hitherto been eclipsed by that of his brother, stepped into the position of the first soldier of the empire. The army, if it did not warmly admire Tiberius, entertained a loyal confidence in a leader who, as Velleius (the historian who served under him) tells us, always made the safety of his soldiers his first care. In the campaign of the year after Drusus's death Tiberius traversed all Germany between the Rhine and the Elbe, and met with slight opposition. But it would be too much to believe the statement of Velleius that " he reduced Germany almost to the position of a tributary province." He was rewarded with the full triumph, the military title of " imperator," and his second consulship, though the opposition of the powerful Sugambri had been only broken by an act of treachery, the guilt of which should perhaps be laid at the door of Augustus. In 7 B.C. there was another but insignificant campaign in Germany. Next year Augustus bestowed on his stepson the tribunician authority for five years. Tiberius was thus in the most formal manner associated with the emperor in the conduct of the government on the civil side; but Tacitus (*Ann.* iii. 56) goes too far when he says that this promotion marked him out as the heir to the throne.

Tiberius now suddenly begged permission to retire to Rhodes and devote himself to study. He seems to have declined absolutely at the time to state his reasons for this course, but he obstinately adhered to it, in spite of the tears of Livia and the lamentations of Augustus to the senate that his son had betrayed him. The departure from Italy was as secret as it could be made. Years afterwards, when Tiberius broke silence about his motives, he declared that he had retired in order to allow the young princes, Gaius and Lucius, sons of Agrippa and Julia, a free course. There was perhaps a portion of the truth wrapped up in this declaration. Like Agrippa, who retired to Mytilene to avoid the young Marcellus, Tiberius had clearly no taste to become the servant of the two children whom Augustus had adopted in their infancy and evidently destined to be joint emperors after his death. But it may well be believed that Tiberius, unlike Agrippa, had no burning ambition to see himself in the place destined for his stepsons; and it may have been in his eyes one of the attractions of exile that it released him from the obligation to aid in carrying out the far-reaching designs which Livia cherished for his sake. But the contemporaries of Tiberius were no doubt right in believing that the scandal of Julia's life did more than all else to render his position at Rome intolerable. His conduct to her from first to last gives a strong impression of his dignity and self-respect. When at length the emperor's eyes were opened, and he inflicted severe punishment upon his daughter, her husband, now divorced by the emperor's act, made earnest intercession for her, and did what he could to alleviate her suffering. At Rhodes Tiberius lived simply, passing his time mainly in the company of Greek professors, with whom he associated on pretty equal terms. He acquired considerable proficiency in the studies of the day, among which was astrology. But his attempts at composition, whether in prose or verse, were laboured and obscure. After five years' absence from Rome, he begged for leave to return; but the boon was angrily refused, and Livia with difficulty got her son made nominally a legate of Augustus, so as in some degree to veil his disgrace. The next two years were spent in solitude and gloom. Then, on the intercession of Gaius, Augustus allowed Tiberius to come back to Rome, but on the express understanding that he was to hold aloof from all public functions—an understanding which he thoroughly carried out.

He had scarcely returned before death removed (A.D. 2) Lucius, the younger of the two princes, and a year and a half later Gaius also died. The emperor was thus left with only one male descendant, Agrippa Postumus, youngest son of Julia, and still a boy. Four months after Gaius's death Augustus adopted Agrippa and at the same time Tiberius. The emperor now indicated clearly his expectation that Tiberius would be his principal successor. The two essential ingredients in the imperial authority—the *proconsulare imperium* and the *tribunicia potestas*—were conferred on Tiberius, and not on Agrippa, who was too young to receive them. Tiberius' career as a general now began anew. In two or three safe rather than brilliant campaigns he strengthened the Roman hold on Germany, and established the winter camps of the legions in the interior, away from the Rhine.

In A.D. 5 it became necessary to attack the formidable confederacy built up by Maroboduus, with its centre in Bohemia. At the most critical moment, when Pannonia and Dalmatia broke out into insurrection, and an unparalleled disaster seemed to be impending, Maroboduus accepted an honourable peace. The four serious campaigns which the war cost displayed Tiberius at his best as a general. When he was about to celebrate his well-won triumphs, the terrible catastrophe to Varus and his legions (A.D. 9) turned the rejoicing into lasting sorrow, and produced a profound change in the Roman policy towards Germany. Although Tiberius with his nephew and adopted son Germanicus made in A.D. 9 and 10 two more marches into the interior of Germany, the Romans never again attempted to bound their domain by the Elbe, but clung to the neighbourhood of the Rhine. Tiberius was thus robbed in great part of the fruit of his campaigns; but nothing can deprive him of the credit of being a chief founder of the imperial system in the lands of Europe. From the beginning of 11, when he celebrated a magnificent triumph, to the time of the emperor's death in 14 Tiberius remained almost entirely in Italy, and held rather the position of joint emperor than that of expectant heir. Agrippa Postumus had proved his incapacity beyond hope, and had been banished to a desolate island. In all probability Tiberius was not present when Augustus died, although Livia

[1] Horace, *Odes*, iv. 14.

spread reports (eagerly amplified by Velleius) of an affectionate interview and a lingering farewell.

Tiberius ascended the throne at the age of fifty-six. What struck his contemporaries most was his absolute impenetrability. All his feelings, desires, passions and ambitions were locked behind an impassable barrier, and had to be interpreted by the very uncertain light of his external acts. It is recorded of him that only once did he as commander take counsel with his officers concerning military operations, and that was when the destruction of Varus's legions had made it imperatively necessary not lightly to risk the loss of a single soldier. The penalty of his inscrutability was widespread dislike and suspicion. But behind his defences there lay an intellect of high power, cold, clear and penetrating all disguises. Few have ever possessed such mental vision, and he was probably never deceived either about the weaknesses of others or about his own. For the littleness and servility of public life in regions below the court he entertained a strong contempt. It is a question whether he ever liked or was liked by a single being; but he did his duty by those with whom he was connected after a thorough though stern and unlovable fashion. As a general he commanded the full confidence of his soldiers, though he was a severe disciplinarian; yet the men of his own legions greeted his accession to the throne with a mutiny. Tiberius proved himself capable in every department of the state more by virtue of industry and application than by genius. His mind moved so slowly and he was accustomed to deliberate so long that men sometimes made the mistake of deeming him a waverer. He was in reality one of the most tenacious of men. When he had once formed an aim he could wait patiently for years till the favourable moment enabled him to achieve it, and if compelled to yield ground he never failed to recover it in the end. The key to much of his character lies in the observation that he had in early life set before himself a certain ideal of what a Roman in high position ought to be, and to this ideal he rigidly adhered. He practised sternness, silence, simplicity of life and frugality as he deemed that they had been practised by the Fabricii, the Curii and the Fabii. That Tiberius's character was stained by vice before he became emperor, no one who fairly weighs the records can believe. The persuasion entertained by many at the end of his life that he had been always a monster of wickedness, but had succeeded in concealing the fact till he became emperor, has slightly discoloured the narratives we possess of his earlier years. The change which came over him in the last years of his life seems to have been due to a kind of constitutional clouding of the spirits, which made him what the elder Pliny calls him, "the gloomiest of mankind," and disposed him to brood over mysteries and superstitions. As this gloom deepened his will grew weaker, his power tended to fall into the hands of unworthy instruments, terrors closed in around his mind, and his naturally clear vision was perturbed.

The change of masters had been anticipated by the Roman world with apprehension, but it was smoothly accomplished. Tiberius was already invested with the necessary powers, and it may even be that the senate was not permitted the satisfaction of giving a formal sanction to his accession. Agrippa Postumus was put to death, but Livia may be reasonably regarded as the instigator of this crime. Livia indeed expected to share the imperial authority with her son. At first Tiberius allowed some recognition to the claim; but he soon shook himself free, and later became estranged from his mother and held no communication with her for years before her death. The history of Tiberius's relations with other members of his family is hardly less miserable. Perhaps with any other commander than Germanicus the dangerous mutiny of the troops on the Rhine which broke out soon after Tiberius's accession would have ended in a march of the discontented legions upon the capital. The perilous episode of Arminius caused the recall of Germanicus and his despatch to the East on an honourable but comparatively inactive mission. The pride and passion of Agrippina, the granddaughter of Augustus and wife of Germanicus, tended to open a breach between the husband and the emperor. In his Eastern command Germanicus found himself perpetually watched and even violently opposed by Piso, the governor of Syria, who was suspected to have received secret orders from Tiberius. When Germanicus died at Antioch in A.D. 19, the populace of Rome combined with Agrippina in demanding vengeance upon Piso; and the emperor was forced to disown him. The insinuation, conveyed by Tacitus, that Piso poisoned Germanicus on orders from Tiberius, will not stand criticism. The death of Germanicus was followed four years later by that of the emperor's son Drusus. These two princes had been firm friends, and Livilla, the wife of Drusus, was sister to Germanicus. Years afterwards it was found that Drusus had fallen a victim to the treachery of his wife Livilla, who had joined her ambition to that of the emperor's minister of State Sejanus. When Drusus died, Tiberius nominated two of Agrippina's sons as his heirs. But Sejanus had grown strong by nursing the emperor's suspicions and dislike for the household of Germanicus, and the mother and the princes were imprisoned on a charge of crime. In his memoirs of his own life Tiberius declared that he killed Sejanus because he had discovered that he entertained a mad rage against the sons of Germanicus. But the destruction of Sejanus did not save Agrippina and her two children. The third son Gaius Caesar (Caligula), lived to become emperor when Tiberius died in 37.

Throughout his reign Tiberius strove earnestly to do his duty to the empire at large; his guiding principle was to maintain with an almost superstitious reverence the constitutional forms which had been constructed by Augustus. Only two changes of moment were introduced. The imperial guard, hitherto only seen near the city in small detachments, was by the advice of Sejanus encamped permanently in full force close to the walls. By this measure the turbulence of the populace was kept in check. The officer in command of the guard became at once the most important of the emperor's lieutenants. The other change was the practically complete abolition of the old comitia. But the senate was treated with an almost hypocritical deference, and a pedantically precise compliance with the old republican forms was observed towards the senatorial magistrates. The care expended by Tiberius on the provinces was unremitting. His favourite maxim was that a good shepherd should shear the flock and not flay it. When he died he left the subject peoples of the empire in a condition of prosperity such as they had never known before and never knew again. Soldiers, governors and officials of all kinds were kept in wholesome dread of vengeance if they oppressed those beneath them or encouraged irregularity of any kind. Strict economy permitted light taxation and enabled the emperor to show generosity in periods of exceptional distress. Public security both in Italy and abroad was maintained by a strong hand, and commerce was stimulated by the improvement of communications. Jurisdiction both within and without the capital was on the whole exercised with steadiness and equity, and the laws of the empire were at many points improved. The social and moral reforms of Augustus were upheld and carried further. Such risings against the emperor's authority as occurred within the Roman domain were put down with no great difficulty. The foreign or rather the frontier policy was a policy of peace, and it was pursued with considerable success. With few exceptions the duties of the Roman forces on the borders were confined to watching the peoples on the other side while they destroyed each other. On the Rhine, at least, masterly inactivity achieved tranquillity which lasted for a long period.

The disrepute which attaches to the reign of Tiberius has come mainly from three or four sources—from the lamentable story of the imperial household, from the tales of hideous debauchery practised in deep retirement at Capreae during the last eleven years of the emperor's life, from the tyranny which Sejanus was permitted to wield in his master's name, and from the political prosecutions and executions which Tiberius encouraged, more by silent compliance than by open incitement. The stories of immorality are recorded chiefly by Suetonius, who has evidently used a poisoned source, possibly the memoirs of the younger Agrippina, the mother of Nero. Tiberius loved to shroud himself in mystery, and such stories are probably the result of unfriendly attempts to penetrate the darkness. If history ventures to doubt the blackness of Theodora, that of Tiberius grows continually lighter under the investigations of criticism. Suetonius makes the emperor's condition to have been one of mania, issuing frequently in the abandonment of all moral restraint. But in that case the authority of Tiberius, which was as firmly upheld during the years spent at Capreae as it had been earlier, must have fallen to pieces and come to an end. With respect to Sejanus, it is impossible to acquit Tiberius of blame. If he was deceived in his favourite he must have been willing to be deceived. He conferred on Sejanus a position as great as had been held by Agrippa during the reign of Augustus, and the minister was actually, and all but formally, joint emperor. Of the administrative ability of Sejanus there can be no question; but the charm and secret of his power lay in the use he made of those apprehensions of personal danger which seem never to have been absent from his master's mind. The growth of "delation," the darkest shadow that lies on the reign, was mainly a consequence of the supremacy and the arts of Sejanus. Historians of Rome in ancient times remembered Tiberius chiefly as the sovereign under whose rule prosecutions for treason on slight pretexts first became rife, and the hateful race of informers was first allowed to fatten on the gains of judicial murder. Augustus had allowed considerable licence of speech and writing against himself, and had made no attempt to set up a doctrine of constructive treason. But the history of the state trials of Tiberius's reign shows conclusively that the straining of the law proceeded in the first instance from the eager flattery of the senate, was in the earlier days checked and controlled to a great extent by the emperor, and was by him acquiesced in at the end of his reign, with a sort of contemptuous indifference, till he developed, under the influence of his fears, a readiness to shed blood.

The principal authorities for the reign of Tiberius are Tacitus and Suetonius. The *Annals* of Tacitus were not published till nearly eighty years after the death of Tiberius. He rarely quotes an authority by name. In all probability he drew most largely from other historians who had preceded him; to some extent he availed himself of oral tradition; and of archives and original records he made some, but comparatively little, use. In his history of Tiberius two influences were at work, in almost equal strength: on the one hand he strives continually after fairness; on the other the bias of a man steeped in senatorial traditions forbids him to attain it. No historian more frequently refutes himself. Suetonius was a biographer rather than an historian, and the ancient biographer was even less given to exhaustive inquiry than the ancient historian; moreover Suetonius was not gifted with great critical faculty, though he told the truth so far as he could see it. His *Lives of the Twelve Caesars* was written nearly at the time when Tacitus was composing the *Annals*, but was published a little later. Velleius Paterculus is by far the oldest authority for any part of Tiberius's life. He had been an officer under Tiberius, and he eulogizes his old general enthusiastically—feeling it necessary, however, to do less than justice to the achievements of Germanicus. To Velleius all defenders of Tiberius have eagerly appealed. In truth it is his silence alone which affords any external aid in repelling the charges of Tacitus and Suetonius, and the fact that Velleius published his work in the lifetime of his master deprives that silence of its value. The eulogy of Sejanus which is linked with that of Tiberius must needs shake faith in the scrupulousness of the author. It is still doubtful whether Dio Cassius (whose *History* ended with the year 229) in his narrative of the reign of Tiberius is to any great extent independent of Tacitus. In recent times a considerable mass of inscriptions has added to our knowledge of the administration of this emperor. The chief account of Tiberius in English is that contained in Dean Merivale's *History of the Romans under the Empire*. Professor E. S. Beesly has written an interesting defence of him in his *Catiline, Clodius and Tiberius* (1878). The best recent history of this period is Hermann Schiller's *Geschichte der römischen Kaiserzeit* (Gotha, 1883). Much historical information is given in the editions of the *Annals* of Tacitus, of which the best in English is that of Furneaux (Oxford, 1884); Freytag, *Tiberius and Tacitus* (Berlin, 1870) (following Stahr, *Tiberius*, Berlin, 1863), exposes the inconsistencies of Tacitus' account. Many monographs have since appeared, written on similar lines, among which may be mentioned Ihne, *Zur Ehrenrettung des Kaisers Tiberius* (Strassburg, 1892); Gentile, *L'Imperatore Tiberio secondo la moderna critica storica* (1887); J. C. Tarver, *Tiberius the Tyrant* (1902). The principles of the imperial administration of the provinces by Tiberius have been treated by Mommsen in the fifth volume of his *History of Rome*, translated into English by W. P. Dickson (1886).

(J. S. R.)

TIBESTI, a mountainous and little known region of the central Sahara, inhabited by the Tibbu (*q.v.*). The country was partly explored in 1870 by Gustav Nachtigal; it had not been again visited by Europeans up to 1910, though French officers had reached Borku on its southern borders. By the Anglo-French declaration of the 21st of March 1899 Tibesti was included in the French sphere of influence in North Africa.

TIBET, or THIBET, a country of central Asia. It is the highest country in the world, comprising table-lands averaging over 16,500 ft. above the sea, the valleys being at 12,000 to 17,400 ft., the peaks at 20,000 to 24,600 ft., and the passes at 16,000 to 19,000 ft. It is bounded on the N. by Turkestan, on the E. by China, on the W. by Kashmir and Ladak, and on the S. by India, Nepal and Bhutan. It has an area of over 1,000,000 sq. m., and an estimated population of about 3,000,000, being very sparsely inhabited.

Origin of Name.—The Tibetans call their country Bod, which

Emery Walker sc.

word in colloquial pronunciation is aspirated into *Bhöd* or *Bhöt*, and in the modern Lhasa dialect is curtailed into *Bhö*. Hence the country is known to Indians as *Bhōt*, and the inhabitants as *Bhōt-ias*. This territory came to be known to Europeans as "Tibet" evidently because the great plateau with its uplands bordering the frontiers of China, Mongolia and Kashmir, through which travellers communicated with this country, is called by the natives *Tö-bhöt* (written *stod-bod*) or "High *Bod*," or "Tibet," which designation in the loose orthography of travellers assumed a variety of forms. Thus in Chinese annals are found *T'u-bat* (5th century, A.D.), *Tu-po-te, Tie-bu-te, T'u-bo-te* (10th and 11th centuries) and at the present day *T'u-fan* (*fan*, as Bushell shows, being the same Chinese character which had formerly the sound of *po*); in Mongolian, *Tübet, Toböt*; in Arabic, *Tubbet*; Istakhri (*c.* 590), *Tobbat*; Rabbi Benjamin (1165), *Thibet*; J. de Plano Carpini (1247), *Thabet*; Rubruquis (1253), Marco Polo (1298), *Tebet*; Ibn Batuta (1340), *Thabat*; Ibn Haukal (976), Al Biruni (1020), Odoric of Pordenone (*c.* 1328), Orazio della Penna (1730), *Tibet*, which is the form now generally adopted. The inhabitants of Tibet call themselves *Bod-pa* (pronounced usually *Bhö-pa*), or "people of Bod." Other Tibetan epithets for the country sometimes used by flowery native writers are "The Icy Land" (*Gangs-c'an*) and the "Country of the Red Faces" (*Gdong-mar-gyi yul*). The Chinese name for central Tibet is *Wei-Ts'ang*, which is a transcription of the Tibetan designation of the two provinces Ü and Tsang (spelt *dbus-gtsang*) that constitute central Tibet. Among the Mongols, Tibetans are called *Tangutu* and the country *Barontala* or the "right side," in contradistinction to *Dzöntala* or "left side," which was their own name for Mongolia itself.

Geography.—Physically Tibet may be divided into two parts, the *lake region* in the west and north-west, and the *river region*, which spreads out on three sides of the former on the east, south, and west. The lake region extends from the Pangong t'so (t'so = lake) in Ladak, near the source of the Indus, to the sources of the Salween, the Mekong and the Yangtse. This region is called the Chang-t'ang (*Byang tang*) or "Northern Plateau" by the people of Tibet. It is some 700 m. broad, and covers an area about equal to that of France. From its great distance from the ocean it is extremely arid, and possesses no river outlet. The mountain ranges are spread out, rounded, disconnected, separated by flat valleys relatively of little depth. The country is dotted over with large and small lakes, generally salt or alkaline, and intersected by streams, and the soil is boggy and covered with tussocks of grass, thus resembling the Siberian tundra and the Pamirs. Its average altitude is over 16,000 ft., the northern portion of it being the highest. Salt and fresh-water lakes are intermingled. The lakes are generally without outlet, or have only a small effluent. The deposits consist of soda, potash, borax and common salt. This last is frequently found piled high and split into blocks apparently of artificial formation, but probably the result of the action of wind and intense cold. The loftiest lake so far as observed is Hospa t'so, near the Lingshi plain on the Kashmir frontier; its altitude is given as 17,930 ft. The lake region is noted for a vast number of hot springs, which are widely distributed between the Himalayas and 34° N., but are most numerous to the west of Tengri Nor (north-west of Lhasa). So intense is the cold in Tibet that these springs are sometimes represented by columns of ice, the nearly boiling water having frozen in the act of ejection. The southern portion, from Lake Pangong to Tengri Nor, is inhabited by pastoral tribes of Tibetans, and possesses a few hamlets, such as Ombo, Rudok and Senja jong. The river region comprises the upper courses of the Brahmaputra (Yaru Tsangpo), the Salween (? Gyama nyul chu), the Yangtsze (Dre chu), the Mekong (Nya-lung chu), and the Yellow River (Ma chu). Amidst the mountains there are many narrow valleys, partially cultivated from an altitude of 12,000 ft. downwards, with here and there fine forests covering the mountain sides. Villages of high stone-built houses are to be found wherever the valley bottoms open out enough to afford a little space for agriculture. The northern portion of Tibet is an arid and wind-swept desert; but in the southern portion the valleys of Lhasa, Shigatse, Gyantse and the Brahmaputra are covered with good soil and groves of trees, well irrigated, and richly cultivated.

The valley of the Brahmaputra (*q.v.*), or Yaru Tsang-po or simply Tsang-po—the river has also various local names—is the great arterial valley of southern Tibet. On the south it is bounded by the Himalayas, on the north by a mountain-system still more vast. This mountain-system was only vaguely known, in fact its existence throughout its length was only suspected, until Sven Hedin, during his journeys in 1906–1908, crossed it at several points. He found the system to form the chief physiographical feature of southern Tibet, and stated it to be "on the whole the most massive range on the crust of the earth, its average height above the sea-level being greater than that of the Himalayas. Its peaks are 4000 to 5000 feet lower than Mount Everest, but its passes average 3000 feet higher than the Himalayan passes." Its extreme breadth is about 120 m. in the central part, its northern limit being marked by the chain of lakes running N.W. and S.E. between 30° and 33° N., beyond which the mountains of central Tibet are much lower. The system at no point narrows to a single range; generally there are three or four across its breadth. As a whole the system forms the watershed between rivers flowing to the Indian Ocean—the Indus and its tributaries, Brahmaputra and its tributaries, and Salween—and the streams flowing into the undrained salt lakes to the north. The principal ranges in the system are the Nien-chen-tang-la, called Kanchung-gangri in the west, the Targo-Gangri-Lapchung range, the very lofty Hlunpo-Gangri range, the Dingla range, &c. The whole system had been marked by inference on some maps before Hedin's discoveries, and named Gangri; Hedin proposed for it the name of Trans-Himalaya.

Geology and Mineral Wealth.—Little is known of the geological structure of the central regions of Tibet. The observations of Strachey, Godwin-Austen and of Griesbach and other members of the Geological Survey of India only extend to the southern edge or rim of the great plateau, where vast alluvial deposits in horizontal strata have been furrowed into deep ravines, while Russian explorers have but superficially examined the mountain regions of the north and north-east, and the British mission to Lhasa in 1904 afforded observations merely along the trade-route to that city.

The general structure of the trans-Himalayan chains appears to indicate that the main axis of upheaval of the whole vast mass of the Tibetan highlands is to be found on two approximately parallel lines, represented the one by the Kuen-lun and the other by a line which is more or less coincident with the watershed between India and the central lake region, extending from Lake Pangong to Tengri Nor, the plateau enclosed between the two being wrinkled by minor folds, of which the relative elevation is comparatively low, averaging from 1000 to 1500 ft. The strike of these folds is usually east and west and roughly parallel to the axes of elevation of the plateau. A remarkable economic feature is the almost universal distribution of gold throughout Tibet. The gold-digging is referred to in somewhat mythical terms by Herodotus. Every river which rises in Tibet washes down sands impregnated with gold, and it has been proved that this gold is not the product of intervening strata, but must have existed primarily in the crystalline rocks of the main axes of upheaval. In western Tibet the gold mines of Jalung have been worked since 1875. They have been visited by native explorers of the Indian Survey, who reported that much gold was produced and remitted twice a year under a Chinese guard to Peking. The Tibetan diggers collected together at the mines chiefly during the winter, when the frost assisted to bind the loose alluvial soil and render excavation easy. These mines are within 200 m. of the Ladak frontier, near the sources of the Indus, at an elevation which cannot be less than 15,000 ft. above sea-level. They are worked in crude desultory fashion and are sometimes abandoned owing to the exorbitant imposts levied on gold production by Chinese and Tibetan officials. Between the Ladak frontier and Lhasa the plateau region teems with evidences of abandoned mines. These mines are excavations in the alluvial soil, never more than from 20 to 30 ft. deep.

The researches of Prjevalsky demonstrate that gold is plentiful in northern and eastern Tibet. Here Tungus diggers were encountered who had extracted handfuls of gold in small nuggets from a stream bed at a depth which they stated to be no greater than 2 ft. Another scientific explorer, W. Mesny, has observed similar evidences of the existence of gold at comparatively shallow depths in Koko Nor region, and records that he has seen nuggets, "varying from the size of a pea to that of a hazel-nut," in eastern Tibet. The gold was almost pure and perfectly malleable. The Gork goldfields, which are visible from Koko Nor, are reported to have yielded to China considerable quantities of gold as lately as 1888. They are now deserted. Prjevalsky, indeed, predicts of northern Tibet that it will prove a "second California" in course of time. But little gold at present finds its way across the Tibetan passes to India; and the export to China has diminished of late years.

Iron is found in eastern Tibet in the form of pyrites, and is rudely smelted locally. Salt and borax exist in abundance in the western lake regions. The exportation of borax to India is only limited by the comparatively small demand. Lapis-lazuli and mercury are among the minor mineral products of the country.

Climate.—The climate of Tibet varies so greatly over the enormous area and different altitudes of the country that no two travellers agree precisely in their records. Tibet is affected by the south-west monsoon, just as the Pamirs are affected, but in varying degrees according to geographical position. In western Tibet, bordering the Kashmir frontier, the climate differs little from that of Ladak. Intense dryness pervades the atmosphere during nine months of the year; but little snow falls, and the western passes are so little subject to intermittent falls of fresh snow as frequently to be traversable during the whole year round (see LADAKH). Low temperatures are prevalent throughout these western regions, whose bleak desolation is unrelieved by the existence of trees or vegetation of any size, and where the wind sweeps unchecked across vast expanses of arid plain. All the western region is but slightly affected by the monsoon. The central lake region, extending from the Kuen-lun to the Himalaya, is also characterized by extreme dryness in autumn, winter and spring, with an abundance of rain in summer, whilst the eastern mountain region, extending to China south of the Dang la (which, with an altitude of about 20,000 ft., stretches from 90° to 97° E. along the parallel of 33° N., and arrests the monsoon currents), is subject to much the same climatic influences as the eastern Himalaya. The southern slopes of the Dang la are deluged with rain, hail and snow throughout the year. Northern Tibet is an arid waste, subject to intense heat in summer and intense cold in winter. In March snow still lies deep in the Tsaidam passes, while Wellby found the heat oppressive in June at 16,000 ft. elevation on the plateau south of the Kuen-lun, and a temperate climate prevailing about the sources of the Dre chu (Yangtsze) in August.

All travellers testify to the perpetual wind currents from the west, which sweep across the salt bogs of Tsaidam (9500 ft.) and through the higher valleys of eastern Tibet. Wind is a prevailing feature throughout Tibet at certain seasons of the year, as it is in the Pamirs, in Turkestan, in western Afghanistan and in Persia. The climate of southern Tibet is, however, subject to considerable modifications from that of the northern and central regions, owing doubtless to its geographical connexion with northern India. Here, at an elevation of 15,000 ft., about the great Lake Dangra, we hear of well-built villages and of richly cultivated fields of barley, indicating a condition of climate analogous to that which prevails in the districts south of Lhasa, and in contrast to the sterility of the lake region generally and the nomadic character of its population. Modern travellers bear witness to a gradual progress of desiccation in the Tibetan uplands. Everywhere there are signs of the diminution of the lakes and the recession of the water line—a phenomenon that has also been observed in the Pamirs. There are still enormous glaciers about the head of the Brahmaputra, but the glacial epoch of the Chang-t'ang highlands has passed away, though comparatively recently.

Flora.—Our knowledge of the flora of northern and central Tibet has been considerably increased by the collections of Prjevalsky, Wellby, Bower, Thorold, Littledale and the Lhasa Mission, and that of eastern Tibet by Rockhill. The former and other collections have been described in W. B. Hemsley's *The Flora of Tibet or High Asia.* Western and southern Tibetan flora were partially explored previously to the advent of these travellers. Professor Maximowicz concludes from an analysis of the Prjevalsky collection that the flora of Tibet is extremely ancient, and that it is chiefly composed of immigrants from the Himalaya and Mongolia. There is also a large percentage of endemic species. Chinese and European plants followed in the process of immigration. Those species which are distinctive of the eastern border ridges are found to reach the plateau, but do not spread westwards, so that a botanic separation or distinction is found to exist between the true plateau of Tibet in the west and the alpine tracts of the east. Thiselton-Dyer classes the flora of Tibet on the whole as belonging to the Arctic-Alpine section of the great northern division, but containing a purely endemic element. Two typical species are *Lychnis apetala,* which extends to Spitsbergen, and the well-known edelweiss. A single fern specimen obtained by Littledale (*Polypodium hastatum*) is indicative of eastern China. Of the forty or fifty genera obtained by Littledale in central Tibet a large proportion are British, including many of the most characteristic mountain forms. In the higher regions of northern and western Tibet the conditions under which vegetation exists are extreme. Here there are no trees, no shrubs, nor any plants above a foot high. Wellby says he saw nothing higher than an onion. The peculiar form of tussocky grass which prevails in the Pamirs is the characteristic feature of the Tibetan Chang-t'ang of the Tsaidam plains and of the bogs north-east of Lhasa. Of grasses indeed there are many forms, some peculiar to Tibet, but no trees or shrubs at any elevation higher than 15,000 ft., except in the Kharo Pass of central Tibet, where Waddell has recorded trees (? *Hippophae* sp.) about 20 ft. high at an elevation of 16,300 ft. A flowering plant (*Saussurea tridactyla*) was discovered by Bower at an elevation of 19,000 ft. In south-eastern Tibet, where Himalayan conditions of climate prevail, we have a completely different class of flora. Of the flora of Tibet Rockhill writes: "In the 'hot lands' (*Tsa-rong*) in southern and south-eastern Tibet, extending even to Batang, peaches, apricots, apples, plums, grapes, water-melons, &c., and even pomegranates, are raised; most of Tibet only produces a few varieties of vegetables, such as potatoes, turnips, beans, cabbages, onions, &c. The principal cereals raised are barley and buckwheat, wheat in small quantities, and a little oats. A few localities in the extreme southern portions of the country, and around Lhasa possibly, are said to produce a non-glutinous variety of rice. A variety of mountain bamboo is found in southern and parts of eastern Tibet, and is much used for basket work. Tibet produces a large number of medicinal plants much prized by the medical profession in China and Mongolia, among others the *Cordyceps sinensis,* the *Coptis teeta,* Wall., and *Pickorhiza kuwoa,* Royle, &c. Rhubarb is also found in great quantities in eastern Tibet and Amdo; it is largely exported for European use, but does not appear to be used medicinally in the country. The trees most commonly found are the plane, poplar, maple, walnut, oak, the *Cupressus funebris,* and various varieties of the genera *Pinus, Abies* and *Larix.* Some valuable plants are obtained in the mountains of south and south-western Tibet, yielding the excellent yellow and red colours used to dye the native cloths." Waddell gives a list of 164 species of plants collected by him at Lhasa, several being new species.

Fauna.—The fauna of Tibet has been by no means exhaustively investigated, especially the rodents and smaller species of animals. Among domesticated animals are to be found the horse, mule, donkey, cattle, sheep and goats, dogs, fowls and pigs, ducks and geese. Probably no country in the world, excepting perhaps inner Africa, so abounds in wild animals as the cold solitudes of the northern plateau. Here are to be found yak, wild asses (*kyang*), several varieties of deer, musk deer and Tibetan antelope (*Pantholops*); also wild sheep (the *bharal* of the Himalaya), *Ovis hodgsoni* and possibly *Ovis poli,* together with wild goats, bears (in large numbers in the north-eastern districts), leopards, otter, wolves, wild cats, foxes, marmots, squirrels, monkeys and wild dogs. To this list must be added the curious sloth-bear *Aeluropus melanoleucus,* a rare eastern species, and the so-called "unicorn" antelopes, the "tākyin" (*Budorcas taxicolor*), also an eastern Indo-Malayan species. Birds are fairly numerous, and include many varieties of water-fowl, several of which (*Anser indicus,* the bar-headed goose, for instance) breed in Tibet, while others are only found as birds of passage. In eastern Tibet, on the Chinese border, varieties of the pheasant tribe abound, some of which are rare. Among them are the "white" pheasant, the *Ceriornis temminckii,* two kinds of eared pheasant and Anderson's pheasant. The Tibetan sand-grouse is peculiar to the country, and the snow-partridge (*Lerva nivicola*) and the snow-cock (*Tetraogallus tibetanus*) are occasionally met with in the uplands, while the ordinary partridge (*Perdix hodgsoni*) is common in the ravines on the plateau.

People.—The Tibetan race, which probably belongs to the Turko-Mongol stock, is divided between the nomadic tent-dwelling Tibetans of the lake region and transition zone between it and the river region, and the settled sedentary population of the valleys. The tent-dwelling Tibetans, called Dokpa or Drupa (spelt *hbrog-pa*), or "Steppe-dwellers," are generally of a more Mongolized type than the people of the lowlands. The males measure about 5 ft. 5 in., except in eastern Tibet, where 5 ft. 9 in. is a common stature; the females are appreciably less. The head is mesati-cephalic, verging on brachycephalic in the case of many of the Dokpa; the hair is black and somewhat wavy; the eyes are usually of a clear brown, in some cases even hazel; the cheek-bones are high, but not so high as with the Mongols; the nose is thick, sometimes depressed at the root, in other cases prominent, even aquiline, though the nostrils are broad. The teeth are strong but irregular; the ears, with tolerably large lobes, stand out from the head, but to a less degree than with the Mongols. The mouth is broad, the lips not full, and, among the people of the lower altitudes, decidedly thin. The beard is sparse, and, with the exception of the moustache, which is sometimes worn, especially in central Tibet, it is plucked out with tweezers. The shoulders are broad, the arms round; the legs are not well developed, the calf is especially small. The foot is somewhat small but broad, the hand coarse. The women are usually stouter than the men. The colour of the skin of the Tibetans is a light brown, sometimes so light as to show ruddy cheeks in children; where exposed to the weather it becomes a dark brown. Their voices are full, deep and powerful. They can endure exposure without much apparent inconvenience; and though the nature of the food they use is such that they cannot stand absolute privation for any considerable length of time, they can exist for long periods on starvation rations, if eked out with weak soup or buttered tea, which is drunk at frequent intervals.

The sedentary population of Tibet has to a greater or less degree the same physical traits as the Dokpa, but as one approaches China, India or the border lands generally, one observes that the admixture of foreign blood has considerably modified the primitive type. Among the customs of the Tibetans, perhaps the most peculiar is polyandry, the brothers in a family having one wife in common. Monogamy, however, seems to be the rule among the pastoral tribes, and polygamy is not unknown in Tibet, especially in the eastern parts of the country.

Their religion is described under Lamaism.

(L. A. W.; T. H. H.*)

Language.—The language of Tibet bears no special name, it is merely known as "The Speech of Bod or Tibet," namely, *Bod-skad* (pronounced *Bhö-kä*), while the vernacular is called *P'al-skad* or "vulgar speech," in contradistinction to the *rje-sa* or "polite respectful speech" of the educated classes, and the *ch'os-skad* or "book language," the literary style in which the scriptures and other classical works are written.

It is not a uniform speech, but comprises several dialects which have been classed by Jaeschke into three groups, namely (1) the central or the dialects of Lhasa and the central provinces of Ü and Tsang (including Spiti) which is the *lingua franca* of the whole country, (2) the western dialects of Ladak, Lahul, Baltistan and Purig, and (3) the eastern dialects of the province of Khams. In addition to these, however, are many sub-dialects of Tibetan spoken in the frontier Himalayan districts and states outside Tibet, namely, in Kunawar and Bashahr, Garhwal, Kumaon, Nepal including especially the Serpa and Murmi of eastern Nepal, Sikkim (where the dialect is called Dänjong-kä), Bhutan (Lho-kä or Duk-kä), all of which are affiliated to a central group of dialects. Farther east the Takpa of Tawang in the eastern Assam Himalayas appears to form a transition between the central and the Sifan group of dialects on the Chinese frontier, which includes the Minyak, Sungpan, Lifan and Tochu dialects. On the north bordering on Turkestan the dialect of the nomadic Hor-pa tribes is much mixed with Turkic ingredients. The number of speakers of Tibetan dialects is probably not far short of eight millions.

Linguistically, Tibetan is allied to the Burmese languages, and forms with the latter a family of the so-called Turano-Scythian stock called "Tibeto-Burman" (*q.v.*), the unity of which family was first recognized by Brian Hodgson in 1828, and indeed several of the dialects of Tibetan are still only known through the copious vocabularies collected by him. The little that was known of the Tibetan language before Hodgson's time was mainly derived from the writings of the Romish friars who resided for several years in Lhasa in the first half of the 18th century.[1] The first serious European student of Tibetan was Csoma de Körös (1784–1842), an indefatigable Hungarian, who devoted his life to the study of this language and the ancient Buddhist records enshrined in its unknown literature. For this purpose he resided like a monk for several years among the lāmas at the monasteries of Zangla and Pukdal in Zanskar and latterly at Kanum in upper Bashahr, enjoying the assistance of learned lāmas. His *Tibetan-English Dictionary*, and pioneer *Tibetan Grammar*, both published in 1834, opened to Europeans the way to acquire a knowledge of the Tibetan language as found in the ancient classics.[2] The next great advance in the study of the Tibetan language we owe to the labours of H. A. Jeaschke of the Moravian mission which was established in Ladak in 1857. This scholarly linguist, equipped with modern methods of scientific research, did not confine himself to the classical period like Csoma, but extended his investigations to the language as a whole, and provided Europeans for the first time with the means of making a practical study of modern Tibetan and the speech of the people His *Tibetan-English Dictionary* and *Tibetan Grammar* are models of scientific precision and important sources of our knowledge of the structure and development of the language, and the former is not superseded by Chandra Das's Dictionary.[3]

Grammar. The language was first reduced to writing with the assistance of Indian Buddhist monks in the middle of the 7th century A.D. by Thonmi, a Tibetan layman. The letters, which are a form of the Indian Sanskrit characters of that period, follow the same arrangement as their Sanskritic prototype. The consonants, 30 in number, which are deemed to possess an inherent sound *a*, are the following: *ka, k'a, ga, nga, ča, č'a, ja, nya, ta, t'a, da, na, pa, p'a, ba, ma, tsa, ts'a, dza, wa, z'a, za, 'ha, ya, ra, la, s'a, sa, ha, a;* the so-called Sanskrit cerebrals are represented by the letters *ta, t'a, da, na, s'a*, turned the other way. *Ya*, when combined as second consonant with *k-, p-, m-*, is written under the first letter. *Ra*, when combined as second letter with *k-, t-, p-*, is written under the first, and when combined with another consonant as first letter over the second. The vowels are *a, i, u, e, o*, which are not distinguished as long or short in writing, except in loan words transcribed from the Sanskrit, &c., though they are so in the vernaculars in the case of words altered by phonetic detrition. By means of agglutination, that is, by adding to the bases form-words as prefixes, suffixes or infixes, the Tibetan language has developed a considerable grammatical system and is now agglutinating rather than isolating. Agglomerations of consonants are often met with as initials, giving the appearance of telescoped words—an appearance which historical etymology often confirms. Many of these initial consonants are silent in the dialects of the central provinces, or have been resolved into a simpler one of another character. The language is much ruled by laws of euphony, which have been strictly formulated by native grammarians. Among the initials, five, viz. *g, d, b, m, 'h*, are regarded as prefixes, and are called so for all purposes, though they belong sometimes to the stem. As a rule none of these letters can be placed before any of the same organic class. Post-positions, *pa* or *ba* and *ma*, are required by the noun (substantive or adjective) that is to be singled out; *po* or *bo* (masc.) and *mo* (fem.) are used for distinction of gender or for emphasis. The cases of nouns are indicated by suffixes, which vary their initials according to the final of the nouns. The plural is denoted when required by adding one of several words of plurality. When several words are connected in a sentence they seldom require more than one case element, and that comes last. There are personal, demonstrative, interrogative and reflexive pronouns, as well as an indefinite article, which is also the numeral for "one." The personal pronouns are replaced by various terms of respect when speaking to or before superiors, and there are many words besides which are only employed in ceremonial language.

[1] The Capuchin friars who were settled in Lhasa for a quarter of a century from 1719 studied the language; two of them, Francisco Orazio della Penna, well known from his accurate description of Tibet, and Cassian di Macerata sent home materials which were utilized by the Augustine friar Aug. Ant. Georgi of Rimini (1711–1797) in his *Alphabetum tibetanum* (Rome, 1762, 4to), a ponderous and confused compilation, which may be still referred to, but with great caution. The Tibetan characters were drawn by Della Penna and engraved by Ant. Fontarita in 1738. In 1820 Abel Rémusat published his *Recherches sur les langues tartares*, a chapter of which was devoted to Tibetan.

[2] The first Tibetan dictionary for Europeans was a *Dictionary of the Bhotanta or Bhutan Language*, published at Serampur near Calcutta in 1828. It was, however, crude and unedited and contained many serious mistakes, having been taken from the MS. notes of an unknown Italian priest (now believed to be Father Juvenal of Agra, who had been stationed near the frontier of Bhutan), whose MS. was translated into English by Fr. Chr. G. Schroeter and published without supervision by any Tibetan scholar; and Csoma was unaware of its existence when compiling his dictionary. At St Petersburg J. J. Schmidt published his *Grammatik der tibetischen Sprache* in 1839 and his *Tibetisch-deutsches Wörterbuch* in 1841, but neither of these works justified the great pretensions of the author, whose access to Mongolian sources had enabled him to enrich the results of his labours with a certain amount of information unknown to his predecessors. In France, P. E. Foucaux published in 1847 a translation from the *Rgya tcher rol-pa*, the Tibetan version of the *Lalita Vistara*, and in 1858 a *Grammaire thibétaine*; while Ant. Schiefner had begun at St Petersburg in 1849 his series of translations and researches. His *Tibetische Studien* (1851–1868) is a valuable collection of documents and observations. In 1861 Lepsius published his paper *Ueber chinesische und tibetische Lautverhältnisse*; and after 1864 Léon Feer brought out in Paris many translations of texts from Tibetan Buddhist literature. In 1828–1849 the *Journal* of the Asiatic Society of Bengal published comparative vocabularies of spoken and written Tibetan by Brian H. Hodgson, and grammatical notices of Tibetan (according to Csoma's grammar).

[3] Jaeschke from 1860 to 1867 made several important communications, chiefly with reference to the phonetics and the dialectical pronunciation, to the academies of Berlin and St Petersburg, and in the *Journal* of the Asiatic Society of Bengal. In 1868 at Kyelang he published by lithography *A Short Practical Grammar of the Tibetan Language, with special reference to the spoken dialects*, and the following year a *Romanized Tibetan and English Dictionary*. He also published in 1871–1876 at Gnadau in Prussia by the same process a Tibetan and German dictionary. Afterwards he prepared for the English Government a *Tibetan-English Dictionary, with special reference to the prevailing dialects*, in 1881. Dr H. Wenzel, one of his pupils, edited in 1883 from his MS. a *Simplified Tibetan Grammar*. Major Th. H. Lewin with the help of a Sikkimese lama compiled *A Manual of Tibetan*, or rather a series of colloquial phrases in the Sikkimese dialect, in 1879. In 1894 Mr Graham Sandberg compiled a useful *Handbook of Colloquial Tibetan*. Père Desgodins in 1899 issued from Hong-Kong a large Tibeto-Latin-French dictionary, *Dictionnaire thibétain-latin-français*. In 1890 Captain H. Ramsay published at Lahore his useful *Practical Dictionary of Western Tibet*. In 1902 was brought out at Calcutta Sarat Chandra Das's *Tibetan English Dictionary with Sanskrit synonyms*, a massive volume compiled with the aid of Tibetan lamas and edited by Graham Sandberg and the Moravian missionary A. W. Heyde. The *Tibetan Manual* by V. C. Henderson (1903) is a useful work, and so is the *Manual of Colloquial Tibetan* by C. A. Bell (Calcutta, 1905), which has full English-Tibetan vocabularies, graduated exercises and examples in the Lhasa dialect of to-day. An interesting and important analysis of many of the dialects and of the general structure of the language has been made by Dr G. A. Grierson, with the collaboration of Dr S. Konow, in his *Linguistic Survey of India* (1908). As regards native philology, the most ancient work extant is a grammar of the Tibetan tongue preserved in the *Bstan-hgyur* (mdo cxxiv.). This collection also contains other works of the same kind, dictionaries by later writers, translations of many Sanskrit works on grammar, vocabulary, &c., and bilingual dictionaries, Sanskrit and Tibetan. As separate publications there are several vocabularies of Chinese and Tibetan; Mongol and Tibetan; Chinese, Manchu, Mongol, Oelöt, Tibetan and Turkish; Tibetan, Sanskrit, Manchu, Mongol and Chinese.

The verb, which is properly a kind of noun or participle, has no element of person, and denotes the conditions of tense and mood by an external and internal inflexion, or the addition of auxiliary verbs and suffixes when the stem is not susceptible of inflexion, so that instead of saying "I go," a Tibetan says "my going." The conditions which approximate most closely to our present, perfect, future and imperative are marked either by aspiration of the initial or by one of the five prefix consonants according to the rules of euphony, and the whole looks like a former system thrown into confusion and disorder by phonetic decay. As to the internal vowel, *a* or *e* in the present tends to become *o* in the imperative, the *e* changing to *a* in the past and future; *i* and *u* are less liable to change. A final *s* is also occasionally added. Only a limited number of verbs are capable of four changes; some cannot assume more than three, some two, and many only one. This deficiency is made up by the addition of auxiliaries or suffixes. There are no numeral auxiliaries or segregatives used in counting, as in many languages of eastern Asia, though words expressive of a collective or integral are often used after the tens, sometimes after a smaller number. A good deal of new research on the grammar is to be found in Grierson's *Linguistic Survey of India*, part III., 1908. In scientific and astrological works, the numerals, as in Sanskrit, are expressed by symbolical words. In the order of the sentence the substantive precedes the adjective and the verb stands last; the object and the adverb precede the verb, and the genitive precedes the noun on which it depends—this contrasts with the order in the isolating Chinese, where the order is subject, verb, object. An active or causal verb requires before it the instrumental instead of the nominative case, which goes only before a neuter or intransitive verb. The chief differences between the classical language of the Tibetan translators of the 9th century and the vernacular, as well as the language of native words, existed in vocabulary, phraseology and grammatical structure, and arose from the influence of the translated texts.

Philology.

The Tibetan language, presenting such marked differences between its written and spoken forms, has a great interest for philologists, on account of its bearing on the history of the monosyllabic languages of eastern Asia, with their so-called "isolation" or absence of form-words and consequently of grammatical forms. Is the Tibetan a monosyllabic language passing to agglutination, or the reverse? The question has turned mainly upon the elucidation of the phenomenon of the silent letters, generally prefixed, which differentiate the spelling of many words from their pronunciation, in the central dialect or current speech of Lhasa. Rémusat rather dubiously suggested, while Schmidt and Schiefner maintained, that the silent letters were a device of grammarians to distinguish in writing words which were not distinguished in speech. But this convenient opinion was not sufficient for a general explanation, being supported by only a few cases. Among these are—(*a*) the addition of silent letters to foreign words in analogy with older terms of the language (*e.g.* the Persian *tadjik* was transcribed *staggzig* or "tiger-leopard," because the foreign term left untouched would have been meaningless for Tibetan readers); (*b*) the addition for the sake of uniformity of prefixed letters to words etymologically deprived of them; (*c*) the probable addition of letters by the Buddhist teachers from India to Tibetan words in order to make them more similar to Sanskrit expressions (for instance *rje-* for "king," written in imitation of *raja*, though the original word was *je* or *she*, as is shown by cognate languages). On the other hand, while phonetically the above explanation was not inconsistent with such cases as r*ka* d*kah*, b*kah*, bs*ka*, and *nga*, r*nga*, *nga*g, s*ngag*s, l*nga*, *nga*d and brt*se*, brd*zun*, db*yar*, &c., where the italicized letters are pronounced in full and the others are left aside, it failed to explain other cases, such as *dgra*, *mgron*, *spyod*, *spyan*, *sbrang*, *sbrul*, *bkra*, *k'ri*, *krad*, *k'rims*, *k'rus*, &c., pronounced *ḍa*, *ḍon*, *čod*, or *šwod*, *čen*, *dang*, *ḍeu*, *ṭa*, *t'i*, *tad* or *teh*, *t'im*, *tu*, &c., and many others, where the spoken forms are obviously the alteration by wear and tear of sounds originally similar to the written forms. Csoma de Körös, who was acquainted with the somewhat archaic sounds of Ladak, was able to point to only a few letters as silent. Foucaux, in his *Grammaire* (1858), quoted a fragment from a native work on grammar several centuries old, in which the pronunciation of the supposed silent letters is carefully described. Since then the problem has been disentangled; and now minor points only remain to be cleared up. Jaeschke devoted special attention to the dialectical sounds, and showed in several papers and by the comparative table prefixed to his dictionary that in the western and eastern dialects these sounds correspond more or less closely to the written forms.

Tones.

Jaeschke first noted the existence of tones in Tibetan, and these have been found by Professor Conrady to have developed on the same lines as in Chinese. Thus intransitive bases seem to have begun only with soft consonants, and it is doubtful whether the parent tongue possessed hard consonants at all; while transitive bases were formed by hardening of the initial consonants and at the same time pronouncing the words in a higher tone, and these two latter changes are supposed to have been indicated by a prefix to the base-word. Many of these old soft initial consonants which are now hardened in the modern dialects are preserved in classical Tibetan, *i.e.* in Tibetan of the 7th to the 9th century A.D. The old language seems to have pronounced prefixes extensively which in modern pronunciation in central Tibet are largely lost, whilst the soft initials have become aspirated or hardened and tones have developed, and in the west and east, where prefixes and soft initials have been preserved, there are no tones. Thus the valuable testimony of these dialects may be added to the evidence furnished by foreign transcriptions of Tibetan words, loan words in conterminous languages, and words of common descent in kindred tongues. And the whole shows plainly that the written forms of words which are not of later remodelling are really the representatives of the pronunciation of the language as it was spoken at the time of the transcription.

The concurrence of the evidence indicated above enables us to form the following outline of the evolution of Tibetan. In the 9th century, as shown by the bilingual Tibeto-Chinese edict at Lhasa, there was relatively little difference between the spoken and the written language. Soon afterwards, when the language was extended to the western valleys, many of the prefixed and most of the important consonants vanished from the spoken words. The *ya-tag* and *ra-tag*, or *y* and *r* subscript, and the *s* after vowels and consonants, were still in force. The next change took place in the central provinces; the ra-tags were altered into cerebral dentals, and the ya-tags became *č*. Later on the superscribed letters and finals *d* and *s* disappeared, except in the east and west. It was at this stage that the language spread in Lahul and Spiti, where the superscribed letters were silent, the *d* and *g* finals were hardly heard, and *as*, *os*, *us* were *ai*, *oi*, *ui*. The words introduced from Tibet into the border languages at that time differ greatly from those introduced at an earlier period. The other changes are more recent and restricted to the provinces of Ü and Tsang. The vowel sounds *ai*, *oi*, *ui* have become *ē*, *ō*, *ū*; and *a*, *o*, *u* before the finals *d* and *n* are now *ä*, *ö*, *ü*. The *mediae* have become aspirate tenues with a low intonation, which also marks the words having a simple initial consonant; while the former aspirates and the complex initials simplified in speech are uttered with a high tone, or, as the Tibetans say, "with a woman's voice," shrill and rapidly. An inhabitant of Lhasa, for example, finds the distinction between *s'* and *z'*, or between *s* and *z*, not in the consonant, but in the tone, pronouncing *s'* and *s* with a high note and *z'* and *z* with a low one. The introduction of the important compensation of tones to balance phonetic losses had begun several centuries before, as appears from a Tibetan MS. (No. 462*b* St Petersburg) partly published by Jaeschke (*Monatsber. Akad. Berl.*, 1867). A few instances will serve to illustrate what has been said. In the bilingual inscriptions, Tibetan and Chinese, set up at Lhasa in 822, and published by Bushell in 1880, we remark that the silent letters were pronounced: Tib. *spudgyal*, now *pugyal*, is rendered *suh-pot-ye* in Chinese symbols; *khri*, now *t'i*, is *kieh-li*; *hbrong* is *puh-lung*; *snyan* is *sheh-njoh* and *su-njoh*; *srong* is *su-lun*, *su-lung* and *si-lung*. These transcriptions show by their variety that they were made from the spoken and not from the written forms, and, considering the limited capacities of Chinese orthoepy, were the nearest attempt at rendering the Tibetan sounds. *Spra* or *spreu* (a monkey), now altered into *ḍeu* at Lhasa, *ṭeu* in Lahul, Spiti and Tsāng, is still more recognizable in the Gyarung *shepri* and in the following degenerated forms—*shreu* in Ladak, *streu-go* in Khams and in cognate languages, *soba* in Limbu, *saheu* in Lepcha, *simai* in Tablung Naga, *sibeh* in Abor Miri, *shibe* in Sibsagar Miri, *sarrha* in Kol, *sara* in Kuri, &c. *Grog*-ma (ant), now altered into the spoken *ṭ'oma*, is still *kyoma* in Bhutan, and, without the suffix, *korok* in Gyarung, *k'oro-* in Sokpa, *k'orok*, *k'alek* in Kiranti, &c. *Grang*-po-(cold), spoken *ṭ'ammo*, is still *grang*-mo in Takpa, *k'yam* in Burmese, &c. A respectful word for "head" is *ü*, written *dbu*, which finds its cognates in Murmi *thobo*, Sibsagar Miri *tub*, &c. *Bya* (bird), spoken *cha*, is still *pye* in Gyarung. *Brjod* (to speak), pronounced *jod*, is cognate to the Burmese *pyauhtso*, the Garo *brot*, &c. The word for "cowries" is *'gron-* in written, *rum-* in spoken Tibetan, and *grwa* in written Burmese; *slop* (to learn), spoken *lop*, is *slop* in Melam. "Moon" is *zlava* in written and *dawa* in spoken language, in which *-va* is a suffix; the word itself is *zla-*, cognate to the Mongol *ssara*, Sokpa *sara*, Gyarung *t-sile*, Vayu *cholo*, &c. The common spoken word for "head" is *go*, written *mgo*, to which the Manipuri *moko* and the Mishmi *mkura* are related. Sometimes the written forms correspond to double words which have disappeared. For instance, *gye* (eight), which is written *brgyad* and still spoken *vrgyad* in Balti in the west and Khams in the east, is *gyäd* in Ladak, Lahul, Tsang and Ü. The same word does not appear elsewhere; but we find its two parts separately, such as Gurung *pre*, Murmi *pre*, Taksya *phre* and Takpa *gyet*, Serpa *gye*, Garo *chet*, &c. *Rta* (horse) is reduced to *ta* in speech, but we find *ri*, *rhyi*, *roh* in Sokpa, Horpa, Tochu, Minyak, and *tā*, *tah*, *teh*, *t'ay* in Lhopa, Serpa, Murmi, Kami, Takpa, &c., both with the same meaning. Such are the various pieces of evidence obtained from an endless number of instances. The cases referred to above do not, owing to the difference of the causes, yield to any explanation of this kind. And it must be admitted that there are also many cases, some of them caused by irregularities of writing, modification of spelling by decay, and by a probable use of prefixes still unascertained, which also resist explanation, though the account just given stands good whatever solution the question of prefixes may receive in future.

Literature.—The religious literature, which is very considerable, is referred to under LAMAISM. The non-religious literature of Tibet is not extensive, probably owing to the printing being in the hands of the priests. One of the most popular and widely circulated books is called *The Hundred Thousand Songs of the Venerable Milaraspa.* Their author Milaraspa (unless the work should be attributed to his disciples), often called Mila, was a Buddhist ascetic of the 11th century, who, during the intervals of meditation travelled through the southern part of middle Tibet as a mendicant friar, instructing the people by his improvisations in poetry and song, proselytizing, refuting and converting heretics, and working manifold miracles. His legends are not without wit and poetical merit. An equally popular book is the *Love Songs of Ts'angs-dbyangs rgyamts'o*, attributed to the dissipated young Dalai lāma who was deposed in 1701 (see LHASA). There are a number of poems written in an elevated style, also dramatic works chiefly of the character of mystery plays, and collections of fairy tales and fables. The *Kesar Epic*, which has been translated by A. H. Francke under the title of the *Kesar Saga*, is a widely known tale of a heroic warrior king of northern Asia named Kesar (believed by some to be a transcription of "Czar"), but it is not found as a printed book. Several collections of folk songs have also been published by A. Francke from Ladak. A long story book, called the *Djiung yi* (*Sgrungs gyi gsungs?*), and regarded as the national epic in Khām, has been partly seen by Desgodins and Baber. It is in prose; but the dialogue, interspersed with songs, is metrical, and is much more extensive than the prose framework. Religious discussions and philosophical dissertations alternate with comic episodes. It includes three divisions—the *Djiung ling*, which describes the invasion of part of Tibet by the Djiung or Moso; the *Hor ling*, which recounts the conquest of the Hor (Turk tribes) by the Tibetans, and conveys much historical information in a tale of magic and marvel; and the *Djia ling* (Chinese division), which narrates a contest of unknown date between the Tibetans and the Chinese. This work has apparently never been published, and even the manuscripts of the three divisions cannot, says Baber, be obtained in a complete form. But every Tibetan, or at least every native of Khām, who possesses any education, is able to recite or to chant passages of great length. Another Tibetan epic in Khaur, the *Gyaldrung*, praises Dagyolong, a famous warrior who subdued the savage men of Khām. Dramatic works exist, as also a version of the *Ramayana* in the first volume of the *Bstodts'ogs* of the *Bstan-hgyur*.

Writing.—Writing was not introduced until the 7th century. Notched sticks (*shing-chram*) and knotted cords were in current use, but the latter contrivance is only faintly alluded to in the Tibetan records, while of the other there are numerous examples. No mention is anywhere made of a hieroglyphical writing, but on the eastern frontier the medicine-men or *tomba* of the Moso have a peculiar pictorial writing, which is known in Europe from two published MSS. (in *Journ. Roy. Asiatic Soc.*, 1885, vol. xvii.); though apparently now confined solely to purposes of witchcraft, it perhaps contains survivals of a former extensive system superseded by the alphabetic writing introduced from India. According to tradition—a tradition of which the details are still open to criticism—the alphabet was introduced from India by Tonmi, a lay Tibetan minister who was sent to India in 632 by King Srong-btsan to study the Sanskrit language and Buddhist literature. Tonmi introduced the modified Sanskritic "writing in thirty characters" (already detailed under *Language* and six of which do not exist in Sanskrit) in two styles—the "thick letters" or "letters with heads" (*u-ch'en*), now commonly used in printed books, and the half-cursive "cornered letters," so called from their less regular heads. The former are traditionally said to have been derived from the Landza character. The Landza of Nepal, however, is certainly not the origin of the Tibetan letter, but rather an ornamental development of the parent letter. The close resemblance of the Tibetan characters "with heads" to the Gupta inscriptions of Allahabad shows them to have been derived from the monumental writing of the period; and various arguments appear to show that the other Tibetan letters came from the same Indian character in the style in which it was used in common life. The Tibetan half-cursive was further developed into the more current "headless" (*u-med*) characters, of which there are several styles. The ancient manuscripts discovered by Dr M. Aurel Stein in Khotan seem to include very early, if not the earliest known, Tibetan documents. (L. A. W.; T. DE L.)

Political Divisions.—Tibetans divide their country into five provinces: (1) *Amdo*, which comprises that part of the Chinese province of Kansuh which is inhabited by Tibetans, and Koko Nor region, extending southwards to the Yellow river and westwards as far as the Tsaidam. Amdo is inhabited in its eastern part by Tibetans, called Rongwa or "ravine-folk," who are agriculturists, and in the western by pastoral tribes, collectively called Panaka or the Three Panakas. (2) *Khams* or *Khamdo*, which includes all eastern Tibet between the Chinese provinces of Szechuen and Yunnan, and the district of Lhorong jong, which forms the eastern border of the Lhasa-governed territory. This province is divided into the five Horba tribes, the eighteen Nyarong states in the valley of the upper Yalung, and the districts of Litang, Batang, Dergē, Gartok Chiamdo and Draya. In Khamdo, but subject to the direct rule of Lhasa, are several small districts, the principal are Nyarong, Tsarong, and Mar Khams or "Lower Khamdo." Most of these districts are governed by *dēba* or chiefs, while a few have kings or *gyalpo*, the most powerful of the latter being the king of Dergē, famous for its inlaid metal and leather work, and of Chagla, or, as it is better known, Tachienlu, as it is called by the Chinese or the Dartsemdo of the Tibetans, the headquarters of the tea trade with China. Khamdo is under the direct rule of the Chinese provincial authorities of Szechuen. Some of its rulers send also tribute missions to Peking. For convenience of classification we may include in Khamdo a long strip of country extending along the northern border of the Lhasa territory of Lhorong jong and Larego as far as Tengri Nor, and bounded to the north by the Dang-la mountains, which is designated by Tibetans as *Gyade* or "the Chinese province." This strip of country has its own native chiefs, but is under the control of a high Manchu officer stationed at Lhasa, known colloquially as the "superintendent of savage tribes." (3) The third political division of Tibet is *Ü* (written Dbus), meaning "Central." It includes Lhasa and a large number of outlying districts in south-eastern Tibet, such as Po, Pemakoichen, Zayul. The pastoral or Dokpa tribes, north and north-east of Tengri Nor, are also under its rule. (4) The fourth division of Tibet, called *Tsang*, includes all south-west Tibet from the Lhasa or Central province to the Indian frontier as far as Lake Manasarowar. (5) The fifth division, called *Nāri* (Mngah-ris) by the Tibetans or *Hūndēsh* by the Indians, who call the inhabitants Hūniyas, comprises the whole country around the sources and along the upper course of the Indus and the Sutlej, and also all north-western Tibet generally, as far as Ladak and the border of Kashmir. Tsang and Nari are under the rule of Lhasa, all the high civil and military authorities in these provinces holding their offices from it. These five provinces, however, do not include the elevated steppes of Tsaidam (extending between the Kuen-lun and the Altyn Tagh or Nan Shan ranges), inhabited by a mixed race of marauding people, Tunguts and Mongols. Yet Tsaidam is geographically but a northern extension of the great Tibetan plateau, and in most of its essential physical features it is more closely allied to the Chang-t'ang of the south than to the great sandy depressions of Chinese Turkestan or Mongolia on the north.

Government.—Though the whole of Tibet is under the suzerainty of China, the government of the country is divided into two distinct administrations, the one under the rule of the Dalai lama of Lhasa, the other under local kings or chiefs, and comprising a number of ecclesiastical fiefs. Both are directed and controlled by the high Chinese officials residing at Lhasa, Sining Fu, and the capital of the Chinese province of Szechuen. North-eastern Tibet or Amdo, and also a portion of Khamdo, are under the supervision of a high official (Manchu) residing at Sining Fu in Kansuh, whose title is Imperial Controller-General of Koko Nor. The native chiefs of the Panaka and other Tibetan tribes of this region are styled *pōmbo* ("official" or "headman") by both the natives and the Chinese. The region under the supervision of the imperial controller includes all the countries north of the upper course of the Dre chu (Yangtsze-kiang). The people pay a small poll-tax to China, and are exempted from any other impost; they also pay a small tax in kind, sheep, butter, &c., to their chiefs. The province of Khamdo, including all eastern Tibet, is governed by local chiefs, styled *gyalpo*, "king," and *dēba*, "chief," succession to the chieftainship being usually assured to the eldest son not a lama. Each chief appoints a certain number of civil and military officers to assist in the government of the country, and each village has its headman or *besē*, also an hereditary office. None of these officials receive salaries; they are only exempt from taxation, and some have grants of land made to them. The only tax paid to China is a so-called "horse-tax" of about 5d. for each family. Once in every five years the chiefs send a tribute mission to the capital of Szechuen, and once every ten years to Peking, but the tribute sent is purely nominal. The Chinese maintain a few small military posts with from six or eight to twenty men stationed in them; they are under the orders of a colonel residing at Tachienlu. There are also a few lama chiefs.

The part of Tibet under the rule of Lhasa, by far the largest and wealthiest, includes the central province of Ü, Tsang, Nari and a number of large outlying districts in southern and even in eastern Tibet. The central government of this part of the country is at Lhasa; the nominal head is the Dalai lama or grand lama. The Tashi lama or head of the monastery of Tashilhunpo near Shigatse is inferior to the Dalai lama in secular authority, of which, indeed, he has little—much less than formerly—but he is considered by some of his worshippers actually superior to him in religious rank. The person next in consideration to the two great lamas is the regent, who is an ecclesiastic appointed during the minority of each Dalai lama. Under him are four ministers of state (*sha-pē* or *kalön*), who divide among themselves, under the immediate supervision of the two imperial Chinese residents (or *amban*), the management of all secular affairs of the country. There is also a Tsong-du or National Assembly, divided into a greater assembly, including all government officials, and called together only to decide on matters of supreme importance, and a lesser assembly, consisting of certain high officials of Lhasa, noblemen, and delegates from the monasteries of Debung, Sera and Galdan, and fairly constantly in session. The Tsong-du discusses all matters of importance, especially relating to foreign policy, and its decisions are final. The army is under the command of the senior Chinese amban, a Tibetan generalissimo or *mag-pön*, and six Tibetan generals (*dah-pön* or *de-pön*). The military duties of the generals are slight, but their political status is high. Under the *dah-pön* are six *rüpön* or colonels, and a number of subordinate officers. The regular army consists (in theory) of 6000 men, on active service for three years, and at home on half-pay for three years. After the six years they pass into the reserve or militia (*yulmag*). The taxes paid to the Lhasa government are mostly in kind, sheep, ponies, meal, butter, wool, native cloth, &c., and the coin paid is said to be about 130,000 ounces of silver a year. Chandra Das states that the crown revenues of Lhasa amount to about 2,000,000 rupees annually. All high Tibetan officials, whether ecclesiastics or laymen, are appointed subject to confirmation by the Chinese government. The administrative subdivisions of the Lhasa country, of which there are fifty-four, are called *jong*, or "prefecture," each of which is under the rule of two *jong-pon*, the one a lama, the other a layman. They collect all taxes, are responsible for the levy of troops, the courier service, corvées, &c., and exercise judicial functions, corresponding directly with Lhasa. There are 123 sub-prefectures under *jong-nyer*. Under them are village headmen or *tso-pön*, headmen or *mi-pön*, and elders or *gyan-po*. All are appointed for indefinite periods by the prefects.

Industries and Trade.—The industries are confined to the manufacture of woollen cloth of various degrees of fineness and colour, and called *truk*, *tirma* and *lawa*, to that of small rugs, pottery of an inferior quality, utensils of copper and iron, some of which show considerable artistic skill in design, and to such other small trades as are necessary to supply the limited wants of the people. The best artisans are Nepalese and Chinese, the former being the best workers in metal and dyers.

Trade Routes, &c. The great trade routes are, first, that which, starting from Cheng-tu, the capital of the Chinese province of Szechuen, passes by way of Tachienlu or Dartsedo, Litang, Batang, Chiamdo, Larego, Lhasa, Gyantse, Shigatse, reaches the Nepalese frontier at Nielam and goes thence to Katmandu. This route is called *Gya-lam*, "the China road" (or "high road"); the great bulk of Tibetan travel goes over it. Minor roads go from Sining Fu in the Chinese province of Kansuh via Tsaidam and the Tang la pass to Nagchuka and Lhasa. This road, called the *Chang lam* or "northern road," was much used by traders till the middle of the 19th century, when the Mahommedan rebellions in north-western China practically closed it. Another road starts from Sung-pan in north-western Szechuen, and, by way of the sources of the Yellow River, joins the Gya-lam at Chiamdo; it is little used, as it passes through the country of the wild marauding Golok. Still another route starts from Tachienlu, and by the valley of the Yalung and the Dze chu runs to Yekundo, and thence to Chiamdo. From this point it leads to Riwoche, and then through Gyade or Chinese province to Nagchuka and Lhasa. An important trade road starts from Likiang Fu in Yunnan, and by way of Chung-tien (Guiedam of the French missionaries) joins the Gyalam at Batang.

The most direct route from India to Lhasa, and that most frequented by the traders of Lhasa, is by the Chumbi Valley, and was followed by the British Mission. It crosses the Himalayas by the Tang Pass (15,200 ft.), and thence proceeds via Gyantse (13,200 ft.) and the Kharo Pass (16,500 ft.), Yamdok Lake (15,000) to the Tsang-po (12,100 ft.), and crossing the river winds up along the Kyi Chu, on which Lhasa stands, 33 m. from the Tsang-po. The total distance from Siliguri railway station is 357 m. From Katmandu, the capital of Nepal, a difficult mountain route runs by Kirong to the No la (16,600 ft.), descending from which pass it strikes the Tsangpo about midway between Lhasa and Lake Manasarowar. Farther west Tibet may be reached from Kumaon by one of a group of passes (of which the best known is the Milam) leading to Lake Manasarowar. The lake becomes a sort of obligatory point on all routes to Tibet which lie between Ladak and Nepal. The Shipki road from Simla, which strikes the Sutlej at Totling (where there is a bridge), leads up to Manasarowar, coinciding with the great high-road (*Changlam*) after passing Totling. The remarkable area of gold-mining industry which lies to the north-east of Gartok is reached by another route from Leh, which, crossing the Chang la close to Leh, passes by Rudok at the eastern extremity of Lake Pangong in a south-easterly direction, running north of the great mountain masses which crowd round the Indus sources. It continues through the central lake district to Tengri Nor and Lhasa. The principal trade with China is carried on over the Lhasa-Tachienlu road.

According to a summary furnished by Lieut.-Colonel Waddell (*Lhasa and its Mysteries*), the chief imports from China are silk, carpets, porcelain and tea-bricks. From Mongolia come leather, saddlery, sheep and horses, with coral, amber and small diamonds from European sources; from Kham perfumes, fruits, furs and inlaid metal saddlery; from Sikkim and Bhutan rice, musk, sugar-balls and tobacco; from Nepal broadcloth, indigo, brasswork, coral, pearls, sugar, spices, drugs and Indian manufactures; from Ladak saffron, dried fruits and articles from India. In the market at Lhasa opium sells for its weight in silver. The exports from Tibet are silver, gold, salt, wool, woollen cloth, rugs, furs, drugs, musk. By the Nepal, Kumaon and Ladak routes go borax, gold and ponies. Patna in Bengal is the chief market for the Nepal trade; Diwangiri and Udalguri for Assam, and Darjeeling and Kalimpong for Sikkim and Chumbi. One of the most universal articles of consumption in Tibet is the Chinese brick-tea, which even passes as currency. The tea imported from Szechuen is for the most part of very inferior quality, estimated at 35% tea-leaves and 65% twigs and other material. It is compressed into large bricks, and costs two-thirds of a penny per pound. Efforts have been made by the planters of the Duars to prepare Indian brick-tea for the Tibetan market, which is calculated to consume some 11,000,000 lb yearly.

Money.—It is curious that Tibet, though using coined money, seems never, strictly speaking, to have had a coinage of its own. Till nearly the end of the 18th century the coinage had for a long time been derived from Nepal. That valley prior to the Gurkha domination (1768) was under three native dynasties (at Bhatgaon, Patan and Katmandu), and these struck silver mohurs, as they were called, of the nominal value of half a rupee. The coins were at first not struck specially for Tibetan use, but were so afterwards. These latter bore (obverse) a Nepalese emblem surrounded by eight fleurons containing the eight sacred Buddhist jewels, and (reverse) an eight-petalled flower surrounded by eight fleurons containing the names of the eight jewels in Tibetan characters. Ingots of Chinese silver were sent from Lhasa with a small proportion of gold dust, and an equal weight in mohurs was returned, leaving to the Nepal rajahs, between gold dust and alloy, a good profit. The quality of these coins (weighing about 81 grains troy) was low, and at last deteriorated so much that the Tibetans deserted the Nepal mints. The Gurkhas, after becoming masters of Nepal, were anxious to renew the profitable traffic in coin, and in this view sent a deputation to Lhasa with a quantity of coin to be put in circulation. But the Gurkhas were mistrusted and their coin refused. A coinage was then issued (it would appear once only) in Tibet for domestic use, modelled on an old Kathmandu pattern and struck by Nepalese artists. The Gurkhas, however, in 1788 and following years continued to strike coins of progressively debased quality, which were rude imitations of the old Nepalese mintage, and to endeavour to force this currency on the Tibetans, eventually making the departure of the latter from old usage a pretext for war and invasion. This brought the intervention of the Chinese, who drove the Gurkhas out of Tibet (1792), and then began to strike silver coins for Lhasa use, bearing Chinese and Tibetan characters. For practical use these Tibeto-Chinese coins (of which $2\frac{1}{2} = 1$ rupee, and which are known as *naktang*, *i.e. nagskyang*, "cash") are cut into aliquot parts by the guidance of the figures on them. Large lumps of Chinese silver, stamped with the imperial seal, are also used. But of late years there has been an enormous influx of Anglo-Indian rupees, so that these have become practically the currency of the country, even to the frontier of China, and are now counted, instead of being valued as bullion. They are called *Piling tanka*, (foreign coins), from the Hindi *tankā*, a rupee.

Weights and Measures.—The weights and measures in use are practically those of China; the dry measures, the most commonly employed, are the *bre* or *bo* of about four pints and the *bchal* of twenty *bo*; the capacity of the *bo* varies according to localities. The most commonly used measures of length are the span (*mto*), the cubit (*kru*), and the arm's-length or fathom (*dompa*).

Exploration.—Tibet was long a *terra incognita* to Europeans. It is difficult of access on all sides, and everywhere difficult to traverse. Its great elevation causes the climate to be rather arctic than tropical, so that there is no gradual blending of the climates and physical conditions of India and Tibet, such as would tend to promote intercourse between the inhabitants of these neighbouring regions; on the contrary, there are sharp lines of demarcation, in a mountain barrier which is scalable at only a few points, and in the social aspects and conditions of life on either side. No great armies have ever crossed Tibet to invade India; even those of Jenghiz Khan took the circuitous route via Bokhara and Afghanistan, not the direct route from Mongolia across Tibet. Added to this was the religious exclusiveness of the Tibetans themselves. Thus it was no easy matter for the early European travellers to find their way into and explore Tibet. Friar Odoric of Pordenone is supposed to have reached Lhasa *c.* 1328, travelling from Cathay; but this visit is doubtful. On the strength of certain statements in the narrative of Fernão Mendes Pinto, some authorities hold that he may have visited Lhasa in the course of his journeys in the middle of the 16th century. The Jesuit Antonio Andrada, a native of Portugal (1580–1634), travelling from India, appears to have entered Tibet on the west, in the Manasarowar Lake region, and made his way across to Tangut and north-western China; in 1661 the Jesuit fathers Johann Grueber (an Austrian) and Albert D 'Orville (a Belgian) travelled from Peking via Tangut to Lhasa, and thence through Nepal to India. The extracts from Grueber's narrative, given by Athanasius Kircher in his *China illustrata* (Amsterdam, 1667), are accompanied by a good drawing of Potala. During the first half of the 18th century various Capuchin friars appear to have passed freely between Calcutta and Lhasa (1708) by way of Nepal. They even founded a mission in Lhasa, which, after failing at first, was more firmly established in 1715 and lasted till 1733.

In 1716 two Jesuits, P. Ipolito Desideri, of Pistoia, and P. Freyre, a Portuguese, reached Lhasa by way of Kashmir, Ladak, and the enormous journey from Ladak by the holy lakes and the valley of the Tsangpo. Desideri remained at Lhasa till April 1721, witnessing the capture of Lhasa successively by Dzungar and Chinese. Of the moderation of the latter, and their abstinence from all outrage or plunder, he speaks highly. His departure was due to controversies between the Jesuits and Capuchins at Rome, which caused an order to be issued for his retirement from Tibet. An interesting letter from him, dated the 10th of April, 1716, is printed in the *Lettres édifiantes*, rec. xv., and he left a large MS. volume of his observations. The next European visitor was Samuel Van de Putte, of Flushing, an LL.D. of Leiden, whose thirst for travel carried him through India to Lhasa (1730), where he is said to have resided a long time, to have acquired the language, and to have become intimate with some of the lamas. After travelling from Lhasa to Peking with a lama mission he returned, again by Lhasa, to India, and was an eyewitness of the sack of Delhi by Nadir Shah in 1737. Unhappily he ordered his papers to be burnt after his death, and the knowledge that such a traveller must have accumulated died with him. In 1745 the Capuchin mission finally collapsed after a revival had been attempted in 1741 by a party under Orazio della Penna, of which Cassiano Beligatti was chronicler. We possess some of the results collected by this mission in an excellent short treatise on Tibet by P. Orazio himself, as well as in the *Alphabetum Tibetanum* of the Augustine monk A. Georgi (Rome, 1762). Some fifty volumes, the relics of the mission library, were in 1847 recovered from Lhasa by Brian Hodgson, through the courtesy of the Dalai lama himself, and were transmitted as an offering to Pope Pius IX. The first Englishman to enter Tibet was George Bogle, a writer of the East India Company, in 1774, on an embassy from Warren Hastings to the Tashi lama of Shigatse. In 1783 Lieut. Samuel Turner was despatched on a mission similar to that of Bogle, and reached Shigatse. In 1811–1812 the first English visit to Lhasa occurred. The traveller was Thomas Manning, a Cambridge man of Caius College, who had been long devoted to Chinese studies, the "friend M." of Charles Lamb, from whom "Elia" professes to have got that translation of a Chinese MS. which furnished the dissertation on roast pig. After residing some years at Canton, Manning went to Calcutta, bent on reaching the interior of China through Tibet, since from the seaboard it was sealed. He actually did reach Lhasa, stayed there about five months, and had several interviews with the Dalai lama, but was compelled to return to India. He never published anything regarding his journey, and its occurrence was known to few, when his narrative was printed, through the zeal of Mr (afterwards Sir) C. Markham, in 1876. The account, though containing some passages of great interest, is disappointing. Manning was the only Englishman known to have reached the sacred city without the aid of an army. But the Abbé Huc states that William Moorcroft, an Englishman who made a journey into Tibet in the neighbourhood of Lake Manasarowar in 1812, and another into Kashgar in 1824, lived in Lhasa for twelve years disguised as a Mussulman. He was supposed to have died on the Afghan frontier in 1825 on his second journey; but if Huc's story is true he reached Lhasa in 1826, and did not leave it till 1838, being assassinated on his homeward journey, when maps and drawings were found on him, and his identity was for the first time suspected by the Tibetans. During the 19th century Europeans were systematically prevented from entering the country or speedily expelled if found in it. In 1844–1846 the French missionaries, Evariste Régis Huc and Joseph Gabet, made their way to Lhasa from China. They travelled from China the route followed by Grueber and by Van de Putte, via Siningfu, and reached Lhasa on the 29th of January 1846. On the 15th of March they were sent off under escort by the rugged road to Szechuen. Huc's book, *Souvenirs d'un voyage*, &c., is one of the most delightful books of travel. Huc was, indeed, not only without science, perhaps without accurate knowledge of any kind, but also without that geographical sense which sometimes enables a traveller to bring back valuable contributions to geographical knowledge though unable to make instrumental observations. He was, however, amazingly clever as a narrator and sketcher of character. It was Ke-shen, a well-known Chinese statesman, who was disgraced for making peace with the English at Canton in 1841, and was then on a special deputation to Lhasa, who ostensibly expelled them. The Tibetan regent, with his enlightened and kindly spirit, is painted by Huc in most attractive colours, and Markham expressed the opinion that the native authorities were then willing to receive strangers, while the jealousy that excluded them was Chinese only. The brothers Henry and Richard Strachey visited Manasarowar Lake in 1846 and 1848 respectively. In 1866 the Abbé Desgodins travelled through portions of eastern Tibet and reached Chiamdo (in Khām), but was prevented from approaching any closer to Lhasa.

The Secret-Service Pundits.

Beginning in 1863 a number of native Indian explorers were sent by the government of India into Tibet, for the purpose of surveying the country and collecting information about its inhabitants. These men were specially trained at Dehra Dun in the work of surveying, and entered Tibet with a strong wooden box with a specially concealed secret drawer for holding observing instruments, a prayer wheel with rolls of blank paper instead of prayers in the barrel on which observations might be noted, and lamaic rosaries by the beads of which each hundred paces might be counted. As may be imagined, they carried their lives in their hands in case of discovery. The best known of these men were Pundit Nain Singh, Pundit Krishna, originally known as A.-K. (from the first and last letters of his name transposed) and Ugyen Gyatso, or U.-G. Nain Singh reached Lhasa in the course of two remarkable journeys. In the first, after an ineffectual attempt by Nepal, he travelled by the Manasarowar Lake, and the road thence eastward, parallel to the course of the Tsangpo, reaching Lhasa on the 10th of January 1866, and leaving it on the 21st of April 1867. On the second journey (1874) he started from Ladak, crossing the vast and elevated plateau by the Tengri Nor and other great lakes, and again reaching Lhasa on the 18th of November. Nain Singh gave an account of his journeys, and of his residence there, which, though brief, is full of intelligence and interest. This enterprising and deserving man, on the completion of his journey in 1875, was rewarded by the Indian government with a pension and grant of land, and afterwards received the gold medal of the Royal Geographical Society and the Companionship of the Star of India. He died early in 1882.

In 1878 A.-K also revisited Lhasa, stayed a year, and afterwards continued into Tsaidam, not returning to India till 1882. Lama Ugyen Gyatso, a semi-Tibetan, who was originally a teacher of Tibetan in a Darjeeling school, was trained by the Indian Survey Department as a surveyor, and being deputed to take tribute from his monastery to Tashilhunpo, he secured permission in 1879 from the Tashilhunpo authorities for Sarat Chandra Das, Bengali schoolmaster at Darjeeling, to visit that monastery, where his name was entered as a student. This was the opportunity for a series of valuable exploratory journeys through the Tibetan provinces adjoining the Indian and Nepalese frontiers, which added greatly to our stock of information about Lhasa and the districts surrounding that city. In their first journey the travellers set out from Jongri in Sikkim, and traversing the north-east corner of Nepal, crossed into Tibet by the Chatang la, and travelled northwards to Shigatse and Tashilhunpo. They returned by much the same way to near Khamba jong, and re-entered Sikkim by the Donkya pass. The journey was fruitful of information and valuable for mapping. Ugyen Gyatso undertook another journey in 1883 to complete and extend his former surveys. Travelling by way of Khamba jong directly to Gyantse and Shigatse, he turned eastwards at the latter town, finished the survey of the Yamdok t'so, and crossed the Himalaya into the valley of the Lobratsangpo or Upper Manas river. At Shakhang jong he was arrested, and his true character discovered. He managed, nevertheless, to extricate himself, and turning north-eastwards he passed through Chetang, and reached Lhasa by way of Samye monastery. From this city he started for Darjeeling, which he reached on December 15th, 1883. Chandra Das made a second journey in 1881, with the intention of reaching Lhasa. He travelled by way of Tashilhunpo, lay dangerously ill for some time at Samding monastery, duly reached Lhasa, where he visited the Dalai Lama, but owing to small-pox in the city could remain there only a fortnight, though he made full use of this time. During a journey home occupying nearly half a year he collected much further valuable information. Sarat Chandra Das's reports of his two journeys were published by the Indian government, but for political reasons were until 1890 kept strictly confidential. In 1899 they were edited by the Royal Geographical Society and in 1902 published. They contain valuable information on the superstitions, ethnology and religion of Tibet. Chandra Das also brought back from his journeys a large number of interesting books in Tibetan and Sanskrit, the most valuable of which have been edited and published by him, some with the assistance of Ugyen Gyatso and other lamas.

Russian Explorers.

The Russian explorer Prjevalsky, although he was not, strictly speaking, an explorer of Tibet, did much incidentally towards determining the conformation of its north-eastern and eastern mountain systems. His third journey into Central Asian wilds, which lasted from March 1879 to October 1880, included the sources of the Hwang Ho, or Yellow river, till then unmapped and unknown. His fourth journey, between November 1883 and October 1885, covered much of northern Tibet, and established the true character of Tsaidam. It was when setting out in 1888 to make an attempt to reach Lhasa that he died.

After Prjevalsky's death, V. I. Roborovski, with several companions, explored the western ranges of the Kuen-lun, and crossed southwards into Tibet, tracing the course of the Kiria river to the north-western plains of the central plateau. The distinguishing feature of these explorations, led by Russian officers, is their high scientific value and the contributions they have offered to the botany, natural history, geology and meteorology of the regions under investigation in addition to the actual geographical data attained. The Kuen-lun is known in their writings as the Russian Range.

W. W. Rockhill, 1888–1889, 1891–1892.

In 1888 Mr W. W. Rockhill, an American possessing the unique qualifications for Tibetan exploration of a profound knowledge of the language and history of the country, coupled with the instincts and training of a scientific explorer, left the lamasery of Kumbum in north-western Kansuh with three Chinese servants and a small caravan, proceeded round the north shore of Koko Nor, crossed eastern Tsaidam, and explored some of the rivers and lakes directly south of that region. Leaving Barong Tsaidam, he travelled south by way of the sources of the Yellow river, till he reached the Dre chu (upper Yangtsze-kiang), which he crossed to the north of the important trading centre of Yekundo. From this point he followed the valley of the Dre chu till about lat. 30° 31′, when he passed into the basin of the Yalung river, traversed the Horba states and finally reached Tachienlu by the Gi la and the valley of the Darchu.

In 1891 Mr Rockhill, starting again from Kumbum with three Chinese, passed south of Koko Nor through the country of the pastoral Panaka Tibetans, and by a very difficult pass (Vahon jamkar la) entered again the basin of the Tsaidam. He then turned west, followed the base of the south Tsaidam range as far as the Naichi Gol, where he entered the southern mountainous region forming the northern borderland of Tibet. From this point the traveller followed a general south-westerly direction around the heads of all the feeders of the upper Dre chu, and thence into the lake region of northern central Tibet, crossing Bonvalot's route south of the Chi-chang t'so and that of Bower a few days farther south. Near the Namru t'so his farther progress south was arrested and he was compelled to take an easterly course. After making a long détour north, often crossing the roads previously travelled by Bonvalot and Bower, and passing by Riwoche, he came to Chiamdo and Tachienlu. The results of Mr Rockhill's two journeys were important and valuable.

A. D. Carey and A. Dalgleish, 1885–1887.

Messrs A. D. Carey and A. Dalgleish in 1885–1887 made a protracted journey from Ladak, in the course of which they crossed the Aksai Chin, reached Khotan, entered the Tarim basin, and subsequently made their way eastward and then southward across the Altyn Tagh and other ranges to the Tsaidam region. Finally a great circuit was made to the north and west, across the Humboldt range, and by Hami, Urumchi, and Yarkand to Ladak again.

Gabriel Bonvalot, 1889–1890.

Bonvalot, accompanied by Father Dedeken of the Belgian Catholic Mission and Prince Henri d'Orléans, left Charkhlik, south-west of the Lob Nor, in November 1889, and taking a very nearly due southerly course, reached on the 13th of February 1890 the eastern end of the Tengri Nor. Then pushing on southwards, he crossed the Nien-chen-tang-la and entered the Dam district near the Lhasa-Sining high road. Here the party was stopped by Tibetan authorities and forced to take the tea route through Chinese Tibet (Gyade) by way of Batasumdo, Chebotenchin, Riwoche, Chiamdo to Chiangka, near the upper Yangtse-kiang, whence they proceeded to Tachienlu by Batang and Litang. Bonvalot noted some extinct volcanoes in the northern Tibet desert.

Captain H. Bower, 1891–1892.

Accompanied by Dr W. G. Thorold, of the India Medical Service, and a native sub-surveyor, Captain Hamilton Bower, I.S.C., set out from Leh on the 1st of June 1891, and crossed the Lanak la and the Ladak frontier on the 3rd of July. From this point the party took a general easterly direction past the Mangtza t'so, Horpa t'so, Charol t'so, and around the northern end of the Aru t'so, all important lakes, at an average altitude of about 16,500 ft. From the Aru t'so the travellers took a south-easterly direction across the great northern plateau or Changtang till they reached the south-east side of the Garing t'so, in about 31° 30′ N. and 89° 10′ E. At this point Bower was stopped by some of the headmen of the Tibetan pastoral tribes (here under the rule of Lhasa), and obliged to make a long circuit to the north well out of Lhasa territory, and then eastward—till he struck the road to Chiamdo through Gyade or Chinese Tibet. Crossing the Sining-Lhasa road a little south of the Dang la range, and about two days' journey north of Nagchuka, Captain Bower crossed the Su chu, and following a course parallel to the Giama-nu chu, he made his way to Riwoche and thence to Chiamdo, from which town he followed the Lhasa-Tachienlu high road to the latter town, which he reached on the 10th of February 1892. The results of Captain Bower's journey were all of first-class importance.

Miss A. R. Taylor, 1892.

Miss Annie R. Taylor, an Englishwoman of the China Inland Mission, started from Tao-chow (Kansuh) in September 1892, accompanied only by five Asiatics. Passing by the famous lamasery of Labrang, south of the Yellow river, she crossed that river and traversed the southern part of the country inhabited by the predatory Tibetan tribes called Golok. Thence, after crossing the upper Yalung, which flows by the town of Kanze, she pursued her journey to the upper course of the Yangtse-kiang (Dre chu), crossing that river somewhere near where A.-K. had crossed it in 1881 and Rockhill in 1889, and then came to the town of Gye-Yekundo. From this point she seems to have followed the Chiamdo road to near that town, when she turned westwards and continued in that direction till she came on the high road from Lhasa to Sining Fu somewhere north of Nagchuka. Here, like all other European travellers who have tried to reach Lhasa from the north, she was stopped by the Lhasan authorities. She appears to have followed about the same route on her way back to China, for she again went to Yekundo and thence by the high road, followed previously by A.-K. and Rockhill, to Tachienlu in Sze-ch'uen, where she arrived on the 12th of April 1893.

Dutreuil de Rhins and F. Grenard, 1893-1894.

In 1893 MM J. L. Dutreuil de Rhins and Fernand Grenard, both Frenchmen, left Cherchen, with Lhasa as their objective. After crossing the Kara muren davan in the Arka Tagh, they entered the lake region of north Tibet and followed a general southerly direction across low ranges of hills and by numerous small lakes till they arrived in 32° 30′ N., where they changed direction to east-south-east, passing to the north of the Chargut and Zilling lakes. The travellers were able to push on as far as the north-eastern bank of the great Tengri Nor, which they reached on the 30th of November 1893. Here they were finally stopped by the Tibetans, and after a delay of six weeks passed in vain attempts to obtain permission to go to Lhasa, they were only allowed to proceed to Nagchuka on the Sining-Lhasa road, and to continue by the Gyade route to Yekundo, near the upper Dre chu, and thence to Sining in Kansuh. From Nagchuka the travellers followed a heretofore unexplored road through the Gyade country, crossing Rockhill's route in the Pere-Sangyi districts near Tashiling (their Tachi gomba). The road followed by them to Yekundo is called by Tibetans the upper road (*gong lam*), and had apparently been followed previously by Miss Taylor. Reaching Yekundo (or Giergundo) on the 21st of May 1894, the travellers started for the Koko Nor and Sining on the 1st of June; but the party was attacked near Tungbumdo (Tumbumdo of previous travellers), and Dutreuil de Rhins was killed on the 5th of June. M Grenard after a few days resumed his march, passed east of the Noring t'so, the eastern extremity of Tosu Nor, and thence by the south-east corner of Koko Nor to the town of Sining Fu in Kansuh. The results of this exploration were a large number of maps and a report of great scientific importance.

St George R. Littledale, 1895.

Mr Littledale, an Englishman, accompanied by his wife, left Khotan in the early part of 1895, and travelling thence to Cherchen, he turned southwards, and following up the course of the Cherchen darya to a point near its source, he continued in that direction between 87° and 89° E. across the northern plateau of Tibet till he reached the Zilling (or Garing) t'so. Pursuing, amid great difficulties, his southerly course, he finally reached the western bank of Tengri Nor. Pushing rapidly on in the direction of Lhasa, when not over 50 m. away from the city (camp, 30° 12′ 12″ N.) he was finally stopped by the Lhasan authorities and obliged, in great part on account of the severe illness of Mrs Littledale, to give up the attempt to reach Sikkim, and to take a direct trail to Ladak. In the latter part of this remarkable journey Littledale's route lay parallel but to the south of the routes followed previously by Nain Sing, and more recently by Bower. Passing by Rudok, the party re-entered Ladak at the village of Shushal on the 27th of October 1895, and Leh on the 2nd of November. Mr Littledale surveyed about 1700 m. of country between Cherchen and Shushal, and brought back a valuable collection of plants, which, added to those collected by other travellers in this part of Tibet, enabled botanists considerably to extend their scanty knowledge of this region.

Captain M. S. Wellby, 1896.

Accompanied by Lieut. N. Malcolm of the 93rd Highlanders, Captain Wellby, of the British army, left Leh on the 4th of May 1896. The travellers were compelled to enter Tibet by way of the Lighten t'so in 35° N. From this point they turned due east and continued, with the usual incidents experienced by all travellers in those regions—cold, storms, lack of food and of grass, loss of ponies and pack animals, &c.—until they reached the northern branch of the Dre chu, the Chumar. Passing into the valley of the Nomoron Gol, south of the Tsaidam, they made their way by Barong Tsaidam to Donkyr and Sining Fu by the high road along the northern shore of the Koko Nor.

Captain H. H. P. Deasy, 1896.

Captain Deasy, of the British army, left Leh on the 27th of May 1896, and crossing the Lanak la, passed by the Mangtza t'so, north of the Horpa t'so, to Yeshil kul. Thence he endeavoured to proceed due east, but was obliged by the nature of the country to turn south, crossing Bower's route on the west side of the Aru t'so. He finally completed a valuable survey of an important part of western Tibet.

Rijnhart, 1898.

In 1898 a Dutch missionary in China named Rijnhart started with his wife from the vicinity of Koko Nor, with the intention of reaching Lhasa, but at the upper Mekong, to the east-north-east of the city, he was murdered, and his wife reached the Chinese province of Sze-ch'uen with great difficulty alone.

Sven Hedin, 1896-1908.

In 1896 Sven Hedin, a Swede (1865–   ), left Kopa, a point about 100 m. south of Cherchen, and after crossing the Arka Tagh took an easterly course between that range and the western continuation of the Kokoshili range till he entered the valley of the most northerly feeders of the Dre chu, when he passed into the valley of the Naichi Gol and entered the Tsaidam. His careful observations concerning the meteorology of this region are of great value, and his surveys between Kopa and the Naichi Gol were in a country not previously explored. During his second and more important journey in Central Asia (1899–1902), Sven Hedin left Charkhlik, on the edge of the Taklamakan desert, in May 1901, intending to cross Tibet in a diagonal direction to the sources of the Indus. He made crossings of the lofty Arka Tagh and other parallel ranges to the south (running east and west). On his final penetration southward, arriving within fourteen days of Lhasa, he left the bulk of his caravan and pushed rapidly on towards that city, but was stopped when about five days from it (Aug. 5, 1901). Rejoining his caravan he turned westward, and passing through the country previously traversed by Bower and Littledale he reached Leh on the 20th of December 1901. His careful and detailed maps, lake soundings, hydrographic, geological, meteorological and other investigations gave him the highest rank among modern explorers.

On a third journey (1906–1908) he travelled by way of Turkish Armenia, Persia, Baluchistan and India, and entered Tibet by way of the Aksai Chin. Proceeding south-east, or diagonally across the country, he traversed 840 m. of unknown country, investigating the lake Ngangon t'so or Ngantse t'so, which had hitherto been only hypothetically mapped, and marched thence over the watershed between this and the Tsangpo. This watershed was found to lie much farther north than had been supposed, and to consist of very lofty mountains, in complicated ranges, from which large tributaries descend to the Tsangpo (Brahmaputra). After a journey of half a year Hedin reached Shigatse; on leaving it he turned north again, intending to explore the large sacred lake Dangra-yumso, west of Ngantse t'so, but when within sight of it he was prevented by Tibetans from approaching it. He now followed a devious route to Lake Manasarowar, entering Nepal for a short distance from Tradum, discovering the main source of the Brahmaputra in a great mass of glaciers called Kubi-gangri, in the northernmost chain of the Himalaya. He next investigated the sources of the Sutlej, made hydrographic investigations of the Manasarowar lakes, with the neighbouring underground waterways, and proceeded thence to Gartok. He confirmed the existence, long suspected, of a lofty mountain chain extending right across the country from the lake Tengri Nor (*i.e.* about 90° E.) to the district north of Gartok (about 81° E.). He returned to Ladak in 1908. He was created a K.C.I.E. in 1910.

Captain P. K. Kozlov, 1900-1901.

In May 1900 Kozlov, in command of the Russian Geographical Society's expedition to Central Asia and Tibet, left Barong Tsaidam, and travelling southwards, came to the Dre chu (his Ndu chu, or Blue river), at about the same point as Rockhill in 1889. Assisted by the old chief of Nyamtso, he crossed the river and reached Yekundo (his Jarku Lomba). One stage beyond this place he left the route followed by former travellers and pushed northwards to near the town of Chiamdo, where after a sharp fight with the natives he turned eastwards. The winter was passed in the valley of the Ra chu, a tributary of the Chiamdo chu (his Dza chu), and excursions were made as far as Derge droncher. In the spring of 1901 the expedition resumed its march eastwards around the Dre chu and the Ja chu (Yalung river), followed up the left bank of the latter and got back to Russian Lelu (Oring t'so) on the 30th of May 1901.

Captain C. G. Rawling, 1903.

In 1903 Captain C. G. Rawling and Lieut. A. J. G. Hargreaves of the Somerset Light Infantry, starting from Leh as a base, carried out careful survey work (their chief object being to extend that of Captain Deasy) in the territory lying east of the British frontier, *i.e.* about 80° to 83° E., and 34° N.

The British armed mission of 1904 performed a brilliant feat of marching and reached Lhasa, whose mysteries were thus unveiled, but this exploit belongs to the section dealing with history, below. (T. H. H.*; L. A. W.; O. J. R. H.)

History.—Previous to the 7th century A.D. there was no indigenous recorded history of the country, the people being steeped in barbarism and devoid of any written language. The little that is known of this prehistoric period is gathered from the legends and the more trustworthy sidelights of contemporary Chinese records.

From the 11th century B.C. the Chinese used to call by the name of Kiang (or Shepherds) the tribes (about 150 in number) of nomads and shepherds in Koko Nor and the north-east of present Tibet; but their knowledge continued to be confined to the border tribes until the sixth century of our era. In the annals of the T'ang dynasty it is said that the population of the country originated from the Bat-Kian or Fah Kiang; and, as the information collected in the first part of the notice concerning Tu-bat, afterwards Tu-ban, the modern Tu-fan, dates partly (as is proved by internal evidence) from a time anterior to the T'ang dynasty (A.D. 618), some degree of reliance may be placed on it. There we are told that Fanni, a scion of the southern Liang dynasty of the Tu-bat family (which flourished from 397 to 415 at Lian-chow in Kansuh), who had submitted to the northern Liang dynasty, fled in 433 with all his people from his governorship of Lin-sung (in Kan-chow) westwards across the Yellow river, and founded beyond Tsih-shih ("heapy stones") a state amidst the Kiang tribes, with a territory extending over a thousand *li*. By his mild and just rule he was soon enabled to establish his sway over an immense territory. His original state was apparently situated along the upper course of the Yalung river, an affluent of the Kin-sha-kiang.

Through the exertions of Prinsep, Csoma de Körös, Emil Schlagintweit, Chandra Das, Rockhill, Huth, Waddell and others, we possess many copies of lists of kings, forming the dynasties of Tibet from the legendary beginnings between the 5th and 2nd century B.C. down to the end of the monarchy in 914. But the serious divergences which they show (except as to later times and in general outlines) make their unauthentic character plain. As one of the lists is accompanied by a commentary, it is the easiest to follow, and requires only to be supplemented here and there from the other lists and from the Chinese sources, translated by Bushell and Rockhill. The first king, Gnya-khri btsan-po, is said to have been the fifth son of King Prasenajit of Kosala, and was born with obliquely drawn eyes. He fled north of the Himalayas into the Bod country, where he was elected king by the twelve chiefs of the tribes of southern and central Tibet. He took up his residence in the Yarlung country south of Lhasa. This Yarlung, which borrowed its name from the Yalung of the state of Fanni Tu-bat, is a river which flows into the Yaro-tsangpo (Brahmaputra). The first king and his six successors are known as the seven celestial *khri*; the next series consists of six kings known as the earthly *legs*; and they were followed by eight terrestrial *ldé*. This threefold succession is apparently an imitation or a debased form of the ancient legend of heavenly, earthly and human rulers, which was carried into Persia and China, and from the latter country into Japan and Tibet—the relative number of kings being altered in the last-named countries to suit local convenience and the small amount of truth which they contain. Whilst giving an Aryan descent to their first kings, the ancient Tibetans assigned to their princesses a divine origin, and called them *lhamo*, "goddess." The gynaecratic habits of the race are manifested in the names of all these kings, which were formed by a combination of those of their parents, the mother's generally preceding that of the father. The *ldé* kings were followed by four rulers simply called *btsan* ("mighty").

Then occurs a break in the lineal descent, and the king next in order (*c.* 461) may be the Tatar Fanni Tu-bat, but most probably his son and successor. His name was Lha-tho thori gnyan-tsan, otherwise Gnyan-tsan of Lha-tho thori, according to the custom usual in Tibet of calling great personages after the name of their birthplace. Lha-tho means "heaps of stones," and therefore appears to be a translation of Tsih-shih, "heapy stones," the country mentioned in connexion with the foundation of a state by Fanni Tu-bat. It was during his reign that the first Buddhist objects are reputed to have reached Tibet, probably from Nepal. Little is said of his three immediate successors. The fourth was gNam-ri srong btsan, who died in 630. During his reign the Tibetans obtained their first knowledge of arithmetic and medicine from China; the prosperity and pastoral wealth of the country were so great that "the king built his palace with cement moistened with the milk of the cow and the yak." To the same king is attributed the discovery of the inexhaustible salt mine called Chang-gi-tsa'wa (Byang-gi-tsa'wa = "northern salt"), which still supplies the greater portion of Tibet. The reign of his illustrious son, Srong tsan gam-po, opened up a new era; he introduced Buddhism and the art of writing from India, and was the founder (in 639) of Lha-ldan, afterwards Lha-sa. He was greatly helped in his proselytism by his two wives, one a Nepal princess, daughter of King Jyoti varma, the other an imperial daughter of China; afterwards, they being childless, he took two more princesses from the Ru-yong (= "left corner" ō) and Mōn (general appellative for the nations between Tibet and the Indian plains) countries. As a conqueror he extended his sway from the still unsubdued Kiang tribes of the north to Ladak in the west, and in the south he carried his power through Nepal to the Indian side of the Himalayas. How far southward this dominion at first extended is not known; but in 703 Nepal and the country of the Brahmans rebelled, and the Tibetan king, the third successor of Srong tsan gam-po, was killed while attempting to restore his power. It is rather curious that nothing is said of this Tibetan rule in India, except in the Chinese annals, where it is mentioned until the end of the monarchy in the 10th century, as extending over Bengal to the sea—the Bay of Bengal being called the Tibetan Sea. J. R. Logan has found ethnological and linguistic evidence of this domination, which was left unnoticed in the Indian histories. Mang-srong mang tsan, the second son and successor of Srong tsan gam-po, continuing the conquests of his father, subdued the Tukuhun Tatars around the Koko-Nor in 663, and attacked the Chinese; after some adverse fortune the latter took their revenge and penetrated as far as Lhasa, where they burnt the royal palace (Yumbu-lagang). Khri lde gtsug-brtan-mesag-ts'oms, the grandson of Mang-srong and second in succession from him, promoted the spread of Buddhism and obtained for his son, Jangts'a Lhapon, who was famous for the beauty of his person, the hand of the accomplished princess Kyimshang, daughter, otherwise *kung-chu*, of the Chinese emperor Juy- (? Tai) tsung. But the lady arrived after the death of her betrothed, and after long hesitation became the bride of the father. She gave birth in 730 to Khri srong lde tsan, in the Buddhist annals the most illustrious monarch of his country, because of the strenuous efforts he made in favour of that religion during his reign of forty-six years (743–789). His son and successor Muni tsan-po, being determined to raise all his subjects to the same level, enacted that there should be no distinction between poor and rich, humble and great. He compelled the wealthy to share their riches with the indigent and helpless and to make them their equals in respect of all the comforts and conditions of life. He repeated this experiment three times; but each time he found that they all returned to their former condition, the rich becoming still richer and the poor still poorer. The sages attributed this curious phenomenon to the good and evil acts of their former lives. Nothing of importance occurred during the following reigns, until that of Ralpachen, who won glory by his care for the translations of the Buddhist scriptures which he caused to be completed, or rewritten more accurately when required. In this reign a severe struggle took place with China, peace being concluded in 821 at Ch'ang-ngan and ratified at Lhasa the following year by the erection of bilingual tablets, which still exist. Ralpachen was assassinated by the partisans of Lang-dharma and the country fell into disorder. Lang-dharma instituted a violent persecution of Buddhism; but he was soon assassinated in his turn and the kingdom divided into a western and an eastern part by his two sons. The partition did not, however, prevent internecine wars. The history for some time now becomes rather intricate and requires some attention. Pal K'or tsan, the second western king, after a reign of thirteen years, died leaving two sons, Thi Tashi Tsegpa-pal and Thi Kyida Nyimagon. The latter went to Nari (Mngari) and founded the capital Purang; he left three sons, of whom the eldest declared himself king of Mang-yul, the second seized Purang, and the youngest, Detsud-gan, became king of the province of Shang-shung (the modern Gughè). The revival of Buddhism began with the two sons of the last-named, the elder of whom became a monk. The younger, Khorré, inherited his father's throne, and was followed in his authority by twenty successors. Tashi Tsegpa also had three sons—Palde, Hodde and Kyide. The descendants of the first made themselves masters of Gung-t'ang, Lugyalwa, Chyipa, Lhatse, Langlung and Tsakor, where they severally ruled as petty chiefs. The descendants of Kyide spread themselves over the Mu, Jang, Tanag, Yarulag and Gyaltse districts, where they also ruled as petty princes. Hodde left four sons—Phabdese, Thide, Thich-ung and Gnagpa. The first and fourth became masters of Tsan-grong, the second took possession of Amdo and Tsongkha, the third became king of Ü (or the central Lhassan province), and removed the capital to Yarlung, south of Lhasa. He was followed on his throne from son to son by eleven successors. History is silent as to the fate of the eastern king, the other son of Lang-dharma, and his successors, but the geographical names of the chieftainships enumerated above make it clear that the western kingdom had extended its power to the east. Chronology is deficient for all that period. While the dynasty of Khorré in Shang-shung and that of Thich'ung in Ü were running, another authority, destined to become the superior of both, had arisen in Tibet. Khorré left his throne to his son Lhade, who was himself succeeded by his three sons, the youngest of whom invited the celebrated Indian Buddhist, Atisha, to leave his monastery Vikramashila for Tibet, where he settled in the great lamaserai of Thoding in Nari. Besides religious books and teachings, he introduced in 1026 the method of computing time by cycles of sixty years, "obtained from the Indian province of Shambala." He was the first of the several chief priests whose authority became paramount in the country. The kings of Ü greatly patronized them, as for instance in the case of the celebrated Sakya Pandita by the seventh of these kings. Pandita, at the special request of Kuyuk, the successor of Ogdai, paid a visit to his court in 1246–1248. Five years afterwards Kublai Khan conquered all the east of Tibet; and, after he had ascended the throne of China, the Mongol emperor invited to his court Phagspa Lodoi Gyaltshan, the nephew of the same Pandita. He remained twelve years with the emperor, and at his request framed for the Mongol language an alphabet imitated from the Tibetan, which, however, did not prove satisfactory, and disappeared after eighty-five years without having been very largely used. In return for his services, Kublai invested Phagspa with sovereign power over (1) Tibet proper, comprising the thirteen districts of Ü and Tsang, (2) Khám and (3) Amdo. From this time the Sakya-pa lamas became the universal rulers of Tibet, and remained so, at least nominally, under twenty-one successive lamas during seventy years (1270–1340). Their name was derived from the Sakya monastery, which was their cradle and abode, and their authority for temporal matters was exercised by specially appointed regents. When the power of the Sakya began to wane, that of the rival monasteries of Digung, Phagdub and Tshal increased largely, and their respective influence and authority overbalanced that of the successors of Phagspa. It was at this troubled epoch that Chyang Chub Gyaltshan, better known as Phagmodu from the name of his native town, appeared on the scene. He subdued Tibet proper and Khám, for the continued possession of which he was, however, compelled to fight for several years; but he succeeded in the long run, and with the approval of the court of Peking established a dynasty which furnished twelve rulers in succession. When the Mongol dynasty of China passed away, the Mings confirmed and enlarged the dominion of the Tibetan rulers, recognizing at the same time the chief lamas of the eight principal monasteries of the country. Peace and prosperity gradually weakened the benign rule of the kings of this dynasty, and during the reign of the last but one internecine war was rife between the chiefs and nobles of Ü and Tsang. This state of things, occurring just as the last rulers of the Ming dynasty of China were struggling against the encroachments of the Manchus, their future successors, favoured the interference of a Khoshot Mongol prince, Tengir To, called in the Tibetan sources king of Koko Nor. The Mongols were interested in the religion of the lamas, especially since 1576, when Altan, khakan of the Tumeds, and his cousin summoned the chief lama of the most important monastery to visit him. This lama was Sodnam rGyamtso, the third successor of Gedundub, the founder of the Tashilhunpo monastery in 1447, who had been elected to the more important abbotship of Galdan near Lhasa, and was thus the first of the great, afterwards Dalai, lamas. The immediate successor of Gedundub, who ruled from 1475 to 1541, had appointed a special officer styled *depa* to control the civil administration of the country. To Sodnam rGyamtso the Mongol khans gave the title of Vajra Dalai Lama in 1576, and this is the first use of the widely known title of Dalai Lama. During the minority of the fifth (really the third) Dalai Lama, when the Mongol king Tengir To, under the pretext of supporting the religion, intervened in the affairs of the country, the Pan-ch'en Lo-sang Ch'o-kyi Gyal-ts'ang lama obtained the withdrawal of the invaders by the payment of a heavy war indemnity, and then applied for help to the first Manchu emperor of China, who had just ascended the throne. This step enraged the Mongols, and caused the advance of Gushri Khan, son and successor of Tengir To, who invaded Tibet, dethroned all the petty princes, including the king of Tsang, and, after having subjugated the whole of the country, made the fifth Dalai lama supreme monarch of all Tibet, in 1645. The Chinese government in 1653 confirmed the Dalai Lama in his authority, and he paid a visit to the emperor at Peking. The Mongol Khoshotes in 1706 and the Sungars in 1717 interfered again in the succession of the Dalai lama, but the Chinese army finally conquered the country in 1720, and the present system of government was established. It is probable that the isolation of Tibet was inspired originally by the Chinese, with the idea of creating a buffer state against European aggression from this direction.

Modern British and Russian Relations.

In 1872–1873 some attempt was made by Indian officials to open up trade with Tibet; further attempts followed in 1884, and in 1886 a mission was organized to proceed to Lhasa. The Chinese, however, although they had at first granted a passport to this mission, later objected to its advance, and it was abandoned. The Tibetans assumed this to show England's weakness; they invaded Sikkim, and in 1888 it was necessary to send a force under General Graham to expel them. In 1890 a treaty was concluded, and trade regulations under this treaty in 1893; but the negotiations were carried on with the Chinese authorities, and the lamas, considering themselves to have received insufficient recognition, repudiated them and offered further insults. A new development presently appeared in the situation. A lama, a Mongolian Buriat by birth and a Russian subject, whose Russianized name was Dorjiev, had come to Lhasa about 1880. When subsequently visiting Russia, he appears to have drawn the attention of the authorities towards Tibet as a field for their statecraft, and he established himself as the unofficial representative of Russia in Lhasa. He obtained a commanding influence over the Dalai Lama, impressed upon him the dangers which threatened Tibet from England, and suggested the desirability of securing Russian protection and even the possibility of converting the tsar and his empire to Buddhism. The Dalai Lama assented, and was even prepared to visit St Petersburg, but was checked by the Tsong-du (assembly). He therefore sent a representative of high rank, who had audience of the tsar, and returned with proposals for a treaty and for the residence of a Russian royal prince in Lhasa in order to promote friendly relations. But both the Chinese authorities in Lhasa and the Tsong-du were averse from any such proceedings. The Dalai Lama, inspired by Dorjiev, now took steps to bring on a crisis by provoking England. He felt sure of Russian support. Russian arms had been imported into Lhasa. It was suspected, although denied, that a treaty was in draft under which Russia should assume the suzerainty of Tibet. A further encroachment on

British territory in Sikkim was made by Tibetans, and various other slights were offered.

The viceroy of India, Lord Curzon, now decided that strong action was necessary; but the home government at first assented only to the despatch of Colonel (afterwards Sir) F. E. Younghusband with a small escort to negotiate at Khambajong, to the north of the Sikkim frontier. The mission arrived at this point on the 7th of July 1903, and here it remained till the 11th of December. No responsible Tibetan representatives appeared, and such negotiations as were carried on were abortive. On the 3rd of October, therefore, the British government authorized the occupation of the Chumbi valley, and an advance to Gyantse in Tibet and military preparations, with the difficult attendant problem of transport, were undertaken. Colonel Younghusband again accompanied the mission, and the troops were commanded by General Ronald Macdonald. The Jelep pass was crossed and the entry into Tibet effected on the 12th of December. An advance was made to Tuna, where part of the expedition wintered. A further advance being made on the 31st of March 1904, the first hostile encounter took place at Guru, when the Tibetans (the aggressors) were defeated. With some further fighting *en route* the expedition reached and occupied Gyantse on the 12th of April; here some of the British forces were subsequently beleaguered, and the most serious fighting took place. In fact the advance to Lhasa, resumed after the storming of the Gyantse *jong* (fort) on the 6th of July, met with comparatively little opposition, and the capital was reached on the 3rd of August. The Dalai Lama had fled with Dorjiev. Partly on this account, and in spite of the attempts of the Chinese authorities to bring about a settlement, there was some delay owing to the attitude of the lamas, but finally a treaty of peace was concluded on the 7th of September. The principal provisions were—the Sikkim frontier violated by the Tibetans was to be respected; marts were to be established for British trade at Gyantse, Gartok and Yatung; Tibet was to pay an indemnity of £500,000 (subsequently reduced to one-third of this sum); and no foreign power was to receive any concession in Tibet, territorial or mercantile, or to concern itself with the government of the country. The expedition left Lhasa on the 23rd of September and reached India again at the close of the following month. The treaty was slightly modified later in matters of detail, while the adhesion of China to the treaty was secured by an agreement of the 27th of April 1906.

British Armed Mission, 1904.

The Anglo-Russian convention of 1907 determined the following conditions with respect to Tibet—the recognition of the suzerain rights of China and the territorial and administrative integrity of the country; that no official representative at Lhasa should be appointed either by England or by Russia, and that no concessions for railways, mines, &c., should be sought by either power. An annex to the convention provided that, except by arrangement between England and Russia, no scientific expedition should be allowed to enter the country for three years.

In January 1908 the final instalment of the Tibetan indemnity was paid to Great Britain, and the Chumbi valley was evacuated. The Dalai Lama was now summoned to Peking, where he obtained the imperial authority to resume his administration in place of the provisional governors appointed as a result of the British mission. He retained in office the high officials then appointed, and pardoned all Tibetans who had assisted the mission. But in 1909 Chinese troops were sent to operate on the Sze-ch'uen frontier against certain insurgent lamas, whom they handled severely. When the Dalai Lama attempted to give orders that they should cease, the Chinese *amban* in Lhasa disputed his authority, and summoned the Chinese troops to enter the city. They did so, and the Dalai Lama fled to India in February 1910, staying at Darjeeling. Chinese troops followed him to the frontier, and he was deposed by imperial decree. The British government, in view of the apparent intention of China to establish effective suzerainty in Tibet, drew the attention of the government at Peking to the necessity of strictly observing its treaty obligations, and especially pointing out that the integrity of the frontier states of Nepal, Bhutan and Sikkim must be respected. To the Dalai Lama, who had attempted to obtain British intervention at Peking, it was made clear that he personally had no claim to this, as the British government could only recognize the *de facto* government in Tibet.

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(T. de L.; L. A. W.; O. J. R. H.)

TIBETO-BURMAN LANGUAGES. The Tibeto-Burman family comprises a long series of dialects spoken from Tibet in the north to Burma in the south, and from the Ladákh wazárat of Kashmir in the west to the Chinese provinces of Sze-ch'uen and Yünnan in the east. In the first place we have the various Tibetan dialects, spoken all over Tibet and in the neighbouring districts of India and China. Another series of dialects, the Himalayan group, is spoken in the southern Himalayas, from Lahul in the west to Bhutan in the east. Some of these dialects approach Tibetan in structure and grammatical principles, while others have struck out new lines of development, probably under the influence of the dialects spoken by an older population. East of Bhutan, to the north of the Assam valley, we find a third small group, the North Assam group, which consists of three dialects. A fourth group, the Bodo group, can be followed in a series of dialects from Bhutan in the north to the Tippeera state in the south. They have at one time extended over most of Assam west of Manipur and the Nāgā hills, and even far into Bengal proper. To the west of the Bodos, in and in the neighbourhood of the Nāgā hills we find a fifth group, the so-called Nāgā group. It comprises dialects of very different kinds. Some of them approach Tibetan and the dialect of the North Assam group. Others lead over to the Bodo languages, and others again connect the Nāgā dialects with their Tibeto-Burman neighbours to the south and east. To the south of the Nāgā hills, in the long chain of hills extending southwards under various names such as the Lushai hills, the Chin hills and the Arakan Yoma, we find a sixth group, the Kuki-Chin dialects. The old Meitei language of Manipur lies midway between this group and the easternmost branch of the Tibeto-Burman family, the Kachin group. The Kachins inhabit the tract of country to the east of Assam and to the north of Upper Burma, including the headwaters of the

Chindwin and the Irrawaddy. The Kachins have not as yet settled down, and are still pushing southwards. The Kachins and the Kuki-Chins gradually and finally merge into Burmese, the language of the ancient kingdom of Burma.

It is impossible to bring the relationship existing between all these various groups under one single formula. The dialects spoken in the Himalayas and in Assam can be described as a double chain connecting Tibetan with Burmese, which are the two principal languages of the family. In the first place the Kachin group runs from the easternmost Tibetan dialects in Sze-ch'uen down to the Burmese of Upper Burma. The second chain has a double beginning in the north. We can trace one line through the North Assam group, the Nāgā, Bodo and Kuki-Chin groups. Another line can be followed from Tibetan through the Himalayan and Bodo groups into Kuki-Chin. The latter dialects finally merge into Burmese.

The original home of the Tibeto-Burman race seems to have been on the Upper Hwangho and the Upper Yangtsze-kiang in the Chinese provinces of Sze-ch'uen and Yünnan. The oldest invaders followed the Tsangpo into Tibet and became the Tibetans of the present day. Other hordes crossed the Brahmaputra and settled in the hills on the southern slopes of the Himalaya range. From the headwaters of the Irrawaddy and the Chindwin successive waves entered Assam and Further India. Some followed the course of the Brahmaputra and settled in the hills to the south and east of the great bend of the river. Others entered the Nāgā hills, while numerous tribes must have followed the Chindwin into Manipur and the hills to the south. The inhabitants of Burma have probably come down along the Chindwin and the Irrawaddy, and the latest immigrants, the Kachins, have only in modern times begun their wanderings southwards through the hills. The tribes settled in the hills north of the Assam valley appear to possess a mixed character. Their home can be considered as a kind of backwater which has been overflowed by the waves of successive invasions.

In their original home the Tibeto-Burmans were the neighbours of Chinese and Tai tribes. Their languages are also closely related to Chinese and Tai, more closely to the former than to the latter. The agreement is apparent in the phonetical system, in vocabulary and in grammar. The principal point in which they differ is the order of words. The Tibeto-Burman family arranges the words of a sentence in the order of subject, object, verb, while the order in Chinese and Tai is subject, verb, object. Together all these languages form one great family, which is usually called Indo-Chinese.

The Indo-Chinese family is usually considered as a typical instance of the so-called isolating languages. The single words do not consist of more than one syllable. They are incapable of inflexion because there are no form-words, which merely denote relation in time and space. Grammatical relations are therefore not indicated by inflexion, but simply by putting together, according to fixed rules, words of which each retains its independence. Thus a sentence such as "the father struck the boy" would be translated "father agent son striking completion." This state of affairs, which is the prevailing condition in Chinese, is not, however, the original one. While the bases of the words are monosyllabic, *i.e.* each word consists of one syllable, comparative philology shows that these bases were often preceded by prefixes, short additions, the meaning of which cannot always be ascertained, but which modified the meaning of the base in the same way as the terminations of other languages. Such prefixes were not accented, and in the course of time they were commonly reduced and often dropped altogether, so that each word (*i.e.* the prefix plus base) itself came to be monosyllabic. Such words were then pronounced in a higher tone, and this gave rise to the development of a complicated system of tones in Chinese, Tai and some Tibeto-Burman languages. The existence of old prefixes can therefore still be inferred from the tones.

This development can still be followed in the Tibeto-Burman languages. They have, to some extent, retained the old prefixes. This is, for example, the case in Old Tibetan and some modern Tibetan dialects, while the prefixes have been dropped in the modern dialect of Central Tibet. Compare Old Tibetan *b-dun*, Balti *ab-dun*, but Central Tibetan *dün*, seven. The connexion between the dropping of prefixes and the development of tones can be seen from the fact that Balti, which has, to some extent, preserved the prefixes, is devoid of tones, while Central Tibetan has developed a system of tones corresponding to that prevailing in Chinese. The same is the case with Kachin and some Nāgā dialects, while the remaining Tibeto-Burman languages apparently agree with such Tibetan dialects as are devoid of tones. The development of tones in many dialects was probably counteracted by the influence of the speech of the former inhabitants whom the Tibeto-Burman found in possession of the country when they invaded their present habitat. Remnants of such old inhabitants are still found in the Khasi hills of Assam, in the midst of the Tibeto-Burman territory. Traces of the speech of an old, non-Tibeto-Burman population, can also be found in some dialects belonging to the Himalayan group.

Through the dropping of old prefixes several different words coincided in form. The same result was effected by another tendency, which is apparent in all Indo-Chinese languages, viz. to harden soft consonants. Thus Tibetan *ba*, cow, is often pronounced *bha* and *pa*. The confusion which might arise from this double tendency is counteracted by the system of tones and the fixed rules for the order of words.

The vocabulary is richly varied. Thus the different varieties of some animal are often denoted by separate words. On the other hand, there are few general terms or such as denote abstract ideas.

All these features of Tibeto-Burman speech tend to make the difference between the dialects considerable, and the changes within one and the same dialect bewildering. Instances are said to be on record where one small tribe has changed its language in the course of a couple of generations so as to be unrecognizable. This fact, if fact it be, can however be accounted for by assuming that the male individuals in question have robbed their wives from some other tribe. At all events, the changes are not so important in cases where we are able to compare the existing vocabulary of a tribe with words noted down, say, a century ago.

The different classes of words are not clearly distinguished, and many instances occur in which a word can be used at will as a noun, as an adjective or as a verb. The verb can, on the whole, be described as a noun of action, and we find phrases such as "my going is" instead of "I go." Inflexion is often effected by isolation. Thus gender is commonly denoted by adding words meaning "male," "female," respectively; number is indicated by means of numerals and words meaning "many," "heap"; and there is no relative pronoun and no clear distinction between the various verbal tenses. Many of the words added in order to indicate relation in time, space, &c., have, however, ceased to be used as separate words, and have become what can for all practical purposes be called case and tense affixes. The inflexion is therefore at the present date, to a great extent, effected by agglutination, *i.e.* by adding modifying particles to the base, which itself remains unchanged. Such particles are only put once if there are more than one word put together in the same relation. Thus an adjective and a qualified noun only takes one "case-suffix." Several dialects have in this way developed a complicated system of grammatical forms, partly perhaps under the influence of non-Tibeto-Burman languages.

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TIBIA, a pipe played by means of a reed mouthpiece, extensively used in classic Rome. The tibia, often mistranslated "flute," was identical with the aulos of the Greeks, and according as it was made with a cylindrical or with a conical bore, it may be regarded as the prototype of our clarinet or oboe. The tibia was used at musical contests, in the theatre, in the arena, at banquets, &c. A set of ivory tibiae of cylindrical bore found at Pompeii in a good state of preservation are in the museum at Naples.

TIBULLUS, ALBIUS (*c.* 54–19 B.C.), Latin elegiac poet. The information which we possess about him is extremely meagre. Besides the poems themselves—that is to say, the first and second books—we have only a few references in later writers and a short *Life* of doubtful authority. We do not know his praenomen; his gentile name has been questioned; nor is his birthplace ascertained. His station was not improbably that of a Roman knight (so the *Life* affirms); and he had inherited a very considerable estate. But, like Virgil, Horace and Propertius, he seems to have lost the greater part of it in 41 amongst the confiscations which Antony and Octavian found expedient to satisfy the rapacity of their victorious soldiery. Tibullus's chief friend and patron was M. Valerius Messalla Corvinus, himself an orator and poet as well as a statesman and a commander. Messalla, like Maecenas, was the centre of a literary circle in Rome; but the bond between its members was that of literature alone. They stood in no relations to the court; and the name of Augustus is not once to be found in the writings of Tibullus. About 30 B.C. Messalla was despatched by Augustus to Gaul to quell a rising in Aquitania and restore order in the country, and Tibullus may have been in his retinue. On a later occasion, probably in 28, he would have accompanied his friend who had been sent on a mission to the East, but he fell sick and had to stay behind in Corcyra. Tibullus had no liking for war, and though his life seems to have been divided between Rome and his country estate, his own preferences were wholly for the country life. His first love, the subject of book i., is called Delia in the poems, but we learn from Apuleius (*Apol.* 10) that her real name was Plania. Delia seems to have been a woman of middle station. It is impossible to give an exact account of the intimacy. The poems which refer to her are arranged in no chronological order. Now she appears as single, now as married; but we do not hear anything either of her marriage or of her husband's death. It is clear, however, that it was the absence of her husband on military service in Cilicia which gave Tibullus the opportunity of making or renewing the acquaintance. It was not dropped when he returned. It was not difficult to deceive the simple soldier; and Delia was an apt pupil in deception—too apt, as Tibullus saw with dismay when he found that he was not the only lover. His entreaties and appeals were of no avail; and after the first book we hear no more of Delia. In the second book the place of Delia is taken by Nemesis, which is also a fictitious name. Nemesis (like the Cynthia of Propertius) was a courtesan of the higher class; and she had other admirers besides Tibullus. He complains bitterly of his bondage, and of her rapacity and hardheartedness. In spite of all, however, she seems to have retained her hold on him until his death. Tibullus died prematurely, probably in 19, and almost immediately after Virgil. His death made a deep impression in Rome, as we learn from his contemporary Domitius Marsus and from the elegy in which Ovid (*Amores*, iii. 19) has enshrined the memory of his predecessor.

The character of Tibullus is reflected in his poems. Though not an admirable it is certainly an amiable one. He was a man of generous impulses and a gentle unselfish disposition. He was loyal to his friends to the verge of self-sacrifice, as is shown by his leaving Delia to accompany Messalla to Asia, and constant to his mistresses with a constancy but ill deserved. His tenderness towards them is enhanced by a refinement and delicacy which are rare among the ancients. Horace and the rest taunt the cruel fair with the retribution which is coming with the years. If Tibullus refers to such a fate, he does it by way of warning and not in any petty spirit of triumph or revenge. Cruelly though he may have been treated by his love, he does not invoke curses upon her head. He goes to her little sister's grave, hung so often with his garlands and wet with his tears, and bemoans his fate to the dumb ashes there. Tibullus has no leanings to an active life: his ideal is a quiet retirement in the country with the loved one at his side. He has no ambition and not even the poet's yearning for immortality. As Tibullus loved the country life so he clung to its faiths, and in an age of crude materialism and the grossest superstition, he was religious in the old Roman way. As a poet he reminds us of Collins and Longfellow. His clear, finished and yet unaffected style made him a great favourite with his countrymen and placed him, in the judgment of Quintilian, at the head of their elegiac writers. And certainly within his own range he has no Roman rival. For natural grace and tenderness, for exquisiteness of feeling and expression, he stands alone. He has far fewer faults than Propertius, and in particular he rarely overloads his lines with Alexandrian learning. But, for all that, his range is limited; and in power and compass of imagination, in vigour and originality of conception, in richness and variety of poetical treatment, he is much his rival's inferior. The same differences are perceptible in the way the two poets handle their metre. Tibullus is smoother and more musical, but liable to become monotonous; Propertius, with occasional harshnesses, is more vigorous and varied. It may be added that in many of Tibullus's poems a symmetrical composition can be traced, although the symmetry must never be forced into a fixed and unelastic scheme.

It is probable that we have lost some of the genuine poems of Tibullus. On the other hand, much has come down to us under his name which must certainly be assigned to others. Only the first and second books can claim his authorship. The first book consists of poems written at various times between 30 and 26. About the second book we can only say that in all likelihood it was published before the poet's death in 19. It is very short, containing only 428 verses, and apparently incomplete. In both books occur poems which give evidence of internal disorder; but scholars cannot agree upon the remedies to be applied.

The third book, which contains 290 verses, is by a much inferior hand. The writer calls himself Lygdamus and the fair that he sings of Neaera. He was born in the same year as Ovid, but there is nothing Ovidian about his work. He has little poetical power, and his style is meagre and jejune. He has a good many reminiscences and imitations of Tibullus and Propertius; and they are not always happy. The separation of the fourth book from the third has no ancient authority. It dates from the revival of letters, and is due to the Italian scholars of the 15th century. The fourth book consists of poems of very different quality. The first is a composition in 211 hexameters on the achievements of Messalla, and is very poor. The author is unknown; but he was certainly not Tibullus. The poem itself was written in 31, the year of Messalla's consulship. The next eleven poems relate to the loves of Sulpicia and Cerinthus. Sulpicia was a Roman lady of high station and, according to Haupt's probable conjecture, the daughter of Valeria, Messalla's sister. She had fallen violently in love with Cerinthus, about whom we know nothing but what the poet tells us, and he soon reciprocated her feelings. The Sulpicia elegies divide into two groups. The first comprises iv. 2–6, containing ninety-four lines, in which the theme of the attachment is worked up into five graceful poems. The second, iv. 8–12 (to which 7 should be added), consists of Sulpicia's own letters. They are very short, only forty lines in all; but they have a unique interest as being the only love poems by a Roman woman that have escaped the ravages of time. Their frank and passionate outpourings remind us of Catullus. The style and metrical handling betray a novice in poetical writing. The thirteenth poem (twenty-four lines) claims to be by Tibullus; but it is hardly more than a cento from Tibullus and Propertius. The fourteenth is a little epigram of four lines with nothing to determine its authorship. Last of all comes the epigram or fragment of Domitius Marsus already referred to. To sum up: the third and fourth books appear in the oldest tradition as a single book, and they comprise pieces by different authors in different styles, none of which can be assigned to Tibullus with any certainty. The natural conclusion is that we have here a collection of scattered compositions, relating to Messalla and the members of his circle, which has been added as an appendix to the genuine relics of Tibullus. When this "Messalla collection" was made cannot be exactly determined; but it was not till after the death of Tibullus, 19 B.C., and probably between 15 and 2 B.C. Besides the foregoing, two pieces in the collection called *Priapea* (one an epigram and the other a longer piece in iambics) have been attributed to Tibullus; but there is little external and no internal evidence of his authorship (see Hiller in *Hermes*, xviii. 343–349).

The value of the short *Vita Tibulli*, found at the end of the Ambrosian, Vatican and inferior MSS., has been much discussed. There is little in it that we could not at once infer from Tibullus himself and from what Horace says about Albius, though it is possible that its compiler may have taken some of his statements from Suetonius's book *De poetis*. It is as follows: "Albius Tibullus eques R. (R. being the customary abbreviation for *Romanus*, the MSS. have the corruption *regalis*), insignis forma cultuque corporis observabilis, ante alios Corvinum Messalam Oratorem (MSS. *Or.*, *i.e. oratorem*) ingenue (MSS. *iginem*) dilexit, cuius et contubernalis Aquitanico bello militaribus donis donatus est. Hic multorum iudicio principem inter elegiographos optinet locum. Epistulae quoque eius, quamquam breves, omnino utiles sunt (the "letters" are the Sulpicia elegies). Obiit adulescens, ut indicat epigramma superscriptum" (*i.e.* the one ascribed to Domitius Marsus. These words seem to be a later addition to the *Life*). It is another moot question of some importance whether our poet should be identified with the Albius of Horace (*Od.* i. 33; *Epist.* i. 4), as is done by the Horatian commentator Porphyrio (A.D. 200–250) in his *Scholia*. Porphyrio's view has been most recently examined by Postgate (*Selections from Tibullus*, appendix A). If it is rejected, the authority of the *Life* is considerably impaired.

Ovid, *Trist*, iv. 10, 53 seq., "successor fuit hic [Tibullus] tibi, Galle, Propertius illi, quartus ab his serie temporis ipse fui." In the preceding couplet he had said, "Vergilium vidi tantum nec amara Tibullo tempus amicitiae fata dedere meae." Ovid, who was born in 43, would be only twenty-four at Tibullus's death if it occurred in 19. The loss of Tibullus's landed property is attested by himself (i. 1, 19 seq.), "Felicis quondam, nunc pauperis agri custodes" (cf. 41, 42). Its cause is only an inference, though a very probable one. That he was allowed to retain a portion of his estate with the family mansion is clear from ii. 4, 53. Tibullus may have been Messalla's *contubernalis* in the Aquitanian War (*Vita Tib.* and *Tib.* i. 7, 9 seq., a poem composed for Messalla's triumph), and may have received *militaria dona* (*Vita*).

Delia's name (from δῆλος) is a translation of Plania. As regards her station, it should be noticed that she was not entitled to wear the *stola*, the dress of Roman matrons (i. 6, 68). Her husband is mentioned as absent (i. 2, 67 seq.). She eludes the *custodes* placed over her (i. 2, 15 and 6, 7). Tibullus's suit was favoured by Delia's mother, of whom he speaks in very affectionate terms (i. 6, 57 seq.). For Tibullus's illness at Corcyra, see i. 3, 1 seq., 55 seq. The fifth elegy was written during estrangement (*discidium*), and the sixth after the return of the husband and during Delia's double infidelity.

Ovid, writing at the time of Tibullus's death (*Am.* iii. 9, 31), says: "Sic Nemesis longum, sic Delia, nomen habebunt, altera cura recens, altera primus amor." Nemesis is the subject of book ii. 3, 4, 6. The mention of a *lena* (ii. 6) settles her position. The connexion had lasted a year when ii. 5 was written (see ver. 109). It is worth noticing that Martial selects Nemesis as the source of Tibullus's reputation (viii. 73, 7; cf. xiv. 193).

Specimens of Tibullus at his best may be found in i. 1, 3, 89–94; 5, 19–36; 9, 45–68; ii. 6. Quintilian says (*Inst.* x. 1, 93), "Elegia quoque Graecos provocamus, *cuius mihi tersus atque elegans maxime videtur auctor Tibullus*; sunt qui Propertium malint; Ovidius utroque lascivior, sicut durior Gallus."

Charisius (pp. 66 and 105) quotes part of a hexameter which is not found in the extant poems of Tibullus.

Lygdamus is probably the real name of the author of the first six elegies in book iii., but little further is known about him. His elegies and the other poems in the third book ("third" and "fourth" books) appear to have been known to Ovid. There are agreements between iii. 5, 15–20, and three passages of Ovid, *Ars. am.* ii. 669 seq.; *Tr.* iv. 10, 6: "cum cecidit fato consul uterque pari" (Lygdamus and Ovid using word for word the same expression for the year of their birth, the consulship of Hirtius and Pansa) and *Am.* xi. 14, 23 seq., much too close to be accidental. We do not know when they were added to the genuine poems of Tibullus.

Most scholars since Lachmann have condemned the "Panegyric on Messalla." It is an inflated and at the same time tasteless declamation, entirely devoid of poetical merit. The language is often absurdly exaggerated, *e.g.* 190 seq. The author himself seems to be conscious of his own deficiencies (1 seq., 177 seq.). Like so many of his contemporaries, he had been reduced to poverty by the loss of his estates (181 seq.). If we could set the question of poetical merit aside, it would not be impossible to identify him with Propertius as in fact is done by Némethy (*op.* cited below). The date is fixed by 121 seq. Sulpicia was the daughter of Servius Sulpicius (iii. 16 = iv. 10, 4), and she seems to have been under the tutelage of Messalla, her uncle by marriage (Haupt, *Opuscula*, iii. 502 seq.).

Some scholars attribute iii. 8–12 = iv. 2–6 to Tibullus himself; but the style is different, and it is best to answer the question, as Bährens does, with a *non liquet*.

The direct ascription of iii. 19 = iv. 13 (verse 13, "nunc licet e caelo mittatur amica Tibullo") to Tibullus probably led to its inclusion in the collection and later on to the addition of the third book to the two genuine ones. For the evidence against the ascription, see Postgate, *Selections*, app. C.

Manuscripts.—The two best MSS. of Tibullus are the Ambrosianus (A), of date about 1374, and the Vaticanus (V), of the 15th century. Besides these we have a number of extracts from Tibullus in *Florilegium Parisinum*, an anthology from various Latin writers which probably goes back to the 11th century, and the *Excerpta frisingensia*, preserved in an 11th-century MS. now at Munich, unfortunately very few in number. Also excerpts from the lost *Fragmentum cuiacianum*, made by Scaliger, and now in the library at Leiden. It only contained the part from iii. 4, 65 to the end. The *Codex cuiacianus*, a late MS. containing Catullus, Tibullus and Propertius, is still extant.

Editions.—Tibullus was first printed with Catullus, Propertius, and the *Silvae* of Statius by Vindelinus de Spira (Venice, 1472), and separately by Florentius de Argentina, probably in the same year. Amongst other editions we may mention those by Scaliger (with Catullus and Propertius, 1577, &c.), Broukhusius (1708), Vulpius (1749), Heyne (1817, 4th ed. by Wunderlich, with supplement by Dissen, 1819), Huschke (1819), Lachmann (1829), Dissen (1835). Among more recent texts Bährens (1878, the first of the modern critical editions), L. Müller (1880, with a useful introduction), Hiller (1885, with index verborum), Postgate (1905). Of the commentaries Heyne's, Huschke's and Dissen's are still of value. The most recent (with Latin notes) is Némethy's (1905–1906). The greater part of the poems are included in Postgate's *Selections* (with English notes, 1903). For further information see the accounts in Teuffel's *History of Roman Literature* (translated by Warr), Schanz's *Geschichte der römischen Litteratur*, and Marx's article *s.v.* "Albius," in Pauly-Wissowa's *Realencyclopädie*. A history of recent contributions is given in A. Cartault's *A propos du corpus Tibullianum* (1906; not quite complete); see also his *Tibulle et les auteurs du Corpus Tibullianum* (Paris, 1909). The following translations into English verse are known—by Dart (London, 1720), Grainger (1739, with Latin text and notes), Cranstoun (1872). *An Essay towards a New Edition of the Elegies of Tibullus, with a Translation and Notes* (London, 1792), contains only i. 1 and 7, 29–48. C. A. Elton's *Specimens of the Classic Poets* (London, 1814; xii. 141–171) contains i. 1; ii. 4; iii. 2–4; 6, 33 to end; iv. 2, 3. To these should probably be added *Tibullus, with other Translations from Ovid, Horace*, &c., by Richard Whiffin (London, 1829). Cranstoun's is the only complete version of merit; but it is far inferior to the translations by Elton. (J. P. P.)

TIBUR (mod. Tivoli, *q.v.*), an ancient town of Latium, 18 m. E.N.E. of Rome by the Via Tiburtina (see TIBURTINA, VIA). It is finely situated at the point where the Anio forms its celebrated falls; it is protected on the E., N., and N.W. by the river and it commands the entrance to its upper course, with an extensive view over the Campagna below. The modern town is in part built upon the terraces of a large temple of Hercules Victor, the chief deity of Tibur, of which some remains exist: many small votive objects in terra-cotta were found in the gorge of the Anio below the town on the north-west in 1898. Below it, on the cliffs above the Anio, is a large building round a colonnaded courtyard in *opus reticulatum* built over the Via Tiburtina (which passes under it in an arched passage), generally known as the villa of Maecenas, but shown by the discovery of inscriptions to have been in reality the meeting place of the Herculanei Augustales, connected probably with the temple.

In an ancient hall at one side of the modern cathedral two *mensae ponderariae*—marble tables with holes in them for measuring solids—erected by one M. Varenus Diphilus, a freedman, a *magister herculaneus*, were found *in situ* in 1883, and in 1902 two vases of statues erected by Diphilus, as inscriptions showed, in honour of his patron, and a bas-relief of a bearded Hercules entirely draped in a long tunic with a lion's skin on his shoulders.

Remains of two small temples—one circular, with Corinthian columns, the other rectangular with Ionic columns—stand at the north-east extremity of the town, above the waterfalls. They are traditionally, but without foundation, attributed to Vesta and the Sibyl of Tibur (Varro adds Albunea, the water goddess worshipped on the banks of the Anio as a tenth Sibyl to the nine mentioned by the Greek writers.

The so-called Tempio della Tosse, an octagonal domed structure just below the town, is probably a tomb of the 4th century A.D. Two Roman bridges and several tombs were found above the falls in 1826.

Tibur was a favourite place of resort in Roman times, and both Augustus and Maecenas had villas here, and possibly Horace also. It is certain that a house was shown as being his in the time of Suetonius; and this has been identified with a villa of the Augustan period, the site of which is now occupied by the monastery of S. Antonio. In his poems he frequently mentions Tibur with enthusiasm. Catullus and Statius, too, have rendered it famous by their poems. The abundance of water from aqueducts and springs and the falls of the Anio were among its chief attractions. The remains of villas in the district are numerous and important (see T. Ashby in *Papers of the British School at Rome*, iii.). The largest is that of Hadrian, situated in the low ground about 2 m. to the south-west of Tibur, and occupying an area of some 160 acres. The remains are extensive and well preserved, though the identifications of the existing buildings with those mentioned by Spartianus who records that Hadrian gave to them the names of various well-known edifices at Athens and elsewhere, cannot in most cases be treated as certain. A large number of statues have been found in the villa, and costly foreign marbles and fine mosaic pavements, some of the last being preserved *in situ*, while among others may be named the mosaic of the doves in the Capitol and that of the masks in the Vatican. Of the fresco and stucco decorations of the walls and ceilings, less is naturally preserved. Excavations have gone on since the 16th century, the last having been carried on by the Italian government to which the greater part of the site now belongs: but little has been done since 1884.[1]

The ancient Tibur was founded, according to tradition, by Tiburtus, Corax and Catillus, grandsons of Amphiaraus. Though on the edge of the Sabine mountains, it was a member of the Latin League. There are remains of ancient roads and outlying forts in its territory dating from the period of its independence. It allied itself with the Gauls in 361 B.C., and in the war which followed the towns of Empulum and Saxula were destroyed (their sites are unknown) and triumphs over Tibur were celebrated in 360 and 354 B.C., and again in 338, when its forces were defeated, with those of Praeneste. It did not, however, lose its independence, but became an ally of Rome, as is shown by an inscription, probably of the 2nd century B.C., in which it is recorded that the ambassadors of Tibur successfully cleared themselves before the Roman senate of a suspicion that they were acting contrary to their treaty with Rome. It acquired Roman citizenship in 90 B.C., though some of its citizens gained the franchise previously. Syphax, king of Numidia, died in the territory of Tibur as a captive in 201 B.C.; and in A.D. 273 Zenobia, queen of Palmyra, was assigned a residence here by Aurelian. Its prosperity during the imperial period was mainly due to the favour in which it stood as a summer resort. During the siege of Rome by Narses, Belisarius occupied Tibur: it was afterwards treacherously surrendered to Totila, whose troops plundered it, but who rebuilt it in A.D. 547.

See H. Dessau in *Corp. inscript. latin.* xiv. 365 sqq. and reff. (Berlin, 1887); *Notizie degli scavi*, passim. (T. As.)

TIBURTINA, VIA, an ancient road of Italy, leading E.N.E. from Rome to Tibur, a distance of about 18 m. It must have come into existence, as a track at any rate, during the establishment of the Latin League. Though it afterwards became an important thoroughfare, the first portion of it always retained its original name, that of Via Valeria (see VALERIA, VIA) being applied only to the portion of the road beyond Tibur. The road is in the main followed by a modern highroad. There is, however, a difficulty about the last portion of its course from the Albulae Aquae (*q.v.*) to Tibur; whereas, according to the milestones and itineraries, it should be 20 m. from Rome to Tibur, it is impossible to make the distance more than 18 m. along any probable line.

See T. Ashby in *Papers of the British School at Rome*, iii. 84 sqq. (T. As.)

TICHBORNE CLAIMANT, THE. Roger Charles Tichborne (1829–1854), whose family name became a household word on account of an attempt made by an impostor in 1868 to personate him and obtain his heritage, was the eldest grandson of Sir Edward Tichborne, the 9th baronet, of a very ancient Hampshire family. Sir John de Tichborne, sheriff of Southampton, was created a baronet by James I. in 1621, and from him his descendants inherited great wealth and the position of one of the leading Roman Catholic families in the south of England. Roger Charles, born at Paris on the 5th of January 1829, was the eldest son of James Francis Doughty-Tichborne (who subsequently became 10th baronet and died in 1862) by Henriette Felicité, natural daughter of Henry Seymour of Knoyle, in Wiltshire. This lady, who hated England, was intent upon bringing up her son as a Frenchman; the result was that he got hardly any education until he went in 1846 to Stonyhurst, whence he proceeded in 1849 to Dublin and joined the 6th Dragoon Guards. His eccentricity and his French accent made him a butt in his regiment, and, being disappointed of war service, he sold out in 1852, and in the following year proceeded on a trip to South America. He sailed in March 1853 from Havre for Valparaiso, whence he crossed the Andes, reaching Rio de Janeiro in 1854. In April of that year he sailed from Rio in the "Bella" and was lost at sea, the vessel foundering with all hands. His insurance was paid and his will proved in July 1855. The baronetcy and estates passed in 1862 to Roger's younger brother, Sir Alfred Joseph Doughty-Tichborne, who died in 1866. The only person unconvinced of Roger's death was his mother the dowager Lady Tichborne, from whom every tramp-sailor found a welcome at Tichborne Park. She advertised largely and injudiciously for the wanderer, and in November 1865 she learnt, through an agency in Sydney, that a man "answering to the description of her son" had been found in the guise of a small butcher at Wagga Wagga, in Queensland. As a matter of fact, the supposed Sir Roger did not correspond at all to the lost heir, who was slim, with sharp features and straight black hair, whereas the claimant was enormously fat, with wavy, light-brown hair. His first letter to Lady Tichborne was not only ignorant and illiterate, but appealed to circumstances (notably a birth-mark and an incident at Brighton) of which she admitted that she had no recollection. But so great was her infatuation with her fixed idea, that she soon overcame the first qualms of distrust and advanced money for the claimant to return to Europe. Like all pretenders, this one was impelled by his entourage, who regarded him in the light of an investment. He himself was reluctant to move, but the credulity of persons under the influence of a romantic story soon came to his aid. Thus an old friend of Sir James Tichborne's at Sydney, though puzzled by the claimant's answers, was convinced by a resemblance to his supposed father. At Sydney, too, he made the acquaintance of Bogle, a negro servant of a former baronet. Bogle sailed with him from Sydney in the summer of 1866, and coached him in the rudiments of the rôle which he was preparing to play. On reaching London on Christmas Day 1866 the claimant paid a flying visit to Tichborne House, near Alresford, where he was soon to obtain two important allies in the old family solicitor, Edward Hopkins, and a Winchester antiquary, Francis J. Baigent, who was intimately acquainted with the Tichborne family history. He next went over to Paris, where in an hotel bedroom on a dark January afternoon he was promptly "recognized" by Lady Tichborne. This "recognition" naturally made an enormous impression upon the English public, who were unaware that Lady Tichborne was a monomaniac. That such a term is no exaggeration is shown by the fact that she at once acquiesced in her supposed son's absolute ignorance of French. She allowed the claimant £1000 a year, accepted his wife, a poor illiterate girl, whom he had married in Queensland, and handed over to him the diaries and letters written by Roger Tichborne from South America. From these documents the claimant now carefully studied his part; he learnt much, too, from Baigent and from two carabiniers of Roger's old regiment, whom he took into his service. The villagers in Hampshire, a number of the county families, and several of Tichborne's fellow officers in the 6th Dragoons, became eager victims of the delusion. The members of the Tichborne family in England, however, were unanimous in declaring the claimant to be an impostor, and they were soon put upon the track of discoveries which revealed that Tom Castro, as the claimant had been called in Australia, was

[1] See H. Winnefeld, *Die Villa des Hadrian* (Berlin, 1895). *Jahrbuch des k. d. arch. Instituts*, Ergänzungsheft III.: R. Lanciani, *La Villa Adriana* (Rome, 1906).

identical with Arthur Orton (1834–1898), the son of a Wapping butcher, who had deserted a sailing vessel at Valparaiso in 1850, and had received much kindness at Melipilla in Chile from a family named Castro, whose name he had subsequently elected to bear during his sojourn in Australia. It was shown that the claimant, on arriving in England from Sydney in 1866, had first of all directed his steps to Wapping and inquired about the surviving members of his family. It was discovered, too, that Roger Tichborne was never at Melipilla, an assertion to which the claimant, transferring his own adventures in South America to the account of the man whom he impersonated, had committed himself in an affidavit. These discoveries and the deaths of Lady Tichborne and Hopkins were so discouraging that the "claimant" would gladly have "retired" from the baronetage; but the pressure of his creditors, to whom he owed vast sums, was importunate. A number of "Tichborne bonds" to defray the expenses of litigation were taken up by the dupes of the imposture, and an ejectment action against the trustees of the Tichborne estates (to which the heir was the 12th baronet, Sir Henry Alfred Joseph Doughty-Tichborne, then two years old) finally came before Chief Justice Bovill and a special jury at the court of common pleas on the 11th of May 1871. During a trial that lasted over one hundred days the claimant exhibited an ignorance, a cunning and a bulldog tenacity in brazening out the discrepancies and absurdities of his depositions, which have probably never been surpassed in the history of crime. Over one hundred persons swore to the claimant's identity, the majority of them—and they were drawn from every class—being evidently sincere in their belief in his cause. It was not until Sir John Coleridge, in a speech of unparalleled length, laid bare the whole conspiracy from its inception, that the result ceased to be doubtful. The evidence of the Tichbornes finally convinced the jury, who declared that they wanted no further evidence, and on the 5th of March 1872 Serjeant Ballantine, who led for the claimant, elected to be non-suited. Orton was immediately arrested on a charge of perjury and was brought to trial at bar before Chief Justice Cockburn in 1873. The defendant showed his old qualities of impudence and endurance, but the indiscretion of his counsel, Edward Kenealy, the testimony of his former sweetheart, and Kenealy's refusal to put the Orton sisters in the box, proved conclusive to the jury, who, on the one hundred and eighty-eighth day of the trial, after half-an-hour's deliberation found that the claimant was Arthur Orton. Found guilty of perjury on two counts, he was sentenced on the 28th of February 1874 to fourteen years' penal servitude. The cost of the two trials was estimated at something not far short of £200,000, and of this the Tichborne estates were mulcted of fully £90,000. The claimant's better-class supporters had deserted him before the second trial, but the people who had subscribed for his defence were stanch, while the populace were convinced that he was a persecuted man, and that the Jesuits were at the bottom of a deep-laid plot for keeping him out of his own. There were symptoms of a riot in London in April 1875, when parliament unanimously rejected a motion (by Kenealy) for referring the Tichborne case to a royal commission, and the military had to be held in readiness. But the agitation subsided, and when Orton emerged from gaol in 1884 the fickle public took no interest in him. The sensation of ten years earlier could not be galvanized into fresh life either by his lectures or his alternate confessions of imposture and reiterations of innocence, and Orton sank into poverty and oblivion, dying in obscure lodgings in Marylebone on the 2nd of April 1898. (T. SE.)

TICINO (Ger. *Tessin*, anc. *Ticinus*), a river of Switzerland and north Italy, which gives its name to the Swiss canton of Ticino (*q.v.*), and gave it in classical times to the town of Ticinum (Pavia). It rises at the foot of the Gries Pass to the west of Airolo; from Airolo to the Lago Maggiore its valley bears the name of Val Leventina, and is followed as far as Bellinzona by the St Gotthard road and railway. It flows through Lago Maggiore, leaving it at its south end at Sesto Calende, and thence flows S.S.E. into the Po, which it joins a little way south of Pavia.

TICINO (Fr. and Ger. *Tessin*), a canton of Switzerland, the only one situated almost wholly on the southern slope of the Alps and inhabited by a population of which the majority is Italian-speaking. It takes its name from the Ticino river, the whole upper course of which (the Val Leventina, with its side glen of Val Blenio, the so-called Riviera, extending from Biasca to near Bellinzona, and the bit beyond Bellinzona), till it swells into the Lago Maggiore, is within the canton. Not far from the head of the Lago Maggiore the lake is increased by the Maggia torrent which is formed by the union of the torrents descending from the mountain glens known as the valleys of Locarno, save the Val Verzasca, the stream from which falls into the lake without joining the Maggia. The third portion of the canton is that called Monte Cenere, including the hilly region between Bellinzona on the Ticino and Lugano, together with most of the lake of that name, and stretching on the south as far as Mendrisio, not far from Como. These three districts were all formerly part of the duchy of Milan till conquered by the Swiss, and in 1803 were joined together to form a Swiss canton of the most artificial kind (Campione, opposite Lugano, is still an Italian "enclave"). Its total area is 1081·1 sq. m., of which 721·9 sq. m. are reckoned as "productive" (forests covering 267·2 sq. m. and vineyards 19·9 sq. m.), while of the rest part is taken up by the Lake of Lugano (the Swiss share of which is $7\frac{1}{2}$ sq. m.), and those of the Lago Maggiore (Swiss share $16\frac{1}{4}$ sq. m.), and by $13\frac{1}{4}$ sq. m. of glaciers. In point of size the canton is surpassed by only four other cantons (Bern, the Grisons, the Valais, and Vaud), while only Vaud can boast of a larger vine-growing district. The highest points in the canton are two of the loftiest summits of the two halves of the Lepontine Alps—the Basodino (10,749 ft.) and the Rheinwaldhorn or Piz Valrhein (11,149 ft.) in the Adula Alps. Save the Ticino valley between Biasca, Bellinzona and Locarno, and the environs of Lugano, the canton is principally composed of hills and mountains, and is therefore poor from the material point of view, though rich in fine scenery.

The canton is traversed from end to end, from Airolo at the southern mouth of the St Gotthard tunnel to beyond Mendrisio (about 74 m.), by the main line of the St Gotthard railway, many of the marvellous engineering triumphs of which occur between Airolo and Biasca. From Bellinzona there is a short branch railway to Locarno (14 m.), whence another runs up to Bignasco ($17\frac{1}{2}$ m.), while from Lugano there is a mountain line up the Monte S. Salvatore (3004 ft.), and from Capolago another similar line up the Monte Generoso (5591 ft., that summit being just on the political frontier). Till 1859 the canton was legally included in the Italian dioceses of Milan (the portion north of Bellinzona, the Val Leventina and the Val Blenio therefore still using the ancient "Ambrosian Liturgy") and of Como (the rest of the canton). In that year the Swiss Confederation abolished this foreign jurisdiction, but practically the two bishops named had charge of these districts till in 1888 the purely Swiss diocese of Lugano was set up, being now joined to that of Basel, and governed by an administrator apostolic. In 1900 the population of the canton was 138,638, of whom 134,774 were Italian-speaking, 3180 German-speaking and 403 French-speaking, while 135,828 were Romanists, 2209 Protestants and 18 Jews. Of the German-speaking inhabitants 260 belonged to the hamlet of Bosco or Gurin, situated at the head of one of the side glens of the Val Maggia, and colonized before 1253 from the neighbouring Tosa or Pommat valley (now politically Italian), which is inhabited by German-speaking emigrants from the canton of the Valais. In 1900 there were in the canton 75,731 women to 62,907 men, the men being in the habit of emigrating in search of work. Up to 1881 Bellinzona, Locarno and Lugano were alternately the political capital, each for six years, but since 1881 Bellinzona is the permanent capital. Yet it is but the second town in size, being surpassed by Lugano (*q.v.*), while after it come Locarno (*q.v.*) and Mendrisio (3338 inhabitants). Being practically Italian, though now "Italian Switzerland," the canton has produced many sculptors, painters and architects. But its industrial development is backward, though the opening of the St Gotthard railway has attracted many foreign travellers. Yet the male population largely migrate in search of work and wages as coffee-house keepers (such as Delmonico, of New York), waiters in cafés, masons, plasterers, labourers, navvies, &c. Fruit, chestnuts and wine are among the principal exports. The canton is divided into 8 administrative districts, which comprise 265 communes. The cantonal constitution is still that of 1830, which, however, has been almost mended out of sight owing to the political struggles that have raged in the canton. The legislature (*Gran consiglio*) is composed of members elected (since 1880) in the proportion of one to every 1200 (or fraction over 600) of the Swiss inhabitants, and holding office for four years. The executive (*Consiglio di stato*) is (since 1892) elected directly by the people, is composed (since 1875) of five members, and holds office for four years. Since 1883 5000 citizens have the right (facultative referendum) of claiming a popular vote as to bills passed by the legislature, while (since 1892) 5000 citizens have the right of "initiative" in legislative matters, though 7000 signatures are required in case of a proposal to revise the cantonal constitution. In 1891 the system of proportional representation was introduced for elections to the cantonal legislature and the communal assemblies. In 1904 a very complicated system of proportional representation was adopted by a narrow majority of the people of Ticino. In elections to the cantonal legislature all fractions below that required to secure a member in the entire canton are added together and then divided by the number of the non-elected candidates, plus one, the persons thus selected being, as far as possible, assigned to the constituencies in which they have obtained most votes (the point remains obscure). In 1904 also the "limited vote" was adopted as to the election of members of the executive, no one being allowed to vote for more than four out of the five members. In 1896, by a strange anomaly only to be explained by the previous political history of the canton, non-resident citizens were given a vote in all cantonal and communal matters, though residence is strictly required for all voters in Federal matters. The two members of the federal *Ständerath* and the seven members of the Federal *Nationalrath* are elected by a popular vote.

The canton is made up of all the permanent conquests (with one or two trifling exceptions) made by different members of the Swiss Confederation south of the main chain of the Alps. From an historical point of view Italian Switzerland falls into three groups: (1) the Val Leventina conquered by Uri in 1440 (previously held from 1403 to 1422); (2) Bellinzona (previously held from 1419 to 1422); the Riviera and the Val Blenio, all won in 1500 from the duke of Milan by men from Uri, Schwyz and Nidwalden, and confirmed by Louis XII. of France in 1503; (3) Locarno, Val Maggia, Lugano and Mendrisio, seized in 1512 by the Confederates when fighting for the Holy League against France, ruled by the twelve members then in the league, and confirmed by Francis I. in the treaty of 1516. These districts were governed by bailiffs holding office two years and purchasing it from the members of the League; each member of group 3 sent annually an envoy, who conjointly constituted the supreme appeal in all matters. This government was very harsh and is one of the darkest pages in Swiss history. Yet only one open revolt is recorded—that of the Val Leventina against Uri in 1755. In 1798 the people were distracted by the Swiss and "Cisalpine republic" parties, but sided with the Swiss. On being freed from their hated masters, they were formed into two cantons of the Helvetic republic—Bellinzona (=1 and 2 above) and Lugano (=3). In 1803 all these districts were formed into one canton—Ticino—which became a full member of the Swiss Confederation. From 1810 to 1813 it was occupied by the troops of Napoleon. The carriage road over the St Gotthard (1820–1830) was made under the constitution of 1814. But many of the old troubles reappeared, and were only done away with by the constitution of the 23rd of June 1830. In 1848, on religious grounds and owing to fears as to customs duties, the canton voted in the minority against the Federal constitution of that year; but in 1874, though the people voted against the revised constitution, the legislature adopted it, and the canton was counted as one of the majority. Since 1830 the local history of the canton has been very disturbed owing to the fact that, though Roman Catholicism is the state religion, and all the population are Roman Catholic (the few Protestants having been expelled from Locarno in 1555), they are divided between the Radical and Ultramontane parties. Since 1876 the intervention of Federal troops (already known in 1870) has been frequent in consequence of conflicts of the local authorities *inter se*, or against the Federal Assembly.

The political troubles of Ticino were increased in 1888 by the foundation of the see of Lugano, considered by the Radicals as likely to advance Clericalism, though it freed Switzerland from foreign ecclesiastical rule. Hence in September 1890 the Radicals carried out a bloody revolution, which necessitated Federal intervention, but at a state trial at Zürich in July 1891 the leaders were acquitted. Political passions still run high in the canton, as the Radicals and Conservatives are nearly balanced in point of numbers.

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(W. A. B. C.)

TICINUM (mod. *Pavia*, *q.v.*), an ancient city of Gallia Transpadana, founded on the banks of the river of the same name (mod. *Ticino*) a little way above its confluence with the Padus (Po). It is said by Pliny to have been founded by the Laevi and Marici, two Ligurian tribes, while Ptolemy attributes it to the Insubres. Its importance in Roman times was due to the extension of the Via Aemilia from Ariminum to the Padus (187 B.C.), which it crossed at Placentia and there forked, one branch going to Mediolanum and the other to Ticinum, and thence to Laumellum where it divided once more—one branch going to Vercellae (and thence to Eporedia and Augusta Praetoria) and the other to Valentia (and thence to Augusta Taurinorum or to Pollentia). The branch to Eporedia must have been constructed before 100 B.C. Ticinum is not infrequently mentioned by classical writers. It was a municipium, and from an inscription we know that a triumphal arch was erected in honour of Augustus and his family, but we learn little of it except that in the 4th century A.D. there was a manufacture of bows there. It was pillaged by Attila in A.D. 452 and by Odoacer in 476, but rose to importance as a military centre in the Gothic period. At Dertona and here the grain stores of Liguria were placed, and Theodoric constructed a palace, baths and amphitheatre and new town walls; while an inscription of Athalaric relating to repairs of seats in the amphitheatre is preserved (A.D. 528–529). From this point, too, navigation on the Padus seems to have begun. Narses recovered it for the Eastern Empire, but after a long siege, the garrison had to surrender to the Lombards in 572. The name Papia, from which the modern name Pavia comes, does not appear until Lombard times, when it became the seat of the Lombard kingdom, and as such one of the leading cities of Italy. Cornelius Nepos, the biographer, appears to have been a native of Ticinum. Of Roman remains little is preserved—there is, for example, no sufficient proof that the cathedral rests upon an ancient temple of Cybele—though the regular ground plan of the central portion, a square of some 1150 yds., betrays its Roman origin, and it may have sprung from a military camp. This is not unnatural, for Pavia was never totally destroyed; even the fire of 1004 can only have damaged parts of the city, and the plan of Pavia remained as it was. Its gates were possibly preserved until early in the 19th century. The picturesque covered bridge which joins Pavia to the suburb on the right bank of the river was preceded by a Roman bridge, of which only one pillar, in blocks of granite from the Baveno quarries, exists under the central arch of the medieval bridge, the rest having no doubt served as material for the latter. The medieval bridge dates from 1351–1354.

See A. Taramelli in *Notizie degli scavi* (1894), 73 sqq. and reff.

(T. As.)

TICKELL, THOMAS (1686–1740), English poet and man of letters, the son of a clergyman, was born at Bridekirk near Carlisle in 1686. After a good preliminary education he went (1701) to Queen's College, Oxford, taking his M.A. degree in 1709. He became fellow of his college in the next year, and in

1711 university reader or professor of poetry. He did not take orders, but by a dispensation from the Crown was allowed to retain his fellowship until his marriage in 1726. Tickell's success in literature, as in life, was mainly due to the friendship of Addison, who procured for him (1717) an under-secretaryship of state, to the chagrin of Richard Steele, who thenceforth bore Tickell no goodwill. During the peace negotiations with France Tickell published in 1713 the *Prospect of Peace*. In 1715 he brought out a translation of the first book of the *Iliad* contemporaneously with Pope's version. Addison's reported description of Tickell's version as the "best that ever was in any language" roused the anger of Pope, who assumed that Addison himself was the author,[1] or had at any rate the principal share in the work. Addison gave Tickell instructions to collect his works, which were printed in 1721 under Tickell's editorship. In 1724 Tickell was appointed secretary to the lords justices of Ireland—a post which he retained until his death, which took place at Bath on the 23rd of April 1740.

Kensington Gardens (1722), his longest poem, is inflated and pedantic. It has been said that Tickell's poetic powers were awakened and sustained by his admiration for the person and genius of Addison, and undoubtedly his best work is the sincere and dignified elegy addressed to the earl of Warwick on Addison's death. His ballad of *Colin and Mary* was long the most popular of his poems. Tickell contributed to the *Spectator* and the *Guardian*.

See "T. Tickell," in *Johnson's Lives of the Poets*; the *Spectator*; Ward's *English Poets*. His *Works* were printed in 1749 and are included in Chalmers's and other editions of the English Poets.

TICKET (O. Fr. *estiquet*, also *estiquette*, mod. *étiquette*, from Ger. *stechen*, to stick up), by origin a small bill stuck up for the purpose of giving notice or information, hence a small printed or written card or slip, containing a notice, order or the like, and more particularly such an one as embodies the terms under which the party issuing the ticket grants some right, privilege or licence to the party to whom it is issued; where there has been valuable consideration for such given by the holder the ticket is the method by which the parties enter into a contract. The most familiar of this last class of tickets is the passenger's ticket issued by railway companies, tramways or "common carriers" in general. The ticket does not usually contain the whole terms of the contract, but refers to the conditions under which it is issued, to which the holder is considered subject if sufficient notice of them is given. A ticket of admission issued for a theatre, or place of entertainment, constitutes a licence to the holder to occupy and use a seat, whether particularized or not, and such parts of the building as may be open to him. Such a licence can be revoked by the issuer, and the holder may be ejected as a trespasser, subject to his right to bring an action for damages.

TICKET-OF-LEAVE, a term first invented for the "emancipists" in the days of Australian transportation (see DEPORTATION); in the English penal system, a document or "pass" handed to a convict who has completed the second stage of his sentence and is about to enter the third and last, that of conditional liberation or semi-freedom, in which he goes at large to earn his own livelihood as a more or less independent member of the community. The "ticket" or "licence" is the outward sign of "remission" gained by industry and blameless conduct in prison (see PRISON), and it may be forfeited for disobedience or neglect of certain conditions endorsed upon the licence. Convicts are by law required to report themselves at an appointed place within forty-eight hours after liberation and again every succeeding month at the police station nearest to their place of abode, between the hours of nine in the morning and nine in the evening. They must get their living by honest means and regular employment, and must reside—that is to say, sleep—at the address notified by them to the police in order that they may be found at once if required for any legal and justifiable purpose. If they change their address or withdraw from any known police district, they must give notice of their removal at the police station at which they have been reporting, stating the place to which they are going, and, as far as practicable, their address there, and also at the nearest police station within forty-eight hours of arriving in any other police district in any part of the United Kingdom. They must produce their licences whenever they are called upon to do so by a police officer.

This treatment of offenders who have already expiated their crimes has been deemed to bear heavily on any who are anxious to turn over a new leaf. To be ever subject to the watchfulness of the police must often increase the licence-holder's difficulty of leading an honest life. The struggle is known to be often severe; employers of labour are not too ready to accept the services of "gaol birds," and free workmen often resent the admission of an old convict amongst their number. Private charity has come forward to diminish or remove this hardship, and many societies have been called into existence for the purpose of assisting discharged prisoners. They are to be found in most of the principal cities of the United Kingdom. London alone has those of the Church Army, the St Giles's Christian Mission, the Salvation Army, the Catholic Aid Society and the Royal Society for the Assistance of Discharged Prisoners, which was founded in 1856 and has done a vast and meritorious work. It labours chiefly in the metropolis; it is supported by private subscriptions, but it has control also over the gratuities of the licencees who accept its aid. The prisoners on release are first examined at the society's office as to their prospects and wishes; they are given some pocket-money out of their own gratuities; and their "liberty clothing," a present from the prison, is changed for more suitable clothes. They are then placed in respectable lodging-houses until employment is obtained for them, after which the society undertakes the reporting to the police and by its own agents exercises a watch over its protégés. There are upwards of sixty-five societies, all certified by the secretary of state, of which the number is increasing; every year the subscriptions increase, more money is expended, more cases are aided and more ex-convicts are rehabilitated. Unfortunately a large number of those who solicit help belong to the class of "lazy loafers who like neither work nor honesty," and who, when the first is found, will not adhere to the latter. Most of the societies employ agents who act as intermediaries between employers and ex-convicts and fill a place analogous to that of the "probation officers" in parts of the United States (see PROBATION); but the probation officer generally interposes at an earlier stage and shields the first offender from the consequences of his act, by sparing him a visit to the gaol. In a speech on Prison Reform in the English House of Commons on the 20th of July 1910, the home secretary outlined a proposed scheme for abolishing ticket-of-leave altogether, and entrusting the after-supervision of released prisoners to a central agency of semi-official character.

Aid to discharged prisoners has been largely undertaken in European countries, where it is known under the name of *patronage*. Local societies exist in most of the capitals and chief cities, and efforts are made to rescue neglected or criminal children and find work for adults on leaving gaol. This assistance has been called by its keenest supporters the best prophylactic for crime. Conditional liberation is in force in most of the Northern states of America, and prisoners are constantly released on "parole" when they have satisfied the parole board (of prison officials) that they will not abuse their liberty; a watch is kept over all thus released, who are expected to make a monthly report of their conduct and actual position at the time of reporting. If any one relapses he is liable to recommittal.

See *Three Reports of Commons' Committee on the Operation of the Act substituting other Punishment in lieu of Transportation* (1856); F. H. Wines, *Punishment and Reformation* (1895). (A. G.).

TICKING, a strong linen or cotton fabric usually woven in stripes of colour; blue and pink with white being the most common. The name is derived from a word "tick," common in various forms to many languages, signifying a case or sheath.

[1] See Warton's note in the *Bathos* (ed. Pope and Elwin, x. 388) where he quotes from Tickell's version and from Addison and says the same author.

Ticking is used for mattresses, awnings and tents. In some qualities it is also used as a foundation for embroidery.

White, grey, or brownish warp threads are usually flax, while the coloured threads are often cotton. The weft is flax or tow. The warps of many of the cheaper kinds are made entirely of cotton, and jute is used for weft in the cheapest grades. A feather tick should be made of fine flax yarns set closely, and there should also be a large number of weft threads per inch. Sometimes the inside of the tick is waxed in order to prevent the feathers from working out.

The structure of the fabric is termed a twill, of which four varieties, each showing four units, are illustrated. Fig. 1, the ordinary three-leaf twill, is more extensively used than any other. Occasionally

FIG. 1.

FIG. 2.

the pattern or twill is in one direction only, but more often the direction is reversed at intervals, thus producing what is technically termed a "herring-bone" or an "arrow-head" twill. Fig. 2 complete on twenty-four threads and three picks shows such a pattern, where the twill is reversed every twelve threads. Figs. 3 and 4 are

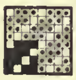

FIG. 3.

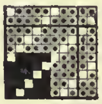

FIG. 4.

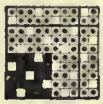

FIG. 5.

the four-thread and five-thread straight twills respectively, while fig. 5 is the five-thread sateen twill. These two latter weaves require a great number of threads and picks per inch, and are used only in the finest ticks. The plain weave is occasionally used for cheaper varieties.

Mattress ticks and awnings are woven with the same twills, but the colouring of these, especially of the former, is more elaborate.

TICKNOR, GEORGE (1791–1871), American educator and author, was born in Boston, Massachusetts, on the 1st of August 1791. He received his early education from his father, Elisha Ticknor (1757–1821), who had been principal of the Franklin public school and was a founder of the Massachusetts Mutual Fire Insurance Company, of the system of free primary schools in Boston, and of the first New England savings bank. In 1805 the son entered the junior class at Dartmouth, where he graduated in 1807. During the next three years he studied Latin and Greek with Rev. Dr John Sylvester Gardiner, rector of Trinity, Boston, and a pupil of Dr Samuel Parr. In 1810 Ticknor began the study of law, and he was admitted to the bar in 1813. He opened an office in Boston, but practised for only one year. He went to Europe in 1815 and for nearly two years studed at the university of Göttingen. In 1817 he became Smith professor of French and Spanish languages and literatures (a chair founded in 1816), and professor of belles-lettres at Harvard, and began his work of teaching in 1819 after travel and study in France, Spain and Portugal. During his professorship Ticknor advocated the creation of departments, the grouping of students in divisions according to proficiency, and the establishment of the elective system, and reorganized his own department. In 1835 he resigned his chair, in which he was succeeded in 1836 by Professor H. W. Longfellow; and he was again in Europe in 1835–1838. After his return he devoted himself to the chief work of his life, the history and criticism of Spanish literature, in many respects a new subject at that time even in Europe, there being no adequate treatment of the literature as a whole in Spanish, and both Bouterwek and Sismondi having worked with scanty or second-hand resources. Ticknor developed in his college lectures the scheme of his more permanent work, which he published as the *History of Spanish Literature* (New York and London, 3 vols., 1849). The book is not merely a story of Spanish letters, but, more broadly, of Spanish civilization and manners. The *History* is exhaustive and exact in scholarship, and direct and unpretentious in style. It gives many illustrative passages from representative works, and copious bibliographical references. It was soon translated into Spanish (1851–1857) by de Gayangos and de Vedia; French (1864–1872), a poor version by Magnabal; and German (1852–1867), by N. H. Julius and Ferdinand Wolf. The second American edition appeared in 1854; the third corrected and enlarged, in 1863; the fourth, containing the author's last revision, in 1872, under the supervision of George S. Hillard; and the sixth in 1888. Ticknor had succeeded his father as a member of the Primary School Board in 1822, and held this position until 1825; he was a trustee of the Boston Atheneum in 1823–1832, and was vice-president in 1833; and he was a director (1827–1835) and vice-president (1841–1862) of the Massachusetts Hospital Life Insurance Company, and a trustee of the Massachusetts General Hospital (1826–1830) and of the Boston Provident Institution for Savings (1838–1850), the bank that his father had helped to found. He was especially active in the establishment of the Boston Public Library (1852), and served in 1852–1866 on its board of trustees, of which he was president in 1865. In its behalf he spent fifteen months abroad in 1856–1857, at his own expense, and to it he gave at various times money and books; a special feature of his plan was a free circulating department. He left to the library his own collection, which was particularly strong in Spanish and Portuguese literatures. He died in Boston on the 26th of January 1871.

Ticknor's minor works include, besides occasional reviews and papers, *Syllabus of a Course of Lectures on the History and Criticism of Spanish Literature* (1823); *Outline of the Principal Events in the Life of General Lafayette* (1825); *Remarks on Changes Lately Proposed or Adopted in Harvard University* (1825); *The Remains of Nathan Appleton Haven, with a Memoir of his Life* (1827); *Remarks on the Life and Writings of Daniel Webster* (1831); *Lecture on the Best Methods of Teaching the Living Languages*, delivered, in 1832, before the American Institute of Education; and the *Life of William Hickling Prescott* (1864).

See *Life, Letters and Journals of George Ticknor* (2 vols., 1876), by George S. Hillard and Mrs Anna (Eliot) Ticknor and Miss Anna Eliot Ticknor. This book was edited, with a critical introduction, in 1909, by Ferris Greenslet.

TICKS, the common name for Arachnida (*q.v.*) belonging to the order Acari, of which they constitute the two families, Ixodidae and Argasidae. Collectively the Ixodidae and Argasidae may be distinguished from other Acari by the presence of a median probe, armed with recurved teeth, which project forwards beneath the mouth and between the palpi, and of a conspicuous spiracular area above and usually behind the base of the fourth leg on each side. As compared with the majority of Acari, ticks are of large size, distended female specimens of some of the species measuring half an inch or more in length, while even the newly hatched young can hardly be regarded as microscopical. The integument is tough, leathery or horny. The mouth parts consist of two small retractile mandibles, of a pair of short palpi and of the toothed probe above mentioned. The palpi and probe or hypostome are attached to a movable sclerite or horny plate called the capitulum. The capitulum, with its associated structures, is sometimes called the rostrum, whereas sometimes the term rostrum is restricted to the hypostome alone. It is by means of the hypostome that ticks pierce the integument and firmly adhere to the host whose blood they suck for food. The two families Argasidae and Ixodidae may be distinguished as follows. In the Argasidae the anterior portion of the dorsal surface of the body is extended forwards above the capitulum, so that this structure is concealed from above; the integument is fairly uniformly granular or coriaceous above and below; the palpi are simple and unmodified; there is no sucker beneath the claws in the adult, and there is only a slight structural difference between the sexes. In the Ixodidae the capitulum is not overlapped by a forward extension of the dorsal area, which is smooth and firmly chitinized either in front or all over; the palpi are usually modified, that is to say, their second and third segments are usually excavated internally to form a sheath for the hypostome; there is a distinct sucker beneath the claws and the difference between the sexes is well marked, the males having the dorsal integument thickly and continuously chitinized, whereas in the females only its anterior portion bears a chitinous plate, the rest of the integument being soft to admit of its distension by the blood which is imbibed in quantity by members of this sex. For a longer or shorter period of their lives ticks are parasitic upon vertebrate animals of various kinds; but although the belief that the bite of certain tropical species is poisonous has long been held by the natives of the countries they infest and has been recorded with corroborative evidence by European authors in books of travel, it is only of recent years that accurate information has been acquired of the part played by these Arachnids in transmitting from one host to another protozoal blood-parasites which cause serious or fatal diseases to man and other animals.

Both the Argasidae and Ixodidae contain pathogenic species, of which the best known are the following: *Ornithodoros monbata*, belonging to the Argasidae, and called *bibo* in Uganda, *monbata* in Angola, and *tampan* on the Zambezi, is widely distributed in tropical Africa from Uganda in the north to the Transvaal in the south. It was first recorded as poisonous by Livingstone and is now known to be the carrier of the Spirochaete of relapsing fever in man, known as tick fever. Although Europeans suffer from this disease far more severely than negroes, death seldom follows. The tick especially infests old huts and camping grounds and is nocturnal in habit, spending the day hidden in crevices of the walls or floor and coming out at night to feed upon the sleeping inmates. An allied species, *O. turicala*, occurs in Mexico and Texas, where it causes considerable destruction amongst poultry and is a pest to mankind as well. A similar bad repute attaches to other species in different parts of South America; while *Argas miniatus* has been proved to be the carrier of the Spirochaete causing spirillosis in fowls in Rio Janeiro, and also in New South Wales whither it has been introduced with imported poultry. *Argas persicus* has been introduced in the same way into South Africa from Europe. As its name indicates it was first discovered in Persia, where the belief in the venomous nature of its bite to human beings is both widespread and historical. It is singular that the Argasidae, which are for the most part parasitic upon birds, contain the only species of ticks, especially *O. monbata*, which are known to be seriously harmful to mankind; whereas amongst the Ixodidae no human pathogenic species has been ascertained to exist, although several forms have been proved to be highly destructive to domestic mammals of different species. The most important of these are the following: *Dermacentor reticulatus*, a species widely distributed in Europe, Asia and America, infects dogs in Europe with the Haematozoon causing the disease known as "biliary fever," and has been asserted to be answerable for the so-called spotted or tick fever in man in the Rocky Mountains. The same canine disease results in South Africa from the bite of *Haemaphysalis leachi*. *Amblyomma hebraeum*, the bont or variegated tick of the Cape Colonists, infects sheep with the Sporozoon causing "heart-water" sickness, and in Europe sheep are inoculated with the same disease by another tick, *Rhipicephalus bursa*. The so-called "coast fever" in cattle in South Africa is conveyed by two distinct species of the genus *Rhipicephalus*, namely by *R. appendiculatus* and *R. simus*, which are locally known respectively as the "brown tick" and the "black-pitted tick." Finally *Margaropus annulatus*, of which there are several geographical races, is the carrier of the germ causing the destructive cattle-disease variously known as "Texas" or "red water" fever in America, South Africa and Australia. In the United States alone the annual pecuniary loss in cattle stock occasioned by the ravages of this tick disease was computed in 1907 at one hundred million dollars. With one or two possible exceptions, like *Argas vespertilonis*, which has only been obtained from European bats, no species of tick is known to be confined to a particular host. The common sheep-tick (*Ixodes vicinus*) of England, for example, infects cattle and dogs as well as sheep; and the pathogenetic Ixodidae above mentioned occur parasitically upon other mammals than those to which they convey the diseases specified. Reptiles are infested as well as mammals, and it is no uncommon thing to find specimens of Ixodidae of various kinds adherent to tortoises, snakes and lizards. Ticks belonging to the Ixodidae differ to a certain extent in their life-histories.

Mature males and females are found together upon the same host. Fertilization is effected by the male transferring spermatophores into the genital orifice of the female by means of his proboscis. The gorged and fertilized female quits her hold of the host, and falling to the ground, proceeds after a short delay to lay her eggs in some sheltered spot. The number of eggs laid is enormous, one computation putting it at twenty thousand. After oviposition, which may extend over several weeks, the female dies. The newly-hatched young has only three pairs of legs and is without spiracular and genital orifices. These young, or larvae as they are called, after the integument has hardened by exposure to the air, climb up the stalks of grain or herbage and cling with outstretched legs waiting for passing animals. They seize hold of the first that brushes by, and crawling to a suitable place become engorged with blood. After about a week's feeding they drop to the ground, lie dormant for a month, during which time they acquire their fourth pair of legs and spiracles, and, moulting, emerge from their old skin as *nymphs*. Nymphs repeat the behaviour of the larvae, and finally moult into the adult, showing the generative orifice, which is the mark of maturity. The adult secures a host in the same way as the young. Both sexes feed upon blood; whereas the male alters but little in appearance, the female becomes enormously distended.

From the foregoing epitome which applies to many species, *Rhipicephalus appendiculatus* for example, it is evident that every individual tick has to find a host on three occasions, namely, as larva, nymph and adult. In *R. bursa*, however, the moult that

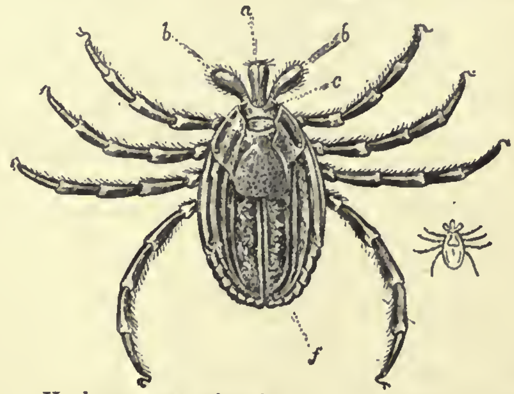

FIG. 1.—*Hyalomma aegyptium* Savigny. Undistended female.
a Rostrum or hypostome; *b*, *b*, Palpi; *c*, Capitulum; *f*, Abdomen.

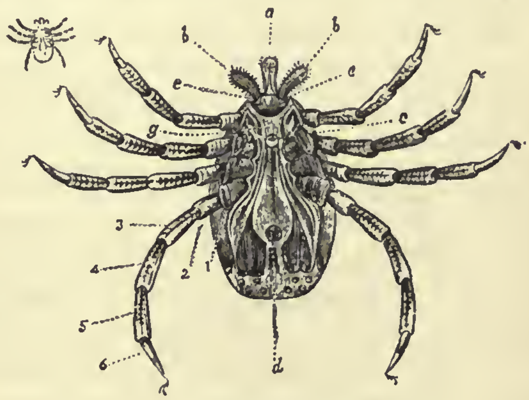

FIG. 2.—The same; under side.

a, Rostrum or hypostome; *b*, *b*, Palpi; *c*, Genital aperture; *d*, Anal orifice; *e*, *e*, Ventral surface of capitulum; *g*, Sternum; 1–7, segments of leg.

transforms the larva into the nymph takes place on the host, and in *Margaropus annulatus* the transformation of larva into nymph and nymph into adult is effected without the temporary sojourn on the ground. Another species, *Hyalomma aegyptium*, the so-called camel-tick of Egypt and Arabia, is alleged to be parasitic only in its mature stage. Again, in *Ornithodorus monbata*, which is parasitic apparently only at night, the young does not hatch from the egg until it has attained the nymphal stage.

It is an interesting and important fact that the newly hatched young of certain species, *Margaropus annulatus* for instance, before it has fed, if produced by a female carrying the germs of spirillosis, can infect healthy organisms with the disease. From this it is evident that the Spirochaetes pass directly from the mother tick to her offspring.

Duration of life in ticks depends upon the conditions of their existence. Under favourable conditions, when food is obtainable, growth is rapid, the time from the hatching of the young until it reaches maturity and dies after oviposition being, for example, about eleven weeks in *R. appendiculatus* and only about three weeks in *M. annulatus*. On the other hand, when food is not obtainable, life may be indefinitely prolonged if the tick be guarded from enemies and from atmospheric conditions inimical to existence. Examples of *Ixodes vicinis* have been kept for two years and three months without feeding, and specimens of *Argas persicus* were still alive after four years' starvation. (R. I. P.)

TICONDEROGA, a village in the township of Ticonderoga, Essex county, New York, U.S.A., on the outlet of Lake George, 100 m. by rail N. by E. of Albany. Pop. (1890), 2267; (1900), 1911; (1905), 1749; (1910), 2475. Ticonderoga is served by the Delaware & Hudson and the Rutland railways. The water from Lake George falls here about 30 ft., providing water-power, and among the manufactures are paper pulp, paper-making machinery and lumber. Flake graphite was discovered in this vicinity as early as 1815, and for years two mines (with quartzite veins, respectively 1–5 and 2–15 ft. thick) at Ticonderoga were the principal source of supply of good crystalline graphite. Commanding a portage on the line of water communication between Canada and the English colonies, Ticonderoga was a place of considerable strategic importance during the Seven Years' War. On a commanding elevation overlooking the present village and Lake Champlain the French began building a fort of earth and timber in 1755 and called it Fort Carillon; later it was named Fort Ticonderoga. Sir William Johnson led an expedition in the same year against this fort and Crown Point; though he failed to capture the forts he defeated Baron Ludwig August Dieskau in the battle of Lake George and erected at the head of the lake Fort William Henry, which was captured by the marquis de Montcalm in 1757. On the 8th of July 1758 less than 4000 Frenchmen were confronted at Fort Carillon by about 6000 British regulars and 10,000 provincials under Lieut.-General James Abercrombie and Brigadier-General George A. Howe, but Howe, the controlling spirit of the British force, had been killed on the 6th of July, and Abercrombie, after an ineffective attack which cost him nearly 2000 men killed or wounded, retreated. In 1758, however, when Montcalm had gone to Quebec to oppose Wolfe and a force of only 400 men was left at Ticonderoga, Lord Amherst with 11,000 men invested it, and on the 26th of July the garrison blew up and abandoned the fortifications. At the beginning of the War of Independence, on the 10th of May 1775, the fort was surprised and captured by Ethan Allen. It was recovered by the British on the 5th of July 1777, during Burgoyne's campaign, was abandoned immediately after Burgoyne's surrender in October 1777, but was re-occupied by the British in 1780. After the close of the war it was allowed to fall into ruins. In 1909, on the occasion of the tercentenary celebration of the discovery of Lake Champlain, the restoration of the fort was begun under the direction of the owner of the site. The settlement of this region was begun soon after the close of the Seven Years' War, and the township of Ticonderoga was set apart from the township of Crown Point in 1804. The village of Ticonderoga was incorporated in 1889. The name "Ticonderoga" is a corruption of an Indian word said to mean "sounding waters."

TIDE (O. Eng. *tīd*, cf. Ger. *Zeit*, time or season, connected with root of Sanskrit *a-diti*, endless), a term used generally for the daily rising and falling of the water of the sea, but more specifically defined below.

I.—General Account of Tides and Tidal Theories

§. 1. *Definition of Tide.*—When, as occasionally happens, a ship in the open sea meets a short succession of waves of unusual magnitude, we hear of tidal waves; and the large wave caused by an earthquake is commonly so described. But the use of the adjective "tidal" appears to us erroneous in this context, for the tide is a rising and falling of the water of the sea produced by the attraction of the sun and moon. A rise and fall of the sea produced by a regular alternation of day and night breezes, by regular rainfall and evaporation, or by any influence which the moon may have on the weather cannot strictly be called a tide. Such alterations may be inextricably involved with the rise and fall of the true astronomical tide, but we shall here distinguish them as meteorological tides. It is well known that there are strongly marked diurnal and semi-diurnal inequalities of the barometer due to the sun's heat, and they may be described as atmospheric meteorological tides.[1] These movements both in the case of the sea and in that of the atmosphere are the result of the action of the sun, as a radiating body, on the earth. True astronomical tides in the atmosphere would be shown by a regular rise and fall in the barometer, but such tides are undoubtedly very minute, and we shall not discuss them in this article, merely referring the reader to the *Mécanique céleste* of Laplace, bks. i. and xiii. We shall in the present article extend the term "tide" to denote an elastic or viscous periodic deformation of a solid or viscous globe under the action of tide-generating forces.

Atmospheric Tides.

§ 2. *General Description of Tidal Phenomena.*[2]—If we live by the sea or on an estuary, we see that the water rises and falls nearly twice a day; speaking more exactly, the average interval from high-water to high-water is about $12^h\ 25^m$, so that the average retardation from day to day is about 50^m. The times of high-water are then found to bear an intimate relation with the moon's position. Thus at Ipswich high-water occurs when the moon is nearly south, at London Bridge when it is south-west, and at Bristol when it is east-south-east. For a very rough determination of the time of high-water it is sufficient to add the solar time of high-water on the days of new and full moon (called the "establishment of the port") to the time of the moon's passage over the meridian, either visibly above or invisibly below the horizon. The interval between the moon's passage over the meridian and high-water varies sensibly with the moon's age. From new moon to first quarter, and from full moon to third quarter (or rather from and to a day later than each of these phases), the interval diminishes from its average to a minimum, and then increases again to the average; and in the other two quarters it increases from the average to a maximum, and then diminishes again to the average.

Variability of Interval after Moon's Transit.

The range of the rise and fall of water is also subject to great variability. On the days after new and full moon the range of tide is at its maximum, and on the day after the first and third quarter at its minimum. The maximum is called "spring tide" and the minimum "neap tide," and the range of spring tide is usually nearly three times as great as that of neap tide. At many ports, however, especially non-European ones, two successive high-waters are of unequal heights, and the law of variability of the difference is somewhat complex; a statement of that law will be easier when we come to consider tidal theories. In considering any single oscillation of water level we find, especially in estuaries, that the interval from high to low-water is longer than that from low to high-water, and the difference between these two intervals is greater at springs than at neaps.

Spring and Neap.

In a river the current continues to run up stream for some considerable time after high-water is attained and to run down similarly after low-water. Much confusion has been occasioned by the indiscriminate use of the term "tide" to denote a tidal current and a rise of water, and it has often been incorrectly inferred that high-water must have been attained at the moment of cessation of the upward current. The distinction between "rising and falling" and "flowing and ebbing" must be maintained in rivers, whilst it is unnecessary at the seaboard. If we examine the progress of the tide-wave up a river we find that high-water occurs at the sea earlier than higher up. If, for instance, on a certain day it is high-water at Margate at noon, it is high-water at Gravesend at a quarter past two, and at London Bridge a few minutes before three. The interval from low to high-water diminishes also as we go up the river; and at some distance up certain rivers—as, for example, the Severn—the rising water spreads over the flat sands in a roaring surf and travels up the river almost like a wall of water. This kind of sudden rise is called a "bore"[3] (*q.v.*). In other cases where the difference between the periods of rising and falling is considerable there are, in each high-water, two or three rises and falls. A double high-water exists at Southampton.

River Tides.

Distinction of Rise and Fall from Flood and Ebb.

When an estuary contracts considerably, the range of tide becomes largely magnified as it narrows; for example, at the

[1] Lord Kelvin shows that the attraction of the sun on these tides must produce an excessively small acceleration of the earth's rotation. See *Société de physique* (September 1881), or *Proc. Roy. Soc. Edin.* (1881–1882), p. 396.

[2] Founded on G. B. Airy's "Tides and Waves," in *Ency. Metrop.*

[3] See a series of papers bearing on this kind of wave by Sir W. Thomson (Lord Kelvin) in *Phil. Mag.* (1886–1887).

Augmentation of Height in Estuaries. entrance of the Bristol Channel the range of spring tides is about 18 ft., and at Chepstow about 50 ft. This augmentation of the height of the tide-wave is due to the concentration of the energy of motion of a large mass of water into a narrow space. At oceanic ports the tidal phenomena are much less marked, the range of tide being usually only 2 or 3 ft., and the interval from high to low-water sensibly equal to that from low to high-water. The changes from spring to neap tide and the relation of the time of high-water to the moon's transit are, however, the same both on the open coast and in rivers.

Land-locked Seas. In long and narrow seas, such as the English Channel, the tide in mid-channel follows the same law as at a station near the mouth of a river, rising and falling in equal times; the current runs in the direction analogous to up stream for three hours before and after high-water, and down stream for the same period before and after low-water. But near the sides of channels and near the mouths of bays the changes of the currents are very complex; and near the headlands separating two bays there is usually at certain times a very swift current, termed a "race."

In inland seas, such as the Mediterranean, the tides are nearly insensible except at the ends of long inlets. Thus at Malta the tides are not noticed by the ordinary observer, whilst at Venice they are conspicuous.

Wind. The effect of a strong wind on the height of tide is generally supposed to be strongly marked, especially in estuaries. In the case of an exceptional gale, when the wind veered round appropriately, Airy states[1] that the water has been known to depart from its predicted height at London by as much as 5 ft. The effect of wind will certainly be different at each port. The discrepancy of opinion on this subject appears to be great—so much so that we hear of some observers concluding that the effect of the wind is insensible. *Atmospheric Pressure.* Variations in barometric pressure also cause departures from the predicted height of water, high barometer corresponding to decrease of height of water. Roughly speaking, an inch of the mercury column will correspond to about a foot of water, but the effect seems to vary much at different ports.[2]

Mariners and hydrographers make use of certain technical terms which we shall now define and explain.

Technical Terms used by Sailors. The "establishment of the port," already referred to above, is the average interval which elapses between the moon's transit across the meridian, at full moon and at change of moon, and the occurrence of high-water. Since at these times the moon crosses the meridian at twelve o'clock either of day or night, the "establishment" is the hour of the clock of high-water at full and change.

It has already been remarked that spring tide occurs at most places a day or a day and a half after full and change of moon. Now it is more important in the theory of the tides to know what occurs at spring tide than what occurs at full and change of moon. Thus the term "the corrected establishment of the port" is used to denote the interval in hours elapsing at spring tide between moon's transit and high-water. The difference between the ordinary and the corrected establishments is of small amount. At any other state of the moon, except full and change, the "interval" or "lunitidal interval" means the interval between the moon's upper or lower transit and high-water.

The average interval elapsing between full or change of moon and spring tide is called the "age of the tide"; as already remarked this interval is commonly about a day or a day and a half, but it may be twice as great in some places. The use of this term arises from the idea that spring tides are generated at some undefined place exactly at full or change of moon, and take an interval of time denoted the "age" to reach the place of observation. The term is not altogether satisfactory, since it implies a theory, but it must be referred to as in general use.

The average height at spring tide between high and low-water marks is called "the spring rise"; the similar height at neap tides is, however, called "the neap range." "Neap rise" is used to mean the average height between high-water of neap tides and low-water of spring tides. Thus both at springs and neaps the term "rise" refers to the rise above the level of low-water at spring tide. French hydrographers call half the spring rise "the unit of height."

[1] Airy, "Tides and Waves." [2] Ibid. §§ 572–573.

The "diurnal inequality" of the tide denotes the fact that successive high-waters and successive low-waters are unequal to one another. In England the diurnal inequality scarcely exists.

The practice of the British admiralty is to refer their soundings and tide tables to "mean low-water mark of ordinary spring tides." This datum is found by taking the mean of all the available observations of spring tides, excluding, however, from the mean any spring tides which may be considered abnormal. The admiralty datum is not, then, susceptible of exact scientific definition; but when it has once been fixed with reference to a bench-mark ashore it is expedient to adhere to it, by whatever process it was first fixed.[3]

When new tidal stations are established in India the datum of reference has, since about 1885, been "Indian low-water mark," which is defined as being below mean sea-level by the sum of the semi-ranges of the tides M_2, S_2, K_1, O (see §§ 24, 25 on Harmonic Analysis below).

In ordinary parlance sailors very commonly use the term "tide" when they mean what may be more accurately described as a tidal current.

§ 3. *Tidal Observation: the Tide-gauge.*—Tidal prediction is only possible when accurate observations have been made of the phenomena to be predicted; and the like is true of verification after prediction. It was formerly thought sufficient to note the heights of the water at high and low-water, together with the times of those events, and the larger part of the observations which exist are still of this character, but complete investigation of the law of tidal oscillations demands that the height of the water should be measured at other times than at high and low-water.

Tide-pole. With whatever degree of thoroughness it is proposed to observe the tides the procedure is much the same. The simplest sort of observation is to note the height of the water on a graduated staff fixed in the sea, with such allowance as may be possible for wave motion. It is, however, far preferable to sink a tube into the sea into which the water penetrates through small holes; and the wave motion is thus annulled. In the calm water inside the tube there lies a float, to which is attached a cord passing over a pulley and counterpoised at the end. The motion of the counterpoise against a scale is observed. In either case the observations may be made every hour, or the times and heights of high and low-water may be noted.

In more careful observations than those referred to above the tidal record is automatic and continuous and is derived by means of an instrument called a tide-gauge.

Tide-gauge. This gauge should be placed in a place where we may obtain a fair representation of the oscillation of the surrounding sea. In such a site a well or tank is built on the shore communicating by a channel with the sea at about 10 ft. below lowest low-water mark. In some cases an artificially constructed well may be dispensed with, where some lagoon or pool exists so near to the sea as to permit junction with the sea by means of a channel below low-water mark. At any rate we suppose that water is provided rising and falling with the tide, without much wave-motion. A cylindrical float, usually a hollow metallic box or a block of greenheart wood, hangs and floats in the well, and is of such density as just to sink without support. The float hangs under very light tension by a platinum wire, or by a metallic ribbon, or by a chain. The suspension wire is wrapped round a wheel, and imparts to it rotation proportional to the rise and fall of tide. By a simple gearing this wheel drives another, by which the range is reduced to any convenient extent. A fine wire wound on the final wheel of the train drags a pencil or pen up and down or to and fro proportionately to the tidal oscillations. The pencil is lightly pressed against a drum, which is driven by clockwork so as to make one revolution per day. The pen leaves its trace or tide-curve on paper wrapped round the drum. The paper is fixed to the drum with the edges of the paper at the XII o'clock line, and the record of a fortnight may be taken without change of paper. An example of a tide-curve for Apollo Bunder, Bombay, from the 1st to the 15th of January 1884, is shown in fig. 1.

The curves are to be read from right to left, and when we reach the left-hand edge of the paper, we re-enter again at the same height on the right-hand edge. The numbers on the successive curves denote the days of the month.

We have chosen an example from a sub-tropical region because it illustrates the remarkable regularity of the tides in a region where the weather is equable. Further, if the reader will note the successive high-waters or low-waters which follow one another on any one day, he will see a strongly marked "diurnal inequality," which would have been barely perceptible in a European tide-curve.

[3] See J. N. Shoolbred on datum levels, *Brit. Assoc. Reports* (1879).

§4. *Tide-Tables and the Degree of Accuracy in Tidal Prediction.*[1]—The connexion between the tides and the movements of the moon and sun is so obvious that tidal predictions were regularly made and published long before mathematicians had devoted their attention to them; and these predictions attained considerable success, although they were founded on empirical methods. During the 18th century, and even in the earlier part of the 19th, the art of prediction was regarded as a valuable family secret to be jealously guarded from the public. The best example of this kind of tide-table was afforded by Holden's tables for Liverpool, founded on twenty years of observation by a harbour-master named Hutchinson.[2]

Empirical Tide-tables.

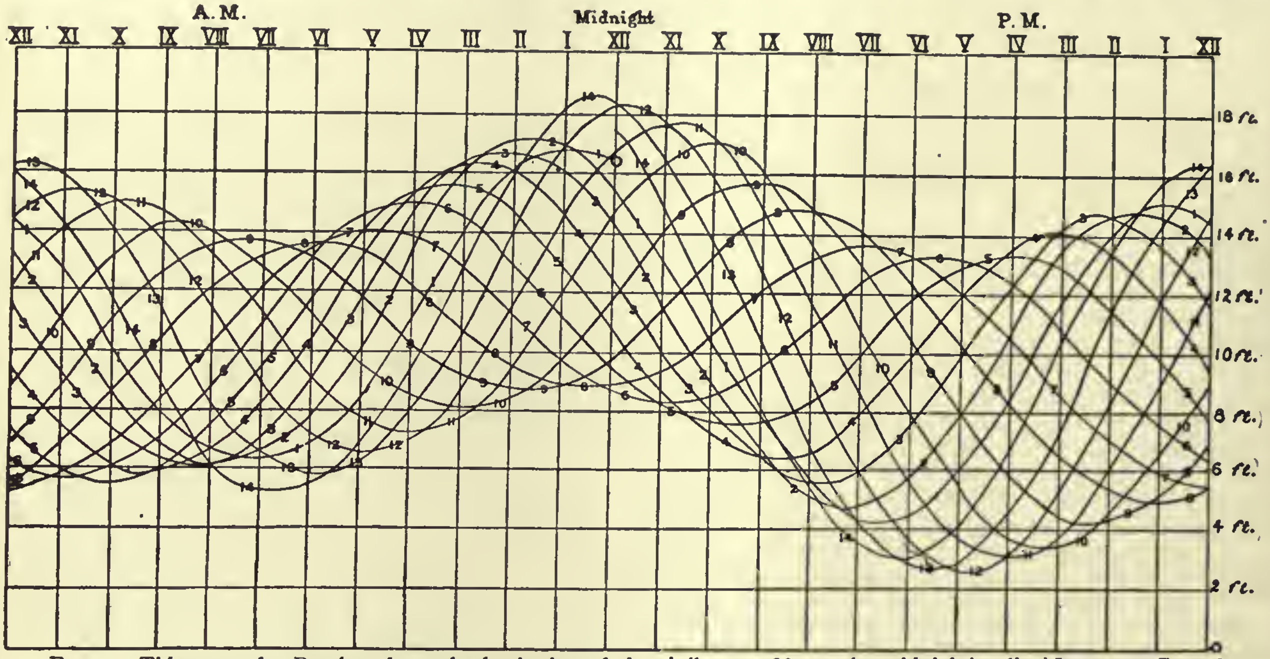

FIG. 1.—Tide-curve for Bombay from the beginning of the civil year 1884 to the midnight ending Jan. 14, 1884, or from 12^h Dec. 31, 1883, to 12^h Jan. 14, 1884, astronomical time. *Zero of Gauge*

About 1832 the researches of W. Whewell and of Sir John Lubbock (senior) pointed the way to improvement on the empirical tables prepared by secret methods, and since that time the preparation of tide-tables has become a branch of science.

A perfect tide-table would tell the height of the water at the place of observation at every moment of the day, but such a table would be cumbrous; it is therefore usual to predict only the times and heights of high-water and of low-water. The best kind of tide-table contains definite forecasts for each day of a definite year, and we may describe it as a special table. Although the table is only made for one definite place, yet it is often possible to give fairly accurate predictions for neighbouring ports by the application of corrections both for time and height. Special tide-tables are published by all civilized countries for their most important harbours.

Prediction for each Day.

But there is another kind of table, which we may describe as a general one, where the heights and times are given by reference to the time at which the moon crosses the meridian. Although such a table is only applicable to a definite place, yet it holds good for all time. In this case it is necessary to refer to the *Nautical Almanac* for the time of the moon's transit, and a simple calculation then gives the required result. In a general tide-table the heights and times are tabulated according to the hour of the clock at which the moon will cross the meridian at the place of observation, distinguishing between the visible and invisible transits. Certain simple corrections have also to be applied. A considerable degree of elaboration has to be given to the table, in order that it may give accurate results, and it would occupy some half-dozen to a dozen pages of a book, its extension varying according to the degree of accuracy aimed at. It might occupy about five minutes to extract a prediction from the more elaborate form of such a table. There are many ports of considerable commercial importance where, nevertheless, it would hardly be worth while to incur the great and repeated expenditure involved in the publication of special tables. But this kind of elaborate general table has been used in few cases,[3] and the information furnished to mariners usually consists either of a full prediction for every day of a future year, or of a meagre statement as to the average rise and interval, which must generally be almost useless.

Prediction by Reference to Time of Moon's Transit.

The success of tidal predictions varies much according to the place of observation. In stormy regions the errors are often considerable, and the utmost that can be expected of a tide-table is that it shall be correct with a steady barometer and in calm weather. But such conditions are practically non-existent, and therefore errors are inevitable.

Meteorological Disturbance of Prediction.

Notwithstanding these perturbations, tide-tables are usually of surprising accuracy even in northern latitudes; this may be seen from the following table showing the results of comparison between prediction and actuality at Portsmouth. The importance of the errors in height depends, of course, on the range of the tide; it is well, therefore, to note that the average ranges of the tide at springs and neaps are 13 ft. 9 in. and 7 ft. 9 in. respectively.

Amount of Error at Portsmouth.

Prediction at such a place as Portsmouth is difficult, on account of the instability of the weather, but, on the other hand, the tides in themselves are remarkably simple in character. Let us now turn to such a port as Aden, where the weather is very uniform, but the tides very complex on account of the large diurnal inequality, which frequently obliterates one of two successive high-waters. The short series of comparisons between actuality and prediction which we give below may be taken as a fair example of what would hold good when a long series is examined. The results refer to the intervals 10th of March to the 9th of April and the 12th of November to the 12th of December 1884. In these two periods there should have been 118 high waters, but the tide-gauge failed to register on one occasion,

Amount of Error at Aden.

[1] References may be given to two papers by G. H. Darwin on this subject, viz. "Tidal Prediction," *Phil. Trans.*, A. (1891) pp. 159–229; and "An apparatus for facilitating the reduction of tidal observations," *Proc. Roy. Soc.* (1892), vol. lii. For a general account without mathematics see Darwin's *Tides*, &c.; this section is founded on chs. xiii. and xiv. of that book. For mathematical methods see Maurice Lévy, *Théorie des marées* (Paris, 1898).

[2] Whewell, *History of Inductive Sciences*, ii. 248; Darwin's *Tides*, *&c.*, ch. iv.

[3] Darwin, "Tidal Prediction," quoted above. This kind of table has been applied with some success at Cairns in North Queensland, where there is a large diurnal inequality.

so that one comparison is lost. We thus have 117 cases to consider, but on one occasion the diurnal inequality obliterated a high-water, leaving 116 actual comparisons. The maximum range of the tide at Aden is 8 ft. 6 in., and this serves to give a standard of importance for the errors in height.

Table of Errors in the Prediction of High-Water at Portsmouth in the months of January, May and September 1897.

Time.		Height.	
Magnitude of Error.	Number of Cases.	Magnitude of Error.	Number of Cases.
		Inches.	
0^m to 5^m	69	0 to 6	89
6^m to 10^m	50	7 to 12	58
11^m to 15^m	25	13 to 18	24
16^m to 20^m	10	19 to 24	6
21^m to 25^m	11	—	—
26^m to 30^m	7	—	—
31^m to 35^m	4	—	—
52^m	1	—	—
—	177	—	177

Table of Errors in the Prediction of High-Water at Aden in March–April and November–December 1884.

Time.		Height.	
Magnitude of Error.	Number of Cases.	Magnitude of Error.	Number of Cases.
		Inches.	
0^m to 5^m	35	0	15
5^m to 10^m	32	1	48
10^m to 15^m	19	2	28
15^m to 20^m	19	3	14
20^m to 25^m	5	4	11
26^m and 28^m	2	No high water.	1
33^m and 36^m	2	—	—
56^m and 57^m	2	—	—
No high water.	1	—	—
—	117	—	117

It would be natural to think that when a prediction is erroneous by as much as fifty-seven minutes it is a very bad one, but such a conclusion may be unjust. There was one case in which the high-water was completely obliterated by the diurnal inequality, but there were many others in which there was nearly complete obliteration, so that the water stood nearly stagnant for several hours. A measure of the degree of stagnation is afforded by the amount of rise from low to high-water. Now, on examining all the eleven cases where the error of time was equal to or over twenty minutes, we find five cases in which the range from low to high-water was less than 8 in., and these include the errors of fifty-six and of fifty-seven minutes. There is one case of a rise of 13 in. with an error of thirty-six minutes; one case of a rise of 17 in. with an error of twenty-two minutes; one of 19 in. rise with thirty-three minutes error. The remaining three cases have rises of 2 ft. 10 in., 3 ft. 9 in., 3 ft. 11 in., and errors of twenty-two, twenty-three, twenty minutes. Thus all the very large errors of time correspond with approximate stagnation, and are unimportant. It is fair to conclude, therefore, that the predictions as to time are very good. The predictions as to height are obviously good, for more than half were within 1 in., and only eleven had an error of as much as 4 in.

When it is considered that the incessant variability of the tidal forces, the complex outlines of the coast, the depth of the sea, the earth's rotation and the perturbations by meteorological influences are all involved, it should be admitted that the success of tidal prediction is remarkable. If further evidence were needed, we might appeal to tidal prediction as a convincing proof of the truth of the theory of gravitation.

§ 5. *General Explanation of the Cause of Tides.*—The moon attracts every particle of the earth and ocean, and by the law of gravitation the force acting on any particle is directed towards the moon's centre, and is jointly proportional to the masses of the particle and of the moon, and inversely proportional to the square of the distance between the particle and the moon's centre. If we imagine the earth and ocean subdivided into a number of small portions or particles of equal mass, then the average, both as to direction and intensity of the forces acting on these particles is equal to the force acting on that particle which is at the earth's centre. For there is symmetry about the line joining the centres of the two bodies, and, if we divide the earth into two portions by an ideal spherical surface passing through the earth's centre and having its centre at the moon, the portion remote from the moon is a little larger than the portion towards the moon, but the nearer portion is under the action of forces which are a little stronger than those acting on the farther portion, and the resultant of the weaker forces on the larger portion is exactly equal to the resultant of the stronger forces on the smaller. If every particle of the earth and ocean were being urged by equal and parallel forces there would be no cause for relative motion between the ocean and the earth. Hence it is the departure of the force acting on any particle from the average which constitutes the tide-generating force. Now it is obvious that on the side of the earth towards the moon the departure from the average is a small force directed towards the moon; and on the side of the earth away from the moon the departure is a small force directed away from the moon. Also these two departures are very nearly equal to one another, that on the near side being so little greater than that on the other that we may neglect the excess. All round the sides of the earth along a great circle perpendicular to the line joining the moon and earth the departure is a force directed inwards towards the earth's centre. Thus we see that the tidal forces tend to pull the water towards and away from the moon, and to depress the water at right angles to that direction.

Tide-generating Forces.

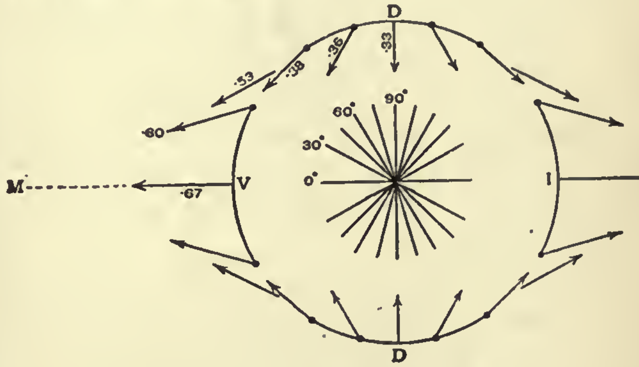

FIG. 2.—Tide-generating Force.

In fig. 2 this explanation is illustrated graphically. The relative magnitudes of the tidal forces are given by the numbers on the figure. M is the direction of the moon, V the centre of the hemisphere of the earth at which the man in the moon would look, I the centre of the hemisphere which would be invisible to him, DD are the sides of the earth where the tidal force is directed towards the earth's centre. The outward forces at V and I are exactly double the inward forces at D and D.

If it were permissible to neglect the earth's rotation and to consider the system as at rest, we should find that the water was in equilibrium when elongated into a prolate ellipsoidal or oval form with its longest axis directed towards and away from the moon.

Theory of Equatorial Canal on Earth.

But it must not be assumed that this would be the case when there is motion. For, suppose that the ocean consisted of a canal round the equator, and that an earthquake or any other cause were to generate a great wave in the canal, this wave would travel along it with a velocity dependent on the depth. If the canal were about 13 miles deep the velocity of the wave would be about 1000 miles an hour, and with depth about equal to the depth of our seas the velocity of the wave would be about half as great. We may conceive the moon's tide-generating force as making a wave in the canal and continually outstripping the wave it generates, for the moon travels along the equator at the rate of about 1000 miles an hour, and the sea is less than 13 miles deep. The resultant oscillation of the ocean must therefore be the summation of a series of partial waves generated at each instant by the moon and always falling behind her, and the aggregate wave, being the same at each instant, must travel 1000 m. an hour so as to keep up with the moon.

Now it is a general law of frictionless oscillation that, if a slowly varying periodic force acts on a system which would oscillate quickly if left to itself, the maximum excursion on one side of the equilibrium position occurs simultaneously with the maximum force in the direction of the excursion; but, if a quickly varying periodic force acts on a system which would oscillate slowly if left to itself, the maximum excursion on one side of the equilibrium position occurs simultaneously with the maximum force in the direction opposite to that of the excursion. An example of the first is a ball hanging by a short string, which we push slowly to and fro; the ball will never quit contact with the hand, and will agree with its excursions. If, however, the ball is hanging by a long string we can play at battledore and shuttlecock with it, and it always meets our blows. The latter is the analogue of the tides, for a free wave in our shallow canal goes slowly, whilst the moon's tide-generating action goes quickly. Hence when the system is left to settle into steady oscillation it is low-water under and opposite to the moon, whilst the forces are such as to tend to make high-water at those times.

Tides Inverted.

If in this case we consider the moon as revolving round the earth, the water assumes nearly the shape of an oblate spheroid or orange-shaped body with the shortest axis pointed to the moon. The rotation of the earth in the actual case introduces a complexity which it is not easy to unravel by general reasoning. We can see, however, that if water moves from a lower to a higher latitude it arrives at the higher latitude with more velocity from west to east than is appropriate to its latitude, and it will move accordingly on the earth's surface. Following out this conception, we see that an oscillation of the water to and fro between south and north must be accompanied by an eddy. The solution of the difficult problem involved in working out this idea will be given below.

The conclusion at which we have arrived about the tides of an equatorial canal is probably more nearly true of the tides of a globe partially covered with land than if we were to suppose the ocean at each moment to assume the prolate figure of equilibrium. In fact, observation shows that it is more nearly low-water than high-water when the moon is on the meridian. If we consider how the oscillation of the water would appear to an observer carried round with the earth, we see that he will have low-water twice in the lunar day, somewhere about the time when the moon is on the meridian, either above or below the horizon, and high-water half-way between the low waters.

If the sun be now introduced we have another similar tide of about half the height, and this depends on solar time, giving low-water somewhere about noon and midnight. The superposition of the two, modified by friction and by the interference of land, gives the actually observed aggregate tide, and it is clear that about new and full moon we must have spring tides and at quarter moons neap tides, and that (the sum of the lunar and solar tide-generating forces being about three times their difference) the range of spring tide will be about three times that of neap tide.

Sun's Influence.

So far we have supposed the luminaries to move on the equator; now let us consider the case where the moon is not on the equator. It is clear in this case that at any place the moon's zenith distance at the upper transit is different from her nadir distance at the lower transit. But the tide-generating force is greater the smaller the zenith or nadir distance, and therefore the forces are different at successive transits. This was not the case when the moon was deemed to move on the equator. Thus there is a tendency for two successive lunar tides to be of unequal heights, and the resulting inequality of height is called a "diurnal tide." This tendency vanishes when the moon is on the equator; and as this occurs each fortnight the lunar diurnal tide is evanescent once a fortnight. Similarly in summer and winter the successive solar tides are generally of unequal height, whilst in spring and autumn this difference is inconspicuous.

Diurnal Tides.

One of the most remarkable conclusions of Laplace's theory of the tides, on a globe covered with ocean to a uniform depth, is that the diurnal tide is everywhere non-existent. But this hypothesis differs much from the reality, and in fact at some ports, as for example Aden, the diurnal tide is so large that during two portions of each lunation there is only one great high-water and one great low-water in each twenty-four hours, whilst in other parts of the lunation the usual semi-diurnal tide is observed.

Evanescent in Ocean of Uniform Depth.

§ 6. *Progress of the Tide-wave over the Ocean and in the British Seas.*—Sufficient tidal data would give the state of the tide at every part of the world at the same instant of time, and if the tide wave is a progressive one, like such wave as we may observe travelling along a canal, we should be able to picture mentally the motion of the tide-wave over the ocean and the successive changes in the height of water at any one place. But we are not even sure that the wave is progressive, for in some oceans, such as perhaps the Atlantic, the motion may be only a see-saw about some line in mid-ocean—up on one side and down on the other; or it may more probably be partly a progressive wave and partly a see-saw or stationary oscillation. In contracted seas the wave is undoubtedly predominantly progressive in character, but too little is known to enable us to speak with any confidence as to wider seas.

Whewell and Airy, while acknowledging the uncertainty of their data, made the attempt to exhibit graphically the progress of the tide-wave over a large portion of the oceans of the world. In the first edition of this article (*Ency. Brit.*, 9th ed.) we reproduced their chart. But, since doubts as to its correctness have gradually accumulated, we think it more prudent to refrain from reproducing it again.[1]

As we have already indicated, the tide in British seas has mainly a progressive character, and the general march of the wave may be exhibited on a chart by what are called cotidal lines. If at the full and change of moon we draw lines on the sea through all the places which have high-water simultaneously, and if we mark such lines successively XII, I, II, &c., being the Greenwich time of high-water along each line, we shall have a succession of lines which show the progress of the wave from hour to hour.

For phases of the moon, other than full and change, the numbers may be taken to represent the interval in hours after the moon's transit, either visible or invisible, until the occurrence of high water. But for these other phases of the moon the interval varies by as much as one hour in excess or defect of the number written on any of the lines. Thus when the moon is about five days old, or five days past full, the numbers must all be reduced by about one hour so that I, II, III, &c., will then be replaced by XII, I, II, &c.; and when the moon is about ten days old, or ten days past full, the numbers must all be augmented by about one hour, and will read II, III, IV, &c. However, for a rough comprehension of the tides in these seas it is unnecessary to pay attention to this variation of the intervals.

Airy in his "Tides and Waves" gives such a chart for Great Britain and the North Sea, and he attempts to complete the cotidal lines conjecturally across the North Sea to Norway, Denmark and the German coast. In this case, as in the more ambitious attempt referred to above, further knowledge has led to further doubt. We therefore give in fig. 3 Berghaus's modification of Airy's Chart,[2] abandoning the attempt to draw complete cotidal lines. In this chart we can watch, as it were, the tide-wave running in from the Atlantic, passing up the Bristol Channel and Irish Sea, travelling round the north of Scotland and southward along the east coasts of Scotland and England. Another branch comes up the Channel, and meets the wave from the north off the Dutch coast. The Straits of Dover are so narrow, however, that it may be doubted whether

[1] Portion of Airy's Chart (*Encycl. Metrop.*, art. "Tides and Waves") is given in Darwin, *Tides and Kindred Phenomena in the Solar System.*

[2] Berghaus's *Physical Atlas* (1891), pt. ii., "Hydrography."

the tides on the English coasts would be profoundly modified if the Straits were completely closed.

It will be noticed that between Yarmouth and Holland the cotidal lines cross one another. Such an intersection of lines is in general impossible; it is indeed only possible if there is a region in which the water neither rises nor falls, because at such a place the cotidal line ceases to have a definite meaning. A set of observations by Captain Hewitt, R.N., made in 1840, appears to prove the existence of a region of this kind at the part of the chart referred to.

(From Berghaus's Atlas.) Emery Walker sc.

FIG. 3.—Cotidal Lines in British Seas.

§ 7. *Historical Sketch.*[1]—The writings of various Chinese, Arabic and Icelandic authors show that some attention was paid by them to the tides, but the several theories advanced are fantastic. It is natural that the writings of the classical authors of antiquity should contain but few references to the tides, for the Greeks and Romans lived on the shores of an almost tideless sea. Nevertheless, Strabo quotes from Posidonius a clear account of the tides on the Atlantic coast of Spain, and connects the tides correctly with the motion of the moon. He also gives the law of the tide in the Indian Ocean as observed by Seleucus the Babylonian, and the passage shows that Seleucus had unravelled the law which governs the diurnal inequality of the tide in that sea.

We shall not give any details as to the medieval speculations on the tides, but pass on at once to Newton, who in 1687 laid the foundation for all that has since been added to the theory of the tides when he brought his grand generalization of universal gravitation to bear on the subject. Johann Kepler had indeed at an early date recognized the tendency of the water of the ocean to move towards the centres of the sun and moon, but he was unable to submit his theory to calculation. Galileo expresses regret that so acute a man as Kepler should have produced a theory which appeared to him to reintroduce the occult qualities of the ancient philosophers. His own explanation referred the phenomenon to the rotation and orbital motion of the earth, and he considered that it afforded a principal proof of the Copernican system.

Kepler.

In the 19th corollary of the 66th proposition of bk. i. of the *Principia*, Sir Isaac Newton introduces the conception of a canal circling the earth, and he considers the influence of a satellite on the water in the canal. He remarks that the movement of each molecule of fluid must be accelerated in the conjunction and opposition of the satellite with the molecule, that is to say when the molecule, the earth's centre and the satellite are in a straight line, and retarded in the quadratures, that is to say when the line joining the molecule and the earth's centre is at right angles to the line joining the earth's centre and the satellite. Accordingly the fluid must undergo a tidal oscillation. It is, however, in propositions 26 and 27 of bk. iii. that he first determines the tidal force due to the sun and moon. The sea is here supposed to cover the whole earth and to assume at each instant a figure of equilibrium, and the tide-generating bodies are supposed to move in the equator. Considering only the action of the sun, he assumes that the figure is an ellipsoid of revolution with its major axis directed towards the sun, and he determines the ellipticity of such an ellipsoid. High solar tide then occurs at noon and midnight, and low-tide at sunrise and sunset. The action of the moon produces a similar ellipsoid, but of greater ellipticity. The superposition of these ellipsoids gives the principal variations of the tide. He then proceeds to consider the influence of latitude on the height of tide, and to discuss other peculiarities of the phenomenon. Observation shows, however, that spring tides occur a day and a half after full and change of moon, and Newton falsely attributed this to the fact that the oscillations would last for some time if the attractions of the two bodies were to cease.

Newton.

The Newtonian hypothesis, although it fails in the form which he gave to it, may still be made to represent the tides if the lunar and solar ellipsoids have their major axes always directed toward a fictitious moon and sun, which are respectively at constant distances from the true bodies; these distances are such that the full and change of the fictitious moon as illuminated by the fictitious sun occur about a day or a day and a half later than the true full and change of moon. In fact, the actual tides may be supposed to be generated directly by the action of the real sun and moon, and the wave may be imagined to take a day and a half to arrive at the port of observation. This period has accordingly been called "the age of the tide." In what precedes the sun and moon have been supposed to move in the equator; but the theory of the two ellipsoids cannot be reconciled with the truth when they move, as in actuality, in orbits inclined to the equator. At equatorial ports the theory of the ellipsoids would at spring tides give morning and evening high waters of nearly equal height, whatever the declinations of the bodies. But at a port in any other latitude these high waters would be of very different heights, and at Brest, for example, when the declinations of the bodies are equal to the obliquity of the elliptic, the evening tide would be eight times as great as the morning tide. Now observation shows that at this port the two tides are nearly equal to one another, and that their greatest difference is not a thirtieth of their sum. Newton here also offered an erroneous explanation of the phenomenon.

"Astres Fictifs."

Age of Tide.

In 1738 the Academy of Sciences of Paris offered, as a subject for a prize, the theory of the tides. The authors of four essays received prizes, viz. Daniel Bernoulli, Leonhard Euler, Colin Maclaurin and Antoine Cavalleri. The first three adopted not only the theory of gravitation, but also Newton's method of the superposition of the two ellipsoids. Bernoulli's essay contained an extended development of the conception of the two ellipsoids, and, under the name of the equilibrium theory, it is commonly associated with his name. Laplace gives an account and critique of the essays of Bernoulli and Euler in the *Mécanique céleste.* The essay of Maclaurin presented little that was new in tidal theory, but is notable as containing certain important theorems concerning the attraction of ellipsoids. In 1746 Jean-le-Rond D'Alembert wrote a paper in which he treated the tides of the atmosphere; but this work, like Maclaurin's, is chiefly remarkable for the importance of collateral points.

D. Bernoulli and Others.

The theory of the tidal movements of an ocean was therefore, as Laplace remarks, almost untouched when in 1774 he first undertook the subject. In the *Mécanique céleste* he gives an

[1] The account from the time of Newton to that of Laplace is founded on Laplace's *Mécanique céleste*, bk. xiii. ch. i.

interesting account of the manner in which he was led to attack the problem. We shall give below the investigation of the tides of an ocean covering the whole earth; the theory is substantially Laplace's, although presented in a different form, and embodying an important extension of Laplace's work by S. S. Hough. This theory, although very wide, is far from representing the tides of our ports. Observation shows, in fact, that the irregular distribution of land and water and the various depths of the ocean in various places produce irregularities in the oscillations of the sea of such complexity that the rigorous solution of the problem is altogether beyond the power of analysis. Laplace, however, rested his discussion of tidal observation on this principle—*The state of oscillation of a system of bodies in which the primitive conditions of movement have disappeared through friction is coperiodic with the forces acting on the system.* Hence if the sea is acted on by forces which vary periodically according to the law of simple oscillations (a simple time-harmonic), the oscillation of the sea will have exactly the same period, but the moment at which high-water will occur at any place and the amplitude of the oscillation can only be derived from observation. Now the tidal forces due to the moon and sun may be analysed into a number of constituent periodic parts of accurately determinable periods, and each of these will generate a corresponding oscillation of the sea of unknown amplitude and phase. These amplitudes and phases may be found from observation. But Laplace also used another principle, by which he was enabled to effect a synthesis of the various oscillations, so that he does not discuss a very large number of these constituent oscillations. As, however, it is impossible to give a full account of Laplace's methods without recourse to technical language, it must suffice to state here that this procedure enabled him to discuss the tides at any port by means of a combination of theory with observation. After the time of Laplace down to 1870, the most important workers in this field were Sir John Lubbock (senior), William Whewell and Sir G. B. Airy. The work of Lubbock and Whewell (see § 33 below) is chiefly remarkable for the co-ordination and analysis of enormous masses of data at various ports, and the construction of trustworthy tide-tables and the attempt to construct cotidal maps. Airy contributed an important review of the whole tidal theory. He also studied profoundly the theory of waves in canals, and explained the effects of frictional resistance on the progress of tidal and other waves.

Laplace.

Principle of Forced Oscillations.

Lubbock, Whewell and Airy.

The comparison between tidal theory and tidal observations has been carried out in two ways which we may describe as the synthetic and the analytic methods. Nature is herself synthetic, since at any one time and place we only observe one single tide-wave. All the great investigators from Newton down to Airy have also been synthetic in their treatment, for they have sought to represent the oscillation of the sea by a single mathematical expression, as will appear more fully in chapter V. below. It is true that a presupposed analysis lay behind and afforded the basis of the synthesis. But when at length tide-gauges, giving continuous records, were set up in many places the amount of data to be co-ordinated was enormously increased, and it was found that the simple formulae previously in use had to be overloaded with a multitude of corrections, so that the simplicity became altogether fictitious. This state of matters at length led Lord Kelvin (then Sir William Thomson) to suggest, about 1870, the analytic method, in which the attempt at mathematical synthesis is frankly abandoned and the complex whole is represented as the sum of a large number of separate parts, each being a perfectly simple wave or harmonic oscillation. All the best modern tidal work is carried on by the analytic method, of which we give an account below in chapter IV.

Kelvin.

Lord Kelvin's other contributions to tidal theory are also of profound importance; in particular we may mention that he established the correctness of Laplace's procedure in discussing the dynamical theory of the tides of an ocean covering the whole earth, which had been impugned by Airy and by William Ferrel. We shall have frequent occasion to refer to his name hereafter in the technical part of this article.

Amongst all the grand work which has been bestowed on the theory of this difficult subject, Newton, notwithstanding his errors, stands out first, and next to him we must rank Laplace. However original any future contribution to the science of the tides may be, it would seem as though it must perforce be based on the work of these two.

§ 8. *The Tide-Predicting Instrument.*—In the field of the practical application of theory Lord Kelvin also made another contribution of the greatest interest, when in 1872 he suggested that the laborious task of constructing a tide-table might be effected mechanically. Edward Roberts bore a very important part in the first practical realization of such a machine, and a tide-predictor now in regular use at the National Physical Laboratory for the Indian government was constructed by Légé under his direction. We refer the reader to Sir William Thomson's (Lord Kelvin's) paper on "Tidal Instruments" in *Inst. C.E.*, vol. lxv., and to the subsequent discussion, for a full account and for details of the share borne by the various persons concerned in the realization of the idea.

Tide-Predicting Instrument.

Fig. 4 illustrates diagrammatically the nature of the instrument. A cord passes over and under a succession of pulleys, every other pulley being fixed or rather balanced and the alternate ones being movable; the cord is fixed at one end and carries a pen or pencil at the other end. In the diagram there are two balanced pulleys and one movable one; a second unit would require one more movable pulley and one more balanced one. If, in our diagram, the lowest or movable pulley were made to oscillate up and down (with a simple harmonic motion), the pencil would execute the same motion on half the linear scale. If the instrument possessed two units and the second movable pulley also rocked up and down, the pencil would add to its previous motion that of this second oscillation, again on half scale. So also if there were any number of additional units, each consisting of one movable and one balanced pulley, the pencil would add together all the separate simple oscillations, and would draw a curve upon a drum, which is supposed to be kept revolving uniformly at an appropriate rate.

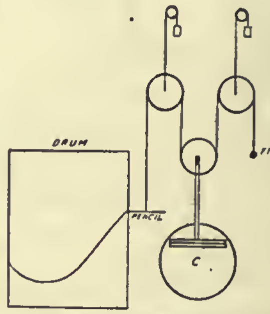

FIG. 4.—Tide-Predicting Instrument.

The rocking motion is communicated to each movable pulley by means of a pin attached to a wheel C sliding in a slot attached to the pulley frame. All the wheels C and the drum are geared together so that, as the drum turns, all the movable pulleys rock up and down. The gearing is of such a nature that if one revolution of the drum represents a single day, the rocking motion of each movable pulley corresponds to one of the simple constituent oscillations or tides into which the aggregate tide-wave is analysed. The nature of the gearing is determined by theoretical considerations derived from the motions of the sun and moon and earth, but the throw of each crank, and the angle at which it has to be set at the start are derived from observation at the particular port for which the tide-curve is required. When the tide-predictor has been set appropriately, it will run off a complete tide-curve for a whole year; the curve is subsequently measured and the heights and times of high and low-water are tabulated and published for a year or two in advance.

The Indian instrument possesses about 20 units, so that the tide-curve is regarded as being the sum of 20 different simple tides; and tide-tables are published for 40 Indian and Oriental ports. A tide-predictor has been constructed for the French government under the supervision of Lord Kelvin and is in use at Paris; another has been made by the United States Coast Survey at Washington; in 1910 one was under construction for the Brazilian government. These instruments, although differing considerably in detail from the Indian predictor, are essentially the same in principle.

§ 9. *Tidal Friction.*—All solid bodies yield more or less to stress; if they are perfectly elastic they regain their shapes after the stresses are removed, if imperfectly elastic or viscous they yield to the stresses. We may thus feel certain that the earth yields to tide-generating force, either with perfect or imperfect elasticity. Chapter VIII. will contain some discussion of this subject, and it must suffice to say here that the measurement of the minute elastic tides of the solid earth has at length been achieved. The results recently obtained by Dr O. Hecker at Potsdam constitute a conspicuous advance on all the previous attempts.

The tides of an imperfectly elastic or viscous globe are obviously subject to frictional resistance, and the like is true of the tides of an actual ocean. In either case it is clear that the system must be losing energy, and this leads to results of so much general interest that we propose to give a short sketch of the subject, deferring to chapter VIII. a more rigorous investigation. It is unfortunately impossible to give even an outline of the principles involved without the use of some technical terms.

General Explanation of Tidal Friction.

In fig. 5 the paper is supposed to be the plane of the orbit of a satellite M revolving in the direction of the arrow about the planet C, which rotates in the direction of the arrow about an axis perpendicular to the paper. The rotation of the planet is supposed to be more rapid than that of the satellite, so that the day is shorter than the month. Let us suppose that the planet is either entirely fluid, or has an ocean of such depth that it is high-water under or nearly under the satellite. When there is no friction, with the satellite at *m*, the planet is elongated into the ellipsoidal shape shown, cutting the mean sphere, which is dotted. The tidal protuberances are drawn with much exaggeration and the satellite is shown as very close to the planet in order to illustrate the principle more clearly. Now, when there is friction in the fluid motion, the tide is retarded, and high-tide occurs after the satellite has passed the meridian. Then, if we keep the same figure to represent the tidal deformation, the satellite must be at M, instead of at *m*. If we number the four quadrants as shown, the satellite must be in quadrant 1. The protuberance P is nearer to the satellite than P′, and the deficiency Q is farther away than the deficiency Q′. Hence the resultant action of the planet on the satellite must be in some such direction as MN. The action of the satellite on the planet is equal and opposite, and the force in NM, not being through the planet's centre, must produce a retarding couple on the planet's rotation, the magnitude of which depends on the length of the arm CN. This tidal frictional couple varies as the height of the tide, and as the satellite's distance. The magnitude of the tidal protuberances varies inversely as the cube of the distance of the satellite, and the difference between the attractions of the satellite on the nearer and farther protuberances also varies inversely as the cube of the distance. Accordingly the tidal frictional couple varies as the inverse sixth power of the satellite's distance. Let us now consider its effect on the satellite. If the force acting on M be resolved along and perpendicular to the direction CM, the perpendicular component tends to accelerate the satellite's velocity. It alone would carry the satellite farther from C than it would be dragged back by the central force towards C. The satellite would describe a spiral, the coils of which would be very nearly circular and very nearly coincident. If now we resolve the central component force along CM tangentially and perpendicular to the spiral, the tangential component tends to retard the velocity of the satellite, whereas the disturbing force, already considered, tends to accelerate it. With the gravitational law of force between the two bodies the retardation must prevail over the acceleration.[1] The action of tidal friction may appear somewhat paradoxical, but it is the exact converse of the acceleration of the linear and angular velocity and the diminution of distance of a satellite moving through a resisting medium. The latter result is generally more familiar than the action of tidal friction, and it may help the reader to realize the result in the present case. Tidal friction then diminishes planetary rotation, increases the satellite's distance and diminishes the orbital angular velocity. The comparative rate of diminution of the two angular velocities is generally very different. If the satellite be close to the planet the rate of increase of the satellite's periodic time or month is large compared with the rate of increase of the period of planetary rotation or day; but if the satellite is far off the converse is true. Hence, if the satellite starts very near the planet, with the month a little longer than the day, as the satellite

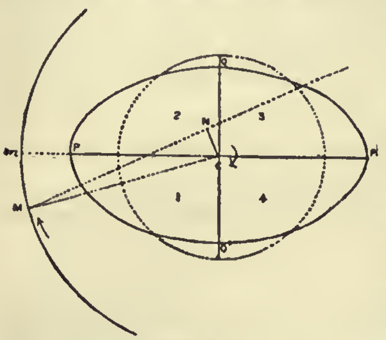

FIG. 5.

Planet's Rotation Retarded.

Satellite's Velocity Retarded.

[1] This way of presenting the action of tidal friction is due to Sir George G. Stokes.

recedes, the month soon increases so that it contains many days. The number of days in the month attains a maximum and then diminishes. Finally the two angular velocities subside to a second identity, the day and month being identical and both very long.

We have supposed that the ocean is of such depth that the tides are direct; if, however, they are inverted, with low-water under or nearly under the satellite, friction, instead of retarding, accelerates the tide; and it would be easy by drawing another figure to see that the whole of the above conclusions would hold equally true with inverted tides.

Attempts have been made to estimate the actual amount of the retardation of the earth's rotation, but without much success. It must be clear from the sketch just given that the effect of tidal friction is that the angular motion of the moon round the earth is retarded, but not to so great an extent as the earth's rotation. Thus a terrestrial observer, who regards the earth as a perfect timekeeper, would look on the real retardation of the moon's angular motion as being an acceleration. Now there is a true acceleration of the moon's angular motion which depends on a slow change in the eccentricity of the earth's orbit round the sun. After many thousands of years this acceleration will be reversed and it will become a retardation, but it will continue for a long time from now into the future; thus it is indistinguishable to us at present from a permanent acceleration. The amount of this true acceleration may be derived from the theories of the motions of the moon and of the earth when correctly developed. Laplace conceived that its observed amount was fully explained in this way, but John Couch Adams showed that Laplace had made a mistake and had only accounted for half of it. It thus appeared that there was an unexplained portion which might be only apparent and might be attributed to the effects of tidal friction.

The time and place of an eclipse of the sun depend on the motions of the moon and earth. Accordingly the records of ancient eclipses, which occurred centuries before the Christian era, afford exceedingly delicate tests of the motions of the moon and earth. At the time when Thomson and Tait's *Natural Philosophy*[2] was first published it was thought that all the numerical data were known with sufficient precision to render it possible to give a numerical estimate of the retardation of the earth's rotation. But the various revisions of the lunar theory which have been made since that date throw the whole matter into doubt. It seems probable that there is some portion of the acceleration of the moon's motion which is unexplained by gravitation, and may therefore be attributed to tidal friction, but its amount is uncertain. We can only say that the amount is very small. It is, however, not impossible that this smallness may be due to counteracting influences which tend to augment the speed of the earth's rotation; such an augmentation would result from shrinkage of the earth's mass through cooling. However this matter may stand, it does not follow that, because the changes produced by tidal friction in a man's lifetime or in many generations of man are almost insensible, the same must be true when we deal with millions of years. It follows that it is desirable to trace the effects of tidal friction back to their beginnings.

We have seen above that this cause will explain the repulsion of a satellite from a position close to the planet to a more remote distance. Now when we apply these considerations to the moon and earth we find that the moon must once have been nearly in contact with the earth. This very remarkable initial configuration of the two bodies seems to point to the origin of the moon by detachment from the earth.

Further details concerning this speculation in cosmogony are given below in chapter VIII.[3]

§ 10. *Bibliography.*—Many works on popular astronomy contain a few paragraphs on the tides, but the treatment is generally so meagre as to afford no adequate idea of the whole subject.

A complete list of works both general and technical bearing on the *theory* of the tides, from the time of Newton down to 1881, is contained in vol. ii. of the *Bibliographie de l'astronomie* by J. C. Houzeau and A. Lancaster (1882). This list does not contain papers on the tides of particular ports, and we are not aware of the existence of any catalogue of works on practical observation, reduction of observations, prediction and tidal instruments. The only general work on the tides, without mathematics, is George Darwin's *Tides and Kindred Phenomena in the Solar System.*[4] This book treats of all the subjects considered in the present article (with references to original sources), and also others such as seiches (*q.v.*) and the bore (*q.v.*).

The most extensive monograph on the tides is *A Manual of Tides* by Mr Rollin A. Harris, published by the United States Coast Survey in a series of parts, of which pt. i. appeared in 1897, and pt. iv.

[2] See that work (ed. 1883), § 830; P. H. Cowell, *M. N. R. Ast. Soc.* (1905), lxv. 861.

[3] For a discussion of the subject without mathematics, see G. H. Darwin's *Tides*.

[4] London (1898) and with important changes (1901, 1911); (Boston, 1898); translations: German, by A. Pockels (Leipzig, 1902, 1911); Italian, by G. Magrini (Turin, 1905), with appendices by translator; Magyar, by Radó von Kövesligethy (Budapest, 1904), with appendices by translator.

B in 1904. This work contains an enormous mass of useful work, and gives not only complete technical developments both on the theoretical and practical sides but also has chapters of general interest. The present writer feels it his duty, however, to dissent from Mr Harris's courageous attempt to construct the cotidal lines of the various oceans.

This work contains the most complete account of the history of tidal theories of which we know. Laplace's admirable history of the subject down to his own time has been summarized in § 7. Dr Giovanni Magrini has an appendix to his translation of Darwin's book, entitled *La Conoscenza della marea nell'antichità*, founded on the researches of Dr Roberto Almagià. Dr Almagià himself gives the results of his researches more fully in a memoir, presented to the Accademia dei Lincei of Rome (5th series, vol. v. fascic. x., 1905, 137 pp).

Another monograph on tides, treating especially the mathematical developments, is Maurice Lévy's *La Théorie des marées* (Paris, 1898). Colonel Baird's *Manual of Tidal Observation* (1886) contains instructions for the installation of tide-gauges, and auxiliary tables for harmonic analysis. Airy's article on "Tides and Waves" in the *Ency. Metrop.*, although superseded in many respects, still remains important. Harris's *Manual* contains a great collection of results of tidal observations made at ports all over the world.

The article "Die Bewegung der Hydrosphäre" in the *Encyklopädie der mathematischen Wissenschaften* (vi. 1, 1908) gives a technical account of the subject, with copious references. The same article is given in English in vol. iv. (1911) of G. H. Darwin's collected *Scientific Papers*; and vols. i. and ii. contain reprints of the several papers by the same author referred to in the present article.

Since the date of the 9th edition of the *Ency. Brit.* some technical discussion of the tides has appeared in textbooks, such as H. Lamb's *Hydrodynamics*.[1] That work also reproduces in more modern form Airy's investigation of the effects of friction on the tides of rivers. We are thus able to abridge the present article, but we shall present the extension by Hough of Laplace's theory of the tides of an ocean-covered planet, which is still only to be found in the original memoirs.

II.—Tide-Generating Forces

§ 11. *Investigations of Tide-Generating Potential and Forces.*—We have already given a general explanation of the nature of tide-generating forces; we now proceed to a rigorous investigation. If a planet is attended by a single satellite, the motion of any body relatively to the planet's surface is found by the process described as reducing the planet's centre to rest. The planet's centre will be at rest if every body in the system has impressed on it a velocity equal and opposite to that of the planet's centre; and this is accomplished by impressing on every body an acceleration equal and opposite to that of the planet's centre.

Tide-Generating Forces.

Let M, m be the masses of the planet and the satellite; r the radius vector of the satellite, measured from the planet's centre; ρ the radius vector, measured from same point, of the particle whose motion we wish to determine; and z the angle between r and ρ. The satellite moves in an elliptic orbit about the planet, and the acceleration relatively to the planet's centre of the satellite is $(M+m)/r^2$ towards the planet along the radius vector r. Now the centre of inertia of the planet and satellite remains fixed in space, and the centre of the planet describes an orbit round that centre of inertia similar to that described by the satellite round the planet but with linear dimensions reduced in the proportion of m to $M+m$. Hence the acceleration of the planet's centre is m/r^2 towards the centre of inertia of the two bodies. Thus, in order to reduce the planet's centre to rest, we apply to every particle of the system an acceleration m/r^2 parallel to r, and directed from satellite to planet.

Now take a set of rectangular axes fixed in the planet, and let $\mathrm{M}_1 r$, $\mathrm{M}_2 r$, $\mathrm{M}_3 r$ be the co-ordinates of the satellite referred thereto; and let $\xi\rho$, $\eta\rho$, $\zeta\rho$ be the co-ordinates of the particle P whose radius vector is ρ. Then the component accelerations for reducing the planet's centre to rest are $-m\mathrm{M}_1/r^2$, $-m\mathrm{M}_2/r^2$, $-m\mathrm{M}_3/r^2$; and since these are the differential coefficients with respect to $\rho\xi$, $\rho\eta$, $\rho\zeta$ of the function

$$-\frac{m\rho}{r^2}(\mathrm{M}_1\xi+\mathrm{M}_2\eta+\mathrm{M}_3\zeta),$$

and since $\cos z=\mathrm{M}_1\xi+\mathrm{M}_2\eta+\mathrm{M}_3\zeta$, it follows that the potential of the forces by which the planet's centre is to be reduced to rest is

$$-\frac{m\rho}{r^2}\cos z.$$

Now let us consider the other forces acting on the particle. The planet is spheroidal, and therefore does not attract equally in all directions; but in this investigation we may make abstraction of the ellipticity of the planet and of the ellipticity of the ocean due to the planetary rotation. This, which we set aside, is considered in the theories of gravity and of the figures of planets. Outside its body, then, the planet contributes forces of which the potential is M/ρ. Next the direct attraction of the satellite contributes forces of which the potential is the mass of the satellite divided by the distance between the point P and the satellite; this is

$$\frac{m}{\sqrt{\{r^2+\rho^2-2r\rho\cos z\}}}.$$

To determine the forces from this potential we regard ρ and z as the variables for differentiation, and we may add to this potential any constant we please. As we are seeking to find the forces which urge P relatively to M, we add such a constant as will make the whole potential at the planet's centre zero, and thus we take as the potential of the forces due to the attraction of the satellite

$$\frac{m}{\sqrt{\{r^2+\rho^2-2r\rho\cos z\}}}-\frac{m}{r}.$$

It is obvious that in the case to be considered r is very large compared with ρ, and we may therefore expand this in powers of ρ/r. This expansion gives us

$$\frac{m}{r}\left\{\frac{\rho}{r}P_1+\frac{\rho^2}{r^2}P_2+\frac{\rho^3}{r^3}P_3+\dots\right\},$$

where $P_1=\cos z$, $P_2=\frac{3}{2}\cos^2 z-\frac{1}{2}$, $P_3=\frac{5}{2}\cos^3 z-\frac{3}{2}\cos z$, &c. The reader familiar with spherical harmonic analysis of course recognizes the zonal harmonic functions; but the result for a few terms, which is all that is necessary, is easily obtainable by simple algebra.

Now, collecting together the various contributions to the potential, and noticing that $\frac{m}{r}\cdot\frac{\rho}{r}P_1=\frac{m\rho}{r^2}\cos z$, and is therefore equal and opposite to the potential by which the planet's centre was reduced to rest, we have as the potential of the forces acting on a particle whose co-ordinates are $\rho\xi$, $\rho\eta$, $\rho\zeta$

$$\frac{M}{\rho}+\frac{m\rho^2}{r^3}\left(\tfrac{3}{2}\cos^2 z-\tfrac{1}{2}\right)+\frac{m\rho^3}{r^4}\left(\tfrac{5}{2}\cos^3 z-\tfrac{3}{2}\cos z\right)+\dots \quad (1)$$

The first term of (1) is the potential of gravity, and the terms of the series, of which two only are written, constitute the tide-generating potential. In all practical applications this series converges so rapidly that the first term is amply sufficient, and thus we shall generally denote

Potential.

$$V=\frac{3m}{2r^3}\rho^2\left(\cos^2 z-\tfrac{1}{3}\right) \quad (2)$$

as the tide-generating potential.[2]

At the surface of the earth ρ is equal to a the earth's radius.

§ 12. *Form of Equilibrium.*—Consider the shape assumed by an ocean of density σ, on a planet of mass M, density δ and radius a, when acted on by disturbing forces whose potential is a solid spherical harmonic of degree i, the planet not being in rotation.

If S_i denotes a surface spherical harmonic of order i, such a potential is given at the point whose radius vector is ρ by

$$V=\frac{3ma^2}{2r^3}\left(\frac{\rho}{a}\right)^i S_i. \quad (3)$$

In the case considered in § 11, $i=2$ and S_i becomes the second zonal harmonic $\cos^2 z-\frac{1}{3}$.

The theory of harmonic analysis tells us that the form of the ocean, when in equilibrium, must be given by the equation

$$\rho=a+e_iS_i. \quad (4)$$

Our problem is to evaluate e_i. We know that the external potential of a layer of matter, of depth e_iS_i and density σ, has the value

$$\frac{4\pi\sigma a}{2i+1}\left(\frac{a}{\rho}\right)^{i+1}e_iS_i.$$

Hence the whole potential externally to the planet and up to its surface is

$$\frac{M}{\rho}+\frac{3ma^2}{2r^3}\left(\frac{\rho}{a}\right)^i S_i+\frac{4\pi\sigma a}{2i+1}\left(\frac{a}{\rho}\right)^{i+1}e_iS_i. \quad (5)$$

The first and most important term is the potential of the planet, the second that of the disturbing force, and the third that of the departure from sphericity.

Since the ocean must stand in a level surface, the expression (5) equated to a constant must be another form of (4). Hence, if we put $\rho=a+e_iS_i$ in the first term of (5) and $\rho=a$ in the second and third terms, (5) must be constant; this can only be the case if the

[1] The theory as presented in the *Mécanique céleste* is unnecessarily difficult, and was much criticized by Airy. Before the publication of the 9th and 10th editions of the *Ency. Brit.* it was necessary for the student to read a number of controversial papers published all over the world in order to get at the matter.

[2] The reader may refer to Thomson and Tait's *Natural Philosophy* (1883), pt. ii. §§ 798–821, for further considerations on this and analogous subjects, together with some interesting examples.

coefficient of S_i vanishes. Hence on effecting these substitutions and equating that coefficient to zero, we find

$$-\frac{M}{a^2}e_i+\frac{3ma^2}{2r^3}+\frac{4\pi\sigma a}{2i+1}e_i=0.$$

But by the definitions of δ and a we have $M=\frac{4}{3}\pi\delta a^3=ga^2$, where g is gravity, and therefore

$$e_i=\frac{\dfrac{3ma^2}{2gr^3}}{1-\dfrac{3\sigma}{(2i+1)\delta}}. \tag{6}$$

In the particular case considered in § 11 we therefore have

$$\rho=a\left[1+\frac{3ma^2/2gr^3}{1-3\sigma/5\delta}(\cos^2 z-\tfrac{1}{3})\right] \tag{7}$$

as the equation to the equilibrium tide under the potential

$$V=\frac{3m}{2r^3}\rho^2(\cos^2 z-\tfrac{1}{3}).$$

If σ were very small compared with δ the attraction of the water on itself would be very small compared with that of the planet on the water; hence we see in the general case that $1/\left(1-\frac{3\sigma}{(2i+1)\delta}\right)$ is the factor by which the mutual gravitation of the ocean augments the deformation due to the external forces. This factor will occur frequently hereafter, and therefore for brevity we write

$$b_i=1-\frac{3\sigma}{(2i+1)\delta}, \tag{8}$$

and we may put (6) in the form

$$e_i=\frac{3ma^2}{2gr^3b_i}. \tag{9}$$

Comparison with (5) then shows that

$$V=gb_i\left(\frac{\rho}{a}\right)^i e_iS_i \tag{10}$$

is the potential of the disturbing forces under which

$$\rho=a+e_iS_i \tag{11}$$

is a figure of equilibrium.

We are thus provided with a convenient method of specifying any disturbing force by means of the figure of equilibrium which it is competent to maintain. In considering the dynamical theory of the tides on an ocean-covered planet, we shall specify the disturbing forces in the manner expressed by (10) and (11). This way of specifying a disturbing force is equally exact whether or not we choose to include the effects of the mutual attraction of the ocean. If the augmentation due to mutual attraction of the water is not included, b_i becomes equal to unity; there is no longer any necessity to use spherical harmonic analysis, and we see that if the equation to the surface of an ocean be

$$\rho=a+S,$$

where S is a function of latitude and longitude, it is in equilibrium under forces due to a potential whose value at the surface of the sphere (where $\rho=a$) is gS.

In treating the theory of tidal observation we shall specify the tide-generating forces in this way, and then by means of "the principle of forced vibrations," referred to in § 7 as used by Laplace for discussing the actual oscillations of the sea, we shall pass to the actual tides at the port of observation.

Effect of Land in Equilibrium Theory.

In this equilibrium theory it is assumed that the figure of the ocean is at each instant one of equilibrium under the action of gravity and of the tide-generating forces. Lord Kelvin has, however, reasserted[1] a point which was known to Bernoulli, but has since been overlooked, namely, that this law of rise and fall of water cannot, when portions of the globe are continents, be satisfied by a constant volume of water in the ocean. The necessary correction to the theory depends on the distribution of land and sea, but a numerical solution shows that it is practically of very small amount.

§ 13. *Development of Tide-generating Potential in Terms of Hour-Angle and Declination.*—We now proceed to develop the tide-generating potential, and shall of course implicitly (§ 12) determine the equation to the equilibrium figure.

We have already seen that, if z be the moon's zenith distance at the point P on the earth's surface, whose co-ordinates referred to A, B, C, axes fixed in the earth, and $a\xi$, $a\eta$, $a\zeta$,

$$\cos z=\xi M_1+\eta M_2+\zeta M_3,$$

where M_1, M_2, M_3 are the moon's direction cosines referred to the same axes. Then, with this value of $\cos z$,

$$\cos^2 z-\tfrac{1}{3}=2\xi\eta M_1M_2+2\frac{\xi^2-\eta^2}{2}\frac{M_1^2-M_2^2}{2}+2\eta\zeta M_2M_3+2\xi\zeta M_1M_3$$
$$+\tfrac{3}{2}\cdot\frac{\xi^2+\eta^2-2\zeta^2}{3}\,\frac{M_1^2+M_2^2-2M_3^2}{3}. \tag{12}$$

[1] Thomson and Tait, *Nat. Phil.* § 807. G. H. Darwin and H. H. Turner, *Proc. Roy. Soc.* (1886).

The axis of C is taken as the polar axis, and AB is the equatorial plane, so that the functions of ξ, η, ζ are functions of the latitude and longitude of the point P, at which we wish to find the potential.

The functions of M_1, M_2, M_3 depend on the moon's position, and we shall have occasion to develop them in two different ways—first in terms of her hour-angle and declination, and secondly (§ 25) in terms of her longitude and the elements of the orbit.

Now let A be on the equator in the meridian of P, and B 90° east of A on the equator. Then, if M be the moon, the inclination of the plane MC to the plane CA is the moon's easterly local hour-angle. Let h_0 = Greenwich westward hour-angle; l = the west longitude of the place of observation; λ = the latitude of the place; δ = moon's declination: then we have

$$M_1=\cos\delta\cos(h_0-l),\ M_2=-\cos\delta\sin(h_0-l),\ M_3=\sin\delta,$$
$$\xi=\cos\lambda,\ \eta=0,\ \zeta=\sin\lambda.$$

Also the radius vector of the place of observation on the earth's surface is a. Whence we find

$$V=\frac{3ma^2}{2r^3}\left\{\tfrac{1}{3}\cos^2\lambda\cos^2\delta\cos 2(h_0-l)+\sin 2\lambda\sin\delta\cos\delta\cos(h_0-l)\right.$$
$$\left.+\tfrac{3}{2}(\tfrac{1}{3}-\sin^2\delta)(\tfrac{1}{3}-\sin^2\lambda)\right\} \tag{13}$$

The tide-generating forces are found by the rates of variation of V for latitude and longitude, and also for radius a, if we care to find the radial disturbing force.

Potential Developed in Hour-angle and Declination.

The westward component of the tide-generating force at the earth's surface, where $\rho=a$, is $dV/a\cos\lambda dl$, and the northward component is $dV/ad\lambda$; the change of apparent level is the ratio of these to gravity g. On effecting the differentiations we find that the westward component is made up of two periodic terms, one going through its variations twice and the other once a day. The southward component has also two similar terms; but it has a third very small term, which does not oscillate about a zero value. This last term corresponds to forces which produce a constant heaping up of the water at the equator; or, in other words, the moon's attraction has the effect of causing a small permanent ellipticity of the earth's mean figure. This augmentation of ellipticity is of course very small, but it is necessary to mention it.

If we consider the motion of a pendulum-bob under the influence of these forces during any one day, we see that in consequence of the semi-diurnal changes of level it twice describes an ellipse with major axis east and west, and the formula when developed shows that the ratio of axes is equal to the sine of the latitude, and the linear dimensions proportional to $\cos^2\delta$. It describes once a day an ellipse whose north and south axis is proportional to $\sin 2\delta\cos 2\lambda$ and whose east and west axis is proportional to $\sin 2\delta\sin\lambda$. Obviously the latter is circular in latitude 30°. When the moon is on the equator, the maximum deflexion occurs when the moon's local hour-angle is 45°, and is then equal to

$$\frac{3m}{2M}\left(\frac{a}{r}\right)^3\cos\lambda.$$

This angle is equal to 0·0174″ $\cos\lambda$. Attempts actually to measure the deflexion of the vertical have at length proved successful (see SEISMOMETER).

III.—DYNAMICAL THEORY OF THE TIDES

§ 14. *Recent Advances in the Dynamical Theory of the Tides.*—The problem of the tidal oscillation of the sea is essentially dynamical. In two papers in the second volume of *Liouville's Journal* (1896) H. Poincaré has considered the mathematical principles involved in the problem, where the ocean is interrupted by land as in actuality. He has not sought to obtain numerical results applicable to any given configuration of land and sea, but he has aimed rather at pointing out methods by which it may some day be possible to obtain such solutions.

Even when the ocean is taken as covering the whole earth the problem presents formidable difficulties, and this is the only case in which it has been solved hitherto.[2]

Laplace gives the solution in bks. i. and iv. of the *Mécanique céleste;* but his work is unnecessarily complicated. In the 9th edition of the *Ency. Brit.* we gave Laplace's theory without these complications, but the theory is now accessible in H. Lamb's *Hydrodynamics* and other works of the kind. It is therefore not reproduced here.

In 1897 and 1898 S. S. Hough undertook an important revision of Laplace's theory and succeeded not only in introducing the effects of the mutual gravitation of the ocean, but

[2] Lord Kelvin's (Sir W. Thomson's) paper on the gravitational oscillations of rotating water, *Phil. Mag.* (October 1880), bears on this subject. It is the only attempt to obtain numerical results in respect to the effect of the earth's rotation on the oscillations of land-locked seas.

also in determining the nature and periods of the free oscillations of the sea.[1] A dynamical problem of this character cannot be regarded as fully solved unless we are able not only to discuss the "forced" oscillations of the system but also the "free." Hence we regard Mr Hough's work as the most important contribution to the dynamical theory of the tides since the time of Laplace. We shall accordingly present the theory briefly in the form due to Mr Hough.

The analysis is more complex than that of Laplace, where the mutual attraction of the ocean was neglected, but this was perhaps inevitable. Our first task is to form the equations of motion and continuity, which will be equally applicable to all forms of the theory.

§ 15. *Equations of Motion.*—Let r, θ, ϕ be the radius vector, colatitude and east longitude of a point with reference to an origin, a polar axis and a zero-meridian rotating with a uniform angular velocity n from west to east. Then if R, H, Ξ be the radial, colatitudinal and longitudinal accelerations of the point, we have

$$\mathrm{R}=\frac{d^2r}{dt^2}-r\left(\frac{d\theta}{dt}\right)^2-r\sin^2\theta\left(\frac{d\phi}{dt}+n\right)^2$$

$$\Xi=\frac{1}{r}\frac{d}{dt}\left(r^2\frac{d\theta}{dt}\right)-r\sin\theta\cos\theta\left(\frac{d\phi}{dt}+n\right)^2$$

$$\mathrm{H}=\frac{1}{r\sin\theta}\frac{d}{dt}\left[r^2\sin^2\theta\left(\frac{d\phi}{dt}+n\right)\right].$$

If the point were at rest with reference to the rotating meridian we should have

$$\mathrm{R}=-n^2r\sin\theta,\ \Xi=-n^2r\sin\theta\cos\theta,\ \mathrm{H}=0.$$

When these considerations are applied to the motion of an ocean relative to a rotating planet, it is clear that these accelerations, which still remain when the ocean is at rest, are annulled by the permanent oblateness of the ocean. As then they take no part in the oscillations of the ocean, and as we are not considering the figure of the planet, we may omit these terms from R and Ξ. This being so we must replace $\left(\frac{d\phi}{dt}+n\right)^2$ as it occurs in R and Ξ by $\left(\frac{d\phi}{dt}\right)^2+2n\frac{d\phi}{dt}$.

Now suppose that the point whose accelerations are under consideration never moves far from its zero position, and that its displacements ξ, $\eta\sin\theta$ in colatitude and longitude are very large compared with ρ its radial displacement. Suppose, further, that the velocities of the point are so small that their squares and products are negligible compared with n^2r^2; then we have

$$\frac{dr}{dt}=\frac{d\rho}{dt},\ \text{a very small quantity;}$$

$$r\sin\theta\frac{d\phi}{dt}=\frac{d}{dt}\left(\eta\sin\theta\right),$$

$$r\frac{d\theta}{dt}=\frac{d\xi}{dt}.$$

Since the radial velocity always remains very small it is not necessary to concern ourselves further with the value of R, and we only require the two other components which have the approximate forms,

$$\left.\begin{aligned}\Xi&=\frac{d^2\xi}{dt^2}-2n\sin\theta\cos\theta\frac{d\eta}{dt},\\ \mathrm{H}&=\sin\theta\frac{d^2\eta}{dt^2}+2n\cos\theta\frac{d\xi}{dt}\end{aligned}\right\}. \qquad (14)$$

We have now to consider the forces by which an element of the ocean is urged in the direction of colatitude and longitude. These forces are those due to the external disturbing forces, to the pressure of the water, surrounding an element of the ocean, and to the attraction of the ocean itself.

If $\mathfrak{e}$ denotes the equilibrium height of the tide, it is a function of colatitude and longitude, and may be expanded in a series of spherical surface harmonics $\mathfrak{e}_i$. Thus we may write the equation to the equilibrium tide in the form.

$$r=a+\mathfrak{e}=a+\Sigma\mathfrak{e}_i.$$

Now it appears from (10) and (11) that the value of the potential, at the surface of the sphere where $\rho=a$, under which this is a figure of equilibrium, is

$$\mathrm{V}=\Sigma gb_i\mathfrak{e}_i.$$

We may use this as specifying the external disturbing force due to the known attractions of the moon and sun, so that $\mathfrak{e}_i$ may be regarded as known.

But in our dynamical problem the ocean is not a figure of equilibrium, and we may denote the elevation of the surface at any moment of time by $\mathfrak{h}$. Then the equation to the surface may be written in the form

$$r=a+\mathfrak{h}=a+\Sigma\mathfrak{h}_i,$$

where $\mathfrak{h}_i$ denotes a spherical harmonic just as $\mathfrak{e}_i$ did before.

[1] *Phil. Trans.*, 189 A, pp. 201–258 and 191 A, pp. 139–185.

The surface value of the potential of the forces which would maintain the ocean in equilibrium in the shape it has at any moment is $\Sigma gb_i\mathfrak{h}_i$. Hence it follows that in the actual case the forces due to fluid pressure and to the attraction of the ocean must be such as to balance the potential just determined. Therefore these forces are those due to a potential—$\Sigma gb_i\mathfrak{h}_i$. If we add to this the potential of the external forces, we have a potential which will include all the forces, the expression for which is $-g\Sigma b_i(\mathfrak{h}_i-\mathfrak{e}_i)$. If further we perform the operations $d/ad\theta$ and $d/a\sin\theta d\phi$ on this potential, we obtain the colatitudinal and longitudinal forces which are equal to the accelerations Ξ and H.

It follows, then, from (14) that the equations of motion are

$$\left.\begin{aligned}\frac{d^2\xi}{dt^2}-2n\sin\theta\cos\theta\frac{d\eta}{dt}&=-\frac{g}{a}\Sigma b_i\frac{d}{d\theta}\left(\mathfrak{h}_i-\mathfrak{e}_i\right)\\ \sin\theta\frac{d^2\eta}{dt^2}+2n\cos\theta\frac{d\xi}{dt}&=-\frac{g}{a\sin\theta}\Sigma b_i\frac{d}{d\phi}\left(\mathfrak{h}_i-\mathfrak{e}\right)\end{aligned}\right\} \qquad (15)$$

Equations of Motion.

It remains to find the equation of continuity. This may be deduced geometrically from the consideration that the volume of an element of the fluid remains constant; but a shorter way is to derive it from the equation of continuity as it occurs in ordinary hydrodynamical investigations. If Φ be a velocity potential, the equation of continuity for incompressible fluid is

$$\delta r\frac{d}{dr}\left(r^2\frac{d\Phi}{dr}\sin\theta\,\delta\theta\,\delta\phi\right)+\delta\theta\frac{d}{d\theta}\left(r\sin\theta\frac{d\Phi}{rd\theta}\delta r\delta\phi\right)$$
$$+\delta\phi\frac{d}{d\phi}\left(r\frac{1}{r\sin\theta}\frac{d\Phi}{d\phi}\delta r\,\delta\theta\right)=0.$$

The element referred to in this equation is defined by r, θ, ϕ, $r+\delta r$, $\theta+\delta\theta$, $\phi+\delta\phi$. The colatitudinal and longitudinal velocities are the same for all the elementary prism defined by θ, ϕ, $\theta+\delta\theta$, $\phi+\delta\phi$, and the sea bottom. Then $\frac{d\Phi}{rd\theta}=\frac{d\xi}{dt}$, $\frac{d\Phi}{r\sin\theta d\phi}=\sin\theta\frac{d\eta}{dt}$; and, since the radial velocity is $d\mathfrak{h}/dt$ at the surface of the ocean, where $r=a+\gamma$, and is zero at the sea bottom, where $r=a$, we have $\frac{d\Phi}{dr}=\frac{r-a}{\gamma}\frac{d\mathfrak{h}}{dt}$. Hence, integrating with respect to r from $r=a+\gamma$ to $r=a$, and again with respect to t from time t to the time when $\mathfrak{h}$, ξ, η all vanish, and treating γ and $\mathfrak{h}$ as small compared with a, we have

$$\mathfrak{h}a\sin\theta+\frac{d}{d\theta}(\gamma\xi\sin\theta)+\frac{d}{d\phi}(\gamma\eta\sin\theta)=0. \qquad (16)$$

This is the equation of continuity, and, together with (15), it forms the system which must be integrated in the general problem of the tides. The difficulties in the way of a solution are so great that none has hitherto been found, except on the supposition that γ, the depth of the ocean, is only a function of latitude. In this case (16) becomes

Equation of Continuity.

$$\mathfrak{h}a+\frac{1}{\sin\theta}\frac{d}{d\theta}(\gamma\xi\sin\theta)+\gamma\frac{d\eta}{d\phi}=0. \qquad (17)$$

§ 16. *Adaptation to Forced Oscillations.*—Since we may suppose that the free oscillations are annulled by friction, the solution required is that corresponding to forced oscillations. Now we have seen from (13) that $\mathfrak{e}$ (which is proportional to V) has terms of three kinds, the first depending on twice the moon's (or sun's) hour-angle, the second on the hour-angle, and the third independent thereof. The coefficients of the first and second vary slowly, and the whole of the third varies slowly. Hence $\mathfrak{e}$ has a semi-diurnal, a diurnal and a long-period term. We shall see later that these terms may be expanded in a series of approximately semi-diurnal, diurnal and slowly varying terms, each of which is a strictly harmonic function of the time.

Thus according to the usual method of treating oscillating systems, we may make the following assumptions as to the form of the solution

$$\left.\begin{aligned}\mathfrak{e}&=\Sigma\mathfrak{e}_i=\Sigma e_i\cos(2nft+s\phi+\alpha)\\ \mathfrak{h}&=\Sigma\mathfrak{h}_i=\Sigma h_i\cos(2nft+s\phi+\alpha)\\ \xi&=\Sigma b_ix_i\cos(2nft+s\phi+\alpha)\\ \eta&=\Sigma b_iy_i\sin(2nft+s\phi+\alpha)\end{aligned}\right\} \qquad (18)$$

where e_i, h_i, x_i, y_i are functions of colatitude only, and e_i, h_i are the associated functions of colatitude corresponding to the harmonic of order i and rank s.

For the semi-diurnal tides $s=2$ and f is approximately unity; for the diurnal tides $s=1$ and f is approximately $\frac{1}{2}$; and for the tides of long period $s=0$ and f is a small fraction.

Substituting these values in (17) we have

$$\Sigma\left[\frac{1}{\sin\theta}\frac{d}{d\theta}(\gamma b_ix_i\sin\theta)+s\gamma b_iy_i+h_ia\right]=0. \qquad (19)$$

Then if we write u_i for h_i-e_i, and put $m=n^2a/g$, substitution from (18) in (15) leads at once to

$$\left.\begin{aligned}f^2\Sigma b_ix_i-f\sin\theta\cos\theta\Sigma b_iy_i&=\frac{1}{4m}\frac{d}{d\theta}\Sigma b_iu_i,\\ f^2\sin\theta\Sigma b_iy_i+f\cos\theta\Sigma b_ix_i&=-\frac{s}{4m\sin\theta}\Sigma b_iu_i.\end{aligned}\right\}. \qquad (20)$$

Solving (20), we have

$$\left.\begin{aligned}(\Sigma b_i x_i)(f^2-\cos^2\theta) &= \frac{1}{4m}\left[\frac{d}{d\theta}\Sigma b_i u_i + \frac{s\cos\theta}{f\sin\theta}\Sigma b_i u_i\right]\\ (\Sigma b_i y_i)\sin^2\theta(f^2-\cos^2\theta) &= -\frac{1}{4m}\left[\frac{\cos\theta}{f}\frac{d}{d\theta}\Sigma b_i u_i + \frac{s}{\sin\theta}\Sigma b_i u_i\right]\end{aligned}\right\} \qquad (21)$$

Then substituting from (21) in (19) we have

$$\frac{1}{\sin\theta}\frac{d}{d\theta}\left[\frac{\gamma(\sin\theta\frac{d}{d\theta}\Sigma b_i u_i+\frac{s}{f}\cos\theta\Sigma b_i u_i)}{f^2-\cos^2\theta}\right] - \frac{s\gamma\left[\frac{\cos\theta}{f}\frac{d}{d\theta}\Sigma b_i u_i+\frac{s}{\sin\theta}\Sigma b_i u_i\right]}{\sin\theta\,(f^2-\cos^2\theta)} + 4ma\Sigma(u_i+e_i)=0. \qquad (22)$$

This is almost the same as Laplace's equation for tidal oscillations in an ocean whose depth is only a function of latitude. If indeed we treat b_i as unity (thereby neglecting the mutual attraction of the water) and replace Σu_i and Σe_i by u and e, we obtain Laplace's equation.

When u_i is found from this equation, its value substituted in (21) will give x_i and y_i.

§ 17. *Zonal Oscillations.*—We might treat the general harmonic oscillations first, and proceed to the zonal oscillations by putting $s=0$. These waves are, however, comparatively simple, and it is well to begin with them. The zonal tides are those which Laplace describes as of the first species, and are now more usually called the tides of long period. As we shall only consider the case of an ocean of uniform depth, γ the depth of the sea is constant. Then since in this case $s=0$, our equation (22), to be satisfied by u_i or h_i-e_i, becomes

$$\frac{d}{d\theta}\left[\frac{\sin\theta\frac{d}{d\theta}\Sigma b_i u_i}{f^2-\cos^2\theta}\right]+\frac{4ma}{\gamma}\sin\theta\Sigma h_i=0.$$

This may be written

$$\frac{d}{d\theta}\Sigma b_i u_i+\frac{4ma}{\gamma}\frac{f^2-\cos^2\theta}{\sin\theta}\int^\theta \Sigma h_i\sin\theta d\theta+A=0, \qquad (23)$$

where A is a constant.

Let us assume

$$h_i=C_iP_i,\quad e_i=E_iP_i$$

where P_i denotes the ith zonal harmonic of $\cos\theta$. The coefficients C_i are unknown, but the E_i are known because the system oscillates under the action of known forces.

If the term involving the integral in this equation were expressed in terms of differentials of harmonics, we should be able to equate to zero the coefficient of each $dP_i/d\theta$ in the equation, and thus find the conditions for determining the C's.

The task then is to express $\frac{f^2-\cos^2\theta}{\sin\theta}\int^\theta P_i\sin\theta d\theta$ in differentials of zonal harmonics.

It is well known that P_i satisfies the differential equation

$$\frac{d}{d\theta}\left(\sin\theta\frac{dP_i}{d\theta}\right)+i(i+1)P_i\sin\theta=0. \qquad (24)$$

Therefore $\int P_i\sin\theta d\theta=-\frac{1}{i(i+1)}\sin\theta\frac{dP_i}{d\theta}$, and

$$\begin{aligned}\frac{f^2-\cos^2\theta}{\sin\theta}\int P_i\sin\theta d\theta &= -\frac{1}{i(i+1)}(f^2-\cos^2\theta)\frac{dP_i}{d\theta}\\ &= -\frac{1}{i(i+1)}(f^2-1)\frac{dP_i}{d\theta}-\frac{1}{i(i+1)}\sin^2\theta\frac{dP_i}{d\theta}.\end{aligned}$$

Another well-known property of zonal harmonics is that

$$\sin\theta\frac{dP_i}{d\theta}=\frac{i(i+1)}{2i+1}(P_{i+1}-P_{i-1}). \qquad (25)$$

If we differentiate (25) and use (24) we have

$$\frac{i(i+1)}{2i+1}\left(\frac{dP_{i+1}}{d\theta}-\frac{dP_{i-1}}{d\theta}\right)+i(i+1)P_i\sin\theta=0. \qquad (26)$$

Multiplying (25) by $\sin\theta$, and using (26) twice over,

$$\sin^2\theta\frac{dP_i}{d\theta}=\frac{i(i+1)}{2i+1}\left\{-\frac{1}{2i+3}\left(\frac{dP_{i+2}}{d\theta}-\frac{dP_i}{d\theta}\right)+\frac{1}{2i-1}\left(\frac{dP_i}{d\theta}-\frac{dP_{i-2}}{d\theta}\right)\right\}.$$

Therefore

$$\begin{aligned}\frac{f^2-\cos^2\theta}{\sin\theta}\int P_i\sin\theta d\theta &= \frac{1}{(2i-1)(2i+1)}\frac{dP_{i-2}}{d\theta}\\ &\quad-\left\{\frac{f^2-1}{i(i+1)}+\frac{2}{(2i-1)(2i+3)}\right\}\frac{dP_i}{d\theta}+\frac{1}{(2i+1)(2i+3)}\frac{dP_{i+2}}{d\theta}.\end{aligned}$$

This expression, when multiplied by $4ma/\gamma$ and by C_i and summed, is the second term of our equation.

The first term is

$$\Sigma b_i(C_i-E_i)\frac{dP_i}{d\theta}.$$

In order that the equation may be satisfied, the coefficient of each $dP_i/d\theta$ must vanish identically. Accordingly we multiply the whole by $\gamma/4ma$ and equate to zero the coefficient in question, and obtain

$$\frac{b_i\gamma}{4ma}(C_i-E_i)+\frac{C_{i-2}}{(2i-1)(2i-3)}-\left\{\frac{f^2-1}{i(i+1)}+\frac{2}{(2i-1)(2i+3)}\right\}C_i+\frac{C_{i+2}}{(2i+3)(2i+5)}=0. \qquad (27)$$

This equation (27) is applicable for all values of i from 1 to infinity, provided that we take C_0, E_0, C_{-1}, E_{-1} as being zero.

We shall only consider in detail the case of greatest interest, namely that of the most important of the tides generated by the attraction of the sun and moon. We know that in this case the equilibrium tide is expressed by a zonal harmonic of the second order; and therefore all the E_i, excepting E_2, are zero. Thus the equation (27) will not involve E_i in any case excepting when $i=2$.

If we write for brevity

$$L_i=\frac{f^2-1}{i(i+1)}+\frac{2}{(2i-1)(2i+3)}-\frac{b_i\gamma}{4ma},$$

the equation (27) is

$$\frac{C_{i+2}}{(2i+3)(2i+5)}-L_iC_i+\frac{C_{i-2}}{(2i-3)(2i-1)}=0. \qquad (28)$$

Save that when $i=2$, the right-hand side is $b_2\gamma E_2/4ma$, a known quantity *ex hypothesi*.

The equations naturally separate themselves into two groups in one of which all the suffixes are even and the other odd. Since our task is to evaluate all the C's in terms of E_2, it is obvious that all the C's with odd suffixes must be zero, and we are left to consider only the cases where $i=2$, 4, 6, &c.

We have said that C_0 must be regarded as being zero; if however we take

$$C_0=-3b_2\gamma E_2/4ma,$$

so that C_0 is essentially a known quantity, the equation (28) has complete applicability for all even values of i from 2 upwards.

The equations are

$$\begin{aligned}&\frac{C_0}{1\cdot3}-L_2C_2+\frac{C_4}{7\cdot9}=0\\ &\frac{C_2}{5\cdot7}-L_4C_4+\frac{C_6}{11\cdot13}=0.\\ &\quad\text{\&c.}\quad\text{\&c.}\end{aligned}$$

It would seem at first sight as if these equations would suffice to determine all the C's in terms of C_2, and that C_2 would remain indeterminate; but we shall show that this is not the case.

For very large values of i the general equation of condition (28) tends to assume the form

$$\frac{C_{i+2}+C_{i-2}}{C_i}+\frac{i^2\gamma}{ma}=0.$$

By writing successively $i+2$, $i+4$, $i+6$ for i in this equation, and taking the differences, we obtain an equation from which we see that, *unless C_i/C_{i+2} tends to become infinitely small*, the equations are satisfied by $C_i=C_{i+2}$ in the limit for very large values of i.

Hence, if C_i does not tend to zero, the later portion of the series for h tends to assume the form $C_i(P_i+P_{i+2}+P_{i+4}\ldots)$. All the P's are equal to unity at the pole; hence the hypothesis that C_i does not tend to zero leads to the conclusion that the tide is of infinite height at the pole. The expansion of the height of tide is essentially convergent, and therefore the hypothesis is negatived. Thus we are entitled to assume that C_i tends to zero for large values of i.

Now writing for brevity

$$a_i=1/(2i+1)(2i+3)^2(2i+5),$$

we may put (28) into the form

$$\frac{C_{i-2}/C_i}{(2i-3)(2i-1)}=L_i-\frac{a_i}{\dfrac{C_i/C_{i+2}}{(2i+1)(2i+3)}}.$$

By successive applications of this formula we may write the right-hand side in the form of a continued fraction.

Let

$$K_i=\frac{a_{i-2}}{L_i-}\,\frac{a_i}{L_{i+2}-}\,\frac{a_{i+2}}{L_{i+4}-}\cdots$$

Then we have

$$\frac{C_{i-2}/C_i}{(2i-3)(2i-1)}=\frac{a_{i-2}}{K_i},$$

or

$$C_i/C_{i-2}=(2i-1)(2i+1)K_i.$$

Thus

$$C_2=3.5K_2C_0;\ C_4=3.5.7.9K_2K_4C_0;\quad C_6=3.5.7.9.11.13K_2K_4K_6C_0,\ \text{\&c.}$$

If we assume that any of the higher C's, such as C_{14} or C_{16}, is of negligible smallness, all the continued fractions K_2, K_4, K_6, &c., may be computed; and thus we find all the C's in terms of C_0, which is equal to $-3b_2\gamma E_2/4ma$. The height of the tide is therefore given by

$$\begin{aligned}\mathfrak{h}&=\Sigma h_i\cos(2nft+a)\\ &=-\frac{3b_2\gamma}{4ma}E_2\{3.5K_2P_2+3.5.7.9K_2K_4P_4+\ldots\}\cos(2nft+a).\end{aligned}$$

It is however more instructive to express $\mathfrak{h}$ as a multiple of the equilibrium tide ϵ, which is as we know equal to $E_2P_2 \cos(2nft+\alpha)$. Whence we find

$$\mathfrak{b} = -\frac{3b_2\gamma}{4ma}\frac{\epsilon}{P_2}\{3\cdot5K_2P_2+3\cdot5\cdot7\cdot9K_2K_4P_4+3\cdot5\ldots13K_2K_4K_6P_6\ldots\}.$$

The number f is a fraction such that its reciprocal is twice the number of sidereal days in the period of the tide. The greatest value of f is that appertaining to the lunar fortnightly tide (Mf in notation of harmonic analysis), and in this case f is in round numbers $1/28$, or more exactly $f^2 = \cdot00133$. The ratio of the density σ of sea-water to δ the mean density of the earth is $\cdot18093$; which value gives us

$$b_2 = 1-\frac{3\sigma}{5\delta} = \cdot89144.$$

The quantity m is the ratio of equatorial centrifugal force to gravity, and is equal to $1/289$. Finally, γ/a is the depth of the ocean expressed as a fraction of the earth's radius.

With these numerical values Mr Hough has applied the solution to determine the lunar fortnightly tide for oceans of various depths. Of his results we give two:—

First, when $\gamma = 7260$ ft. $= 1210$ fathoms, which makes $\gamma/4ma = 1/40$, he finds

$$\mathfrak{b} = \frac{\epsilon}{P_2}\{\cdot2669P_2 - \cdot1678P_4 + \cdot0485P_6 - \cdot0081P_8 + \cdot0009P_{10} - \cdot0001P_{12}\ldots\}.$$

If the equilibrium theory were true we should have

$$\mathfrak{b} = \frac{\epsilon}{P_2}\{P_2\};$$

thus we see how widely the dynamical solution differs from the equilibrium value.

Secondly, when $\gamma = 58080$ ft. $= 9680$ fathoms, and $\gamma/4ma = 1/5$, he finds

$$\mathfrak{b} = \frac{\epsilon}{P_2}\{\cdot7208P_2 - \cdot0973P_4 + \cdot0048P_6 - \cdot0001P_6\ldots\}.$$

From this we see that the equilibrium solution presents some sort of approximation to the dynamical one; and it is clear that the equilibrium solution would be fairly accurate for oceans which are still quite shallow when expressed as fractions of the earth's radius, although far deeper than the actual sea.

The tides of long period were not investigated by Laplace in this manner, for he was of opinion that a very small amount of friction would suffice to make the ocean assume its form of equilibrium. In the arguments which he adduced in support of this view the friction contemplated was such that the integral effect was proportional to the velocity of the water relatively to the bottom. It is probable that proportionality to the square of the velocity would have been nearer the truth, but the distinction is unimportant.

The most rapid of the oscillations of this class is the lunar fortnightly tide, and the water of the ocean moves northward for a week and then southward for a week. In oscillating systems, where the resistances are proportional to the velocities, it is usual to specify the resistance by a "modulus of decay," namely the time in which a velocity is reduced by friction to e^{-1} or $1/2\cdot78$ of its initial value. Now in order that the result contemplated by Laplace may be true, the friction must be such that the modulus of decay is short compared with the semi-period of oscillation. It seems certain that the friction of the ocean bed would not reduce a slow ocean current to one-third of its primitive value in a day or two. Hence we cannot accept Laplace's discussion as satisfactory, and the investigation which has just been given becomes necessary. (See § 34).

§ 18. *Tesseral Oscillations.*—The oscillations which we now have to consider are those in which the form of surface is expressible by the tesseral harmonics. The results will be applicable to the diurnal and semi-diurnal tides—Laplace's second and third species.

Transformation of Equation.

If we write $\sigma = s/f$ the equation (22) becomes

$$\frac{d}{d\theta}\left[\frac{\left(\sin\theta\frac{d}{d\theta}+\sigma\cos\theta\right)\Sigma b_iu_i}{s^2-\sigma^2\cos^2\theta}\right] - \frac{\left(\sigma\cos\theta\frac{d}{d\theta}+s^2\operatorname{cosec}\theta\right)\Sigma b_iu_i}{s^2-\sigma^2\cos^2\theta}$$
$$+\frac{4ma}{\gamma\sigma^2}\sin\theta\Sigma h_i = 0. \qquad (29)$$

If we write D for the operation $\sin\theta\frac{d}{d\theta}$, the middle term may be arranged in the form

$$-\frac{\sigma\cot\theta\,(D+\sigma\cos\theta)(\Sigma b_iu_i)}{s^2-\sigma^2\cos^2\theta} - \frac{\Sigma b_iu_i}{\sin\theta}.$$

Therefore on multiplying by $\sin\theta$ the equation becomes

$$(D-\sigma\cos\theta)\left[\frac{(D+\sigma\cos\theta)(\Sigma b_iu_i)}{s^2-\sigma^2\cos^2\theta}\right] - (\Sigma b_iu_i) + \frac{4ma}{\gamma\sigma^2}\sin^2\theta\Sigma h_i = 0. \qquad (30)$$

We now introduce two auxiliary functions, such that

$$\Sigma b_i(h_i - e_i) = \Sigma b_iu_i$$
$$= (D-\sigma\cos\theta)\Psi + (s^2-\sigma^2\cos^2\theta)\Phi. \qquad (31)$$

It is easy to prove that

$$\left.\begin{aligned}(D+\sigma\cos\theta)(D-\sigma\cos\theta) &= D^2-s^2+\sigma\sin^2\theta+(s^2-\sigma^2\cos^2\theta),\\ (D-\sigma\cos\theta)(D+\sigma\cos\theta) &= D^2-s^2-\sigma\sin^2\theta+(s^2-\sigma^2\cos^2\theta).\end{aligned}\right\} \quad (32)$$

Also

$$(D+\sigma\cos\theta)(s^2-\sigma^2\cos^2\theta)\,\Phi = (s^2-\sigma^2\cos^2\theta)(D+\sigma\cos\theta)\Phi$$
$$+2\sigma^2\sin^2\theta\cos\theta\,\Phi. \qquad (33)$$

Now perform $D+\sigma\cos\theta$ on (31), and use the first of (32) and (33), and we have

$$(D+\sigma\cos\theta)(\Sigma b_iu_i) = (D^2-s^2+\sigma\sin^2\theta+s^2-\sigma^2\cos^2\theta)\Psi.$$
$$+(s^2-\sigma^2\cos^2\theta)(D+\sigma\cos\theta)\Phi + 2\sigma^2\sin^2\theta\cos\theta\,\Phi. \qquad (34)$$

The functions Ψ and Φ are as yet indeterminate, and we may impose another condition on them. Let that condition be

$$(D^2-s^2+\sigma\sin^2\theta)\Psi = -2\sigma^2\sin^2\theta\cos\theta\,\Phi. \qquad (35)$$

Then (34) may be written

$$\frac{(D+\sigma\cos\theta)(\Sigma b_iu_i)}{s^2-\sigma^2\cos^2\theta} = \Psi + (D+\sigma\cos\theta)\Phi.$$

Substituting from this in (30), and using the second of (32), the function Ψ disappears and the equation reduces to

$$(D^2-s^2-\sigma\sin^2\theta)\Phi + \frac{4ma}{\gamma\sigma^2}\sin^2\theta\,\Sigma h_i = 0. \qquad (36)$$

Since by (35) $-\sigma^2\cos^2\theta\,\Phi = \frac{1}{2}\frac{\cos\theta}{\sin^2\theta}(D^2-s^2+\sigma\sin^2\theta)\Psi$, (31) may be written

$$\Sigma b_iu_i = \left[D-\sigma\cos\theta+\tfrac{1}{2}\frac{\cos\theta}{\sin^2\theta}(D^2-s^2+\sigma\sin^2\theta)\right]\Psi + s^2\Phi. \qquad (37)$$

The equations (35), (36) and (37) define Ψ and Φ, and furnish the equation which must be satisfied.

If we denote $\cos\theta$ by μ the zonal harmonics are defined by

$$P_i = \frac{1}{2^i i!}\left(\frac{d}{d\mu}\right)^i(\mu^2-1)^i.$$

The following are three well-known properties of zonal harmonics:

$$\frac{d}{d\mu}\left[(1-\mu^2)\frac{dP_i}{d\mu}\right] + i(i+1)P_i = 0, \qquad (38)$$

$$(i+1)P_{i+1} - (2i+1)\mu P_i + iP_{i-1} = 0, \qquad (39)$$

$$\frac{dP_{i+1}}{d\mu} - \frac{dP_{i-1}}{d\mu} = (2i+1)P_i. \qquad (40)$$

If $P_i^s \begin{smallmatrix}\cos\\ \sin\end{smallmatrix} s\phi$ are the two tesseral harmonics of order i and rank s, it is also known that

$$P_i^s = (1-\mu^2)^{\frac{1}{2}s}\frac{d^sP_i}{d\mu^s}. \qquad (41)$$

Let us now assume

$$h_i = C_i^sP_i^s, \quad e_i = E_i^sP_i^s, \quad \Psi = \Sigma\alpha_i^sP_i^s, \quad \Phi = \Sigma\beta_i^sP_i^s.$$

These must now be substituted in our three equations (35), (36), (37), and the result must be expressed by series of the P_i^s functions. It is clear then that we have to transform into P_i^s functions the following functions of P_i^s, namely

$$\frac{1}{\sin^2\theta}(D^2-s^2\pm\sigma\sin^2\theta)P_i^s, \quad \cos\theta P_i^s,$$
$$\left[D-\sigma\cos\theta+\tfrac{1}{2}\frac{\cos\theta}{\sin^2\theta}(D^2-s^2+\sigma\sin^2\theta)\right]P_i^s.$$

If we differentiate (38) s times, and express the result by means of the operator D, we find

$$(D^2-s^2)P_i^s + i(i+1)P_i^s\sin^2\theta = 0. \qquad (42)$$

Again, differentiating (39) s times and using (40), we find

$$(i-s+1)P_{i+1}^s - (2i+1)\cos\theta\,P_i^s + (i+s)P_{i-1}^s = 0. \qquad (43)$$

Lastly, differentiating (41) once and using (38), (40) and (43)

$$DP_i^s = \frac{i(i-s+1)}{2i+1}P_{i+1}^s - \frac{(i+1)(i+s)}{2i+1}P_{i-1}^s. \qquad (44)$$

By means of (42), (43) and (44) we have

$$\frac{1}{\sin^2\theta}(D^2-s^2\pm\sigma\sin^2\theta)P_i^s = [-i(i+1)\pm\sigma]P_i^s,$$

$$\cos\theta\,P_i^s = \frac{i+s}{2i+1}P_{i-1}^s + \frac{i-s+1}{2i+1}P_{i+1}^s,$$

$$\left[D-\sigma+\tfrac{1}{2}\frac{\cos\theta}{\sin^2\theta}(D^2-s^2+\sigma\sin^2\theta)\right]P_i^s = -\frac{(i-s+1)[\sigma+i(i-1)]}{2(2i+1)}P_{i+1}^s$$
$$-\frac{(i+s)[\sigma+(i+1)(i+2)]}{2(2i+1)}P_{i-1}^s.$$

Therefore the equations (35), (36), (37) give

$$\Sigma\left[\alpha_i^s\{-i(i+1)+\sigma\}P_i^s + 2\sigma^2\beta_i^s\left\{\frac{i+s}{2i+1}P_{i-1}^s + \frac{i-s+1}{2i+1}P_{i+1}^s\right\}\right] = 0,$$

$$\Sigma\left[\beta_i^s\{-i(i+1)-\sigma\}P_i^s + \frac{4ma}{\gamma\sigma^2}C_i^sP_i^s\right] = 0,$$

$$\Sigma\left[b_i(C_i^s-E_i^s)P_i^s + \alpha_i^s\left\{\frac{(i-s+1)[\sigma+i(i-1)]}{2(2i+1)}P_{i+1}^s\right.\right.$$
$$\left.\left.+\frac{(i+s)[\sigma+(i+1)(i+2)]}{2(2i+1)}P_{i-1}^s\right\} - \beta_i^s s^2P_i^s\right] = 0.$$

Since these equations must be true identically, the coefficients of P_i^s in each of them must vanish. Therefore

$$\left.\begin{aligned} a_i^s\{\sigma-i(i+1)\}+2\sigma^2\left\{\beta_{i+1}^s\frac{i+s+1}{2i+3}+\beta_{i-1}^s\frac{i-s}{2i-1}\right\}=0,\\ -\beta_i^s\{\sigma+i(i+1)\}+\frac{4ma}{\gamma\sigma^2}C_i^s=0,\\ b_i(C_i^s-E_i^s)+a_{i-1}^s\frac{(i-s)[\sigma+(i-1)(i-2)]}{2(2i-1)}\\ +a_{i+1}^s\frac{(i+s+1)[\sigma+(i+2)(i+3)]}{2(2i+3)}-\beta_i^s s^2=0.\end{aligned}\right\} \quad (45)$$

If we eliminate the a's and β's from the third equation (45), by means of the first two, we find

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$$\xi_{i-2}^s C_{i-2}^s-L_i^s C_i^s+\eta_{i+2}^s C_{i+2}^s=\frac{\gamma b_i}{4ma}E_i^s, \quad (46)$$

where

$$L_i^s=\frac{s^2}{\sigma^2[\sigma+i(i+1)]}+\frac{(i^2-s^2)[\sigma+(i-1)(i-2)]}{(4i^2-1)[\sigma-(i-1)i][\sigma+i(i+1)]}+\frac{[(i+1)^2-s^2][\sigma+(i+2)(i+3)]}{[4(i+1)^2-1][\sigma-(i+1)(i+2)][\sigma+i(i+1)]}-\frac{\gamma b_i}{4ma}$$

$$\xi_{i-2}^s=\frac{-(i-s)(i-s-1)}{(2i-1)(2i-3)[\sigma-(i-1)i]},$$

$$\eta_{i+2}^s=\frac{-(i+s+1)(i+s+2)}{(2i+3)(2i+5)[\sigma-(i+1)(i+2)]}.$$

In the case of the luni-solar semi-diurnal tide (called K_2 in the notation of harmonic analysis) we have $i=2$, $s=2$, $\sigma=2$. Hence it would appear that these formulae for L_i^s and ξ_{i-2}^s fail by becoming indeterminate, but i and s are rigorously integers, whereas σ depends on the "speed" of the tide; accordingly in the case referred to we must regard terms involving $(i-s)$ as vanishing in the limit when σ approaches to equality with i $(i-1)$. For this particular case then we find

$$L_2^2=\frac{3}{35}-\frac{\gamma b_2}{4ma} \text{ and } \xi_0^s=0.$$

The equation (46) for the successive C's is available for all values of i provided that C_{-1}, E_{-1}, C_0, E_0 are regarded as being zero.

As in the case of the zonal oscillations, the equations with odd suffixes separate themselves from those with even suffixes, so that the two series may be treated independently of one another. Indeed, as we shall see immediately, the series with odd suffixes are satisfied by putting all the C's with odd suffixes zero for the case of such oscillations as may be generated by the attractions of the moon or sun.

For the semi-diurnal tides $i=2$, $s=2$, and f is approximately equal to unity. Hence the equilibrium tide is such that all the E_i^s, excepting E_2^2, are zero.

For the diurnal tides $i=2$, $s=1$, and f is approximately equal to $\frac{1}{2}$. Hence all the E_i^s, excepting E_2^1, are zero. Since in neither case is there any E with an odd suffix, we need only consider those with even suffixes.

In both cases the first equation among the C's is

$$-L_2^s C_2^s+\eta_4^s C_4^s=\frac{\gamma b_2}{4ma}E_2^s (s=2 \text{ or } 1).$$

It follows that if we write

$$\xi_0^s C_0^s=-\frac{\gamma b_2}{4ma}E_2^s (s=2 \text{ or } 1),$$

the equation of condition amongst the C's would be of general applicability for all even values of i from 2 upwards.

The symbols ξ^s_0, η^s_2 do not occur in any of the equations, and therefore we may arbitrarily define them as denoting unity, although the general formulae for ξ and η would give them other values. Accordingly we shall take

$$\xi_0^s C_0^s=C_0^s=-\frac{\gamma b_2}{4ma}E_2^s (s=2 \text{ or } 1).$$

With this definition the equation

$$\xi_{i-2}^s C_{i-2}^s-L_i^s C_i^s+\eta_{i+2}^s C_{i+2}^s=0 (s=2 \text{ or } 1)$$

is applicable for $i=2$, 4, 6, &c.

It may be proved as in the case of the tides of long period that we may regard C_i^s/C_{i+2}^s as tending to zero. Then our equation may be written in the form

$$\xi_{i-2}^s\frac{C_{i-2}^s}{C_i^s}=L_i^s-\frac{\xi_i^s\eta_{i+2}^s}{\xi_i^s C_i^s/C_{i+2}^s},$$

and by successive applications the right-hand side may be expressed in the form of a continued fraction. Let us write

$$H_i^s=\frac{\xi_{i-2}^s\eta_i^s}{L_i^s-}\,\frac{\xi_i^s\eta_{i+2}^s}{L_{i+2}^s-}\,\frac{\xi_{i+2}^s\eta_{i+4}^s}{L_{i+4}^s-}\cdots$$

Hence our equation may be written

$$\xi_{i-2}^s\frac{C_{i-2}^s}{C_i^s}=\frac{\xi_{i-2}^s\eta_i^s}{H_i^s}$$

Whence

$$C_i^s=\frac{H_i^s}{\eta_i^s}C_{i-2}^s.$$

It follows that

$$C_2^s=\frac{H_2^s}{\eta_2^s}C_0^s, \quad C_4^s=\frac{H_2^s H_4^s}{\eta_2^s\eta_4^s}C_0^s, \quad C_6^s=\frac{H_2^s H_4^s H_6^s}{\eta_2^s\eta_4^s\eta_6^s}C_0^s, \text{ \&c.}$$

Then since we have defined

$$\eta_2^s=1 \text{ and } C_0^s=-\frac{\gamma b_2}{4ma}E_2,$$

all the C's are expressed in terms of known quantities. Hence the height of tide $\mathfrak{b}$ is given by

$$\mathfrak{b}=\Sigma h_i\cos(2nft+s\phi+a)$$
$$=-\frac{\gamma b_2}{4ma}E_2^s\cos(2nft+s\phi+a)\left[H_2^s P_2^s+\frac{H_2^s H_4^s}{\eta_4^s}P_4^s+\frac{H_2^s H_4^s H_6^s}{\eta_4^s\eta_6^s}P_6^s\ldots\right]$$

But the equilibrium tide $\mathfrak{e}$ is given by

$$\mathfrak{e}=E_2^s P_2^s\cos(2nft+s\phi+a).$$

Hence we may write our result in the following form, which shows the relationship between the true dynamical tide and the equilibrium tide:—

$$\mathfrak{b}=-\frac{\gamma b_2}{4ma}\frac{\mathfrak{e}}{P_2^s}\left\{H_2^s P_2^s+\frac{H_2^s H_4^s}{\eta_4^s}P_4^s+\frac{H_2^s H_4^s H_6^s}{\eta_4^s\eta_6^s}P_6^s+\ldots\right\}$$

From a formula equivalent to this Mr Hough finds for the lunar semi-diurnal tide $(s=2)$, for a sea of 1210 fathoms $\left(\frac{\gamma}{4ma}=\frac{1}{40}\right)$,

$$\mathfrak{b}=\frac{\mathfrak{e}}{P_2^2}\left\{\cdot 10396P_2^2+\cdot 57998P_4^2-\cdot 19273P_6^2+\cdot 03054P_8^2\ldots\right\}.$$

This formula shows us that at the equator the tide is "inverted," and has 2·4187 times as great a range as the equilibrium tide.

For this same ocean he finds that the solar semi-diurnal tide is "direct" at the equator, and has a range 7·9548 as great as the equilibrium tide.

Now the lunar equilibrium tide is 2·2 times as great as the solar equilibrium tide, and since 2·2×2·4187 is only 5·3, it follows that in such an ocean the solar tides would have a range half as great again as the lunar. Further, since the lunar tides are "inverted" and the solar "direct," spring tide would occur at quarter moon and neap tide at full and change.

We give one more example from amongst those computed by Mr Hough. In an ocean of 9680 fathoms $(\gamma/4ma=1/5)$, he finds

$$\mathfrak{b}=\frac{\mathfrak{e}}{P_2^2}\left\{1\cdot 7646P_2^2-\cdot 06057P_4^2+\cdot 001447P_6^2\ldots\right\}.$$

At the equator the tides are "direct" and have a range of 1·9225 as great as the equilibrium tide. In this case the tides approximate in type to those of the equilibrium theory, although at the equator, at least, they have nearly twice the range.

We do not give any numerical results for the diurnal tides, for reasons which will appear from the following section.

§ 19. *Diurnal Tide approximately evanescent.*—The equilibrium diurnal tide is given by

$$\mathfrak{e}=E_2^1 P_2^1\cos(2nft+\phi+a),$$

where f is approximately $\frac{1}{2}$ and the associated function for $i=2$, $s=1$ is

$$P_2^1=3\sin\theta\cos\theta.$$

Now the height of tide is given by

$$\mathfrak{b}=\Sigma C_i^s P_i^s\cos(2nft+\phi+a),$$

and the problem is to evaluate the constants C_i^s.

If possible suppose that $\mathfrak{b}$ is also expressed by a single term like that which represents $\mathfrak{e}$, so that

$$\mathfrak{b}=3C_2^1\sin\theta\cos\theta\cos(2nft+\phi+a).$$

Then the differential equation (22) to be satisfied becomes

$$\gamma(C_2^1-E_2^1)\left\{\frac{1}{\sin\theta}\frac{d}{d\theta}\left(\frac{\sin\theta\frac{du}{d\theta}+\frac{1}{f}u\cos\theta}{f^2-\cos^2\theta}\right)-\frac{\frac{\cos\theta}{f}\frac{du}{d\theta}+\frac{u}{\sin\theta}}{\sin\theta(f^2-\cos^2\theta)}\right\}+4ma\,C_2^1 u=0,$$

where u is written for brevity in place of $\sin\theta\cos\theta$.

Now when f is rigorously equal to $\frac{1}{2}$, it may be proved by actual differentiation that the expression inside the brackets { } vanishes identically, and the equation reduces to $C_2^1=0$.

We thus find that in this case the differential equation is satisfied by zero oscillation of water-level. In other words we reach Laplace's remarkable conclusion that there is no diurnal rise and fall of the tides. There are, it is true, diurnal tidal currents, but they are so arranged that the water level remains unchanged.

In reality f is not rigorously $\frac{1}{2}$ (except for the tide called K_2) and there will be a small diurnal tide. The lunar diurnal tide called O has been evaluated for various depths of ocean by Mr Hough and is found always to be small.

§ 20. *Free Oscillations of the Ocean.*—Mr Hough discusses the various types of free oscillations of the ocean. They are very complex, and consist of westward waves and eastward waves of very various periods. He finds, as was to be expected, that if, for an ocean of given depth, a free wave very nearly coincides in period with the forced lunar or solar wave, the actual tide is largely augmented. Thus, for example, for an ocean of 29,000 ft. in depth the solar semi-diurnal tide would have a height at the equator 235 times as great as the equilibrium height, and would be inverted so that low water would agree with the high water of the equilibrium theory.

The general outcome of the discussion is that it is impossible to foresee the height of any forced tide-wave by mere general inspection. If this is so in the simple case of an ocean of uniform depth, how much more must it be true of oceans of various depths interrupted by continents?

§ 21. *Stability of the Ocean.*—Imagine a globe of density δ, surrounded by a spherical layer of water of density σ. Then, still maintaining the spherical figure, and with water still covering the nucleus, let the layer be displaced sideways. The force on any part of the water distant r' from the centre of the water and r from the centre of the nucleus is $\frac{4}{3}\pi\sigma r'$ towards the centre of the fluid sphere and $\frac{4}{3}\pi(\delta-\sigma)r$ towards the centre of the nucleus. If δ be greater than σ there is a force tending to carry the water from places where it is deeper to places where it is shallower; and therefore the equilibrium, thus arbitrarily disturbed, is stable. If, however, δ is less than σ (or the nucleus lighter than water) the force is such that it tends to carry the water from where it is shallower to where it is deeper and therefore the equilibrium of a layer of fluid distributed over a nucleus lighter than itself is unstable. As Lord Kelvin remarks,[1] if the nucleus is lighter than the ocean, it will float in the ocean with part of its surface dry. Suppose, again, that the fluid layer be disturbed, so that its equation is $r=a(1+s_i)$, where s_i is a surface harmonic of degree i; then the potential due to this deformation is $\frac{4\pi\sigma}{2i+1}\frac{a^{i+3}}{r^{i+1}}s_i$, and the whole potential is

Stabilities of Various Orders.

$$\frac{4\pi\delta a^3}{3r}+\frac{4\pi\sigma}{2i+1}\frac{a^{i+3}}{r^{i+1}}s_i.$$

If, therefore, $\sigma/(2i+1)$ is greater than $\frac{1}{3}\delta$, the potential of the forces due to deformation is greater than that due to the nucleus. But we have seen that a deformation tends to increase itself by mutual attraction, and therefore the forces are such as to increase the deformation. If, therefore, $\sigma=\frac{1}{3}(2i+1)\delta$, all the deformations up to the ith are unstable, but the $(i+1)$th is stable.[2] If, however, σ be less than δ, then all the deformations of any order are such that there are positive forces of restitution. For our present purpose it suffices that the equilibrium is stable when the fluid is lighter than the nucleus.

§ 22. *Precession and Nutation.*—Suppose we have a planet covered with a shallow ocean, and that the ocean is set into oscillation. Then, if there are no external disturbing forces, so that the oscillations are "free," not "forced," the resultant moment of momentum of the planet and ocean remains constant. And, since each particle of the ocean executes periodic oscillations about a mean position, it follows that the oscillation of the ocean imparts to the solid earth oscillations such that the resultant moment of momentum of the whole system remains constant. But the mass of the ocean being very small compared with that of the planet, the component angular velocities of the planet necessary to counterbalance the moment of momentum of the oscillations of the sea are very small compared with the component angular velocities of the sea, and therefore the disturbance of planetary rotation due to oceanic reaction is negligible. If now an external disturbing force, such as that of the moon, acts on the system, the resultant moment of momentum of sea and earth is unaffected by the interaction between them, and the precessional and nutational couples are the same as if sea and earth were rigidly connected together. Therefore the additions to these couples on account of tidal oscillation are the couples due to the attraction of the moon on the excess or deficiency of water above or below mean sea-level. The tidal oscillations are very small in height compared with the equatorial protuberance of the earth, and the density of water is $\frac{4}{11}$ths of that of surface rock; hence the additional couples are very small compared with the couples due to the moon's action on the solid equatorial protuberance. Therefore precession and nutation take place sensibly as though the sea were congealed in its mean position. If the ocean be regarded as frictionless, the principles of energy show us that these insensible additional couples must be periodic in time, and thus the corrections to nutation must consist of semi-diurnal, diurnal and fortnightly nutations of absolutely insensible magnitude. We shall have much to say below on the results of the introduction of friction into the conception of tidal oscillations as a branch of speculative astronomy.

Corrections to Precession and Nutation Insensible.

§ 23. *Some Phenomena of Tides in Rivers.*—As a considerable part of our practical knowledge of tides is derived from observations in estuaries and rivers, we shall state the results of an investigation of waves which travel along a shallow canal, and we refer the reader to the article WAVES for the mathematical investigations on which they are based.

It must be premised that when the profile of a wave does not present the simple harmonic form, it is convenient to analyse its shape into a series of partial waves superposed on a fundamental wave; and generally the principle of harmonic analysis is adopted in which the actual wave is regarded as the sum of a number of simple waves.

Suppose that the water is contained in a straight and shallow canal of uniform depth h, and that at one end the canal debouches on to the open sea. Suppose further that in the open sea there is a forced oscillation of water level, given by this formula

$$\eta=H\sin nt$$

where η is the elevation of the water at time t above its mean level, $2\pi/n$ the period of the oscillation and H the amplitude of the oscillation.

Waves will clearly be transmitted along the canal, and the problem is to obtain a formula which shall represent the oscillations of level at any distance x measured from the mouth of the canal.

The mathematical investigation shows that, if g denotes gravity, the formula for the oscillation of water level at the point defined by x is

$$\eta=H\sin n\left(t-\frac{x}{\sqrt{gh}}\right)+\frac{3H^2n}{4h\sqrt{gh}}x\sin 2n\left(t-\frac{x}{\sqrt{gh}}\right).$$

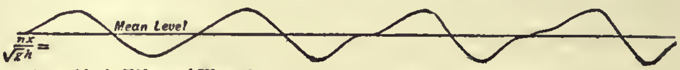
The second of these terms is proportional to x, and if the canal were infinitely long it would become infinite. The difficulty thus occasioned may be eluded by supposing the canal to debouch on a second sea in which a second appropriate oscillation is maintained. In actuality friction gradually annuls all motion, and no such difficulty arises.

The first term of the formula is called the fundamental tide, the second gives what is called the first over-tide; and further approximation would give second and third over-tides, &c. All the over-tides travel up the river at the same rate as the fundamental, but they have double, treble, quadruple frequencies or "speeds," and the ratio of the amplitude of the first over-tide to the fundamental is

$$\frac{3H}{4h}\frac{nx}{\sqrt{gh}}.$$

As a numerical example, let the range of tide at the river mouth be 20 ft., and the depth of the river 50 ft. The "speed" of the semi-diurnal tide, which is an angular velocity, is 28·98° per hour or 1/1·9 radians per hour; $\sqrt{gh}=27$ miles per hour; hence $\frac{3H}{4h}\frac{nx}{\sqrt{gh}}=\frac{1}{342}x.$ Therefore 34 miles up the river the over-tide is 1/10th of the fundamental and has a range of 2 ft. If the river shallows very gradually, the formula wiil still hold, and we see that the height of the over-tide varies as $(\text{depth})^{-\frac{3}{2}}$.

Fig. 6[3] read from left to right exhibits the progressive change of shape. The steepness of the advancing crest shows that a shorter



(From Airy's *Tides and Waves.*)

FIG. 6.—Tide Wave in Rivers.

time elapses between low to high water than inversely. The same investigation shows that the law of the ebb and flow of currents, mentioned in § 2, must hold good.

The second law of waves in rivers to which we draw attention relates to the effects produced by the simultaneous propagation into shallow water of two waves of different periods. It appears that the effect is not simply the summation of the two separate waves.

Suppose that at the mouth of the river the oscillation of the open sea is represented by

$$\eta=H_1\sin n_1t+H_2\sin(n_2t+\epsilon).$$

Then we find that at distance x from the river's mouth the wave is given by the formula

$$\begin{aligned}\eta = H_1\sin n_1\left(t-\frac{x}{\sqrt{gh}}\right)&+H_2\sin\left[n_2\left(t-\frac{x}{\sqrt{gh}}\right)+\epsilon\right]\\ &+\frac{3H_1H_2}{4h}\frac{n_1+n_2}{\sqrt{gh}}x\sin\left[(n_1+n_2)\left(t-\frac{x}{\sqrt{gh}}\right)+\epsilon\right]\\ &-\frac{3H_1H_2}{4h}\frac{n_1-n_2}{\sqrt{gh}}x\sin\left[(n_1+n_2)\left(t-\frac{x}{\sqrt{gh}}\right)+\epsilon\right].\end{aligned}$$

The first two terms give us the two waves just as if each existed by itself. The third and fourth terms give the results of their combination, and are called "compound" tides, the first being a summation tide and the second a difference tide.

As a numerical example, suppose at the mouth of a river 50 ft. deep that the solar semi-diurnal tide has a range $2H_1=4$ ft., and the lunar semi-diurnal tide has a range $2H_2=12$; then $n_1+n_2=59/57$ radians per hour, and $n_1-n_2=1/57$ radians per hour, and as before $\sqrt{gh}=27$ miles per hour.

With these figures

$$\frac{3H_1H_2}{4h}\frac{n_1+n_2}{\sqrt{gh}}x=\frac{1}{170}x.$$

[1] Thomson and Tait, *Nat. Phil.* § 816.

[2] Compare an important paper by H. Poincaré, in *Acta math.* (1885), 7; 3, 4.

[3] From Airy's *Tides and Waves*, with omission of part which was erroneous.

Thus 15 miles up the river the quater-diurnal tide (called MS in harmonic analysis) would have a range of 1/60 of an inch. Where the two interacting compound tides are nearly of the same "speed" the summational compound tide is much the larger of the two. As before, when the river shallows gradually this formula will still hold true.

It is interesting to note the kind of effect produced by these compound tides. When the primary tides are in the same phase (as at spring tide)

$$n_1 t = n_2 t + \epsilon,$$

and we may write the formula in the form

$$\eta = (H_1+H_2)\sin n_1\left(t-\frac{x}{\sqrt{gh}}\right) + \frac{3H_1H_2}{4h}\frac{n_1+n_2}{\sqrt{gh}}x\sin\left[2n_1t-\frac{(n_1+n_2)x}{\sqrt{gh}}\right] + \frac{3H_1H_2}{4h}\frac{n_1-n_2}{\sqrt{gh}}x\sin\frac{(n_1-n_2)x}{\sqrt{gh}}.$$

Hence the front slope of the tide-wave is steeper at springs than at neaps, and the compound tide shows itself at springs in the form of an augmentation of the first over-tide; the converse holds at neaps. Also mean water-mark is affected to a slight extent as we go up the river by an inequality represented by the last term.

IV.—Harmonic Analysis

§ 24. *Outline of the Method.*—We have seen in § 13 that the potential of the tide-generating force of the moon consists of three terms, one being approximately semi-diurnal, one approximately diurnal, and one varying slowly. In consequence of the irregular motion of the moon in right ascension and in declination and the variability of parallax, none of these three classes of terms is simply harmonic in time. The like is also true of the potential of the sun's tide-generating force. In the method of harmonic analysis we conceive the tidal forces or potential due to each disturbing body to be developed in a series of terms each consisting of a constant (determined by the elements of the planet's orbit and the obliquity of the ecliptic) multiplied by a simple harmonic function of the time. Thus in place of the three terms of the potential as developed in § 13 we have an indefinitely long series of terms for each of the three terms. The loss of simplicity in the expression for the forces is far more than counterbalanced by the gain of facility for the discussion of the oscillations of the water. This facility arises from the dynamical principle of forced oscillations, which we have explained in the historical sketch. Applying this principle, we see that each individual term of the harmonic development of the tide-generating forces corresponds to an oscillation of the sea of the same period, but the amplitude and phase of that oscillation must depend on a network of causes of almost inextricable complication. The analytic or harmonic method, then, represents the tide at any port by a series of simple harmonic terms whose periods are determined from theoretical considerations, but whose amplitudes and phases are found from observation. Fortunately the series representing the tidal forces converges with sufficient rapidity to permit us to consider only a moderate number of harmonic terms in the series.

Now it seems likely that the corrections which have been applied in the use of the older synthetic method might have been clothed in a more satisfactory and succinct mathematical form had investigators first carried out the harmonic development. In this article we shall therefore invert history and come back on the synthetic method from the analytic, and shall show how the formulae of correction stated in harmonic language may be made comparable with them in synthetic language. One explanation is expedient before proceeding with the harmonic development. There are certain terms in the tide-generating forces of the moon, depending on the longitude of the moon's nodes, which complete their revolution in 18·6 years. Now it has been found practically convenient, in the application of the harmonic method, to follow the synthetic plan to the extent of classifying together terms whose periods differ only in consequence of the movement of the moon's node, and at the same time to conceive that there is a small variability in the intensity of the generating forces.

Fusion of Terms affected by Motion of Moon's Node.

§ 25. *Development of Equilibrium Theory of Tides in Terms of the Elements of the Orbits.*—Within the limits at our disposal we cannot do more than indicate the processes to be followed in this development. We have already seen in (2) that the expression for the moon's tide-generating potential is

$$V = \frac{3m}{2r^3}\rho^2(\cos^2 z - \tfrac{1}{3}),$$

and in (12) that

$$\cos^2 z - \tfrac{1}{3} = 2\xi\eta M_1M_2 + 2\frac{\xi^2-\eta^2}{2}\cdot\frac{M_1^2-M_2^2}{2} + 2\eta\zeta M_2M_3 + 2\xi\zeta M_1M_3 + \frac{3}{2}\,\frac{\xi^2+\eta^2-2\zeta^2}{3}\cdot\frac{M_1^2+M_2^2-2M_3^2}{3},$$

where M_1, M_2, M_3 and ξ, η, ζ are respectively the direction cosines referred to axes fixed in the earth of the moon and of a place on the earth's surface at which the potential V is to be evaluated. At such a place the radius vector ρ is equal to a the earth's radius.

Let the axes fixed in the earth be taken as follows: the axis C the north polar axis; the axis A through the earth's centre and a point on the equator on the same meridian as the place of observation; the axis B at right angles to the other two and eastward of A. Then if λ be the latitude of the place of observation

$$\xi = \cos\lambda,\ \eta = 0,\ \zeta = \sin\lambda.$$

With these values we have

$$\cos^2 z - \tfrac{1}{3} = \tfrac{1}{2}\cos^2\lambda(M_1^2-M_2^2) + \sin 2\lambda\,.\,M_1M_2 + \tfrac{1}{2}(\tfrac{1}{3}-\sin^2\lambda)(M_1^2+M_2^2-2M_3^2).$$

In fig. 7 let ABC be the axes fixed in the earth; XYZ a second set of axes, XY being the plane of the moon's orbit; M the projection of the moon in her orbit; I=ZC, the obliquity of the lunar orbit to the equator; χ=AX=BCY; l=MX, the moon's longitude in her orbit measured from X, the descending node of the equator on the lunar orbit, hereafter called the "intersection."

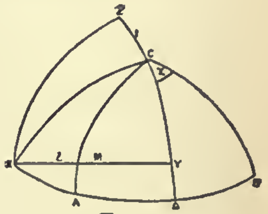


Fig. 7.

Then

$$M_1 = \cos l\cos\chi + \sin l\sin\chi\cos I = \cos^2\tfrac{1}{2}I\cos(\chi-l) + \sin^2\tfrac{1}{2}I\cos(\chi+l),$$

$$M_2 = -\cos l\sin\chi + \sin l\cos\chi\cos I = -\cos^2\tfrac{1}{2}I\sin(\chi-l) - \sin^2\tfrac{1}{2}I\sin(\chi+l),$$

$$M_3 = \sin l\sin I = 2\sin\tfrac{1}{2}I\cos\tfrac{1}{2}I\sin l.$$

When these expressions are substituted in $M_1^2-M_2^2$, M_1M_3, $M_1^2+M_2^2-2M_3^2$, it is clear that the first will have terms in the cosines of $2(\chi-l)$, 2χ, $2(\chi+l)$; the second in sines of $\chi-2l$, χ, $\chi+2l$; and the third in cos $2l$, together with a term depending only on I.

Now let c be the moon's mean distance, e the eccentricity of her orbit, and let

$$X = \left[\frac{c(1-e^2)}{r}\right]^{\frac{3}{2}}M_1,\ Y = \left[\frac{c(1-e^2)}{r}\right]^{\frac{3}{2}}M_2,\ Z = \left[\frac{c(1-e^2)}{r}\right]^{\frac{3}{2}}M_3,$$

and $\tau = \dfrac{3m}{2c^3}$.

Then we have for the lunar tide-generating potential at the place of observation

Tide-generating Potential.

$$V = \frac{\tau a^2}{(1-e^2)^3}[\tfrac{1}{2}\cos^2\lambda\,.\,(X^2-Y^2) + \sin 2\lambda\,.\,XZ + \tfrac{1}{2}(\tfrac{1}{3}-\sin^2\lambda)(X^2+Y^2-2Z^2) \tag{47}$$

The only parts of this expression which are variable in time are the functions of X, Y, Z.

To complete the development the formulae of elliptic motion are introduced in these functions, and terms which appear numerically negligible are omitted. Finally, the three X-Y-Z functions are obtained as a series of simple time-harmonics, the arguments of the sines and cosines being linear functions of the earth's rotation, the moon's mean motion, and the longitude of the moon's perigee. The next step is to pass, according to the principle of forced oscillations, from the potential to the height of tide generated by the forces corresponding to that potential. The X-Y-Z functions being simple time-harmonics, the principle of forced oscillations allows us to conclude that the forces corresponding to V in (47) will generate oscillations in the ocean of the same periods and types as the terms in V, but of unknown amplitudes and phases. Now let $\mathfrak{X}^2-\mathfrak{Y}^2$, $\mathfrak{X}\mathfrak{Z}$, $(\mathfrak{X}^2+\mathfrak{Y}^2-2\mathfrak{Z}^2)$ be three functions having respectively similar forms to those of

$$\frac{X^2-Y^2}{(1-e^2)^3},\ \frac{XZ}{(1-e^2)^3},\ \text{and}\ \frac{(X^2+Y^2-2Z^2)}{(1-e^2)^3},$$

but differing from them in that the argument of each of the simple time-harmonics has some angle subtracted from it, and that the term is multiplied by a numerical factor. Then, if g be gravity and h the height of tide at the place of observation, we must have

Height of Tide at any Port.

$$h = \frac{\tau a^2}{g}[\tfrac{1}{2}\cos^2\lambda(\mathfrak{X}^2-\mathfrak{Y}^2) + \sin 2\lambda\mathfrak{X}\mathfrak{Z} + \tfrac{3}{2}(\tfrac{1}{3}-\sin^2\lambda)\tfrac{1}{3}(\mathfrak{X}^2+\mathfrak{Y}^2-2\mathfrak{Z}^2)]. \tag{48}$$

The factor $\tau a^2/g$ may be more conveniently written $\dfrac{3m}{2M}\left(\dfrac{a}{c}\right)^3 a$, where M is the earth's mass. It has been so chosen that, if the equilibrium theory of tides were fulfilled, with water covering the whole earth, the numerical factors in the $\mathfrak{X}$-$\mathfrak{Y}$-$\mathfrak{Z}$ functions would be each unity and the alterations of phase would be zero. The terms in $(\mathfrak{X}^2+\mathfrak{Y}^2-2\mathfrak{Z}^2)$ require special consideration. The function of the latitude being $\tfrac{1}{3}-\sin^2\lambda$, it follows that, when in the northern hemisphere it is high-water north of a certain critical latitude, it is low-water on the opposite side of that parallel; and the same is true of the southern hemisphere. It is best to adopt a uniform system for the whole earth, and to regard high-tide and high-water as

Definition of High Tide of Tide of Long Period.

consentaneous in the equatorial belt, and of opposite meanings outside the critical latitudes. We here conceive the function always to be written $\frac{1}{3}-\sin^2\lambda$, so that outside the critical latitudes high-tide is low-water. We may in continuing the development write the $\mathfrak{X}$-$\mathfrak{Y}$-$\mathfrak{Z}$ functions in the form appropriate to the equilibrium theory with water covering the whole earth, for the actual case it is only then necessary to multiply by the reducing factor, and to subtract the phase alteration κ. As these are unknown constants for each place, they would only occur in the development as symbols of quantities to be deduced from observation. It will be understood, therefore, that in the following schedules the "argument" is that part of the argument which is derived from theory, the true complete argument being the "argument" $-\kappa$, where κ is derived from observation.

Up to this point we have supposed the moon's longitude and the earth's position to be measured from the "intersection"; but in order to pass to the ordinary astronomical formulae we must measure the longitude and the earth's position from the vernal equinox. Hence we determine the longitude and right ascension of the "intersection" in terms of the longitude of the moon's node and the inclination of the lunar orbit, and introduce them into our formulae for the $\mathfrak{X}$-$\mathfrak{Y}$-$\mathfrak{Z}$ functions. The expressions for the functions corresponding to solar tides may be written down by symmetry, and in this case the intersection is actually the vernal equinox.

Explanation of Schedules below.

The final result of the process sketched is to obtain a series of terms each of which is a function of the elements of the moon's or sun's orbit, and a function of the terrestrial latitude of the place of observation, multiplied by the cosine of an angle which increases uniformly with the time. We shall now write down the result in the form of a schedule; but we must first state the notation employed: e, $e_{,}$ = eccentricities of lunar and solar orbits; I, ω = obliquities of equator to lunar orbit and ecliptic; p, $p_{,}$ = longitudes of lunar and solar perigees, ϖ, $\varpi_{,}$ = hourly increments of p, $p_{,}$; s, h = moon's and sun's mean longitudes; σ, η = hourly increments of s, h; t = local mean solar time reduced to angle; $\gamma-\eta=15^\circ$ per hour; λ = latitude of place of observation; ξ, ν = longitude in lunar orbit, and R.A. of the intersection; N = longitude of moon's node; i = inclination of lunar orbit. The "speed" of any tide is defined as the rate of increase of its argument, and is expressible, therefore, as a linear function of γ, η, σ, ϖ; for we may neglect $\varpi_{,}$ as being very small.

Speed Defined.

The following schedules, then, give h the height of tide. The arrangement is as follows. First, there is a universal coefficient $\frac{3}{2}\frac{m}{M}\left(\frac{a}{c}\right)^3 a$, which multiplies every term of all the schedules. Secondly, there are general coefficients, one for each schedule, viz. $\cos^2\lambda$ for the semi-diurnal terms, $\sin 2\lambda$ for the diurnal, and $\frac{1}{2}-\frac{3}{2}\sin^2\lambda$ for the terms of long period. In each schedule the third column, headed "coefficient," gives the functions of I and e. In the fourth column is given the mean semi-range of the corresponding term in numbers, which is approximately the value of the coefficient in the first column when $I=\omega$; but we pass over the explanation of the mode of computing the values. The fifth column contains arguments, linear functions of t, h, s, p, ν, ξ. In [A, i.] $2t+2(h-\nu)$ and in [A, ii.] $t+(h-\nu)$ are common to all the arguments. The arguments are grouped in a manner convenient for subsequent computation. Lastly, the sixth is a column of speeds, being the hourly increases of the arguments in the preceding column, estimated in degrees per hour. It has been found practically convenient to denote each of these partial tides by an initial letter, arbitrarily chosen. In the first column we give a descriptive name for the tide, and in the second the arbitrarily chosen initial.

The schedule for the solar tides is drawn up in precisely the same manner, the only difference being that the coefficients are absolute constants. In order that the comparison of the importance of the solar tides with the lunar may be complete, the same universal coefficient $\frac{3}{2}\frac{m}{M}\left(\frac{a}{c}\right)^3 a$ is retained, and the special coefficient for each term is made to involve the factor $\frac{\tau_{,}}{\tau}$. Here $\tau_{,}=\frac{3}{2}\frac{m_{,}}{c_{,}^3}$, $m_{,}$ being the sun's mass. With

$$\frac{M}{m}=81{\cdot}5,\ \frac{\tau_{,}}{\tau}={\cdot}46035=\frac{1}{2{\cdot}17226}.$$

Mode of Reading Schedules Explained.

To write down any term, take the universal coefficient, the general coefficient for the class of tides, the special coefficient, and multiply by the cosine of the argument. The result, taken with the positive sign, is a term in the equilibrium tide, with water covering the whole earth. The transition to the actual case by the introduction of a factor and a delay of phase (to be derived from observation) has been already explained. The sum of all the terms is the complete expression for the height of tide h.

It must be remarked that the schedule of tides is here largely abridged, and that the reader who desires fuller information must refer to the *Brit. Assoc. Report* for 1883, or vol. i. of G. H. Darwin's *Scientific Papers*, or to Harris's *Manual of Tides*.

A.—*Schedule of Lunar Tides.*

$$\text{Universal Coefficient}=\frac{3}{2}\frac{m}{M}\left(\frac{a}{c}\right)^3 a.$$

i.—Semi-diurnal Tides; General Coefficient = $\cos^2\lambda$.					
Descriptive Name.	Initial.	Coefficient.	Mean Value of Coefficient.	Argument $2t+2(h-\nu.)$	Speed in Degrees per m. s. Hour.
Principal lunar.	M_2	$\frac{1}{2}(1-\frac{5}{2}e^2)\cos^4\frac{1}{2}I$	·45426	$-2(s-\xi)$	28·9841042°
Luni-solar (lunar portion)	K_2	$\frac{1}{2}(1+\frac{3}{2}e^2)\frac{1}{2}\sin^2 I$	·03929	—	30·0821372°
Larger elliptic	N	$\frac{1}{2}\cdot\frac{7}{2}e\cos^4\frac{1}{2}I$	·08706	$-2(s-\xi)-(s-p)$	28·4397296°

ii.—Diurnal Tides; General Coefficient = $\sin 2\lambda$.					
Descriptive Name.	Initial.	Coefficient.	Mean Value of Coefficient.	Argument $t+(h-\nu)$.	Speed in Degrees per m.s. Hour.
Lunar diurnal	O	$(1-\frac{5}{2}e^2)\frac{1}{2}\sin I\cos^2\frac{1}{2}I$	·18856	$-2(s-\xi)+\frac{1}{2}\pi$	13·9430356°
Luni-solar (lunar portion)	K_1	$(1+\frac{3}{2}e^2)\frac{1}{2}\sin I\cos I$	·18115	$-\frac{1}{2}\pi$	15·0410686°
Larger elliptic	Q	$\frac{7}{2}e\cdot\frac{1}{2}\sin I\cos^2\frac{1}{2}I$	·03651	$\left\{-2(s-\xi)-(s-p)+\frac{1}{2}\pi\right\}$	13·3986609°

iii.—Long Period Tides; General Coefficient $\frac{1}{2}-\frac{3}{2}\sin^2\lambda$.					
Descriptive Name.	Initial.	Coefficient.	Mean Value of Coefficient.	Argument.	Speed in Degrees per m.s. Hour.
Change of mean level.	—	$(1+\frac{3}{2}e^2)\frac{1}{2}(1-\frac{3}{2}\sin^2 I)$	·25224[1]	Of variable part is N, the long. of node	29·34° per annum
Fortnightly.	Mf	$(1-\frac{5}{2}e^2)\frac{1}{2}\sin^2 I$	·07827	$2(s-\xi)$	1·0980330°

B.—*Schedule of Solar Tides.*

$$\text{Universal Coefficient}=\frac{3}{2}\frac{M}{m}\left(\frac{a}{c}\right)^3 a.$$

Descriptive Name.	Initial.	Coefficient.	Value of Coefficient.	Argument.	Speed in Degrees per m.s. Hour.
i.—Semi-diurnal Tides; General Coefficient = $\cos^2\lambda$.					
Principal solar	S_2	$\frac{\tau_{,}}{\tau}(1-\frac{5}{2}e_{,}^2)\frac{1}{2}\cos^4\frac{1}{2}\omega$	·22137	$2t$	30·0000000°
Luni-solar (solar portion)	K_2	$\frac{\tau_{,}}{\tau}(1+\frac{3}{2}e_{,}^2)\frac{1}{4}\sin^2\omega$	·01823	$2t+2h$	30·0821372°
Larger elliptic	T	$\frac{\tau_{,}}{\tau}\frac{1}{2}\,\frac{7}{2}e_{,}\cos^4\frac{1}{2}\omega$	·01243	$2t-(h-p_{,})$	29·9589324°
ii.—Diurnal Tides; General Coefficient = $\sin 2\lambda$.					
Solar diurnal	P	$\frac{\tau_{,}}{\tau}(1-\frac{5}{2}e_{,}^2)\frac{1}{2}\sin\omega\cos^2\frac{1}{2}\omega$	·08775	$t-h+\frac{1}{2}\pi$	14·9589314°
Luni-solar (solar portion)	K_1	$\frac{\tau_{,}}{\tau}(1+\frac{3}{2}e_{,}^2)\frac{1}{2}\sin\omega\cos\omega$	·08407	$t+h-\frac{1}{2}\pi$	15·0410686°
iii.—Long Period Tides; General Coefficient = $\frac{1}{2}-\frac{3}{2}\sin^2\lambda$					
Semi-annual	Ssa	$\frac{\tau'}{\tau}(1-\frac{5}{2}e_{,}^2)\frac{1}{2}\sin^2\omega$	·03643	$2h$	0·0821372°

From the fourth columns we see that the coefficients in descending order of magnitude are M_2, K_1 (both combined), S_2, O, K_1 (lunar), N, P, K_1 (solar) K_2 (both combined), K_2 (lunar), Mf, Q, K_2 (solar), Ssa.

Scale of Importance of Tides.

The tides which we omit from the schedules are relatively unimportant, but nevertheless commonly evaluated in accurate tidal work, are all lunar tides, viz. the following semi-diurnal tides: the smaller elliptic tide L, the larger and smaller evectional tides ν, λ, the variational tide μ. Also the following diurnal tides, viz. the smaller elliptic tide M_1, a tide of speed $\gamma+\sigma-\varpi$ called J. Also amongst the tides of long period, the luni-solar fortnightly called MSf.

The tides depending on the fourth power of the moon's parallax

[1] The mean value of this coefficient is $\frac{1}{2}(1+\frac{3}{2}e^2)(1-\frac{3}{2}\sin^2 i)(1-\frac{3}{2}\sin^2\omega)$ $={\cdot}25$, and the variable part is approximately $-(1+\frac{3}{2}e^2)\sin i\cos i\sin\omega$ $\cos\omega\cos N=-\ {\cdot}0328\cos N$.

arise from the potential $V=\frac{m}{r^4}\rho^3(\frac{5}{2}\cos^3 z-\frac{3}{2}\cos z)$. They give rise to a small diurnal tide M_1, and to a small ter-diurnal tide M_3; but we shall not give the analytical development.

§ 26. *Over-Tides, Compound Tides and Meteorological Tides.*—We have in § 23 stated results derived from dynamical theory as to over-tides, which represent the change of profile of the wave as it advances in shallow water. The only tides in which it has hitherto been thought necessary to represent this change of form belong to the principal lunar and principal solar series. Thus, besides the fundamental astronomical tides M_2 and S_2, the over-tides M_4, M_6, M_8 and S_4, S_6 are usually deduced by harmonic analysis.

Over-Tides.

Compound tides have been also referred to in § 23; they represent a result of the combination of two waves of different speeds travelling through shallow water. On combining the speeds of the important tides, it will be found that there is in many cases a compound tide which has itself a speed identical with that of an astronomical or meteorological tide. We thus find that the tides O, K_1, P, M_2, Mf, Q, M_1, L are liable to perturbation in shallow water. We refer to the *Brit. Assoc. Report* for 1883 or to Harris's *Manual* for a schedule, with initials, of the compound tides which are usually evaluated.

Compound Tides.

All tides whose period is an exact multiple or submultiple of a mean solar day, or of a tropical year, are affected by meteorological conditions. Thus all the tides of the principal solar astronomical series S, with speeds $\gamma-\eta$, $2(\gamma-\eta)$, $3(\gamma-\eta)$, &c., are subject to more or less meteorological perturbation. An annual inequality in the diurnal meteorological tide S_1 will also give rise to a tide $\gamma-2\eta$, and this will be fused with and indistinguishable from the astronomical P; it will also give rise to a tide with speed γ, which will be indistinguishable from the astronomical part of K_1. Similarly the astronomical tide K_2 may be perturbed by a semi-annual inequality in the semi-diurnal astronomical tide of speed $2(\gamma-\eta)$. Although the diurnal tide S_1 or $\gamma-\eta$ and the semi-annual and annual tides of speeds 2η and η are all quite insensible as arising from astronomical causes, yet they have been found of sufficient importance to be considered. The annual and semi-annual tides are of enormous importance in some rivers, representing in fact the yearly flooding in the rainy season. In the reduction of these tides the arguments of the S series are t, $2t$, $3t$, &c., and of the annual, semi-annual, ter-annual tides h, $2h$, $3h$. As far as can be foreseen, the magnitudes of these tides are constant from year to year.

Meteorological Tides.

§ 27. *On the Form of Presentation of Results of Tidal Observations.*—Supposing n to be the speed of any tide in degrees per mean solar hour, and t to be mean solar time elapsing since 0^h of the first day of (say) a year of continuous observation, then the immediate result of harmonic analysis is to obtain a height R and an angle ζ such that the height of this tide at the time t is given by

Immediate Result of Harmonic Analysis.

$$R\cos(nt-\zeta).$$

R is the semi-range of the tide (say) in British feet, and ζ is an angle such that ζ/n is the time elapsing after 0^h of the first day until it is high water of this particular tide. It is obvious that ζ may have any value from 0° to 360°, and that the results of the analysis of successive years of observation will not be comparable with one another when presented in this form.

But let us suppose that the results of the analysis are presented in a number of terms of the form

$$fH\cos(V+u-\kappa),$$

where V is a linear function of the moon's and sun's mean longitudes, the mean longitude of the moon's and sun's perigees, and the local mean solar time at the place of observation, reduced to angle at 15° per hour. V increases uniformly with the time, and its rate of increase per mean solar hour is the n of the first method, and is called the speed of the tide. It is supposed that u stands for a certain function of the longitude of the node of the lunar orbit at an epoch half a year later than 0^h of the first day. Strictly speaking, u should be taken as the same function of the longitude of the moon's node, varying as the node moves; but, as the variation is but small in the course of a year, u may be treated as a constant and put equal to an average value for the year, which average value is taken as the true value of u at exactly mid year. Together $V+u$ constitute that function which has been tabulated as the "argument" in the schedules of § 25. Since $V+u$ are together the whole argument according to the equilibrium theory of tides, with sea covering the whole earth, it follows that κ/n is the lagging of the tide which arises from kinetic action, friction of the water, imperfect elasticity of the earth, and the distribution of land. It is supposed that H is the mean value in British feet of the semi-range of the particular tide in question; f is a numerical factor of augmentation or diminution, due to the variability of the obliquity of the lunar orbit. The value of f is the ratio of the "coefficient" in the third column of the preceding schedules to the mean value of the same term. It is obvious, then, that, if the tidal observations are consistent from year to year, H and κ should come out the same from each year's reductions. It is only when the results are presented in such a form as this that it will be possible to judge whether the harmonic analysis is yielding satisfactory results. This mode of giving the tidal results is also essential for the use of a tide-predicting machine (see § 8).

Final Form; Tidal Constants.

We must now show how to determine H and κ from R and ζ. It is clear that $H=R/f$, and the determination of f from the schedules depends on the evaluation of the mean value of each of the terms in the schedules, into which we shall not enter. If V_0 be the value of V at 0^h of the first day when t is zero, then clearly

$$-\zeta=V_0+u-\kappa,$$

so that

$$\kappa=\zeta+V_0+u.$$

Thus the rule for the determination of κ is: *Add to the value of ζ the value of the argument at 0^h of the first day.*

The results of harmonic analysis are usually tabulated by giving H, κ under the initial letter of each tide; the results are thus comparable from year to year.[1] For the purpose of using the tide-predicting machine the process of determining H and κ from R and ζ has simply to be reversed, with the difference that the instant of time to which to refer the argument is 0^h of the first day of the new year, and we must take note of the different values of u and f for the new year. Tables[2] have been computed for f and u for all longitudes of the moon's node and for each kind of tide, and the mean longitudes of moon, sun, and lunar perigee may be extracted from any ephemeris. Thus when the mean semi-range H and the retardation κ of any tide are known its height may be computed for any instant. The sum of the heights for all the principal tides of course gives the actual height of water.

Tidal Constants.

§ 28. *Numerical Harmonic Analysis.*—The tide-gauge furnishes us with a continuous graphical record of the height of the water above some known datum mark for every instant of time. The first operation performed on the tidal record is the measurement in feet and decimals of the height of water above the datum at every mean solar hour. The period chosen for analysis is about one year and the first measurement corresponds to noon.

Treatment of Tide Curves.

If T be the period of any one of the diurnal tides, or the double period of any one of the semi-diurnal tides, it approximates more or less nearly to 24 solar hours, and, if we divide it into 24 equal parts, we may speak of each as a T-hour.

The process of harmonic analysis consists of finding the average height of water at each of the 24 T-hours of the T-day, but we shall not go into the way in which this may be done.[3] It must suffice to say that it depends on the fact that in the long run any given T-hour will fall at all hours of any other special day.

The final outcome is that we obtain the height of water at each of the 24 T-hours of a T-day, freed from the influence of all the other tides. We may see that it is thus possible to isolate the T-tide. When this has been done let t denote T-time expressed in T-hours, and let n be 15°. Then we express the height h as given by the averaging process above indicated by the formula

$$h=A_0+A_1\cos nt+B_1\sin nt+A_2\cos 2nt+B_2\sin 2nt+\ldots,$$

where t is 0, 1, 2, . . . 23.

See the article Harmonic Analysis for the numerical processes by which A_0, A_1, B_1, A_2, B_2, &c., may be evaluated. It is obvious that such a formula as $A\cos nt+B\sin nt$ may easily be reduced to the form $R\cos(nt-\zeta)$. An actual numerical example of harmonic analysis of tidal observations is given in the *Admiralty Scientific Manual* (1886) in the article "Tides," or G. H. Darwin's *Scientific Papers*, vol. i.

V.—Synthetic Method

§ 29. *On the Method and Notation.*—The general nature of the synthetic method has been already explained; we now propose to show how the expressions for the tide may be developed from the result as expressed in the harmonic notation. If it should be desired to make a comparison of the results of tidal observation as expressed in the synthetic method with those of the harmonic method, or the converse, or to compute a tide-table from the harmonic constants by reference to the moon's transits and the declinations and parallaxes of sun and moon, analytical expressions founded on a procedure indicated in the following sections are necessary.

In chapter iv. the mean semi-range and angle of retardation of any one of the tides have been denoted by H and κ. We shall here, however, require to introduce several of the H's and κ's into the same expression, and they must therefore be distinguished from one another. This may in general be done conveniently by writing as a subscript letter the initial of the corresponding tide; for example H_m, κ_m will be taken to denote the H and κ of the lunar tide M_2. This notation does not suit the K_2 and K_1 tides,

[1] See, for example, a collection of results by Baird and Darwin, *Proc. Roy. Soc.* (1885), No. 239, and a more extensive one in Harris's *Manual*.

[2] *Report on Harmonic Analysis to Brit. Assoc.* (1883), and more extended table in Baird's *Manual of Tidal Observation* (London, 1887).

[3] See Darwin's *Tides* for an account without mathematics.

and we shall therefore write H'', κ'' for the semi-diurnal K_2, and H', κ' for the diurnal K_1 tide. These two tides proceed according to sidereal time and arise from the sun and moon jointly, and a synthesis of the two parts of each is effected in the harmonic method, although that synthesis is not explained in chapter iv. It is now necessary to reverse this partial synthesis, in order to obtain a more complete one. We must therefore note that the ratio of the solar to the lunar part of the total K_2 tide is 0·46407; so that 0·683 H'' is the lunar portion of the total K_2. There will be no occasion to separate the two portions of K_1, and we shall retain the synthesis which is effected in the harmonic method.

§ 30. *Semi-Diurnal Tides.*—The process adopted is to replace the mean longitudes and elements of the orbit in each term of the harmonic development of the schedules of § 25 by hour-angles, declinations, and parallaxes.

Mean Longitude and Elements Replaced by Hour-angle, Declination and Parallax.

At the time t (mean solar time of port reduced to angle) let α, δ, ψ be ☽'s R.A., declination, and hour-angle, and l ☽'s longitude measured from the "intersection." These and other symbols when written with a subscript accent are to apply to the sun. Then ν being the R.A. of the intersection, we have from the right-angled spherical triangle of which the sides are l, δ, $\alpha-\nu$ the relations

$$\tan(\alpha-\nu)=\cos I\tan l,\quad \sin\delta=\sin I\sin l. \tag{49}$$

Now $s-\xi$ is the ☽'s mean longitude measured from the intersection and $s-p$ is the mean anomaly; hence approximately

$$l=s-\xi+2e\sin(s-p). \tag{50}$$

From (49) and (50) we have approximately

$$\alpha=s+(\nu-\xi)+2e\sin(s-p)-\tan^2\tfrac{1}{2}I\sin 2(s-\xi).$$

Now, h being the ☉'s mean longitude, $t+h$ is the sidereal hour-angle, and $\psi=t+h-\alpha$.

Hence

$$t+h-s-(\nu-\xi)=\psi+2e\sin(s-p)-\tan^2\tfrac{1}{2}I\sin 2(s-\xi). \tag{51}$$

Again, if we put

$$\cos^2\Delta=1-\tfrac{1}{2}\sin^2 I \tag{52}$$

we have approximately from (49) and (50)

$$\left.\begin{aligned}\frac{\cos^2\delta-\cos^2\Delta}{\sin^2\Delta}&=\cos 2(s-\xi)\\ \text{whence}\quad \frac{\sin\delta\cos\delta}{\sigma\sin^2\Delta}\frac{d\delta}{dt}&=\sin 2(s-\xi)\end{aligned}\right\}. \tag{53}$$

Obviously Δ is such a declination that $\sin^2\Delta$ is the mean value of $\sin^2\delta$ during a lunar month. Again, if P be the ratio of the ☽'s parallax to her mean parallax, the equation to the ellipse described

$$\left.\begin{aligned}\text{gives}\quad \frac{1}{e}(P-1)&=\cos(s-p)\\ \text{whence}\quad -\frac{1}{e(\sigma-\varpi)}\frac{dP}{dt}&=\sin(s-p)\end{aligned}\right\}. \tag{54}$$

Now it appears in schedule A of § 25 that the arguments of all the lunar semi-diurnal tides are of the form $2(t+h-\nu)\pm 2(s-\xi)$ or $\pm(s-p)$. It is clear, therefore, that the cosines of such angles may by the relations (51), (53), (54) be expressed in terms of hour-angles, declinations and parallaxes. Also by means of (52) we may introduce Δ in place of I in the coefficients of each term. An approximate formula for Δ is $16·51°+3·44°\cos N-0·19°\cos 2N$. Details will be found in the *Brit. Assoc. Report* for 1885.

We shall not follow the analytical processes in detail, but the formulae given show the possibility of replacing the symbols used in the method of harmonic analysis by others involving R.A., declination and parallax.

Before giving the results of the processes indicated it must be remarked that greater succinctness is obtained by the introduction of the symbol δ' to denote the ☽'s declination at a time earlier than that of observation by an interval which may be called the "age of the declinational inequality," and is computed from the formula $\tan(\kappa''-\kappa_m)/2\sigma$ or $52·2^h\tan(\kappa''-\kappa_m)$. Similarly, it is convenient to introduce P' to denote the value of P at a time earlier than that of observation by the "age of the parallactic inequality," to be computed from $\tan(\kappa_m-\kappa_n)/(\sigma-\varpi)$ or $105·3^h\tan(\kappa_m-\kappa_n)$. These two "ages" probably do not differ in general much from a third period, computed from $(\kappa_s-\kappa_m)/2(\sigma-\eta)$, which is called the "age of the tide."

Age of Declinational Parallactic and Corrections.

The similar series of transformations when applied to the solar tides lead to simpler results, because $\Delta_{,}$ is a constant, being 16·33°, and the "ages" may be treated as zero; besides the terms depending on $d\delta_{,}/dt$ and $dP_{,}/dt$ are negligible. Formulae for the semi-diurnal tide of great exactness are obtainable by means of these transformations, but they lack the simplicity of those obtained in the harmonic method. On the other hand they are in some respects even more exact, since all lunar inequalities are represented. We shall not give the complex formulae which represent the complete substitution of R.A., declination and parallax in the earlier formulae, but shall content ourselves with rougher results, which are still fairly accurate.

Let us write them

$$\left.\begin{aligned}M&=P'^3\frac{\cos^2\nabla}{\cos^2\Delta_{,}}H_m+\frac{\cos^2\delta'-\cos^2\Delta}{\sin^2\Delta_{,}}0·683\,H''\cos(\kappa''-\kappa_m),\\ 2\mu&=\kappa_m+\frac{\cos^2\delta'-\cos^2\Delta}{\sin^2\Delta_{,}}0·683\frac{H''}{H_m}\sin(\kappa''-\kappa_m),\\ M_{,}&=P_{,}^3\frac{\cos^2\delta_{,}}{\cos^2\Delta_{,}}H_s,\\ 2\mu_{,}&=\kappa_s.\end{aligned}\right\} \tag{55}$$

Then we find that the height h_2 of the complete lunar and solar semi-diurnal tide is represented with a fair degree of approximation by

$$h_2=M\cos 2(\psi-\mu)+M_{,}\cos 2(\psi_{,}-\mu_{,}). \tag{56}$$

The first of these is the lunar tide, and it will be observed that the height M depends on the cube of the moon's parallax at a time earlier than that of observation by "the age of the parallactic inequality," and that it depends also on the moon's declination at a time earlier by "the age of the declinational inequality." The phase of the tide, represented by the angle 2μ, also has a declinational inequality.

Synthesis giving one Lunar and one Solar Tide.

The second term is the solar tide, and it also has parallactic and declinational inequalities.

The formulae (55), (56) have been used in an example of the computation of a tide-table given in the *Admiralty Scientific Manual* (1886).

§ 31. *Synthesis of Lunar and Solar Semi-Diurnal Tides.*—Let A be the excess of ☽'s over ☉'s R.A., so that

$$\left.\begin{aligned}A&=\alpha-\alpha_{,},\\ \psi_{,}&=\psi+A,\\ \text{and}\quad h_2&=M\cos 2(\psi-\mu)+M_{,}\cos 2(\psi+A-\mu_{,}).\end{aligned}\right\} \tag{57}$$

The synthesis is then completed by writing

$$\begin{aligned}H\cos 2(\mu-\phi)&=M+M_{,}\cos 2(A-\mu_{,}+\mu),\\ H\sin 2(\mu-\phi)&=\phantom{M+{}}M_{,}\sin 2(A-\mu_{,}+\mu),\\ \text{so that}\quad h_2&=H\cos 2(\psi-\phi).\end{aligned} \tag{58}$$

Then H is the height of the total semi-diurnal tide and $\phi/(\gamma-d\alpha/dt)$ or approximately $\phi/(\gamma-\sigma)$ or $\frac{2}{29}\phi$, when ϕ is given in degrees, is the "interval" from the moon's transit to high water.

Synthesis to obtain Single Term.

The formulae for H and ϕ may be written

$$\left.\begin{aligned}H&=\sqrt{\{M^2+M_{,}^2+2MM_{,}\cos 2(A-\mu_{,}+\mu)\}}\\ \tan 2(\mu-\phi)&=\frac{M_{,}\sin 2(A-\mu_{,}+\mu)}{M+M_{,}\cos 2(A-\mu_{,}+\mu)}.\end{aligned}\right\} \tag{59}$$

Since A goes through its period in a lunation, it follows that H and ϕ have inequalities with a period of half a lunation. These are called the "fortnightly inequalities in the height and interval.

Fortnightly Inequality.

Spring tide obviously occurs when $A=\mu_{,}-\mu$. Since the mean value of A is $s-h$ (the difference of the mean longitudes), and since the mean values of μ and $\mu_{,}$ are $\frac{1}{2}\kappa_m$, $\frac{1}{2}\kappa_s$, it follows that the mean value of the period elapsing after full moon and change of moon up to spring tide is $(\kappa_s-\kappa_m)/2(\sigma-\eta)$. The association of spring tide with full and change is obvious, and a fiction has been adopted by which it is held that spring tide is generated in those configurations of the moon and sun, but takes some time to reach the port of observation. Accordingly $(\kappa_s-\kappa_m)/2(\sigma-\eta)$ has been called the "age of the tide." The average age is about 36 hours as far as observations have yet been made. The age of the tide appears not in general to differ very much from the ages of the declinational and parallactic inequalities.

Age of Tide.

In computing a tide-table it is found practically convenient not to use A, which is the difference of R.A.'s at the unknown time of high-water, but to refer the tide to A_0, the difference of R.A.'s at the time of the moon's transit. It is clear that A_0 is the apparent time of the moon's transit reduced to angle at 15° per hour. We have already remarked that $\phi/(\gamma-d\alpha/dt)$ is the interval from transit to high-water, and hence at high-water

$$A=A_0+\frac{d\alpha/dt-d\alpha_{,}/dt}{\gamma-d\alpha_{,}/dt}\phi. \tag{60}$$

As an approximation we may attribute to all the quantities in the second term their mean values, and we then have

Reference to Moon's Transit.

$$A=A_0+\frac{\sigma-\eta}{\gamma-\sigma}\mu$$

$$\text{and}\quad A-\mu_{,}+\mu=A_0-\mu_{,}+\frac{\gamma-\eta}{\gamma-\sigma}\mu=A_0-\mu_{,}+\tfrac{30}{29}\mu. \tag{61}$$

This approximate formula (61) may be used in computing from (59) the fortnightly inequality in the "height" and "interval."

In this investigation we have supposed that the declinational and parallactic corrections are applied to the lunar and solar tides before their synthesis; but it is obvious that the process may be reversed, and that we may form a table of the fortnightly inequality based on mean values H_m and H_s and afterwards apply corrections. This is the process usually adopted, but it is less exact. The labour of computing the fortnightly inequality, especially by graphical methods, is not great, and the plan here suggested seems preferable.

§ 32. *Diurnal Tides.*—These tides have not been usually treated with much completeness in the synthetic method. In the tide-tables of the British Admiralty we find that the tides at some ports are "affected by diurnal inequality"; such a statement may be interpreted as meaning that the tides are not to be predicted by the information given in the so-called tide-table. The diurnal tides are indeed complex, and do not lend themselves easily to a complete synthesis. In the harmonic notation the three important tides are K_1, O, P, and the lunar portion of K_1 is nearly equal to O in height, whilst the solar portion is nearly equal to P. A complete synthesis may be carried out on the lines adopted in treating the semi-diurnal tides, but the advantage of the plan is lost in consequence of large oscillations of the amplitude through the value zero, so that the tide is often represented by a negative quantity multiplied by a circular function. It is best, then, only to attempt a partial synthesis, and to admit the existence of two diurnal tides. One of these will be a tide consisting of K_1 and P united, and the other will be O.

We shall not give the requisite formulae, but refer the reader to the *Brit. Assoc. Report* for 1885. A numerical example is given in the *Admiralty Manual* for 1886.

§ 33. *On the Reduction of Observations of High- and Low-Water.*[1]—A continuous register of the tide or observation at fixed intervals of time, such as each hour, is certainly the best; but for the adequate use of such a record some plan analogous to harmonic analysis is necessary. Observations of high- and low-water only have, at least until recently, been more usual. In the reduction the immediate object is to connect the times and heights of high- and low-water with the moon's transits by means of the establishment, age and fortnightly inequality in the interval and height. The reference of the tide to the establishment is not, however, scientifically desirable, and it is better to determine the mean establishment, which is the mean interval from the moon's transit to high-water at spring tide, and the age of the tide, which is the mean period from full moon and change of moon to spring tide.

Graphical Determination of Establishment, &c.

For these purposes the observations may be conveniently treated graphically.[2] An equally divided horizontal scale is taken to represent the twelve hours of the clock of civil time, regulated to the time of the port, or—more accurately—arranged always to show apparent time by being fast or slow by the equation of time; this time-scale represents the time-of-clock of the moon's transit, either upper or lower. The scale is perhaps most conveniently arranged in the order V, VI,...XII, I...IIII. Then each interval of time from transit to high-water is set off as an ordinate above the corresponding time-of-clock of the moon's transit. A sweeping curve is drawn nearly through the tops of the ordinates, so as to cut off minor irregularities. Next along the same ordinates are set off lengths corresponding to the height of water at each high-water. A second similar figure may be made for the interval and height at low-water. In the curve of high-water intervals the ordinate corresponding to XII. is the establishment, since it gives the time of high-water at full moon and change of moon. That ordinate of high-water intervals which is coincident with the greatest ordinate of high-water heights gives the mean establishment. Since the moon's transit falls about fifty minutes later on each day, in setting off a fortnight's observations there will be about five days for each four times-of-clock of the upper transit. Hence in these figures we may regard each division of the time-scale I to II, II to III, &c., as representing twenty-five hours instead of one hour. Then the distance from the greatest ordinate of high-water heights to XII is called the age of the tide. From these two figures the times and heights of high- and low-water may in general be predicted with fair approximation. We find the time-of-clock of the moon's upper or lower transit on the day, correct by the equation of time, read off the corresponding heights of high- and low-water from the figures, and the intervals being also read off are added to the time of the moon's transit and give the times of high- and low-water. At all ports there is, however, an irregularity of heights and intervals between successive tides, and in consequence of this the curves present more or less of a zigzag appearance. Where the zigzag is perceptible to the eye, the curves must be smoothed by drawing them so as to bisect the zigzags, because these diurnal inequalities will not present themselves similarly in the future. When, as in some equatorial ports, the diurnal tides are large, this method of tidal prediction fails in the simple form explained above. It may however be rendered applicable by greater elaboration.[3]

This method of working out observations of high- and low-water was not the earliest. In the *Mécanique Céleste*, bks. i. and v., Laplace treats a large mass of tidal observations by dividing them into classes depending on the configurations of the tide-generating bodies. Thus he separates the two syzygial tides at full moon and change of moon and divides them into equinoctial and solstitial tides. He takes into consideration the tides of several days embracing these configurations. He goes through the tides at quadratures on the same general plan. The effects of declination and parallax and the diurnal inequalities are similarly treated. Lubbock (*Phil. Trans.*, 1831, seq.) improved the method of Laplace by taking into account all the observed tides, and not merely those appertaining to certain configurations. He divided the observations into a number of classes. First, the tides are separated into parcels, one for each month; then each parcel is sorted according to the hour of the moon's transit. Another classification is made according to declination; another according to parallax; and a last for the diurnal inequalities. This plan was followed in treating the tides of London, Brest, St Helena, Plymouth, Portsmouth and Sheerness. Whewell (*Phil. Trans.*, 1834, seq.) did much to reduce Lubbock's results to a mathematical form, and made a highly important advance by the introduction of graphical methods by means of curves. The method explained above is due to him. Airy remarks of Whewell's papers that they appear to be "the best specimens of reduction of new observations that we have ever seen."

Methods of Laplace, Lubbock, Whewell.

VI.—Tidal Deformation of the Solid Earth

§ 34. *Elastic Tides.*—The tide-generating potential varies as the square of the distance from the earth's centre, and the corresponding forces act at every point throughout its mass. No solid matter possesses the property of absolute rigidity, and we must therefore admit the probable existence of tidal elastic deformation of the solid earth. The problem of finding the state of strain of an elastic sphere under given stresses was first solved by G. Lamé;[4] he made, however, but few physical deductions from his solution. An independent solution was found by Lord Kelvin,[5] who drew some interesting conclusions concerning the earth.

Elastic Tides.

His problem, in as far as it is now material, is as follows. Let a sphere of radius a and density w be made of elastic material whose bulk and rigidity moduli are k and n, and let it be subjected to forces due to a potential per unit volume, equal to $\tau w r^2(\sin^2\lambda - \frac{1}{3})$, where λ is latitude. Then it is required to find the strain of the sphere. We refer the reader to the original sources for the methods of solution applicable to spherical shells and to solid spheres. The investigation applies either to tidal or to rotational stresses. In the case of tides $\tau = \frac{3}{2}m/c^3$, m and c being the moon's mass and distance, and in the case of rotation $\tau = -\frac{1}{2}\omega^2$, ω being the angular velocity about the polar axis. The equation to the surface is found to be

$$r = a\left\{1 + \frac{15wa^2}{19n}\left[1 + \frac{\frac{6}{95}\,n/k}{1+\frac{4}{57}n/k}\right]\tau(\sin^2\lambda - \tfrac{1}{3})\right\}.$$

In most solids the bulk modulus is considerably larger than the rididity modulus, and in this discussion it is sufficient to neglect n compared with k. With this approximation, the ellipticity e of the surface becomes

$$e = \frac{5wa^2}{19n}\tau.$$

Now suppose the sphere to be endued with the power of gravitation, and write

$$\mathfrak{r} = \frac{19n}{5wa^2}, \qquad \mathfrak{g} = \frac{2}{5}\frac{g}{a},$$

where g is gravity at the surface of the globe. Then, if there were no elasticity, the ellipticity would be given by $e = \tau/\mathfrak{g}$, and without gravitation by $e = \tau/\mathfrak{r}$. And it may be proved in several ways that, gravity and elasticity co-operating,

$$e = \frac{\tau}{\mathfrak{r} + \mathfrak{g}} = \frac{\tau}{\mathfrak{g}} \cdot \frac{1}{1 + \mathfrak{r}/\mathfrak{g}}.$$

If n be the rigidity of steel, and if the globe have the size and mean density of the earth, $\mathfrak{r}/\mathfrak{g} = 2$, and with the rigidity of glass $\mathfrak{r}/\mathfrak{g} = \frac{2}{3}$. Hence the ellipticity of an earth of steel under tide-generating force would be $\frac{1}{3}$ of that of a fluid earth, and the fraction for glass would be $\frac{3}{5}$. If an ocean be superposed on the globe, the visible tide will be the excess of the fluid tide above the solid tide. Hence for steel the oceanic tides would be reduced to $\frac{2}{3}$, and for glass to $\frac{2}{5}$ of the tides on a rigid earth.

It is not possible in general to compute the tides of an ocean lying on an unyielding nucleus. But Laplace argued that friction would cause the tides of long period (§ 17) to conform to the equilibrium law, and thus be amenable to calculation. Acting on this belief, G. H. Darwin discussed the tides of long period as observed during 33 years at various ports, and found them to be $\frac{2}{3}$ as great as on an unyielding globe, indicating an elasticity equal to that of steel.[6] Subsequently W. Schweydar repeated the calculation from 194 years of observation with nearly the same result.[7] But as Laplace's argument appears to be unsound (§ 17), the conclusion seems to become of doubtful validity. Yet subsequently Lord Rayleigh showed

[1] Founded on Whewell's article "Tides," in *Admiralty Manual* (ed. 1841), and on Airy's "Tides and Waves," in *Ency. Metrop.*

[2] For a numerical treatment, see *Directions for Reducing Tidal Observations*, by Commander Burdwood, R.N. (London, 1876).

[3] G. H. Darwin "On Tidal Prediction," *Phil. Trans.* (1891), vol. 189 A.

[4] *Théorie math. de l'élasticité* (1866), p. 213.

[5] Thomson and Tait, *Nat. Phil.* §§ 732–737 and 833–842, or *Phil. Trans.* (1863), pt. ii., p. 583. Compare, however, J. H. Jeans, *Phil. Trans.* (1903), 201 A, p. 157.

[6] Thomson & Tait, *Nat. Phil.* § 843.

[7] *Beiträge zur Geophysik* (1907) ix. 41.

that the existence in the ocean of continental barriers would have the same effect as that attributed by Laplace to friction, and thus he re-established the soundness of the result.[1]

A wholly independent estimate derived from what is called the variation of latitude also leads to the same conclusion, namely that the earth is about as stiff as steel.[2]

The theory of the tides of an elastic planet gives, *mutatis mutandis*, that of the tides of a viscous spheroid. The reader who desires to know more of this subject and to obtain references to original memoirs may refer to G. H. Darwin's *Tides*.

VII.—Tidal Friction

§ 35. *Investigation of the Secular Effects of Tidal Friction.*—We have indicated in general terms in § 9 that the theory of tidal friction leads to an interesting speculation as to the origin of the moon. We shall therefore investigate the theory mathematically in the case where a planet is attended by a single satellite moving in a circular orbit, and rotates about an axis perpendicular to that orbit. In order, however, to abridge the investigation we shall only consider the case where the planetary rotation is more rapid than the satellite's orbital motion.

Suppose an attractive particle or satellite of mass m to be moving in a circular orbit, with an angular velocity ω, round a planet of mass M and suppose the planet to be rotating about an axis perpendicular to the plane of the orbit, with an angular velocity n; suppose, also, the mass of the planet to be partially or wholly imperfectly elastic or viscous, or that there are oceans on the surface of the planet; then the attraction of the satellite must produce a relative motion in the parts of the planet, and that motion must be subject to friction, or, in other words, there must be frictional tides of some sort or other. The system must accordingly be losing energy by friction, and its configuration must change in such a way that its whole energy diminishes. Such a system does not differ much from those of actual planets and satellites, and, therefore, the results deduced in this hypothetical case must agree pretty closely with the actual course of evolution, provided that time enough has been and will be given for such changes. Let C be the moment of inertia of the planet about its axis of rotation, r the distance of the satellite from the centre of the planet, h the resultant moment of momentum of the whole system, e the whole energy, both kinetic and potential, of the system. It is assumed that the figure of the planet and the distribution of its internal density are such that the attraction of the satellite causes no couple about any axis perpendicular to that of rotation. A special system of units of mass, length and time will now be adopted such that the analytical results may be reduced to their simplest forms. Let the unit of mass be $Mm/(M+m)$. Let the unit of length γ be such a distance that the moment of inertia of the planet about its axis of rotation may be equal to the moment of inertia of the planet and satellite, treated as particles, about their centre of inertia, when distant γ apart from one another. This condition gives

Energy Diminished by Friction.

$$M\left(\frac{m\gamma}{M+m}\right)^2 + m\left(\frac{M\gamma}{M+m}\right)^2 = C;$$

Let the unit of time τ be the time in which the satellite revolves through 57·3° about the planet, when the satellite's radius vector is equal to γ. This system of units will be found to make the three following functions each equal to unity, viz. $\mu^{\frac{1}{2}}Mm(M+m)^{-\frac{1}{2}}$, μMm, and C, where μ is the attractional constant. The units are in fact derived from the consideration that these functions shall each be unity. In the case of the earth and moon, if we take the moon's mass as $\frac{1}{82}$ of the earth's and the earth's moment of inertia as $\frac{1}{3}Ma^2$ (as is very nearly the case), it may easily be shown that the unit of mass is $\frac{1}{83}$ of the earth's mass, the unit of length 5·26 earth's radii or 33,506 kilometres (20,807 miles), and the unit of time 2 hrs. 41 mins. In these units the present angular velocity of the earth's diurnal rotation is expressed by 0·7044, and the moon's present radius vector by 11·454. The two bodies being supposed to revolve in circles about their common centre of inertia with an angular velocity ω, the moment of momentum of orbital motion is

Special Units.

Moment of Momentum.

$$M\left(\frac{mr}{M+m}\right)^2\omega + M\left(\frac{Mr}{M+m}\right)^2\omega = \frac{Mm}{M+m}r^2\omega.$$

Then, by the law of periodic times in a circular orbit,

$$\omega^2 r^3 = \mu(M+m);$$

whence $$\omega r^2 = \mu^{\frac{1}{2}}(M+m)^{\frac{1}{2}}r^{\frac{1}{2}}.$$

Thus the moment of momentum of orbital motion

$$=\mu^{\frac{1}{2}}Mm(M+m)^{-\frac{1}{2}}r^{\frac{1}{2}},$$

and in the special units this is equal to $r^{\frac{1}{2}}$. The moment of momentum of the planet's rotation is Cn, and $C=1$ in the special units. Therefore

$$h = n + r^{\frac{1}{2}}. \qquad (62)$$

Since the moon's present radius vector is 11·454, it follows that the orbital momentum of the moon is 3·384. Adding to this the rotational momentum of the earth, which is 0·704, we obtain 4·088 for the total moment of momentum of the moon and earth. The ratio of the orbital to the rotational momentum is 4·80, so that the total moment of momentum of the system would, but for the obliquity of the ecliptic, be 5·80 times that of the earth's rotation. Again, the kinetic energy of orbital motion is

$$\tfrac{1}{2}M\left(\frac{mr}{M+m}\right)^2\omega^2 + \tfrac{1}{2}m\left(\frac{Mr}{M+m}\right)^2\omega^2 = \tfrac{1}{2}\frac{Mm}{M+m}r^2\omega^2 = \tfrac{1}{2}\frac{\mu Mm}{r}.$$

The kinetic energy of the planet's rotation is $\frac{1}{2}Cn^2$. The potential energy of the system is $-\mu Mm/r$. Adding the three energies together, and transforming into the special units, we have

$$2e = n^2 - 1/r. \qquad (63)$$

Now let $\quad x = r^{\frac{1}{2}}, \quad y = n, \quad Y = 2e.$

It will be noticed that x, the moment of momentum of orbital motion is equal to the square root of the satellite's distance from the planet. Then equations (62) and (63) become

$$h = y + x \qquad (64)$$

$$Y = y^2 - 1/x^2 = (h-x)^2 - 1/x^2 \qquad (65)$$

(64) is the equation of conservation of moment of momentum, or, shortly, the equation of momentum; (65) is the equation of energy.

Now consider a system started with given positive moment of momentum h; and we have all sorts of ways in which it may be started. If the two rotations be of opposite kinds, it is clear that we may start the system with any amount of energy, however great, but the true maxima and minima of energy compatible with the given moment of momentum are supplied by $dY/dx=0$,

Maximum and Minimum Energy.

or $\quad x - h + 1/x^3 = 0,$

that is to say, $$x^4 - hx^3 + 1 = 0. \qquad (66)$$

We shall presently see that this quartic has either two real roots and two imaginary, or all imaginary roots. The quartic may be derived from quite a different consideration, viz. by finding the condition under which the satellite may move round the planet so that the planet shall always show the same face to the satellite—in fact, so that they move as parts of one rigid body. The condition is simply that the satellite's orbital angular velocity $\omega = n$, the planet's angular velocity of rotation, or $y = 1/x^3$, since $n = y$ and $r^{\frac{1}{2}} = \omega^{-\frac{1}{3}} = x$. By substituting this value of y in the equation of momentum (64), we get as before

No Relative Motion between Satellite and Planet when Energy Maximum or Minimum.

$$x^4 - hx^3 + 1 = 0.$$

At present we have only obtained one result, viz. that, if with given moment of momentum it is possible to set the satellite and planet moving as a rigid body, it is possible to do so in two ways, and one of these ways requires a maximum amount of energy and the other a minimum; from this it is clear that one must be a rapid rotation with the satellite near the planet and the other a slow one with the satellite remote from the planet. Of the three equations

$$h = y + x, \qquad (67)$$

$$Y = (h-x)^2 - 1/x^2, \qquad (68)$$

$$x^3 y = 1, \qquad (69)$$

(67) is the equation of momentum, (68) that of energy, and (69) may be called the equation of rigidity, since it indicates that the two bodies move as though parts of one rigid body.

Equations of Momentum, Energy, and no Relative Motion.

To illustrate these equations geometrically, we may take as abscissa x, which is the moment of momentum of orbital motion, so that the axis of x may be called the axis of orbital momentum. Also, for equations (67) and (69) we may take as ordinate y, which is the moment of momentum of the planet's rotation, so that the axis of y may be called the axis of rotational momentum. For (68) we may take as ordinate Y, which is twice the energy of the system, so that the axis of Y may be called the axis of energy. Then, as it will be convenient to exhibit all three curves in the same figure, with a parallel axis of x, we must have the axis of energy identical with that of rotational momentum. It will not be necessary to consider the case where the resultant moment of momentum h is negative, because this would only be equivalent to reversing all the rotations; h is therefore to be taken as essentially positive. The line of momentum whose equation is (67) is a straight line inclined at 45° to either axis, having positive intercepts on both axes. The curve of rigidity whose equation is (69) is clearly of the same nature as a rectangular hyperbola, but it has a much more rapid rate of approach to the axis of orbital momentum than to that of rotational momentum. The intersections (if any) of the curve of rigidity with the line of momentum have abscissae which are the two roots of the quartic $x^4 - hx^3 + 1 = 0$. The quartic has, therefore, two real roots or all imaginary roots. Then, since $x = r^{\frac{1}{2}}$, the intersection which is more remote from the origin indicates a configuration where the satellite is remote from the planet; the other gives the configuration where the satellite is closer to the planet. We have already learnt that these two correspond respectively to minimum and maximum energy. When x is very large the equation to the curve of energy is $Y = (h-x)^2$, which is the equation to a parabola with a vertical axis parallel to Y and distant h from the origin, so that the axis of the parabola passes through the intersection of the line of momentum

[1] *Phil. Mag.* (1903), v. 136.
[2] Hough, *Phil. Trans.* (1897), 187 A, p. 319.

with the axis of orbital momentum. When x is very small, the equation becomes $Y=-1/x^2$. Hence the axis of Y is asymptotic on both sides to the curve of energy. If the line of momentum intersects the curve of rigidity, the curve of energy has a maximum vertically underneath the point of intersection nearer the origin and a minimum underneath the point more remote. But if there are no intersections, it has no maximum or minimum.

Fig. 8 shows these curves when drawn to scale for the case of the earth and moon, that is to say, with $h=4$. The points a and b, which are the maximum and minimum of the curve of energy, are supposed to be on the same ordinates as A and B, the intersections of the curve of rigidity with the line of momentum. The intersection of the line of momentum with the axis of orbital momentum is

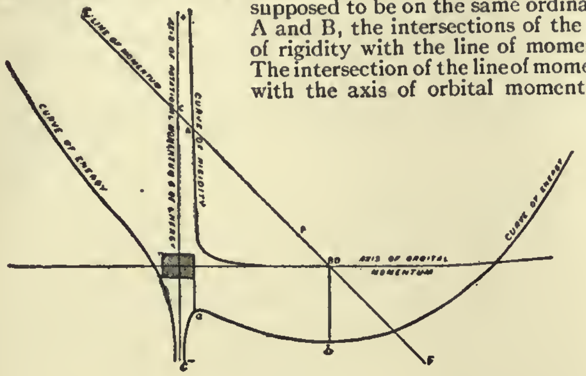


FIG. 8.

denoted by D, but in a figure of this size it necessarily remains indistinguishable from B. As the zero of energy is quite arbitrary the origin for the energy curve is displaced downwards, and this prevents the two curves from crossing one another in a confusing manner. On account of the limitation imposed we neglect the case where the quartic has no real roots. Every point of the line of momentum gives by its abscissa and ordinate the square root of the satellite's distance and the rotation of the planet, and the ordinate of the energy curve gives the energy corresponding to each distance of the satellite. Part of the figure has no physical meaning, for it is impossible for the satellite to move round the planet at a distance less than the sum of the radii of the planet and satellite. For example, the moon's diameter being about 2200 m. and the earth's about 8000, the moon's distance cannot be less than 5100 miles. Accordingly a strip is marked off and shaded on each side of the vertical axis within which the figure has no physical meaning. The point P indicates the present configuration of the earth and moon. The curve of rigidity $x^3y=1$ is the same for all values of h, and by moving the line of momentum parallel to itself nearer to or further from the origin, we may represent all possible moments of momentum of the whole system. The smallest amount of moment of momentum with which it is possible to set the system moving as a rigid body, with centrifugal force enough to balance the mutual attraction, is when the line of momentum touches the curve of rigidity. The condition for this is clearly that the equation $x^4-hx^3+1=0$ should have equal roots. If it has equal roots, each root must be $\frac{3}{4}h$, and therefore

Least Momentum for which no Relative Motion Possible.

$$(\tfrac{3}{4}h)^3-h(\tfrac{3}{4}h)^3+1=0,$$

whence $h^4=4^4/3^3$, or $h=4/3^{\frac{3}{4}}=1\cdot75$. The actual value of h for the moon and earth is about 4; hence, if the moon-earth system were started with less than $\frac{7}{16}$ of its actual moment of momentum, it would not be possible for the two bodies to move so that the earth should always show the same face to the moon. Again, if we travel along the line of momentum, there must be some point for which yx^3 is a maximum, and since $yx^3=n/\omega$ there must be some point for which the number of planetary rotations is greatest during one revolution of the satellite; or, shortly, there must be some configuration for which there is a maximum number of days in the month. Now yx^3 is equal to x^3 $(h-x)$, and this is a maximum when $x=\frac{3}{4}h$ and the maximum number of days in the month is $(\frac{3}{4}h)^3(h-\frac{3}{4}h)$ or $3^3h^4/4^4$; if h is equal to 4, as is nearly the case for the earth and moon, this becomes 27. Hence it follows that we now have very nearly the maximum number of days in the month. A more accurate investigation in a paper on the "Precession of a Viscous Spheroid" in *Phil. Trans.* (1879), pt. i., showed that, taking account of solar tidal friction and of the obliquity to the ecliptic, the maximum number of days is about 29, and that we have already passed through the phase of maximum.

Maximum Number of Days in Month.

We will now consider the physical meaning of the figure. It is assumed that the resultant moment of momentum of the whole system corresponds to a positive rotation. Now imagine two points with the same abscissa, one on the momentum line and the other on the energy curve, and suppose the one on the energy curve to guide that on the momentum line. Since we are supposing frictional tides to be raised on the planet, the energy must degrade, and however the two points are set initially the point on the energy curve must always slide down a slope, carrying with it the other point. Looking at the figure, we see that there are four slopes in the energy curve, two running down to the planet and two down to the minimum. There are therefore four ways in which the system may degrade, according to the way it was started; but we shall only consider one, that corresponding to the portion AB*ba* of the figure. For the part of the line of momentum AB the month is longer than the day, and this is the case with all known satellites except the nearer one of Mars. Now, if a satellite be placed in the condition A—that is to say, moving rapidly round a planet which always shows the same face to the satellite—the condition is clearly dynamically unstable, for the least disturbance will determine whether the system shall degrade down the slopes *ac* or *ab*—that is to say, whether it falls into or recedes from the planet. If the equilibrium breaks down by the satellite receding, the recession will go on until the system has reached the state corresponding to B. It is clear that, if the intersection of the edge of the shaded strip with the line of momentum be identical with the point A, which indicates that the satellite is just touching the planet, then the two bodies are in effect parts of a single body in an unstable configuration. If, therefore, the moon was originally part of the earth, we should expect to find this identity. Now in fig. 9, drawn to scale to represent the earth and moon, there is so close an approach between the edge of the shaded band and the intersection of the line of momentum and curve of rigidity that it would be scarcely possible to distinguish them. Hence, there seems a probability that the two bodies once formed parts of a single one, which broke up in consequence of some kind of instability. This view is confirmed by the more detailed consideration of the case in the paper on the "Precession of a Viscous Spheroid," already referred to, and subsequent papers, in the *Phil. Trans.*[1]

Discussion of Figure.

History of Satellite as Energy Degrades.

§ 36. *Effects of Tidal Friction on the Elements of the Moon's Orbit and on the Earth's Rotation.*—It would be impossible within the limits of the present article to discuss completely the effects of tidal friction; we therefore confine ourselves to certain general considerations which throw light on the nature of those effects. We have in the preceding section supposed that the planet's axis is perpendicular to the orbit of the satellite, and that the latter is circular; we shall now suppose the orbit to be oblique to the equator and eccentric. For the sake of brevity the planet will be called the earth, and the satellite the moon. The complete investigation was carried out on the hypothesis that the planet was a viscous spheroid, because this was the only theory of frictionally resisted tides which had been worked out. Although the results would be practically the same for any system of frictionally resisted tides, we shall speak below of the planet or earth as a viscous body.[2]

We shall show that if the tidal retardation be small the obliquity of the ecliptic increases, the earth's rotation is retarded, and the moon's distance and periodic time are increased. Fig. 9 represents the earth as seen from above the south pole, so that S is the pole and the outer circle the equator. The earth's rotation is in the direction of the curved arrow at S. The half of the inner circle which is drawn with a full line is a semi-small-circle of south latitude, and the dotted semicircle is a semi-small-circle in the same north latitude. Generally dotted lines indicate parts of the figure which are below the plane of the paper. If the moon were cut in two and one half retained at the place of the moon and the other half transported to a point diametrically opposite to the first half with reference to the earth, there would be no material change in the tide-generating forces. It is easy to verify this statement by reference to § 11. These two halves may be described as moon and anti-moon, and such a substitution will facilitate the explanation. Let M and M′ be the projections of the moon and anti-moon on to the terrestrial sphere. If the fluid in which the tides are raised were perfectly frictionless,[3] or if the earth were a perfect fluid or perfectly elastic, the apices of the tidal spheroid would be at M and M′. If, however, there is internal friction, due to any sort of viscosity, the tides will lag, and we may suppose the tidal apices to be at T and T′. Now suppose the tidal protuberances to be replaced by two equal heavy particles at T and T′, which are instantaneously rigidly connected with the earth. Then the attraction of the moon on T is greater

Obliquity of the Ecliptic Increases.

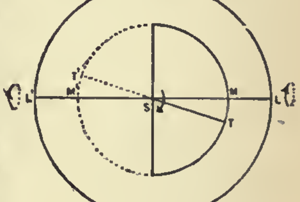


FIG. 9.

[1] For further consideration of this subject see a series of papers by G. H. Darwin in *Proceed.* and *Trans.* of the Royal Society from 1878 to 1881, and app. G. (*b*) t. pt. ii. vol. i. of Thomson and Tait's *Nat. Phil.* (1883); or *Scientific Papers*, vol. ii.

[2] These explanations, together with other remarks, are to be found in the abstracts of G. H. Darwin's memoirs in *Proc. Roy. Soc.*, 1878 to 1881.

[3] We here suppose the tides not to be inverted. If they are inverted the conclusion is precisely the same.

than on T′, and that of the anti-moon on T′ is greater than on T. The resultant of these forces is clearly a pair of forces acting on the earth in the direction TM, T′M′. These forces cause a couple about the axis in the equator, which lies in the same meridian as the moon and anti-moon. The direction of the couple is shown by the curved arrows at L,L′. If the effects of this couple be compounded with the existing rotation of the earth according to the principle of the gyroscope, the south pole S will tend to approach M and the north pole to approach M′. Hence, supposing the moon to move in the ecliptic, the inclination of the earth's axis to the ecliptic diminishes, or the obliquity increases. Next the forces TM, T′M′ clearly produce, as in the simpler case considered in § 9, a couple about the earth's polar axis, which tends to retard the diurnal rotation.

This general explanation remains a fair representation of the state of the case so long as the different harmonic constituents of the aggregate tide-wave do not suffer very different amounts of retardation; and this is the case so long as the viscosity is not great. The rigorous result for a viscous planet shows that in general the obliquity will increase, and it appears that, with small viscosity of the planet, if the period of the satellite be longer than two periods of rotation of the planet, the obliquity increases, and vice versâ. Hence, zero obliquity is only dynamically stable when the period of the satellite is less than two periods of the planet's rotation.

Inclination of Plane of Orbit Generally Decreases.

It is possible, by similar considerations, to obtain some insight into the effect which tidal friction must have on the plane of the lunar orbit, but as the subject is somewhat complex we shall not proceed to a detailed examination of the question. It must suffice to say that in general the inclination of the lunar orbit must diminish. Now let us consider a satellite revolving about a planet in an elliptic orbit, with a periodic time which is long compared with the period of rotation of the planet; and suppose that frictional tides are raised in the planet. The major axis of the tidal spheroid always points in advance of the satellite, and exercises on it a force which tends to accelerate its linear velocity. When the satellite is in perigee the tides are higher, and this disturbing force is greater than when the satellite is in apogee. The disturbing force may therefore be represented as a constant force, always tending to accelerate the motion of the satellite, to which is added a periodic force accelerating in perigee and retarding in apogee. The constant force causes a secular increase of the satellite's mean distance and a retardation of its mean motion. The accelerating force in perigee causes the satellite to swing out farther than it would otherwise have done, so that when it comes round to apogee it is more remote from the planet. The retarding force in apogee acts exactly inversely, and diminishes the perigean distance. Thus, the apogean distance increases and the perigean distance diminishes, or in other words, the eccentricity of the orbit increases. Now consider another case, and suppose the satellite's periodic time to be identical with that of the planet's rotation. Then, when the satellite is in perigee, its angular motion is faster than that of the planet's rotation, and when in apogee it is slower; hence at apogee the tides lag, and at perigee they are accelerated. Now the lagging apogean tides give rise to an accelerating force on the satellite, and increase the perigean distance, whilst the accelerated perigean tides give rise to a retarding force, and decrease the apogean distance. Hence in this case the eccentricity of the orbit will diminish. It follows from these two results that there must be some intermediate periodic time of the satellite for which the eccentricity does not tend to vary.

Eccentricity of Orbit Generally Increases.

But it May Decrease.

But the preceding general explanation is in reality somewhat less satisfactory than it seems, because it does not make clear the existence of certain antagonistic influences, to which, however, we shall not refer. The full investigation for a viscous planet shows that in general the eccentricity of the orbit will increase. When the viscosity is small the law of variation of eccentricity is very simple: if eleven periods of the satellite occupy a longer time than eighteen rotations of the planet, the eccentricity increases, and vice versâ. Hence in the case of small viscosity a circular orbit is only dynamically stable if the eleven periods are shorter than the eighteen rotations.

VIII.—Cosmogonic Speculations Founded on Tidal Friction

§ 37. *History of the Earth and Moon.*—We shall not attempt to discuss the mathematical methods by which the complete history of a planet, attended by one or more satellites, is to be traced. The laws indicated in the preceding sections show that there is such a problem, and that it may be solved, and we refer to G. H. Darwin's papers for details (*Phil. Trans.*, 1879–1881). It may be interesting, however, to give the various results of the investigation in the form of a sketch of the possible evolution of the earth and moon, followed by remarks on the other planetary systems and on the solar system as a whole.

We begin with a planet not very much more than 8000 m. in diameter, and probably partly solid, partly fluid, and partly gaseous. It is rotating about an axis inclined at about 11° or 12° to the normal to the ecliptic, with a period of from two to four hours, and is revolving about the sun with a period not much shorter than our present year. The rapidity of the planet's rotation causes so great a compression of its figure that it cannot continue to exist in an ellipsoidal form with stability; or else it is so nearly unstable that complete instability is induced by the solar tides. The planet then separates into two masses, the larger being the earth and the smaller the moon. It is not attempted to define the mode of separation, or to say whether the moon was initially a chain of meteorites. At any rate it must be assumed that the smaller mass became more or less conglomerated and finally fused into a spheroid, perhaps in consequence of impacts between its constituent meteorites, which were once part of the primeval planet. Up to this point the history is largely speculative, for the investigation of the conditions of instability in such a case surpasses the powers of the mathematician. We have now the earth and moon nearly in contact with one another, and rotating nearly as though they were parts of one rigid body. This is the system which was the subject of dynamical investigation. As the two masses are not rigid, the attraction of each distorts the other; and, if they do not move rigorously with the same periodic time, each raises a tide in the other. Also the sun raises tides in both. In consequence of the frictional resistance to these tidal motions, such a system is dynamically unstable. If the moon had moved orbitally a little faster than the earth rotated, she must have fallen back into the earth; thus the existence of the moon compels us to believe that the equilibrium broke down by the moon revolving orbitally a little slower than the earth rotates. In consequence of the tidal friction the periodic times both of the moon (or the month) and of the earth's rotation (or the day) increase; but the month increases in length at a much greater rate than the day. At some early stage in the history of the system the moon was conglomerated into a spheroidal form, and acquired a rotation about an axis nearly parallel to that of the earth.

Conjectural Genesis of Moon from Earth.

Earth and Moon Subject of Investigation.

The Moon.

The axial rotation of the moon is retarded by the attraction of the earth on the tides raised in the moon, and this retardation takes place at a far greater rate than the similar retardation of the earth's rotation. As soon as the moon rotates round her axis with twice the angular velocity with which she revolves in her orbit, the position of her axis of rotation (parallel with the earth's axis) becomes dynamically unstable. The obliquity of the lunar equator to the plane of the orbit increases, attains a maximum, and then diminishes. Meanwhile the lunar axial rotation is being reduced towards identity with the orbital motion. Finally, her equator is nearly coincident with the plane of the orbit, and the attraction of the earth on a tide, which degenerates into a permanent ellipticity of the lunar equator, causes her always to show the same face to the earth.

The Earth and Lunar Orbit.

All this must have taken place early in the history of the earth, to which we now return. At first the month is identical with the day, and as both these increase in length the lunar orbit will retain its circular form until the month is equal to $1\frac{7}{11}$ days. From that time the orbit begins to be eccentric, and the eccentricity increases thereafter up to its present magnitude. The plane of the lunar orbit is at first practically identical with the earth's equator, but as the moon recedes from the earth the sun's attraction begins to make itself felt. We shall not attempt to trace the complex changes by which the plane of the lunar orbit is affected. It must suffice to say that the present small inclination of the lunar orbit to the ecliptic accords with the theory.

As soon as the earth rotates with twice the angular velocity with which the moon revolves in her orbit, a new instability sets in. The month is then about twelve of our present hours, and the day about six such hours in length. The inclination of the equator to the ecliptic now begins to increase and continues to do so until finally it reached its present value of $23\frac{1}{2}°$. All these changes continue and no new phase now supervenes, and at length we have the system in its present configuration. The minimum time in which the changes from first to last can have taken place is 54,000,000 years.

Distortion of Plastic Planet.

There are other collateral results which must arise from a supposed primitive viscosity or plasticity of the earth's mass. For during this course of evolution the earth's mass must have suffered a screwing motion, so that the polar regions have travelled a little from west to east relatively to the equator. This affords a possible explanation of the north and south trend of our great continents. The whole of this argument reposes on the imperfect rigidity of solids and on the internal friction of semi-solids and fluids; these are *verae causae.* Thus changes of the kind here discussed must be going on, and must have gone on in the past. And for this history of the earth and moon to be true throughout, it is only necessary to postulate a sufficient lapse of time, and that there is not enough matter diffused through space materially to resist the motions of the moon and earth in perhaps 200,000,000 years. It seems hardly too much to say that, granting these two postulates, and the existence of a

The Theory Postulates Sufficient Lapse of Time.

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[1] See criticism, by Nolan, *Genesis of Moon* (Melbourne, 1885); also *Nature* (Feb. 18, 1886).

primeval planet such as that above described, a system would necessarily be developed which would bear a strong resemblance to our own. A theory, reposing on *verae causae* which brings into quantitative correlation the lengths of the present day and month, the obliquity of the ecliptic, and the inclination and eccentricity of the lunar orbit should have claims to acceptance.

§ 38. *The Influence of Tidal Friction on the Evolution of the Solar System and of the Planetary Sub-systems.*[1]—According to the nebular hypothesis of Kant and Laplace the planets and satellites are portions detached from contracting nebulous masses, and other theories have been advanced subsequently in explanation of the present configuration of the solar system. We shall here only examine what changes are called for by the present theory of tidal friction. It may be shown that the reaction of the tides raised in the sun by the planets must have had a very small influence in changing the dimensions of the planetary orbits round the sun, and it appears improbable that the planetary orbits have been sensibly enlarged by tidal friction since the origin of the several planets.

Planetary Sub-systems.

Similarly it appears unlikely that the satellites of Mars, Jupiter and Saturn originated very much nearer the present surfaces of the planets that we now observe them. But, the data being insufficient, we cannot feel sure that the alteration in the dimensions of the orbits of these satellites has not been considerable. It remains, however, nearly certain that they cannot have first originated almost in contact with the present surfaces of the planets, in the same way as in the preceding sketch has been shown to be probable with regard to the moon and earth. Numerical data concerning the distribution of moment of momentum in the several planetary sub-systems exhibit so striking a difference between the terrestrial system and those of the other planets that we should from this alone have grounds for believing that the modes of evolution have been considerably different. The difference appears to lie in the genesis of the moon close to the present surface of the planet, and we shall see below that solar tidal friction may be assigned as a reason to explain how it has happened that the terrestrial planet had contracted to nearly its present dimensions before the genesis of a satellite, but that this was not the case with the exterior planets. The efficiency of solar tidal friction is very much greater in its action on the nearer planets than on the farther ones. The time, however, during which solar tidal friction has been operating on the external planets is probably much longer than the period of its efficiency for the interior ones, and a series of numbers proportional to the total amount of rotation destroyed in the several planets would present a far less rapid decrease as we recede from the sun than numbers simply expressive of the efficiency of tidal friction at the several planets. Nevertheless it must be admitted that the effect produced by solar tidal friction on Jupiter and Saturn has not been nearly so great as on the interior planets. And, as already stated, it is very improbable that so large an amount of momentum should have been destroyed as materially to affect the orbits of the planets round the sun.

Distribution of Satellites Amongst the Planets.

We will now examine how the difference of distances from the sun may have affected the histories of the several planets. According to the nebula hypothesis, as a planetary nebula contracts, the increasing rapidity of the rotation causes it to become unstable, and an equatorial portion of matter detaches itself. The separation of that part of the mass which before the change had the greatest angular momentum permits the central portion to resume a planetary shape. The contraction and the increase of rotation proceed continually until another portion is detached, and so on. There thus recur at intervals epochs of instability, and something of the same kind must have occurred according to other rival theories. Now tidal friction must diminish the rate of increase of rotation due to contraction, and therefore if tidal friction and contraction are at work together the epochs of instability must recur more rarely than if contraction alone acted. If the tidal retardation is sufficiently great, the increase of rotation due to contraction will be so far counteracted as never to permit an epoch of instability to occur. Since the rate of retardation due to solar tidal friction decreases rapidly as we recede from the sun, these considerations accord with what we observe in the solar system. For Mercury and Venus have no satellites, and there is progressive increase in the number of satellites as we recede from the sun. Whether this be the true cause of the observed distribution of satellites amongst the planets or not, it is remarkable that the same cause also affords an explanation, as we shall now show, of that difference between the earth with the moon and the other planets with their satellites which has caused tidal friction to be the principal agent of change with the former, but not with the latter.

Case of Earth and Moon Different from others.

In the case of the contracting terrestrial mass we may suppose that there was for a long time nearly a balance between the retardation due to solar tidal friction and the acceleration due to contraction, and that it was not until the planetary mass had contracted to nearly its present dimensions that an epoch of instability could occur. It may also be noted that if there be two equal planetary masses which generate satellites, but under very different conditions as to the degree of condensation of the masses, the two satellites will be likely to differ in mass; we cannot, of course, tell which of the two planets would generate the larger satellite. Thus, if the genesis of the moon was deferred until a late epoch in the history of the terrestrial mass, the mass of the moon relatively to the earth would be likely to differ from the mass of other satellites relatively to their planets. If the contraction of the planetary mass be almost completed before the genesis of the satellite, tidal friction will thereafter be the great cause of change in the system; and thus the hypothesis that it is the sole cause of change will give an approximately accurate explanation of the motion of the planet and satellite at any subsequent time. We have already seen that the theory that tidal friction has been the ruling power in the evolution of the earth and moon co-ordinates the present motions of the two bodies and carries us back to an initial state when the moon first had a separate existence as a satellite; and the initial configuration of the two bodies is such that we are led to believe that the moon is a portion of the primitive earth detached by rapid rotation or by other causes.

Let us now turn to the other planetary sub-systems. The satellites of the larger planets revolve with short periodic times; for the smallness of their masses would have prevented tidal friction from being a very efficient cause of change in the dimensions of their orbits, and the largeness of the planet's masses would have caused them to proceed slowly in their evolution. The satellites of Mars present one of the most remarkable features in the solar system, for, whereas Mars rotates in 24h. 37m., Deimos has a period of 30h. 18m. and Phobos of only 7h. 39m. The minuteness of these satellites precludes us from supposing that they have had much influence on the rotation of the planet, or that the dimensions of their own orbits have been much changed.

Satellites of Mars.

The theory of tidal friction would explain the shortness of the periodic time of Phobos by the solar retardation of the planet's rotation, which would operate without directly affecting the satellites' orbital motion. We may see that, given sufficient time, this must be the ultimate fate of all satellites. Numerical comparison shows that the efficiency of solar tidal friction in retarding the terrestrial and martian rotations is of about the same degree of importance, notwithstanding the much greater distance of the planet Mars. In the above discussion it will have been apparent that the earth and moon do actually differ from the other planets to such an extent as to permit tidal friction to have been the most important factor in their history.

Summary.

By an examination of the probable effects of solar tidal friction on a contracting planetary mass, we have been led to assign a cause for the observed distribution of satellites in the solar system, and this again has itself afforded an explanation of how it happened that the moon so originated that the tidal friction of the lunar tides in the earth should have been able to exercise so large an influence. We have endeavoured not only to set forth the influence which tidal friction may have, and probably has had in the history of the system, if sufficient time be granted, but also to point out what effects it cannot have produced. These investigations afford no grounds for the rejection of theories more or less akin to the nebular hypothesis; but they introduce modifications of considerable importance. Tidal friction is a cause of change of which Laplace's theory took no account; and, although the activity of that cause may be regarded as mainly belonging to a later period than the events described in the nebular hypothesis, yet it seems that its influence has been of great, and in one instance of even paramount, importance in determining the present condition of the planets and their satellites.

Limitation of Time.

Throughout the whole of this discussion it has been supposed that sufficient time is at our disposal. Yet arguments have been adduced which seemed to show that this supposition is not justifiable, for Helmholtz, Lord Kelvin and others have attempted to prove that the history of the solar system must be comprised within a period considerably less than a hundred million years.[2] But the discovery of radio-activity and the consequent remarkable advances in physics throw grave doubt on all such arguments, and we believe that it is still beyond our powers to assign definite numerical limits to the age of the solar system.

Dr T. J. J. See (*Researches on the Evolution of Stellar Systems;* vol. ii. (1910) *Capture Theory*) rejects the applicability of tidal friction to the cosmogony of the solar system, and argues that the satellites were primitively wandering bodies and were captured by the gravitational attraction of the planets. Such captures are considered by Dr See to be a necessary result of the presence in space of a resisting medium; but the present writer does not feel convinced by the arguments adduced. (G. H. D.)

TIDORE or TIDOR, an island of the Malay Archipelago, off the W. coast of Halmahera, S. of Ternate. It is nearly circular and has an area of about 30 sq. m. Several quiescent volcanic peaks, reaching 5700 ft., occupy most of the island, and are covered with forests. The capital, Tidore, on the east coast, is a walled town and the seat of a sultan tributary to the Dutch

[1] A review of this and of cognate subjects is contained in G. H. Darwin's presidential address to the Brit. Assoc. in 1905.

[2] Thomson and Tait's *Nat. Phil.*, app. E; *Nature* (Jan. 27, 1887); Wolf, *Théories cosmogoniques* (1886).

and of a Dutch *controleur* (commissioner or agent). By an agreement of 1879 the sultan exercises authority over some parts of Halmahera, the Papuan Islands, the western half of New Guinea and the islands in Geelvink Gulf. The sultanate is included in the residency of Ternate (*q.v.*). The population, of Malay race and Mahommedans in religion, is about 8000. They live by agriculture (cotton, tobacco, nutmegs, &c.) and fishing.

TIECK, JOHANN LUDWIG (1773–1853), German poet, novelist and critic, was born in Berlin on the 31st of May 1773, his father being a rope-maker. He was educated at the Friedrich-Werdersche Gymnasium, and at the universities of Halle, Göttingen and Erlangen. At Göttingen Shakespeare and the Elizabethan drama were the chief subjects of his study. In 1794 he returned to Berlin, resolved to make a living by his pen. He contributed a number of short stories (1795–1798) to the series of *Straussfedern*, published by the bookseller C. F. Nicolai and originally edited by J. K. A. Musäus, and wrote *Abdallah* (1796) and a novel in letters, *William Lovell* (3 vols. 1795–1796). These works are, however, immature and sensational in tone. Tieck's transition to romanticism is to be seen in the series of plays and stories published under the title *Volksmärchen von Peter Lebrecht* (3 vols., 1797), a collection which contains the admirable fairy-tale *Der blonde Eckbert*, and the witty dramatic satire on Berlin literary taste, *Der gestiefelte Kater*. With his school and college friend W. H. Wackenroder (1773–1798), he planned the novel *Franz Sternbalds Wanderungen* (vols. i–ii. 1798), which, with Wackenroder's *Herzensergiessungen* (1798), was the first expression of the romantic enthusiasm for old German art. In 1798 Tieck married and in the following year settled in Jena, where he, the two brothers Schlegel and Novalis were the leaders of the new Romantic school. His writings between 1798 and 1804 include the satirical drama, *Prinz Zerbino* (1799), and *Romantische Dichtungen* (2 vols., 1799–1800). The latter contains Tieck's most ambitious dramatic poems, *Leben und Tod der heiligen Genoveva*, *Leben und Tod des kleinen Rotkäppchens*, which were followed in 1804 by the remarkable "comedy" in two parts, *Kaiser Oktavianus*. These dramas, in which Tieck's poetic powers are to be seen at their best, are typical plays of the first Romantic school; although formless, and destitute of dramatic qualities, they show the influence of both Calderon and Shakespeare. *Kaiser Oktavianus* is a poetic glorification of the middle ages.

In 1801 Tieck went to Dresden, then lived for a time near Frankfort-on-the-Oder, and spent many months in Italy. In 1803 he published a translation of *Minnelieder aus der schwäbischen Vorzeit*, between 1799 and 1804 an excellent version of *Don Quixote*, and in 1811 two volumes of Elizabethan dramas, *Altenglisches Theater*. In 1812–1817 he collected in three volumes a number of his earlier stories and dramas, under the title *Phantasus*. In this collection appeared the stories *Der Runenberg*, *Die Elfen*, *Der Pokal*, and the dramatic fairy tale, *Fortunat*. In 1817 Tieck visited England in order to collect materials for a work on Shakespeare (unfortunately never finished) and in 1819 he settled permanently in Dresden; from 1825 on he was literary adviser to the Court Theatre, and his semi-public readings from the dramatic poets gave him a reputation which extended far beyond the Saxon capital. The new series of short stories which he began to publish in 1822 also won him a wide popularity. Notable among these are *Die Gemälde*, *Die Reisenden*, *Die Verlobung*, *Des Lebens Überfluss*. More ambitious and on a wider canvas are the historical or semi-historical novels, *Dichterleben* (1826), *Der Aufruhr in den Cevennen* (1826, unfinished), *Der Tod des Dichters* (1834); *Der junge Tischlermeister* (1836; but begun in 1811) is an excellent story written under the influence of Goethe's *Wilhelm Meister; Vittoria Accorombona* (1840), in the style of the French Romanticists, shows a falling-off. In later years Tieck carried on a varied literary activity as critic (*Dramaturgische Blätter*, 2 vols., 1825–1826; *Kritische Schriften*, 2 vols., 1848); he also edited the translation of Shakespeare by A. W. Schlegel, who was assisted by Tieck's daughter Dorothea (1799–1841) and by Graf Wolf Heinrich Baudissin (1789–1878); *Shakespeares Vorschule* (2 vols., 1823–1829); the works of H. von Kleist (1826) and of J. M. R. Lenz (1828). In 1841 Friedrich Wilhelm IV. of Prussia invited him to Berlin where he enjoyed a pension for his remaining years. He died on the 28th of April 1853.

Tieck's importance lay rather in the readiness with which he adapted himself to the new ideas which arose at the close of the 18th century, than in any conspicuous originality or genius. His importance as an immediate force in German poetry is restricted to his early period. In later years it was as the helpful friend and adviser of others, or as the well-read critic of wide sympathies, that Tieck distinguished himself.

Tieck's *Schriften* appeared in 20 vols. (1828–1846), and his *Gesammelte Novellen* in 12 (1852–1854). *Nachgelassene Schriften* were published in 2 vols. in 1855. There are several modern editions of *Ausgewählte Werke* by H. Welti (8 vols., 1886–1888); by J. Minor (in Kürschner's *Deutsche Nationalliteratur*, 144, 2 vols., 1885); by G. Klee (with an excellent biography, 3 vols., 1892), and G. Witkowski (4 vols., 1903). *The Elves* and *The Goblet* were translated by Carlyle in *German Romance* (1827), *The Pictures* and *The Betrothal* by Bishop Thirlwall (1825). A translation of *Vittoria Accorombona* was published in 1845. Tieck's Letters have not yet been collected, but *Briefe an Tieck* were published in 4 vols. by K. von Holtei in 1864. See for Tieck's earlier life R. Köpke, *Ludwig Tieck* (2 vols., 1855); for the Dresden period, H. von Friesen, *Ludwig Tieck: Erinnerungen* (2 vols., 1871); also A. Stern, *Ludwig Tieck in Dresden* (*Zur Literatur der Gegenwart*, 1879); J. Minor, *Tieck als Novellendichter* (1884); B. Steiner, *L. Tieck und die Volksbücher* (1893); H. Bischof, *Tieck als Dramaturg* (1897); W. Miessner, *Tiecks Lyrik* (1902).

TIEDEMANN, FRIEDRICH (1781–1861), German anatomist and physiologist, eldest son of Dietrich Tiedemann (1748–1803), a philosopher and psychologist of considerable repute, was born at Cassel on the 23rd of August 1781. He graduated in medicine at Marburg in 1804, but soon abandoned practice. He devoted himself to the study of natural science, and, betaking himself to Paris, became an ardent follower of Baron Cuvier. On his return to Germany he maintained the claims of patient and sober anatomical research against the prevalent speculations of the school of Lorenz Oken, whose foremost antagonist he was long reckoned. His remarkable studies of the development of the human brain, as correlated with his father's studies on the development of intelligence, deserve mention. He spent most of his life as professor of anatomy and physiology at Heidelberg, a position to which he was appointed in 1816, after having filled the chair of anatomy and zoology for ten years at Landshut, and died at Munich on the 22nd of January 1861.

TIEL, a town in the province of Gelderland, Holland, on the right bank of the Waal (here crossed by a pontoon bridge), 25 m. by rail west of Nijmwegen. Pop. (1900), 10,788. It possesses fine streets and open places, but of its fortifications the Kleiberg Gate (1647) alone remains. The principal buildings are St Martin's church (15th century), the town hall, court-house and the historical castle of the family of van Arkel. In 1892 a harbour was built, but the shipping of Tiel is now chiefly confined to craft for inland navigation. It carries on a flourishing trade, especially in fruit, and is an important market for horses and cattle. It also manufactures agricultural implements, furniture, paper, tobacco, &c.

Five miles W.N.W. of Tiel is the small town of Buren, which contains some interesting old houses and is an important market for horses. Buren was the seat of an independent lordship which is mentioned as early as 1152. In later times it was held in fief, first from the dukes of Brabant, then from the dukes of Gelderland. In 1492 the emperor Charles V. raised it to a countship, and in 1551 it passed by marriage to Prince William of Orange Nassau. The title is now sometimes used by the royal family of the Netherlands when travelling incognito. The castle was destroyed in the beginning of the 19th century, and the site of it is now marked by the park on the west side of the town. It contained not less than 170 apartments and was memorable for the imprisonment within its walls of Arnoud duke of Gelderland (d. 1473), and as the birthplace of Philip William of Orange in 1554.

TIELE, CORNELIS PETRUS (1830–1902), Dutch theologian and scholar, was born at Leiden on the 16th of December 1830. He was educated at Amsterdam, first studying at the Athenaeum Illustre, as the communal high school of the capital was then named, and afterwards at the seminary of the Remonstrant Brotherhood. He was destined for the pastorate in his own brotherhood. After steadily declining for a considerable period, this had increased its influence in the second half of the 19th century by widening the inelastic tenets of the Dutch Methodists, which had caused many of the liberal clergy among the Lutherans and Calvinists to go over to the Remonstrants. Tiele certainly had liberal religious views himself, which he early enunciated from the pulpit, as Remonstrant pastor of Moordrecht (1853) and at Rotterdam (1856). Upon the removal of the seminary of the brotherhood from Amsterdam to Leiden in 1873, Tiele was appointed one of its leading professors. In 1877 followed his appointment at the university of Leiden as professor of the history of religions, a chair specially created for him. Of his many learned works, the *Vergelijkende geschiedenis van de egyptische en mesopotamische Godsdiensten* (1872), and the *Geschiedenis van den Godsdienst* (1876; new ed. 1891), have been translated into English, the former by James Ballingall (1878–1882), the latter by J. Estlin Carpenter (1877) under the title "Outlines of the History of Religion" (French translation, 1885; German translation, 1895). A French translation of the *Comparative History* was published in 1882. Other works by Tiele are: *De Godsdienst van Zarathustra, van het Ontstaan in Baktrië, tot den Val van het Oud-Perzische Rijk* (1864) a work now embodied, but much enlarged and improved by the latest researches of the author, in the *History of Religions* (vol. ii. part ii., Amsterdam, 1901), a part which appeared only a short time before the author's death; *De Vrucht der Assyriologie voor de vergelijkende geschiedenis der Godsdiensten* (1877; German ed., 1878); *Babylonisch-assyrische Geschichte* (two parts, Leipzig, 1886–1888); *Western Asia, according to the most Recent Discoveries* (London, 1894). He was also the writer of the article "Religions" in the 9th edition of the *Ency. Brit.* A volume of Tiele's sermons appeared in 1865, and a collection of his poems in 1863. He also edited (1868) the poems of Petrus Augustus de Génestet. Tiele was best known to English students by his *Outlines* and the Gifford Lectures "On the Elements of the Science of Religion," delivered in 1896–1898 at Edinburgh University. They appeared simultaneously in Dutch at Amsterdam, in English in London and Edinburgh (1897–1899, 2 vols.). Edinburgh University in 1900 conferred upon Tiele the degree of D.D. *honoris causâ*, an honour bestowed upon him previously by the universities of Dublin and Bologna. He was also a fellow of at least fifteen learned societies in Holland, Belgium, France, Germany, Italy, Great Britain and the United States. He died on the 11th of January 1902. In 1901 he had resigned his professorship at Leiden University. Tiele's zeal and power for work were as extraordinary as his vast knowledge of ancient languages, peoples and religions, upon which his researches, according to F. Max Müller, have shed a new and vivid light. With Abraham Kuenen and J. H. Scholten, amongst others, he founded the "Leiden School" of modern theology. From 1867 he assisted A. Kuenen, A. D. Loman and L. W. Rauwenhoff editing the *Theologisch Tijdschrift*.

His brother Pieter Anton Tiele (1834–1888) acted for many years as the librarian of Utrecht University, and distinguished himself by his bibliographical studies, more especially by his several works on the history of colonization in Asia. Among these the most noteworthy are: *De Opkomst van het nederlandsch Gezag in Oost-Indie* (1886); *De Vestiging der Portugeezen, in Indie* (1873), and other books on the early Portuguese colonization in the Malay Archipelago.

TIENTSIN, the largest commercial city in Chih-li, the metropolitan province of China. Pop. (1907), about 750,000. It is situated at the junction of the Peiho and the Hun-ho, which is connected by the grand Canal with the Yangtsze-kiang. It is a prefectural city, and has, since the conclusion of the foreign treaties, become the residence of the viceroy of the province during a great portion of the year. The town is built on a vast alluvial plain, which extends from the mountains beyond Peking to the sea, and through which the Peiho runs a circuitous course, making the distance by water from Tientsin to the coast about 70 m. as against 30 m. by railway.

The appearance of the city has greatly changed since the Boxer rising in 1900. After that event the city walls, which measured about three quarters of a mile each way, were razed, wide streets were made, the course of the river straightened, electric lighting and tramways introduced and a good water service supplied. Among the public buildings are a university (in which instruction is given in western learning) and an arsenal. There are several cotton mills and important rice and salt markets. The city has always been a great commercial depot; a wharf nearly two miles long affords ample facilities for vessels able to cross the bar of the Peiho, over which there is a depth of water varying from 9 to 12 ft.

In 1907 the imports amounted to 79,500,000 taels (a tael in 1907 averaged 3s. 3d.); viz. foreign imports 61,200,000, native imports 18,317,000 taels; the exports in the same year amounted to 17,253,000. Valuable cargoes of tea are landed here for carriage overland, via Kalgan and Kiakhta, to Siberia. During the winter the river is frozen. The principal articles of import are shirtings, drills, jeans and twills, opium, woollens, steel, lead, needles, Japanese sea-weed and sugar; and of export, wool, skins, beans and pease, straw braid, coal, dates, tobacco and rhubarb. The coal exported is brought from the Kaiping colliery to the east of Tientsin; its output in 1885 was 181,039 tons and in 1904 28,956 tons.

The importance of Tientsin has been enhanced by the railways connecting it with Peking on the one hand and with Shanhai-kwan and Manchuria on the other. The British concession, in which the trade centres, is situated on the right bank of the river Peiho below the native city, and occupies some 200 acres. It is held on a lease in perpetuity granted by the Chinese government to the British Crown, which sublets plots to private owners in the same way as is done at Hankow. The local management is entrusted to a municipal council organized on lines similar to those which obtain at Shanghai. Besides the British concession the French, Germans, Russians, Japanese, Austrians, Italians and Belgians have separate settlements, five miles in all, the river front being governed by foreign powers.

In 1853 Tientsin was besieged by an army of T'aip'ing rebels, which had been detached from the main force at Nanking for the capture of Peking. The defences of Tientsin, however, saved the capital, and the rebels were forced to retreat. Five years later Lord Elgin, accompanied by the representative of France, steamed up the Peiho, after having forced the barriers at Taku, and took peaceable possession of the town. Here the treaty of 1858 was signed. But in 1860, in consequence of the treacherous attack made on the British plenipotentiary the preceding year at Taku, the city and suburbs were occupied by an allied British and French force, and were held for two years. The city was constituted an open port. On the establishment of Roman Catholic orphanages some years later the pretensions of the priests so irritated the people that on the occurrence of an epidemic in the schools in the year 1870 they attacked the French and Russian establishments and murdered twenty-one of the foreign inmates, besides numbers of their native followers. The Chinese government suppressed the riot, paid £80,000 in compensation and sent a representative to Europe to apologize for the outbreak.

During the period 1874–1894, when Li Hung-Chang was viceroy of Chih-li and *ex officio* superintendent of trade, he made Tientsin his headquarters and the centre of his experiments in military and naval education. As a consequence the city became the chief focus of enterprise and foreign progress. Having arrogated to himself the practical control of the foreign policy of the nation, Li's yamen became the scene of many important negotiations, and attracted distinguished visitors from all parts of the globe. The loss of prestige consequent on the Japanese War brought about the retirement of Li, and with it the political importance of Tientsin ceased. Both the foreign concessions and the native city suffered severely during the hostilities resulting from the Boxer movement in June–July, 1900. (See China: *History* § D.)

TIEPOLO, GIOVANNI BATTISTA (1692–1769), Italian painter, was born at Venice, and acquired the rudiments of his art from Gregorio Lazzarini, and probably from Piazzetta, though the decisive influence on the formation of his style was the study of Paolo Veronese's sumptuous paintings. When hardly out of his teens he developed an extraordinary facility of brushwork, and proved himself, as a fresco-painter, a colourist of the first order, though this early mastery of technique made him frequently neglect form and composition. The more solid qualities of Paolo Veronese—depth of thought and balance of design—are frequently wanting in his work, but he approaches the earlier master in richness of colour and in the management of difficult effects of lighting. He decorated many Venetian churches and palaces with ceilings and frescoes full of turbulent movement and rich colour, extending his operations to the near cities of the mainland and to Bergamo (Colleoni Chapel) and Milan (ceiling at Palazzo Chierici). In 1750 he proceeded to Würzburg to paint the magnificent ceilings and frescoes at the archbishop's palace. From 1753 to about 1763 he worked again at Venice and in the cities of north-east Italy, until he was summoned to Madrid by Charles III. to paint some frescoes for the royal palace. He died at Madrid in 1769. He was the last important figure in Venetian art, and at the same time the initiator of the baroque period.

Tiepolo's altarpieces and easel pictures show more clearly even than his frescoes how deeply he was imbued with the spirit of Paolo Veronese, for in these smaller works he paid more attention to the balance of composition, whilst retaining the luminosity of his colour harmonies. The majority of his works, both in fresco and in oils, are to be found in Venice in the churches of S. Aloise, SS. Apostoli, Gesuati, SS. Giovanni e Paolo, in the Scalzi, and the Scuola del Carmine, the Academy, and the Palazzi Labia, Rezzonico, and Quirini-Stampalia, and the Doge's Palace. Besides the cities already mentioned, Padua, Udine, Parma and Vicenza boast of fine examples of his work. At the National Gallery are two designs for altarpieces, a "Deposition from the Cross," "Esther at the Throne of Ahasuerus," and "The Marriage of Marie de Médicis." Two versions of "Christ and the Adulteress" are in the collection of Dr L. Richter. Other easel pictures by Tiepolo are at the Louvre, and at the Berlin and Munich galleries. His paintings in Madrid belong to the closing years of his life and show signs of waning power. Tiepolo also executed some notable work with the etching-needle, the list comprising some fifty plates. His two sons, Giovanni Domenico (about 1726–1804) and Lorenzo, did not attain to his excellence.

See *Les Tiepolo*, by Henry de Chennevières (Paris, 1898); and Pompeo Molmenti, *G. B. Tiepolo* (Milan, 1910).

TIERNEY, GEORGE (1761–1830), English Whig politician, was born at Gibraltar on the 20th of March 1761, being the son of a wealthy Irish merchant of London, who was living there as prize agent. He was sent to Eton and Peterhouse, Cambridge, where he took the degree of LL.B. in 1784, and was called to the bar; but he abandoned law and plunged into politics. He contested Colchester in 1788, when both candidates received the same number of votes, but Tierney was declared elected. He was, however, defeated in 1790. He sat for Southwark from 1796 to 1806, and then represented in turn Athlone (1806–1807), Bandon (1807–1812), Appleby (1812–1818), and Knaresborough (1818–1830). When Fox seceded from the House of Commons, Tierney became a prominent opponent of Pitt's policy. In 1797 Wilberforce noted in his diary that Tierney's conduct was "truly Jacobinical"; and in May 1798 Pitt accused him of want of patriotism. A duel ensued at Putney Heath on Sunday, the 27th of May 1798; but neither combatant was injured. In 1803 Tierney, partly because peace had been ratified with France and partly because Pitt was out of office, joined the ministry of Addington as treasurer of the navy, and was created a privy councillor; but this alienated many of his supporters among the middle classes, and offended most of the influential Whigs. On the death of Fox he joined (1806) the Grenville ministry as president of the board of control, with a seat in the cabinet, and thus brought himself once more into line with the Whigs. After the death of George Ponsonby in 1817 Tierney became the recognized leader of the opposition in the House of Commons. In Canning's ministry he was master of the mint, and when Lord Goderich succeeded to the lead Tierney was admitted to the cabinet; but he was already suffering from ill-health and died suddenly at Savile Row, London, on the 25th of January 1830.

Tierney was a shrewd man of the world, with a natural aptitude for business. His powers of sarcasm were a cause of terror to his adversaries, and his presence in debate was much dreaded. His arguments were felicitous, and his choice of language was the theme of constant admiration. Lord Lytton, in his poem of St Stephen's, alludes to "Tierney's airy tread," and praises his "light and yet vigorous" attack, in which he inflicted, "with a placid smile," a fatal wound on his opponent.

TIERRA DEL FUEGO, an archipelago at the southern extremity of South America, from which it is separated by Magellan Strait, at the First Narrows and other points scarcely a mile wide. The group lies between 52° 40′ and 55° 59′ S. and 63° 30′ and 74° 30′ W. stretching nearly in a line with the Patagonian Andes for over 400 m. N.W. and S.E., between Capes Pillar (Desolation Island) and Horn, and for about 270 m. W. and E. from Cape Pillar to Catherine Point at the north of the main island of Tierra del Fuego. Southwards it tapers to 120 m. between Capes Horn and San Diego, east of which extends Staten Island, which terminates in Cape St John. The boundary between Argentina and Chile has been settled in such a manner that Argentina holds that part of the main island of Tierra del Fuego which is situated east of the meridian of Cape Espiritu Santo, the frontier striking the north shore of Beagle Channel about its centre; and Chile holds all the western part of the main island and the other numerous islands to the west and to the south of Beagle Channel. The Argentine side is known as the Territory of Tierra del Fuego (including Staten Island), and the Chilean forms part of the Territory of Magallanes. Although on ordinary maps this region presents to the eye a hopelessly confused aggregate of islands, channels and fjord-like inlets, it is nevertheless clearly disposed in three main sections: (1) the main island; (2) the islands to the south, from which it is separated by Beagle Channel; (3) the islands to the west, marked off from those to the south by the Brecknock Peninsula.

Knowledge of these lands increased considerably during the later years of the 19th century, and their reputation for dreariness has been favourably modified. The climate in the eastern and southern regions is not so rigorous as was believed, there are no barren lands, the soil is fertile and can support fruitful industries, and the aborigines are far from being so dangerous as they were once considered to be. The greater part of the main island of Tierra del Fuego is formed by the continuation of the Tertiary beds of the Patagonian tableland cut by the transversal depression of Magellan Strait and by the low land extending from Useless Bay on the west to San Sebastian Bay on the east, of so recent origin that there exist still some salt lakes, this depression being represented in the old charts as an inter-oceanic passage for small boats. Although in 1880 numerous prospectors discovered extensive deposits of alluvial gold, its exploitation was not generally successful, and farms took the place of mines. By the end of the 19th century 120 square miles had been occupied by cattle and sheep on the Argentine side, and about the same extent on the Chilean; and the cattle industry proved very profitable.

The undulating tableland has an average height of 300 ft. above the sea, and its climate, however cold in winter—in 1892 and 1893 the temperature reached 12·6° F.—allows of the cultivation of barley, oats and occasionally potatoes, which, however, grow better along Beagle Channel. To the south the tableland is higher and more broken, being drained by the Silva and Grande, among smaller rivers, the Grande being navigable in some parts by small craft. To the west and south-west the general character of the land changes; the ends of the Tertiary beds are raised in small hills and Mesozoic rocks appear, forming broken ridges of the Pre-Cordillera, a name given on the continent to the ridges which precede, to the east, the Andes. In this region appears the Antarctic forest in which predominates the *Fagus antarctica* and *F. betuloides*, *Drymis Winteri*, *Berberis licifolia*, *Pernettia*, *Desfonteinia* and *Philesia buxifolia*. Lake Solier and Lake Fagnano receive the waters of these mountains and hills. Lake Fagnano is only 180 ft. above the sea, and its depth reaches 700 ft. To the south of the lake rises the south-eastern prolongation of the Cordillera of the Andes, with ridges of a uniform height of 3500 ft., in which predominate crystalline schists which do not seem to be very old. Some peaks of Tertiary granite break the uniformity, such as Mt Sarmiento (7200 ft.), Mt Darwin, of which two peaks have been measured (6201 and 7054 ft.), and Mt Olivaia (4324 ft.). Sarmiento, the culminating point of the archipelago, was generally supposed to be volcanic, but it presents such extremely precipitous flanks that John Ball considered it more probably "a portion of the original rock skeleton that formed the axis of the Andean chain during the long ages that preceded the great volcanic outbursts that have covered the framework of the western side of South America."[1] Sir Martin Conway, who ascended it, ascertained that it is not a volcano. This is altogether an alpine region with numerous snow-clad summits and glaciers descending down to the sea. Deep valleys, which seem to be only the prolongation of fjords, penetrate into the chain in the southern slope where exist several harbours on which settlements have been founded. Yendegaia, Lapatia and Ushuaia Bays are among the larger. Ushuaia is the site of the capital of the Argentine Territory, and has shown considerable development, having regular communication by monthly steamers with Buenos Aires, while smaller steamers serve the different settlements along the coast. Cattle farms prosper along Beagle Channel, the timber industry is growing, lignite seams have been discovered, and alluvial gold is washed principally at Slogget Bay. These regions, as they become more known, may even invite the attention of tourists by their sublime scenery. Staten Island to the east of Tierra del Fuego has been settled by the Argentine government; there are a prison and lighthouse at St John Harbour, and a first-class permanent meteorological and magnetic station.

The division of the archipelago to the south of Beagle Channel includes the islands of Hoste, Navarin, Gordon, Londonderry, Stewart, Wollaston and numerous islets, disposed in triangular form with the base on Beagle Channel and the apex at the rocky headland of Cape Horn. At its west end Beagle Channel takes the name of Darwin Sound, which leads to the Pacific at the Londonderry and Stewart Islands. Partial exploration in this region was conducted by the French Mission du Cap Horn in 1882–1883, and the geological foundations are granite and basic volcanic rocks. The western group of islands, demarcated by Brecknock Peninsula, includes Clarence Island and Captain Cook's Desolation Land, with Dawson Island and numerous rocks and islets. Desolation Land was supposed by Cook to form a continuous mass stretching from the western entrance of Magellan Strait to Cockburn Channel, but it actually consists of several islands, separated from each other by very narrow channels flowing between the Pacific and the western branch of Magellan Strait. The name Desolation is given to the northern member of the group terminating at Cape Pillar; the southernmost and largest island nearer to Clarence Island, is Santa Iñes. In other cases small surveys among these fjords have shown that several of the larger islands are cut by channels which separate them into smaller ones, while elsewhere the low valleys which unite the mountains and hills are the result of post-Glacial deposits that have filled part of the former channels, these islands being the summits of an old continuous half-submerged mountain chain. At Dawson Island the Chilean government has established settlements, and a Roman Catholic mission has carried on work among the Alakaluf Indians.

Climate.—At Ushuaia ten years' meteorological observations[2] have shown a mean annual temperature of 42·84° F., with a winter mean of 34·7° and a summer mean of 50·18°. These figures show that tolerably mild winters (as a whole, apart from the extremes of cold already indicated) are followed by cool summers, both seasons being accompanied by overcast skies, constant and sudden changes from fair to foul weather; while fogs, mists, rains, snows and high winds (prevailing throughout the year) endanger the navigation of the intricate inland channels. The precipitation during ten years at Ushuaia has been observed to average 24·8 in. But on the southern seaward islands, under the influence of the prevalent westerly or south-westerly winds, it is very much heavier, and reaches 59 in. at Staten Island.

Fauna.—In the main island of Tierra del Fuego, the low-lying plains with their rich growth of tall herbage are frequented by the rhea, guanaco and other animals common to the adjoining mainland. In the southern and western islands the fauna is restricted mainly to foxes, bats, rats, mice, the sea otter, the penguin and other aquatic birds, and various cetaceans in the surrounding waters.

Inhabitants.—To the three geographical divisions correspond three well-marked ethnical groups—the Onas of the main island, the Yagans (Yahgans) of the south and the Alakalufs of the west. With the settlement of the main island, which is now sometimes called Onisia, leaving the name of Tierra del Fuego to the archipelago, the Onas tribe has become fairly known. Their origin, like that of the other groups, is obscure. Undoubtedly among these Indians are many that recall some Patagonian types; it seems that they are not the same as the Tehuelche type, but that they pertain to one of the races that in earlier times existed in Patagonia. Their language is closely allied to that called Old Tehuelche; it is a hard, slow-spoken speech, not at all resembling the soft, rapidly-spoken language of the Yagans, which has many points of similarity with that of the Alakalufs. The isolation of the Onas is peculiarly marked, inasmuch as they are an insular people who do not use boats. Their life is nomadic, and they are hunters, living upon the flesh of the guanaco, and using only tussock-roots and wild celery for vegetable food. Their skill in and necessary devotion to the chase influence their whole mode of life; "their moral code is based upon a standard of physical culture and health."[3] They live in small groups, every member of which is connected by family ties; between these groups, as in the case of the Yagans and Alakalufs, the vendetta is common. They have no gods, though certain legends are preserved. They have maintained their stock untainted, and have withstood the influence of the white man to a remarkable degree (for example, they use no spirituous or fermented drink), though they have suffered a serious decrease in numbers at his hands. The men average about 5 ft. 10 in. in height; the women 5 ft. 6 in. They are of a light copper colour, with black straight hair, and remarkably muscular. The Yagans live under conditions of extraordinary rigour. In order to obtain food, they venture naked in small canoes into the treacherous seas; their life is a constant battle with starvation and a rude climate, and their character has become rude and low in consequence. They have no higher social unit than the family. On the authority of Charles Darwin they have been held by many to be cannibals, but they are not, although those suffering from incurable ailments are often put to death. Although taller than the Negritoes of the eastern hemisphere (4 ft. 10 in. to 5 ft. 4 in.), the Yagans present in some respects a more debased type characterized by low brows, prominent zygomatic arches, large tumid lips, flat nose, loose wrinkled skin, black restless eyes very wide apart, coarse black unkempt hair, and head and chest disproportionately large compared with the extremely slender and outwardly curved legs. The missionaries, who have reduced the language to writing (Gospel of St Luke, London, 1881), assert that it contains no fewer than 30,000 words, although the numerals stop at *five*, already a compound form, and although the same word expresses both *hand* and *finger*; but it appears that a large number of the words included in this total are compounds. Comparatively little is known about the Alakalufs. They have a reputation for treachery, and for assaults on shipwrecked crews. They are hunters both on land and on the water, using the bow and arrow like the Onas, and building canoes often of large size.

The aborigines are decreasing rapidly in the whole archipelago, and although the Rev. Thomas Bridges, who, as missionary first and then as farmer, resided thirty years there, calculated the population to be 10,000 when he arrived, towards the close of the 19th century it was estimated to be little more than 1000.

Tierra del Fuego was discovered by Fernando de Magellan in 1520, when he sailed through the strait named after him, and called this region the "Land of Fire," either from now extinct volcanic flames, or from the fires kindled by the natives along parts of his course. In 1578 Sir Francis Drake first sighted the point which in 1616 was named Cape Hoorn (anglicized Horn) by the Dutch navigators Jacob Lemaire and Willem Cornelis Schouten (1615–1617). In 1619 the brothers Garcia and Gonçalo de Nodal first circumnavigated the archipelago, which was afterwards visited at intervals by Captain Sir John Narborough (1670), M. de Gennes and the Sieur Froger (1696), Commodore John Byron (1764), Samuel Wallis and Philip Carteret (1767), James Cook (1768) and James Weddell (1822). But no systematic exploration was attempted until the British Admiralty undertook a thorough survey of the whole group by Philip Parker King (1826–1828) and Robert Fitzroy (1831–1836). The latter expedition (*Voyage of the "Beagle"*) was accompanied by Charles Darwin, then a young man. To these admirable surveys is due most of the present geographical terminology of the archipelago. Subsequently the work of exploration was continued by Dumont d'Urville (1837), Charles Wilkes (1839), Parker Snow (1855), various later travellers, a selection of whose works are quoted below, and British, American and Roman Catholic missionaries.

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TIETJENS, THÉRÈSE JOHANNE ALEXANDRA (1831–1877), Hungarian soprano vocalist, was born at Hamburg on the 17th of July 1831. Her voice was trained at Hamburg, where she made a successful début in 1849 as Lucrezia Borgia in Donizetti's opera. Thence she proceeded to Frankfort and Vienna. She sang for the first time in London in 1858, appearing as Valentine in *Les Huguenots*. Her success was so great that for the rest of her life she made England her home, and soon gained as brilliant a reputation in concert and oratorio work as she had already won upon the stage. Her voice was a dramatic soprano of magnificent quality, and her powers as an actress were supreme. Her most famous parts were Fidelio, Medea (in Cherubini's opera) and Donna Anna (in Don Giovanni). She died in London on the 3rd of October 1877, having endeared herself to the English people as much by her private virtues as by her artistic gifts.

TIFFANY, CHARLES LEWIS (1812–1902), American jeweler, was born at Killingly, Connecticut, on the 15th of February 1812. At fifteen he became a clerk in his father's store, but removed to New York City in 1837, and with John B. Young opened a fancy goods store. In 1847 the firm began to manufacture gold jewelry, and in 1848, when the political unrest in Europe caused great depreciation in the price of precious stones, Tiffany invested heavily in diamonds, which were sold at a great profit a few years later. The firm became Tiffany, Young & Ellis in 1841 and was reorganized as Tiffany & Company (Mr Young and Mr Ellis retiring) in 1853. In 1851 the firm had established the sterling silver standard of ·925 fine, subsequently adopted by other jewelers; and in the same year had founded a branch house in Paris. In 1858 Tiffany bought the unused portion of the Atlantic telegraph cable which he made into cane handles or sold in sections. At the beginning of the Civil War, foreseeing that the jewelry business would suffer, he turned most of his capital to the manufacture of swords, medals and similar war material. In 1868 the company was incorporated, and branches were established at London and at Geneva. Tiffany made a speciality of importing historic gems, jewelry and art works, and in 1887 bought some of the crown jewels of France, paying for them about half a million dollars. He was made a chevalier of the Legion of Honour in 1878. He died in New York on the 18th of February 1902.

TIFFANY, LOUIS COMFORT (1848–), American artist, son of Charles L. Tiffany, was born in New York City, on the 18th of February 1848. He was a pupil of George Inness and of Samuel Coleman, New York, and of Léon Bailly, Paris. He became a member of the Society of American Artists (1877), of the National Academy of Design (1880), of the American Water Color Society, and of the Société Nationale des Beaux Arts, Paris. He travelled extensively in Europe, and painted in oil and water-colour, but subsequently devoted himself to decorative glass work. He became president and art director of the Tiffany Glass and Decorating Co., and produced a "Favrile" glass, of unusual beauty of colour.

TIFFIN, a city and the county-seat of Seneca county, Ohio, U.S.A., on the Sandusky river, about 40 m. S.S.E. of Toledo. Pop. (1900), 10,989, of whom 1168 were foreign-born; (1910 census), 11,894. Tiffin is served by the Baltimore & Ohio, the Cleveland. Cincinnati, Chicago & St Louis and the Pennsylvania railways, and by an electric line to Fostoria, about 12 m. west. It is the seat of an Ursuline College for girls, founded in 1863 and incorporated with power to confer degrees in 1878; and of Heidelberg University (Reformed Church), founded in 1850, incorporated as Heidelberg College in 1851 and reincorporated under its present name in 1890. The Heidelberg Theological Seminary was conducted here from 1850 to 1907, when it was combined with the "School of Theology" of Ursinus College, Collegeville, Pennsylvania, to form the Central Theological Seminary of the Reformed Church in the United States, which in 1908 was removed to Dayton, Ohio. In Tiffin are the St Francis Home (1869), and the National Orphans' Home (1897). The city had 87 factories in 1905, of which 54·2% were owned by individuals, and the value of the factory products was $2,434,502. Tiffin was settled in 1817, incorporated as a town in 1835, and chartered as a city in 1850, when the village of Ft. Ball, on the opposite side of the Sandusky, was consolidated with it. It was named in honour of Edward Tiffin (1766–1829), a native of Carlisle, England, who emigrated to the United States. He graduated at the University of Pennsylvania in 1789, removed in 1796 to Chillicothe, Ohio. where he practised medicine and was a local Methodist preacher. He was speaker of the House of Representatives of the North-west Territory in 1799, president (1802) of the convention which framed the first constitution of Ohio, the first governor of the state (1803–1807), a Democratic member of the United States Senate in 1807–1809, first commissioner of the United States General Land Office in 1812–1814, and surveyor-general of public lands north-west of the Ohio River in 1814–1829.

TIFLIS, a government of Russian Transcaucasia, occupying the eastern portion of the great valley which stretches between the main Caucasus range and the Armenian highlands, from the Meskes Mountains eastward, and extending up into the higher regions on both north and south. The district of Akhaltsikh lies actually on the Armenian highlands. The government is rich in minerals, but only copper is extracted, at Alaverdi and Akhtal; petroleum and other mineral springs are abundant. The government is drained by the Kura and its tributaries (Lyakhva, Aragva, Yora and Alazan), all of whose waters are largely used for irrigation; but in the lower parts of the valley there are extensive waterless steppes, Shirak and Karayaz, on the left bank of the Kura, which are chiefly inhabited by nomad Tatars. The area of the government is 15,601 sq. m. (17,140 with the Zakataly district), and the estimated population in 1906 was 1,081,900. The government is divided into nine districts, the chief towns of which are Tiflis, Akhalkalaki, Akhaltsikh, Dushet, Gori, Signakh and Telav. Agriculture is the principal occupation. Good silk is produced, especially in the region of Kakhetia. Livestock breeding is extensively carried on on the steppes. About one-fourth of the area is under forest. The natives exhibit remarkable skill in the manufacture of leather and metallic goods, felt, woollen stuffs (*e.g.* carpets and shawls) and gold embroidery.

TIFLIS, a town of Russian Caucasia, capital of the government of the same name and of the governor-generalship of Caucasia, picturesquely situated (44° 48′ E., 41° 42′ N.) at the foot of bare high mountains, on both banks of the river Kura, 300 ft. above the Black Sea. It is connected by rail with Poti and Batum (217 m.) on the Black Sea, with Baku on the Caspian Sea (342 m.), with Kars (185 m.), and, via Baku and Petrovsk, with the railway system of European Russia, which it joins at Beslan, near Vladikavkaz. Omnibuses also run regularly across the main range to Vladikavkaz, which by this route is only 133 m. distant. The heat in summer is excessive (mean, 73·4° F.), owing to the confined position; but the surrounding hills (1500 to 2400 ft.) shelter the town effectively from the cold winds of winter (mean, 34·7°). A large square, cathedrals, handsome streets, gardens, bridges, many fine buildings—among them the grand-ducal palace, the opera-house and the museum—European shops, the club or "circle," hotels and public offices, are evidence of western civilization. Among the modern public buildings are the Hall of Fame (1885), the Caucasian Museum, a cathedral of the Catholic Greek Church, and a sericultural museum. The chief of the older edifices is the (Sion) cathedral, which traces back its origin to the 5th century. Other churches date from the 14th and 15th centuries, the Armenian cathedral of Van from 1480, and the Catholic church from the 14th century. At Tiflis are the Caucasian branch of the Russian Geographical Society, an astronomical and a physical observatory, a botanical garden and museum, and a public library. There are cotton and silk factories, tanneries, soap-works and brick-works. The artisans of Tiflis are renowned as silversmiths, gunsmiths and sword-makers. Tiflis is the chief centre for the import of raw silk and silken goods, raw cotton, cottons, woollens, boots, tobacco, wine, carpets, and dried fruits from Persia and Transcaucasia, while manufactured wares are imported from Russia. The city has considerably developed, and had, in 1897, 160,645 inhabitants, as compared with 104,024 in 1883. They include Georgians, Russians, Germans, Persians and Tatars.

In the old division of Tiflis three distinct towns were included—Tiflis, Kal'a (the fort) and Isni; subsequently Tiflis seems to have been known as Sāidābād, Kal'a as Tiflis, and Isni as Aulabār. Kal'a and Isni possessed citadels; that of the former contained the church of St Nicholas and a royal palace; that of the latter the church of the Holy Virgin and the residence of the archimandrite. The town is now divided into quarters: the Russian (the finest of all), the German, the Armenian, and that in which are congregated Jews, Mahommedans and the mass of Orientals.

The Georgian annals put the foundation of Tiflis back to A.D. 379. In the later half of the 5th century the chieftain of Georgia, Wakhtang, Gurgaslan, transferred his capital from Mtskhet to the warm springs of Tphilis, where he erected several churches and a fort. In 570 the Persians took the place and made it the residence of their rulers, but retained it only for ten years. Tiflis suffered successive plunderings and devastations at the hands of the Greeks in 626, of one of the commanders of the Caliph Omar in 731, of the Khazars in 828, and of the Arabs in 851. The Georgians, however, always managed to return to it and to keep it in their permanent possession. In the course of the succeeding centuries Tiflis fell repeatedly into Persian hands; and it was plundered by the Mongol conqueror Tamerlane towards the end of the 14th century. Afterwards the Turks seized it several times, and towards the end of the 17th century the Lesghians attacked it. In 1795, when the shah of Persia plundered Tiflis, Russia sent troops to its protection, and the Russian occupation became permanent in 1799.

Perhaps one of the fullest accounts of Tiflis is contained in Brosset's edition of the *Description géographique de la Géorgie* (St Petersburg, 1842), by the illegitimate son of Wakhtang VI., king of Karthli (*i.e.* Georgia), who became a pensioner of Peter the Great. (P. A. K.; J. T. Be.)

TIGELLINUS, SOPHONIUS, minister and favourite of the emperor Nero, was a native of Agrigentum, of humble origin and possibly of Greek descent. During the reign of Caligula he was banished (A.D. 39) for adultery with the emperor's sisters, but recalled by Claudius (41). Having inherited a fortune, he bought land in Apulia and Calabria and devoted himself to breeding race-horses. In this manner he gained the favour of Nero, whom he aided and abetted in his vices and cruelties. In 62 he was promoted to the prefecture of the praetorian guards. In 64 he made himself notorious for the orgies arranged by him in the Basin of Agrippa, and was suspected of incendiarism in connexion with the great fire, which, after having subsided, broke out afresh in his Aemilian gardens. In 65, during the investigation into the abortive conspiracy of Piso, he and Poppaea formed a kind of imperial privy council. In 67 he accompanied Nero on his tour in Greece. When the emperor's downfall appeared imminent, Tigellinus deserted him, and with Nymphidius Sabinus brought about the defection of the praetorians. Under Galba he was obliged to give up his command, but managed to save his life by lavishing presents upon Vinius, the favourite of Galba, and his daughter. Otho on his accession (69) determined to remove one so universally detested by the people. While in the baths at Sinuessa, Tigellinus received the news that he must die, and, having vainly endeavoured to gain a respite, cut his throat.

See Tacitus, *Annals*, xiv., xv., xvi.; *Hist.* i. 72; Dio Cassius lix. 23, lxii. 13, 15, 27, lxiii. 12, 21, lxiv. 3; Suetonius, *Galba*, 15; Plutarch, *Galba*, *Otho*; ancient authorities quoted by Mayor on Juvenal, i. 155; B. W. Henderson, *Life and Principate of the Emperor Nero* (1903).

TIGER (*Felis tigris*), an animal only rivalled by the lion in size, strength and ferocity among the cat-like beasts of prey (see CARNIVORA). Almost everything that is stated in the article LION concerning the structure of the skeleton, teeth and claws of that animal will apply equally well to the tiger, the difference between the two lying mainly in the skin and its coverings. A tiger's skull may, however, always be distinguished from that

The Tiger (*Felis tigris*).

of a lion by the circumstance that the nasal bones extend higher on the forehead than the maxillae, instead of stopping on nearly the same line. Although examples of both species present considerable variations in size, it is ascertained that the length of the largest-sized Bengal tiger may exceed that of any lion. Much larger specimens are recorded, but 10 feet from the tip of the nose to the end of the tail is no unusual length for a large male tiger. The female is somewhat smaller and has a lighter and narrower head. The tiger has no mane, but in old males the hair on the cheeks is rather long and spreading. The ground-colour of the upper and outer parts of the head, body, limbs and tail is bright rufous fawn; and these parts are beautifully marked with transverse stripes of a dark, almost black colour. The markings vary much in different individuals, and even on the two sides of the same individual. The under-parts of the body, the inside of the limbs, the cheeks and a large spot over each eye are nearly white. The tigers which inhabit hotter regions, as Bengal and the south Asiatic islands, have shorter and smoother hair, and are more richly coloured and distinctly striped than those of northern China and Siberia, in which the fur is longer, softer and lighter-coloured. The Siberian tiger is *F. tigris mongolica*, and the Persian *F. tigris virgata*. Black and white phases have been recorded, but they are rare. The tiger is exclusively Asiatic, but has a very wide range in that continent, having been found in almost all suitable localities south of a line drawn from the river Euphrates, passing along the southern shores of the Caspian and Sea of Aral by Lake Baikal to the Sea of Okhotsk. Its most northern range is the territory of the Amur, its most southern the islands of Sumatra, Java and Bali. Westward it reaches to Turkish Georgia and eastward to the island of Saghalin. It is absent, however, from the great elevated plateau of Central Asia, nor does it inhabit Ceylon, Borneo or the other islands of the Indo-Malay Archipelago, except those named.

The principal food of the tiger in India is cattle, deer, wild hog and pea-fowl, and occasionally human beings. The regular "man-eater" is generally an old tiger whose vigour is past, and whose teeth are worn and defective; it takes up its abode in the neighbourhood of a village, the population of which it finds an easier prey than wild animals. Though chiefly affecting grassy plains or swamps, tigers are also found in forests, and seem to be fond of haunting the neighbourhood of old ruins. As a rule, they do not climb trees; but when pressed by fear, as during an inundation, they have been known to do so. They take to the water readily and are good swimmers. The tigers of the Sundarbans (Ganges delta) continually swim from one island to the other to change their hunting-grounds for deer. The following extract from Sir J. Fayrer's *Royal Tiger of Bengal* (1875) may complete this notice of the tiger's habits.

The tigress gives birth to from two to five, even six cubs; but three is a frequent number. She is a most affectionate and attached mother, and generally guards and trains her young with the most watchful solicitude. They remain with her until nearly full-grown, or about the second year, when they are able to kill for themselves and begin life on their own account. Whilst they remain with her she is peculiarly vicious and aggressive, defending them with the greatest courage and energy, and when robbed of them is terrible in her rage; but she has been known to desert them when pressed, and even to eat them when starved. As soon as they begin to require other food than her milk, she kills for them, teaching them to do so for themselves by practising on small animals, such as deer and young calves or pigs. At these times she is wanton and extravagant in her cruelty, killing apparently for the gratification of her ferocious and bloodthirsty nature, and perhaps to excite and instruct the young ones, and it is not until they are thoroughly capable of killing their own food that she separates from them. The young tigers are far more destructive than the old. They will kill three or four cows at a time, while the older and more experienced rarely kill more than one, and this at intervals of from three or four days to a week. For this purpose the tiger will leave its retreat in the dense jungle, proceed to the neighbourhood of a village or gowrie, where cattle feed, and during the night steal on and strike down a bullock, drag it into a secluded place, and then remain near the "murrie" or "kill," for several days, until it has eaten it, when it will proceed in search of a further supply, and, having found good hunting ground in the vicinity of a village or gowrie, continue its ravages, destroying one or two cows or buffaloes a week. It is very fond of the ordinary domestic cattle, which in the plains of India are generally weak, half-starved, undersized creatures. One of these is easily struck down and carried or dragged off. The smaller buffaloes are also easily disposed of; but the buffalo bulls, and especially the wild ones, are formidable antagonists, and have often been known to beat the tiger off, and even to wound him seriously. (W. H. F.; R. L.*)

TIGER-CAT, typically *Felis tigrina*, an American wild cat ranging from Mexico, on the east of the Andes to Paraguay and the central forest region of Argentina. Together the head and body measure something over 30 in., of which the tail counts for a third. The fur is grizzly grey, with black spots that do not form chains. The name is also applied to the Ocelot (*q.v.*), and often used of any small striped or spotted wild cat, either from the western or eastern hemisphere.

TIGER-FLOWER, known botanically as *Tigridia*, a genus of bulbous plants (natural order Iridaceae), natives of Mexico, Central America, Peru and Chile. They have long narrow plicately-veined leaves springing from the bulb and a stem bearing two or three scattered smaller leaves and above a few flowers emerging from a spathe. The flowers are spotted (whence the name tiger-flower or tiger-iris) and have free segments springing from a tube; the three large broad outer segments are concavely spreading, the three inner are much smaller and more erect. *T. pavonia* (Flower of Tigris) has large flowers with a golden orange, white or yellow ground colour.

TIGHE, MARY (1772–1810), Irish poet, daughter of the Rev. William Blachford, was born on the 9th of October 1772. In 1793 she contracted what proved to be an unhappy marriage with her cousin, Henry Tighe, of Woodstock, Co. Wicklow. She died on the 24th of March 1810, at Woodstock, Co. Kilkenny, and was buried at Inistioge. Mrs Tighe was the author of a poem of unusual merit, *Psyche or the Legend of Love*, printed privately in 1805 and published posthumously in 1811 with some other poems. It is founded on the story as told by Apuleius, and is written in the Spenserian stanza. The poem had many admirers, and high praise is awarded it in a contemporary notice in the *Quarterly Review* (May 1811).

TIGLATH-PILESER (Ass. *Tukulti-pal-E-sarra*, "my confidence is the son of E-sarra," *i.e.* the god In-Aristi), the name of several Assyrian kings. The numbering of these kings is not certain.

TIGLATH-PILESER I., the son of Assur-ris-isi, ascended the throne *c.* 1120 B.C., and was one of the greatest of Assyrian conquerors. His first campaign was against the Moschi who had occupied certain Assyrian districts on the Upper Euphrates; then he overran Commagene and eastern Cappadocia, and drove the Hittites from the Assyrian province of Subarti north-east of Malatia. In a subsequent campaign the Assyrian forces penetrated into the Kurdish mountains south of Lake Van and then turned westward, Malatia submitting to the invader. In his fifth year Tiglath-Pileser attacked Comana in Cappadocia, and placed a record of his victories engraved on copper plates in a fortress he built to secure his Cilician conquests. The Aramaeans of north Syria were the next to be attacked, and he thrice made his way as far as the sources of the Tigris. The command of the high road to the Mediterranean was secured by the possession of the Hittite town of Pethor at the junction of the Euphrates and Sajur, and at Arvad he received presents, including a crocodile, from the Egyptian king, and, embarking in a ship, killed a dolphin in the sea. He was passionately fond of the chase and was also a great builder, the restoration of the temple of Assur and Hadad at Assur (*q.v.*) being one of his works.

TIGLATH-PILESER II. or III., son of Hadad-nirari II., appears to have reigned from about 950 to 930 B.C., but nothing is known about him.

TIGLATH-PILESER III. or IV., was a successful general who usurped the Assyrian throne on the 13th of Iyyar 745 B.C., after the fall of the older dynasty, and changed his name of Pulu (Pul) to that of the famous conqueror of earlier times. In Babylonia, however, he continued to be known as Pulu. He was a man of great ability, both military and administrative, and initiated a new system of policy in Assyria which he aimed at making the head of a centralized empire, bound together by a bureaucracy who derived their power from the king. The empire was supported by a standing army and an elaborate system of finance. The first task of Tiglath-Pileser was to reduce the Aramaean tribes to order, and so win the gratitude of the Babylonian priests. Then he struck terror into the wild tribes on the eastern frontiers of the kingdom by a campaign which extended into the remotest parts of Media. Next came the defeat of a northern coalition headed by Sar-duris of Ararat, no fewer than 72,950 of the enemy being captured along with the city of Arpad, where the Assyrian king received the homage of various Syrian princes. Arpad revolted soon afterwards, but after a siege was taken in 740 B.C. The following year Azariah of Judah appears among the enemies of Tiglath-Pileser, who had overthrown his Hamathite allies and annexed the nineteen districts of Hamath. The conquered populations were now transported to distant parts of the empire. In 737 B.C. Tiglath-Pileser again marched into Media, and in 735 he invaded Ararat and wasted the country round the capital Van to a distance of 450 miles. In 734 B.C. he was called to the help of Yahu-khazi (Ahaz) of Judah, who had been attacked by Pekah of Israel and Rezon (Rasun) of Damascus. Rezon, defeated in battle, fled to his capital which was at once invested by the Assyrians, while with another portion of his army Tiglath-Pileser ravaged Syria and overran the kingdom of Samaria. Ammon, Moab, Edom and the queen of Sheba sent tribute, and Teima in northern Arabia was captured by the Assyrian troops. In 732 B.C. Damascus fell; Rezon was put to death, and an Assyrian satrap appointed in his stead. Tyre also was made tributary. The next year Tiglath-Pileser entered Babylonia, but it was not until 729 B.C. that the Chaldaean prince Ukin-zer (Chinzirus) was driven from Babylon and Tiglath-Pileser acknowledged as its legitimate ruler. In the early part of Tebet 727 B.C. he died, after having built two palaces, one at Nineveh, the other at Calah.

See P. Rost, *Die Keilschrifttexte Tiglat-Pilesers III.* (1893); also BABYLONIA AND ASSYRIA, § v. *History* ("Second Assyrian Empire"); and authorities quoted in § viii. *Chronology.*

TIGRANES, or DIKRAN, king of Armenia (*c.* 95–55 B.C.). Armenia had by the conquests of Alexander the Great become a province of the Macedonian Empire; but it was never thoroughly subjected to the foreign rule. A Persian family, that of Hydarnes, one of the associates of Darius Hystaspis, which possessed large domains in Armenia and had been invested with the satrapy for several generations, was dominant in the country, and assumed the royal title in defiance of the Seleucid. Antiochus III. the Great put an end to this dynasty about 211 and divided Armenia into two satrapies, which he gave to two generals of Persian origin, the district of Sophene in the west (on the Euphrates and the sources of the Tigris) to Zariadres, the eastern part, called Armenia Major (round the lake of Van) to Artaxias (see ARMENIA). After the battle of Magnesia (190) both made themselves independent; Artaxias conquered the valley of the Araxes, where he founded his new capital Artaxata (" town of Artaxias," said to be built by the advice of Hannibal, Strabo xi. 528; Plut. *Luc.* 31). He was defeated and taken prisoner by Antiochus IV. *Epiphanes* in 165 (Appian, *Syr.* 45, 66), but soon became independent again in the troubles which followed his death (cf. Diod. xxxi. 22, 27a); and his successors extended their power even farther against Media and the districts on the Kur. But from 140 the Parthians became the dominant power east of the Euphrates. King Artavasdes of Armenia was attacked by Mithradates II. the Great about 105 B.C. (Justin xlii. 2). He had to give his son Tigranes (b. 140 B.C. according to Lucian, *Macrob.* 15; by Appian, *Syr.* 48, he is called " son of Tigranes "; if that is correct, he probably was the nephew of Artavasdes) as hostage to the Parthians, and he obtained his freedom only by ceding seventy valleys bordering on Media (Strabo xi. 532; cf. xvi. 745; Justin xxxviii. 3). This sketch of the earlier history of Armenia is principally based upon the data given by Strabo xi. 528, 531 seq. The traditions preserved by the Armenian historians (who fancy that an Arsacid dynasty ruled over Armenia since the time of Alexander) have no historical value whatever.

Tigranes, who ascended the throne in 95 or 94 B.C. (Plut. *Luc.* 21), immediately began to enlarge his kingdom. He deposed Artanes, the last king of Sophene from the race of Zariadres (Strabo xi. 532), and entered into close alliance with Mithradates VI. Eupator of Pontus, whose daughter Cleopatra he married. In 93 he invaded Cappadocia in the interest of Mithradates, but was driven back by Sulla in 92 (Plut. *Sulla*, 5, Justin xxxviii. 3). During his first war with Rome, Mithradates was supported by Tigranes, although he abstained from interfering openly. But he meanwhile began war with the Parthians, whose empire was weakened after the death of Mithradates II. (about 88) by internal dissensions and invasions of the Scythians. Tigranes reconquered the valleys which he had ceded, and laid waste a great part of Media, down to Ecbatana (Isidor. Charac. 6), and the districts of Nineveh and Arbela; the kings of Atropatene, Gordyene (the country of the Carduchi, now Bohtan), Adiabene (the former Assyria) and Osroene (Edessa) became his vassals, who attended him like slaves wherever he went; northern Mesopotamia also was torn from the Parthian Empire (Strabo xi. 532, 747; Plut. *Luc.* 32). In 83 he invaded Syria, defeated the last successors of Seleucus and occupied Cilicia, of which the eastern parts still belonged to the Seleucids (Justin xl. 1; Appian, *Syr.* 48; Plut. *Luc.* 14, 21). In the war between Mithradates and Sulla he did not interfere, but after the death of Sulla (78) he occupied Cappadocia again and expelled King Ariobarzanes I., the vassal of the Romans (Appian, *Mithr.* 67; Strabo xii. 539). During the next years wars are mentioned in Syria, where the princess Cleopatra Selene attempted in vain to restore the Seleucid rule, but was besieged in Acco and afterwards killed (Joseph. *Ant.* xiii. 16, 4; Strabo xvi. 749), and in Cilicia, where he destroyed the Greek town of Soli (Plut. *Pomp.* 28; Dio Cass. xxxvi. 37). Tigranes now had become "king of kings" and the mightiest monarch of Asia. So he built a new royal city, Tigranocerta, on the borders of Armenia and Mesopotamia, between Mt Masius and the Tigris, where he accumulated all his wealth and to which he transplanted the inhabitants of twelve Greek towns of Cappadocia, Cilicia and Syria (Plut. *Luc.* 21, 26; Appian, *Mithr.* 67; Strabo xi. 522, 532, 539; Plin. vi. 26 seq.; for the situation, which is much disputed, cf. Tac. *Ann.* xiv. 24, xv. 5, ed. Furneaux). He also transplanted many Arabic tribes into Mesopotamia (Plut. *Luc.* 21; Plin. vi. 142). But the Romans could not tolerate encroachment upon their sphere of power, and in 69 Lucullus invaded Armenia. Tigranes was beaten at Tigranocerta on the 6th of October 69, and again near Artaxata in September 68. The recall of Lucullus gave some respite to the two kings, who even invaded Asia Minor again. But meanwhile a son of Tigranes and Cleopatra, called Tigranes, like his father, rebelled against him (as the old man had already killed two of his sons, he had reason enough to be afraid for his life) and found refuge with the Parthian king Phraates III., whose daughter he married and who sent him back with an army (Appian, *Mithr.* 104; Plut. *Pomp.* 33; Dio Cass. xxxvi. 51). The old king now gave up all hope of resistance; he put a price on the head of Mithradates, and when Pompey advanced into Armenia and united with the younger Tigranes, he surrendered himself to the Roman general (66 B.C.). Pompey now changed his policy; he received the old Tigranes graciously and gave him back his diadem, while he treated the son very coolly and soon made him prisoner. The younger Tigranes was led in triumph into Rome, where he found his death when he tried to escape from his confinement by the intrigues of P. Clodius in 58 (Dio Cass. 38, 30). The father after his defeat ruled about ten years longer over Armenia, as vassal of the Romans. He died about 56, and was succeeded by his son Artavasdes. (See also MITHRADATES.) (ED. M.)

TIGRÉ, a northern province of Abyssinia; one of the three principal divisions of the country, the others being Amhara or Gondar in the centre and Shoa in the south. The *ras* (or prince) of Tigré has been often a more powerful potentate than the nominal emperor. Tigré contains the town of Axum (*q.v.*), capital of the ancient Ethiopic Empire. Adua (Adowa, *q.v.*) is the capital of the province. (See ABYSSINIA.)

Tigrina, the dialect spoken in Tigré and Lasta, is nearer the ancient Geez than is Amharic, the official and more widely diffused language of Abyssinia. See J. Schreiber, *Manuel de la langue tigrai* (Vienna, 1887–1893); and L. de Vito, *Grammatica della lingua tigrigna* (Rome, 1895).

TIGRIS (Old Persian *Tigrā*, *Diklat* of the cuneiform inscriptions, *Hiddekel* of the Old Testament, *Diglath* of the Targum, *Digla* of the Arabs), a great river of western Asia, rising from two principal sources. The more western of these is about 10 m. S. of Lake Geuljik (Colchis of the ancients), at an altitude of 5050 ft., some 2 or 3 m. only from the channel of the Euphrates, which here forms a peninsula by a great bend (38° 10′ N., approximately 39° 20′ E.). The eastern source, which joins the main stream at Til (37° 45′ N., 41° 46′ E.), is itself divided into two branches, or rather it may be said to consist of a network of small streams, the most northerly of which has its origin in about 38° 40′ N. to the west of Lake Van, and close to the headwaters of the Murad Su, the eastern branch of the Euphrates, while the most easterly point is situated in a region about 42° 50′ E., southward of the same lake. The two sources together drain the region south as the Euphrates drains the region north of the Taurus mountains. After the junction of the two branches the river pursues a winding course, generally south-east, for about 800 m. to the point of union with the Euphrates at Garmat Ali, whence it is known as the Shatt-el-Arab until it empties into the Persian Gulf some 70 m. lower down. For some five or six centuries before 1908–1909 the junction with the Euphrates was at Korna, some 30 m. above Garmat Ali. On the western side there are no tributaries at the present day. As late as A.D. 1200, however, the Arabian geographers mention a tributary, the Tharthar, navigable in flood time, which flowed from the Jaghigagh branch of the Khabur, a tributary of the Euphrates, to the Tigris. Ormsby, in 1832, also reported a river, the Asās Amir, as coming down from the Sinjar hills and joining the Tigris near Kal-'at Shergat, about 35° 30′ N.; but this seems now to be a dry bed. On the eastern side of the river, on the other hand, there are several important tributaries descending from the Persian mountains: the Khabur, a little north of 37° N., navigable for rafts; the Great Zab, at 36° N., just below Nimrud, the ancient Calah; the Little Zab, about 35° 15′ N.; the 'Adhem at 34° N. and the very large and important Diyala, a little below Bagdad, at 33° 15′ N.

The course of the Tigris is much shorter than that of the Euphrates, about 1150 m. as compared with 1800 m., but its volume of water is greater, at least in its lower course. At Bagdad it has an average breadth of about 200 yards and a current in flood time of about 4½ m. per hour. It is navigable for steamers to a point a little above the mouth of the Great Zab, about 30 m. south of Mosul, at which point navigation is blocked by two ancient dams, erected, apparently, to control the river for the Assyrian city of Calah, the ruins of which are called Nimrud by the natives after these dams, which they conceive to be the work of that mythical hero. Were it not for these dams steamers might reach Mosul itself, at an elevation of 353 ft. above the Persian Gulf. Two lines of steamers, an English and a Turkish, furnish an inadequate service between Basra and Bagdad, but there is no steam navigation on the river above the latter city. Small sailing craft navigate upwards as far as Samārra; above this all navigation is downward, and by raft. For rafts the river is navigable from Diarbekr and is termed by the natives "the cheap cameleer." The rafts used are the so-called *kelleks*, of wood supported on inflated skins, which are broken up at Bagdad, the wood sold and the skins carried back by caravan.

Near the source of the Tigris, at Arghana-Ma'den, are copper mines. In the neighbourhood of Diarbekr is iron. Below Mosul, for some distance, occur sulphurous and bituminous springs. There are also in that neighbourhood famous marble quarries. This part of the river's course, the ancient Assyria, is also a rich agricultural region.

From a little above the confluence of the Great Zab downward, the banks of the river are absolutely uninhabited, and the river flows through a desert until Tekrit is reached. Beginning shortly below Tekrit there are indications of considerable canalization, both for the purpose of irrigating country remote from the river, and also of shortening the course of the river for navigation. In ancient times the country on both sides of the river was well irrigated below this point, the waters of the Tigris were under thorough control, and it and its lower tributaries, the 'Adhem and the Diyala, were made, by means of huge canals, to furnish great water-ways for the country between it and the Persian hills eastward. Of these canals the best known, and probably the greatest, was the Nahrawan, which, leaving the Tigris, on its eastern side, above Samārra, over 100 m. north of Bagdad, rejoined it below Kut-el-Amara, an equal distance to the south. None of these canals is serviceable at the present time, and few carry water in any part of their course, even in flood time.

A little south of Samārra the stony plateau of Mesopotamia ends, and the alluvial plain of Irak, ancient Babylonia, begins. Here the palm groves begin also, and from this point to a little beyond Bagdad the shores of the river are well cultivated. At the point of entering the alluvial plain the bed of the Tigris seems to be lower than that of the Euphrates, so that the canals run from the latter to the former stream. At Bagdad the Tigris and Euphrates are less than 35 m. apart, then they recede again, the Tigris bending eastward, until, below the Shatt-el-Haī, they are separated by almost 100 m. From Bagdad downward, the course of the Tigris is peculiarly serpentine and shifting. The mud brought down by it, calculated at 7150 lb an hour at Bagdad, is not deposited in marshes to form alluvium, as in the case of the Euphrates, but although in flood time the river becomes at places an inland sea, rendering navigation extremely difficult and uncertain, the bulk of the mud is deposited in banks, shoals and islands in the bed of the river, and is finally carried out into the Persian Gulf. At Kut-el-Amara, approximately half way from Bagdad to Korna, the bed of the Tigris is higher than that of the Euphrates, and accordingly from this point downward, its waters flow into the Euphrates and not vice versa.

Shortly below Kut-el-Amara all traces of ancient canalization on the east side vanish, and it would appear as though much of that region, now largely under water at flood time, constituted an inland sea. On the west side, however, there are the remains of several canals or channels, some still carrying water, one of which, the Shatt-el-Haī, leaving the Tigris at Kut-el-Amara, and emptying into the Euphrates at Nasrieh, is still navigable. Indeed, in the time of the caliphate this was the channel of the Tigris, and on its banks stood the important city of Wasit. At a much more remote period also the great city of Lagash stood by or on its banks. In the time of the Sassanian kings, however, as at the present time, the Tigris occupied a more easterly course. Indeed, the lower course of the Tigris, even more than that of the Euphrates, has always been subject to change. Below the Shatt-el-Haī the country on both sides of the river is practically a swamp, except where the palm groves have formed land.

The Tigris begins to rise about the middle of November and is highest in May and June, and lowest in September and October. The principal towns on its banks are Diarbekr (anc. *Amida*), on the western branch; Bitlis, on the eastern branch; Mosul; Tekrit, a town dating from Persian days, said to have been founded by Shapur I. son of Ardashir I., formerly important, but now relatively insignificant; Samārra, also called Samira, the capital of the caliphate from A.D. 836 to 892, a place of pilgrimage of the Shia Moslems, containing magnificent tombs of two of their *Imams* the tenth and eleventh, with another much venerated shrine of the twelfth, as well as some interesting ruins; and Bagdad. While the Tigris never played the same rôle historically as the Euphrates, numerous remains of antiquity are to be seen along its course. Cuneiform inscriptions and bas-reliefs have been found at the sources of both the western and eastern Tigris, as well as at various points on the cliffs along the upper course of both branches. Opposite Mosul are the ruins of ancient Nineveh, the last capital of Assyria, and 20 m. below that the ruins of Calah, the second capital; while 35 m. farther south, on the opposite bank, lies Kal'at-Shergat, the ancient Assur, the original name-place and capital of the Assyrian Empire. A little south of Samārra are found remains of the Median Wall, which stretched south-west towards the Euphrates near Sahlawych, marking the edge of the Babylonian alluvial plain. In this neighbourhood also stood the ancient Opis. At Bagdad, besides the memorials of the caliphate, may be seen a few remains of the old Babylonian city of Bagdadu, and a dozen miles southward, on the east bank of the river, stands Takhti-Khesra, the royal palace at Ctesiphon, the most conspicuous and picturesque ruin in all Babylonia, opposite which, on the other side of the river, are the low ruin mounds of ancient Seleucia.

See W. F. Ainsworth, *Researches in Assyria* (1838); R. F. Chesney, *Expedition to the Euphrates and Tigris* (1850); W. F. Ainsworth, *The Euphrates Expedition* (1888); Guy Le Strange, "Description of Mesopotamia and Bagdad" (*Journal of the Royal Asiatic Society*, 1895); E. Sachau, *Am Euphrat und Tigris* (1900. (J. P. Pe.)

TILBURG, a town in the province of north Brabant, Holland, and a junction station 13½ m. by rail E. by S. of Breda. A steam tramway connects it northwards with Waalwijk. Pop. (1905), 46,517. Tilburg has risen into importance since the separation of Belgium from Holland as one of the chief industrial centres of the south. It has Roman Catholic and Protestant churches, a synagogue, a cloth hall, a higher-burgher school, an art and music school, and a Roman Catholic seminary. The woollen manufacture is the chief industry, besides which there are leather, soap, oil and tobacco factories, as well as breweries, tanneries and iron foundries.

TILBURY DOCKS, on the north shore of the Thames, in the county of Essex, England. They lie opposite Gravesend 25 m. below London Bridge and about the same distance from the Nore, being thus within the port of London. They were constructed in 1886 by the East & West India Docks Company, and were later owned by the London & India Docks Company. The docks are four in number, having, with tidal basin and entrance locks, a total area of 74 acres. The depth of water in the tidal basin is 25 ft. at low tide and 44 ft. at high tide. The length of quayage is about 2½ m., and there is extensive warehousing as well as accommodation for passengers, as the largest passenger steamers trading with the Port of London lie here. Railway communication is provided by the London, Tilbury & Southend line, and there is direct connexion for goods traffic with all the northern lines.

TILDEN, SAMUEL JONES (1814–1886), American statesman, was born at New Lebanon, New York, on the 9th of February 1814. In 1834 he entered Yale University, but soon withdrew on account of ill health, and later studied in the University of the City of New York. He was admitted to the bar in 1841, and rose rapidly to the front rank. In the financial troubles between 1850 and 1860 it is said that more than half the railways north of the Ohio river and between the Hudson and the Missouri rivers were at some time his clients. In spite of his activity at the bar, Tilden maintained an interest in politics, serving in the State Assembly in 1846 and in the state constitutional conventions of 1846 and 1867. In 1848, largely on account of his personal attachment to Martin Van Buren, he participated in the revolt of the "Barnburner" or free-soil faction of the New York Democrats, and in 1855 was the candidate of the "softshell," or anti-slavery, faction for attorney-general of the state. During the Civil War, although he opposed several of the war measures of President Lincoln's administration, he gave the Union cause his heartiest support. In 1866 Tilden became chairman of the Democratic state committee, and soon came into conflict with the notorious "Tweed ring" of New York City. As the "ring" could be destroyed only by removing the corrupt judges who were its tools, Tilden, after entering the Assembly in 1872 to promote the cause of reform, took a leading part in their impeachment. By analysing the bank accounts of certain members of the "ring," he obtained legal proof of the principle on which the spoils had been divided. His fame as a reformer brought him to the governor's chair in 1874, and he at once gave his attention to a second set of plunderers—the "canal ring," made up of members of both parties who had been systematically robbing the state through the maladministration of its canals—and succeeded in breaking them up. In 1876 the Democrats nominated him for the presidency, the Republicans nominating Rutherford B. Hayes of Ohio. The result was the disputed election of 1876, when two sets of returns were sent to Washington from the states of Florida, Louisiana, South Carolina and Oregon. As the Federal Constitution contained no provision for settling a dispute of this kind the two houses of Congress agreed to the appointment of an extra-constitutional body, the "Electoral Commission" (*q.v.*) which decided all the contests in favour of the Republican candidates. Tilden counselled his followers to abide quietly by the result. In 1878 the New York *Tribune* (Republican) published a series of telegraphic despatches in cipher, accompanied by translations, by which it attempted to prove that during the crisis following the election Tilden had been negotiating for the purchase of the electoral votes of South Carolina and Florida. Tilden denied emphatically all knowledge of such despatches, and appeared voluntarily before a Congressional sub-committee in New York City to clear himself of the charge. The attempts to implicate him in corrupt transactions were not successful; but his political opponents endeavoured to make capital in subsequent campaigns, out of the "Cipher Dispatches." The remainder of his life was spent in retirement at his country home, Greystone, near Yonkers, New York, where he died on the 4th of August 1886. Of his fortune (estimated at $5,000,000) approximately $4,000,000 was bequeathed for the establishment and maintenance of "a free public library and reading-room in the City of New York"; but, as the will was successfully contested by relatives, only about $2,000,000 of the bequest was applied to its original purpose; in 1895 the Tilden Trust was combined with the Astor and Lenox libraries to form the New York Public Library.

See the *Writings and Speeches of Samuel J. Tilden* (2 vols., New York, 1885) and *Letters and Literary Memorials of Samuel J. Tilden* (2 vols., New York, 1908), both edited by John Bigelow; also Bigelow's *Life of Samuel J. Tilden* (2 vols., New York, 1895); and P. L. Haworth's *The Hayes-Tilden Disputed Presidential Election of 1876* (Cleveland, 1906).

TILE (O. Eng. *tigel*, Fr. *tuile*, connected with Lat. *tegula*), the name given to flat slabs of baked clay or other material used for a great variety of architectural purposes, such as covering roofs, floors and walls.

1. *Roofing Tiles.*[1]—In the most important temples of ancient Greece the roof was covered with tiles of white marble, fitted together in the most perfect way so as to exclude the rain. In most cases as in the Athenian Parthenon and the existing temple of Aegina the tiles were large slabs of marble, with a flange along each side over which joint tiles (ἁρμοί) were accurately fitted (see A. in fig. 1). In the temple of Apollo at Bassae, though the main building was of limestone, the roof was covered with very beautiful tiles of Parian marble, which are specially mentioned by Pausanias as being one of the chief beauties of the temple. Some of these were found by Mr Cockerell during his excavations at Bassae early in the 19th century.[2] In design they resemble the other examples mentioned above, but are peculiar in having a joint piece worked out of the same slab of marble as the adjacent tiles (see B in fig. 1) at great additional cost of material and labour, in order to secure a more perfect fit. Fig. 2 shows the way in which they were set on the roof. Great splendour of effect must have been gained by continuing the gleaming white of the columns and walls on to the roof. All along the eaves each end of a row of joint tiles was usually covered by an antefixa, an oval topped piece of marble with honeysuckle or some other conventional pattern carved in relief.[3] In most cases the Greeks used terra-cotta roofing tiles, shaped like the marble ones of fig. 1, A. Others were without a flange, being formed by a concave upper surface to prevent the rain getting underneath the joint tiles. The lower edge of the tile, whether of marble or of clay, was usually half-lapped and fitted into a corresponding rebate in the upper edge of the next tile (see D in fig. 1). The ἁρμοί also were half-lapped at the joints (see E in fig. 1). All these were usually fastened with bronze nails to the rafters of the roof. In some cases each joint-tile had a projecting peg to fix it to the next ἁρμός, as shown at F. In the temples of Imperial Rome marble roofing tiles were used like those shown at fig. 1. These were copied from Greek work along with other salient architectural features. For domestic and other less important work clay tiles (*tegulae*) were employed, of the form shown in A, fig. 3. These are narrower at the lower edge, so as to fit into the upper

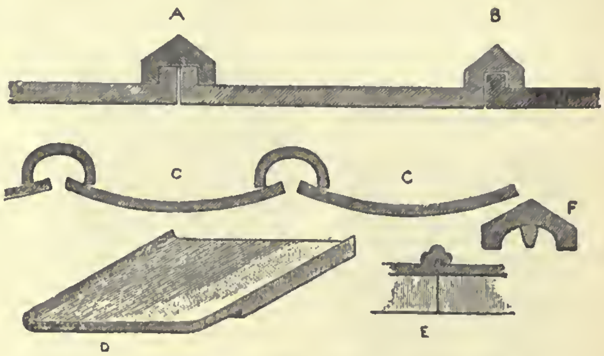

FIG. 1.—Examples of roofing tiles from Greek Temples.

A, B, Marble tiles from Aegina and Bassae, showing two methods of working the joint tiles.
C, C, Clay tiles from Olympia.
D, Sketch showing method of jointing at the lower edge.
E, Longitudinal section of a clay joint-tile (ἁρμός).
F, Joint-tile with peg to fix it.

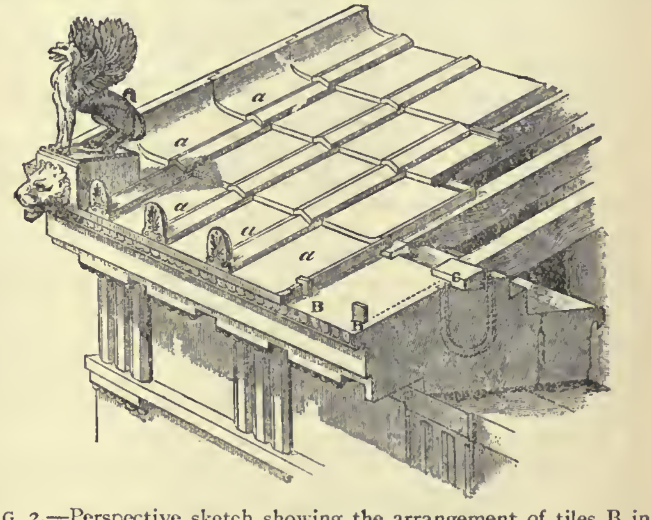

FIG. 2.—Perspective sketch showing the arrangement of tiles B in fig. 1, at Bassae.

B, B, Dowels to fix the joint-tiles. C, Tilting piece. *a*, *a*, Flat surface of tiles.

[1] In Egypt and Assyria temples and palaces were mostly roofed with stone, while inferior buildings had flat roofs covered with beaten clay (see also TERRA COTTA).

[2] See Cockerell, *Temples of Aegina and Bassae* (London, 1860).

[3] Marble tiles are said to have been first made by Byzes of Naxos about 620 B.C.; see Pausanias v. 10, 2.

edge of the next tile and the joints were covered with a semicircular joint tile (imbrex). Rows of terra-cotta antefixae were set along the eaves of the roof, and were often moulded with very beautiful reliefs. In localities which supply laminated stone, such as Gloucestershire and Hampshire in Britain, the Romans often roofed their buildings with stone tiles fastened

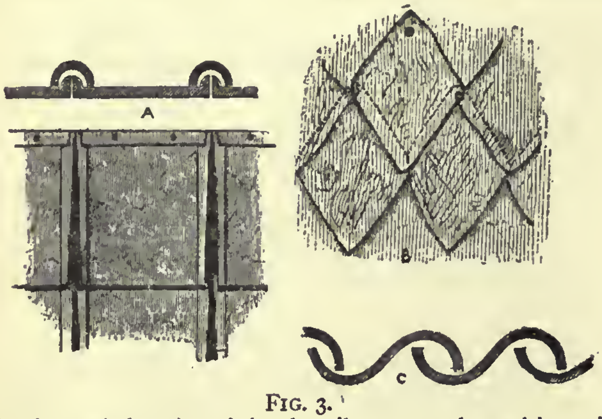

FIG. 3.
A, Section and elevation of the clay tiles commonly used in ancient Rome.
B, Roman stone tiles, each fixed with one iron nail at the top angle.
C, Pan-tiles used in medieval and modern times.

with iron nails. Fig. 3, B, shows an example from a Roman villa at Fifehead Neville, in Dorset, England. Each slab had a lap of about 2″ over the row of tiles below it; many large iron nails were found with these stone tiles.

In a few cases, in the most magnificent temples of ancient Rome, as in those of Capitoline Jupiter and of Venus and Rome, and also the small circular temple of Vesta[1] tiles of thickly gilded bronze were used, which must have had a most magnificent effect. Those of the last named building are specially mentioned by Pliny (*H.N.* xxxiv. 7) as having been made of Syracusan bronze[2]—an alloy in great repute among the Romans. The bronze tiles from the temples of Jupiter Capitolinus and of Venus and Rome were taken by Pope Honorius I. (625–638) to cover the basilica of St Peter, whence they were stolen by the Saracens during their invasion of the Leonine city in 846.[3]

In medieval times lead or copper[4] in large sheets was used for the chief churches and palaces of Europe; but in more ordinary work clay tiles of very simple form were employed. One variety, still very common in Italy, is shown in C, fig. 3. In this form of so-called "pan-tile" each tile has a double curve, forming a *tegula* and *imbrex* both in one. Stone tiles were also very common throughout the middle ages. Another kind of roofing tile, largely used in pre-Norman times, and for some centuries later for certain purposes, was made of thin pieces of split wood, generally oak; these are called "shingles." They stand the weather fairly well, and many old examples still exist, especially on the wooden towers and spires of East Anglia.

At the present day, when slate is not used, tiles of burnt clay are the ordinary roofing material, and many complicated forms have been invented to exclude rain. Most of these are, however, costly and do not answer better than the rectangular tile about 9 by 6 in., fastened with two copper or even stout zinc nails, and well bedded on mortar mixed with hair. For additional security clay tiles are usually made with two small projections at the upper edge, which hook on to the battens to which they are nailed. The district round Broseley (Shropshire) is one of the chief centres in England for the manufacture of roofing tiles of the better sort. The common kinds are made wherever good brick-clay exists. In some places pan-tiles are still used and have a very picturesque effect; but they are liable to let in the rain, as they cannot be securely nailed or well bedded in mortar. In Gloucestershire, Yorkshire, north-east Lancashire and other counties of England, stone tiles are still employed, but are rapidly going out of use, as they require very strong roof timbers to support them, and the great extension of railways has made the common purple slates cheap in nearly every district. The green slates of the Lake District are now extensively used for this purpose, often with excellent effect.

Some of the mosques and palaces of Persia are roofed with the most magnificent, enamelled, lustred tiles, decorated with elaborate painting, so that they shine like gold in the sun. They were specially used from the 13th century to the 15th. In style and manufacture the finest of them resemble the frieze shown in fig. 5.

2. *Wall Tiles.*—These are partly described under MURAL DECORATION (*q.v.*).[5] In most oriental countries tiles were used in the most magnificent way throughout the middle ages especially in Constantinople, Broussa, Damascus, Cairo, Moorish Spain, and in the chief towns of Persia. Fig. 4 shows a fine example from a mosque in Damascus. From the 12th to the 16th century a special kind of lustred tiles was largely employed for dadoes, friezes and other wall surfaces, being frequently made in large slabs, modelled boldly in relief with sentences from sacred books or the names and dates of reigning caliphs. The whole was picked out in colour, usually dark or turquoise blue, on a ground of cream-white enamel, and in the last firing minute ornaments in copper lustre were added over the whole design, giving the utmost splendour of effect (see fig. 5). Great skill and taste are shown by the way in which the delicate painted enrichments are made to contrast with the bold decoration in relief. These lustred tiles sometimes line the prayer-niche in houses and mosques; in such cases the slabs usually have a conventional representation of the kaaba at Mecca, with a lamp hanging in front of it and a border of sentences from the Koran.[6] The mosques of Persia are specially rich in this method of decoration,

FIG. 4.—Wall Tiles from Damascus, of the 16th century.

FIG. 5.—Persian Lustred Tiles of the 13th century, forming part of a frieze.

[1] The dome of the Pantheon was covered with tiles or plates of bronze thickly gilt, as were also the roofs of the forum of Trajan.

[2] Bronze tiles for small buildings such as this were usually of a pointed oval form, something like the feathers of a bird. This kind of tiling is called *pavonaceum* by Pliny, *H.N.*, xxxvi. 22.

[3] Part of the bronze tiles had been stripped from the temple of Jupiter by the Vandals in 455; see Procopius, *Bell. Van.* i. 5.

[4] The gilt domes of Moscow are examples of this use of copper. See also the domed churches at Rotterdam, Amsterdam, Hamburg and Lübeck.

[5] For the enamelled wall tiles of ancient Egypt, see CERAMICS.

[6] The Victoria and Albert Museum, London, contains many fine examples of the early as well as of the later sorts, like those shown in fig. 4.

magnificent examples existing at Natenz, Seljuk, Tabriz, Isfahan and other places.[1] Indian tile-work is specially described in the article KASHI.

Stamped Spanish tile decoration in its earliest form was an imitation of mosaic, pieces of enamelled tile of various colours being arranged in geometrical patterns, or combined with glass or stone for the purpose. In the 14th and 15th centuries this process was supplanted by one in which the variously shaped and coloured sections of tile were separated by means of narrow bands of the same material, enamelled in white and disposed in various combinations of geometrical interlacing. Of this kind are the bulk of the Alhambra tiles. But the tediousness of the process gave rise, about 1450, to what is known as the *cuerda seca* (or "dry cord") method, in which narrow fillets at the edges of the separating interlacings were first stamped upon the tile itself and filled with clay and manganese; these being fired (thus forming a "dry cord" or line) formed shallow compartments which were in turn filled with coloured enamel, white being used for the interlacings themselves. The process was much in vogue in Andalusia and Castile until about 1550, when there arose the method *de cuenca* in which the parts of the design to receive different coloured enamels were stamped, slightly concave (*cuenca*—a bowl or socket), their edges alone being left in relief. This process lasted until about the commencement of the 18th century.

At Manises, Paterna and elsewhere in Valencia, soon after the middle of the 14th century there commenced an extensive production of white enamelled tiles painted with designs in blue (more rarely in lustre and manganese) for wall and pavement decoration. This manufacture continued throughout the 15th century and produced some of the finest freehand tile designs that are known to-day. The motives included figure compositions, animals, plants, coats of arms, &c., drawn with great skill and facility. Most of these tiles are to be found in old houses in the city and province of Valencia.

In Catalonia, in the 16th century, blue and white painted tiles were produced in imitation of those of Valencia. For the most highly finished of these stencils were employed to block out the designs.

Polychrome painting upon tiles in the Italian manner was introduced into Spain by Niculose Francisco of Pisa, who settled at Seville (1503–1508) and executed altar-pieces and architectural details in tile work. This imported Italian style was much affected for armorial decoration.

In the 16th and 17th centuries tiles of a coarse kind of majolica were used for wall decoration in southern Spain; some rich examples still exist in Seville. These were the work of Italian potters who had settled in Spain.

LITERATURE.—A. Van de Put, *Hispano-Moresque Ware of the XVth Century* (1904); G. J. de Osma, *Apuntes sobre ceramica morisca: textos y documentos valencianos, No. 1* (1906), and "Los Letreros ornamentales en la ceramica morisca del siglo XV." (in the review *Cultura española*, no. ii., 1906); J. Font y Guma, *Rajolas valencianas y catalanas* (1905); J. Gestoso y Perez, *Historia de los barros vidriados sevillanos* (1904).

3. *Floor Tiles.*—After the development of painted and lustred tiles in Spain and Italy for the decoration of wall surfaces, they were also introduced, during the latter part of the 15th and the first part of the 16th centuries, as pavements, especially in the chapels of the famous cathedrals of those countries. Comparatively few examples of these pavements now exist, as the majolica enamel was too soft to stand the wear of the feet of worshippers. The earliest known pavement of this type is that in the church of San Giovannia Carbonara in Naples, which is dated, approximately, 1440. The tiles, square and hexagonal in shape, are coated with white enamel and are painted chiefly in dark blue, with touches of green and purple. The British Museum, the Louvre and other museums have secured odd examples of these tiles. It seems probable from the technical methods of the work that it was produced by a Spanish or even a Moorish hand. It is well known that Moorish tile-makers did travel both into Italy and into France to embellish the palaces of great nobles or the chapels they founded. There is the well-known instance of the Moorish potter, Jean de Valence, who, in 1384, was brought to France by Jean de Berry to make tiles for the adornment of his ducal palace at Poitiers. One of the most important of these early majolica pavements is that made for the Convent of San Paulo at Parma, now in the museum of that town, which was probably laid down in 1482. One of the south chapels in the church of S. Maria del Popolo in Rome has a very fine pavement of painted tiles, executed probably at Forli, about 1480, for Cardinal della Rovere (Julius II.), whose arms—an oak tree—are repeated over and over again among the rich decorations. A still more magnificent tile floor, in the uppermost of Raphael's Vatican *loggie*, is mentioned in the article DELLA ROBBIA, where also are described the exquisite, enamelled tiles which Luca della Robbia made as a border for the tomb of Bishop Federighi at Fiesole near Florence. Fine examples of tile pavements of 1486 exist in the basilica of S. Petronio at Bologna. The chapel of St Catherine at Siena and the church of S. Sebastiano at Venice have majolica pavements of about 1510. Fig. 6 shows an example of about this date from

(Victoria and Albert Museum.)
FIG. 6.—Majolica Paving Tiles from Siena, made in 1509.

the Petrucci Palace in Siena, now in the Victoria and Albert Museum. In the early part of the 16th century majolica tiles from Spain were occasionally imported into England. At the south-east of the mayor's chapel at Bristol there exists, though much worn, a fine pavement of Spanish tiles dating from about 1520. Others have been found in London, at Newington Butts, and in other places.

Long before the southern nations of Europe were introducing their painted majolica tile pavements, a much more practical type of flooring tile was in use in Germany, France and England; of these the English encaustic tile pavements, dating from the early years of the 13th century to the end of the 16th century, are particularly important and beautiful. These Northern peoples had no knowledge of enamels and colours such as was possessed by the contemporary tile-makers of Moorish Spain or of Italy, and they were confined to the native red-brick earths and white pipeclays for their materials. The method of decoration was as simple and homely as the materials. Slabs of ordinary red-brick clay freed from pebbles, but not from grit or sand, were shaped by pressing cakes of clay into a mould of wood or baked clay, carved in such fashion that when the clay was just hard and dry enough to be removed from the mould the important elements of the design were formed as sunk cells divided by broad raised outlines. While this red tile was still soft and plastic, a thickish paste of pipeclay or other light burning clay was poured into the cells and allowed to stiffen.

[1] See Coste, *Monuments de la Perse* (Paris, 1867).

When the whole had dried sufficiently the surface was scraped level, with a thin sharp tool, with the result that the tile appeared with a kind of cloisonné design, the cloisons or boundaries of the cells being, of course, the upstanding ridges of the moulded red tile.[1] Over the surface of the tile finely powdered galena (native sulphide of lead) was freely dusted, and the whole was fired at one operation with the resulting production of a tile or tiles bearing a yellowish white pattern relieved against red or chocolate, and glazed with a natural lead glaze, which was much harder and better adapted to resist wear than the majolica glazes of Spain or Italy. The origin of this type of pavement tile is still obscure; one idea is that they were a development of the Roman Mosaic pavement, for, in examples discovered at Fountains Abbey and at Prior Crauden's Chapel, Ely, in which the tiles were of great variety of form and size, and, instead of the patterns being wholly inlaid in the tiles themselves, the design is, to a large extent, produced by the outlines of the individual pieces, which, in the later examples, are cut to the forms required to be represented, including the subject of the "Temptation of Adam and Eve," trees, lions, &c., the tesserae being also enriched with what may be more strictly called encaustic decoration. The more probable origin of this method of work seems, however, to be a development of the pavement tiles with simple incised designs which were made in the northern parts of Burgundy, in the Rhine Valley and in Flanders. Most interesting examples of these incised tiles are to be found in the cathedral of St Omer, which are known to be of the 12th century, and it seems impossible to resist the conclusion that such incised work forms the starting-point of the English encaustic tile-makers. A similar piece of work exists in Canterbury Cathedral, where we have stone tiles engraved with pictorial designs, the sunk parts being filled with a dark cement—this pavement also belongs to the 12th century.

Four styles of decoration are found on medieval Gothic tiles (1) incised or impressed, (2) raised, (3) inlaid, (4) slip-painted. It is to the third of these groups—the inlaid—that the name of "encaustic" tiles had been particularly given. The manufacture of medieval Gothic tiles was apparently the secret of certain religious houses in England, belonging either to the Benedictine or the Cistercian Orders. The earliest date at which we have tangible proof of the existence of this art is 1237, in which year it was ordered that the king's little chapel at Westminster should be paved with "painted tile": "mandatum est etc., quod Parvum capellam apud Westm. tegula picta decenter paveari faciatis," Rot. Claus. 22, Henry III. M. 19, A.D. 1237-38. In 1840 the removal of a wooden floor in the chapter-house at Westminster, exposed to view a tile pavement in good preservation which, though it can hardly be the pavement in question, is evidently of contemporary manufacture.

The finest and most artistic of these early English tiles were those found in Chertsey Abbey in Surrey. They were found in a very fragmentary condition on the Abbey site, but have been to a great extent pieced together by Mr Shurlock. Practically all the tiles that have been recovered are now in the British Museum (a number of them were formerly in the architectural museum at Westminster). They present a remarkable series of illustrations from the English romance of Sir Tristram and of events in the history of Richard Cœur-de-Lion (see Hobson's *Catalogue of English Pottery in the British Museum*, pl. ii.). Mention should also be made of the tile pavement discovered at the abbey of Halesowen in south Staffordshire. Many of these tiles are of very similar design to those of Chertsey, while some appear to have been made from the same moulds. From the evidence of inscriptions it would appear that this pavement was laid down in the latter part of the 13th century.

Combinations of tiles forming a cross were frequently used as mortuary slabs; an example is in Worcester Cathedral *in situ*, whilst detached component tiles of similar slabs are to be found in other ancient churches.

[1] It is interesting to note the similarity of technique between the English encaustic tiles, and the later methods of Hispano-Moorish work. The English filled their cells in the surface of the tiles with another clay, the Spanish-Moorish potters with coloured glaze.

Encaustic tiles are almost exclusively used for pavements, but an interesting instance of their employment for wall decoration occurs in the Abbey Church of Great Malvern, where these tiles have probably been originally used to form a reredos, and bear designs representing Gothic architecture in perspective, have introduced into them the sacred monogram "I.H.S.," the crowned monogram of "Maria," the symbols of the Passion, the Royal Arms and other devices. This example is also interesting as bearing the date of its manufacture on the margin "Anno R.R. H.VI. XXXVJ.," that is the thirty-sixth year of the reign of Henry VI. (1457–1458).

Kilns for tile-burning have been found at Bawsey, near Lynn, Norfolk; Malvern, containing some 15th-century tiles; Repton; Farringdon Street, London; and Great Saredon, in Staffordshire, with tiles of the 16th century.

LITERATURE.—John Gough Nicholls, *Examples of Encaustic Tiles* (1845); Henry Shaw, *Specimens of Tile Pavements* (1858); T. Oldham, *Ancient Irish Pavement Tiles*; Frank Renaud, "The Uses and Teachings of Ancient Encaustic Tiles" (*Trans. Lancashire and Cheshire Antiquarian Society*, vol. ix.); W. W. Pocock's article in *The Surrey Archaeological Collections* (1885); J. R. Holiday on "Halesowen," in *Transactions of the Birmingham and Midland Institute* (1871); Manwaring Shurlock, *Tiles from Chertsey Abbey* (1885); Major Heales, F.S.A., *The Chertsey Tiles* (1880); W. Burgess, in *The Builder* (July 24, 1858).

With the downfall of the monasteries in the reign of Henry VIII. the making of encaustic tiles in England appears to have come to an end, and for nearly two centuries foreign tiles were imported from Germany, the Netherlands, Italy and Spain, or workmen from those countries must have practised their art here. There are in evidence the well-known green glazed tiles in the British Museum which, if made in England at all, are obviously inspired by contemporary German work, and the tiles used in the house of Sir Nicholas Bacon (*c.* 1509–1579) are obviously the work of an Italian majolist, whether they were made in Italy or in England. Increasing intercourse with the Netherlands brought into this country and, during the 17th century into the American colonies, the famous Delft tiles, painted either in blue, or in blue and manganese purple, on a tin enamel ground like that of the contemporary Delft pottery. From the 16th century onwards every country in Europe continued to makes tiles by methods strictly analogous with their contemporary pottery (see CERAMICS). Thus we have in Italy and Spain, throughout the 17th and 18th centuries, wall tiles in the style of the debased Italian majolica; in Germany a continuation of the ancient German stove tiles, either glazed with green, brown or black glaze, or bearing painted designs in the crude colours characteristic of the contemporary German pottery; in France there were, first, the painted tile pavements of Masseot Abaquesne of Rouen (1542–1557), and later the decorative tiles produced at Rouen, Nevers, Marseilles and elsewhere, always in the style of the current pottery of the same centres; and painted tiles for the decoration of fireplaces and for use as wall panels formed a considerable part of the output of the Dutch factories. Wherever imitations of Delftware were made, in England, Germany or the north of France, the manufacture of similar tiles naturally followed; and at Lambeth, Liverpool and Bristol, the chief centres of this industry in England, large quantities of tiles were made, especially during the 18th century. The tiles produced at Lambeth and Bristol factories were invariably painted after the manner of their Dutch prototypes, but during the latter half of the 18th century Liverpool became famous for its printed tiles, in which designs, mostly in black, transferred from engraved copper plates, took the place of hand-painting. Fine examples of all these 18th-century English tiles are to be found in the British Museum; the Guildhall Museum; the Victoria and Albert Museum, London; and in the museums at Liverpool and Bristol.

During the 17th and 18th centuries the old painted and decorated pavement tiles seemed to have been entirely replaced by the common buff or red terra-cotta "quarries" so largely used in farmhouse kitchens, dairies, &c., and it is to the painted tiles for walls and fireplaces that we have to look for the progress of the art.

The modern revival of tile-making in Europe dates from about 1830, when Samuel Wright, a potter of Shelton, near Stoke-upon-Trent, was granted a patent for the manufacture of tiles by mechanical means. His patent was extended for fourteen years, and in 1844 was purchased, in equal shares, by Herbert Minton—head of the famous firm of Mintons, of Stoke-upon-Trent—and Fleming St John, of Worcester. In 1848 the firm of Mintons acquired the sole right of the patent, and

FIG. 7.—A Panel of De Morgan's.

for many years Mintons were the most famous tile manufacturers in the world. In 1850 the firm of Maw & Co. purchased the remaining stock of encaustic tiles made at Worcester, and, on the expiration of Wright's patent, commenced to manufacture at the old works at Worcester, removing in 1851 to Benthall, Shropshire, and afterwards, about 1887, to their present works at Jackfield in the same district.

From the methods thus invented in England all the modern processes of tile-making have sprung. In some cases they resemble the old "plastic" method of encaustic tile-making as it was practised in England in the middle ages, except that the tile is finally pressed in a mechanical press.

The tile-makers of this mid-Victorian period owed much of their success to the birth of modern Gothic architecture, and many of their designs were produced by such famous architects as Pugin, Gilbert Scott, Street, &c., so that between 1850 and 1880 encaustic tiles had a great vogue for pavement work not only in England, but in all civilized countries, and fine examples of the rich encaustic pavements made at Mintons', Maw's, or Godwin's of Hereford, are to be found in most of the restored cathedrals and churches of this period.

Side by side with the revival of this ancient process, there was developed an essentially modern process of manufacturing by compressing pulverized clay in metal dies under a screw press. This was the outgrowth of a patent granted to Richard Prosser in 1840, and worked out and perfected at the works of Minton at Stoke-upon-Trent. The advantages of this method of manufacture consist in (*a*) greater rapidity in execution than can be effected by the plastic method, and (*b*) the greater mechanical accuracy of the finished tile due to the steel dies used in shaping the tile and to the diminished contraction in drying and firing. This essentially modern method of tile-making is really an outcome of the methods introduced in the manufacture of English earthenware (see CERAMICS), and it has not only been extensively developed in England, but has been adopted, practically without modification, in all the leading countries of Europe and in the United States.

The manufacture of tiles by the compression of powdered clay rendered possible the introduction of many varieties—plain, inlaid, embossed and incised. The designs in these cases, though generally based on old work, are so different, especially in mechanical finish, that they form a class of tiles entirely distinct from old work. Economically, and for all practical purposes, they afford a style such as the world has never before seen, but, like many modern productions—perfect in execution and finish—they lack the spontaneity and artistic charm of the work of bygone days.

Since the middle of the 19th century artist-potters in many countries have gone back to the ancient methods of production for richly painted tile panels, and, in this connexion, the productions of Deck in France, William de Morgan and Pilkington's in England, mark a distinct departure from contemporary modern work.

The extended use of tiles for interior decoration has created a large trade in these articles, either for wall or floor decoration. Among the most important firms engaged in this branch of the ceramic industry must be mentioned Mintons, Hollins & Co., Maw & Co., and Pilkington's in England; Villeroy & Boch in Germany; Utschneider & Co. in France; Boch Frères in Belgium; Thooft & Labouchere at Delft, Holland; and the American Encaustic Tile Co., in the United States.

LITERATURE.—Besides the works mentioned in connexion with special sections in the text a good deal of information about tiles in general, and modern tiles in particular, will be found in Furnival, *Leadless Decorative Tiles*, &c.; L. L. Jewitt, *Ceramic Art of Great Britain*; see also Forrer, *Geschichte der europäischen Fliesen-Keramik*. (W. B.*)

TILLEMONT, SÉBASTIEN LE NAIN DE (1637–1698), French ecclesiastical historian, was born in Paris on the 30th of November 1637. His father, a wealthy member of the legal class, being a devoted Jansenist, the boy was brought up in the little schools of Port Royal. Here his bent towards historical study was warmly encouraged, and in 1660 he was made a tutor in the seminary of Buzenval, Jansenist bishop of Beauvais. Ten years later he came back to Paris, and was eventually persuaded (1676) to enter the priesthood, and become a chaplain at Port Royal. In 1679 the storm of persecution drove him to settle on his family estate of Tillemont, between Montreuil and Vincennes. There he spent the remainder of his life, dying on the 10th of January 1698. He was buried at Port Royal; in 1711, on the desecration of the cemetery, his remains were transferred to the church of St André des Arcs in Paris.

From the age of twenty he was at work on his two great books—the *Mémoires pour servir à l'histoire ecclésiastique des six premiers siècles*, and the *Histoire des empereurs* during the same period. Both works began to appear during his lifetime—the *Histoire* in 1690, the *Mémoires* in 1693—but in neither case was the publication finished till long after his death. To his modesty Bossuet bears witness, when he told him to stand up sometimes, and not be always on his knees before a critic. Gibbon vouches for his learning, when (in the 47th chapter) he speaks of "this incomparable guide, whose bigotry is overbalanced by the merits of erudition, diligence, veracity and scrupulous minuteness." There is a full account of his life in the 4th volume of Sainte-Beuve's *Port Royal.*

TILLEY, SIR SAMUEL LEONARD (1818–1896), Canadian statesman, was born at Gagetown, New Brunswick, on the 18th of May 1818, the son of Samuel Tilley, an American Loyalist, who had settled in St John in 1783. In 1850 he was elected to the local legislature as a Liberal representative of St John. He soon became prominent from his opposition to the liquor traffic, and in 1855 persuaded the assembly to pass a prohibitory law, which proved a failure, and was repealed. From 1860 to March 1865 he was premier of the province, and was prominent in organizing the conference on the union of the maritime provinces, which met at Charlottetown in 1864, and which soon widened into a discussion of Canadian federation. In 1865 he was defeated in a general election on the federation question, but returned to power in 1866, partly through an intrigue of the colonial office. From 1868 till November 1873 he held various portfolios in the Dominion cabinet; from 1873 to 1878 he was lieutenant-governor of New Brunswick, but in 1878 was again elected as member for St John, and entered the Conservative cabinet as minister of finance. Later in 1878 he introduced and carried through parliament the "national policy" of protection, on which issue the election of 1878 had been won. The tariff so introduced became the basis of Canadian financial policy. In October 1885 ill health forced him to retire from the cabinet, and he was again appointed lieutenant-governor of New Brunswick, which position he held till 1893. He died on the 25th of June 1896. In 1879 he was created K.C.M.G. His kindly and honourable private character was admitted by all; his political merits are judged differently by advocates and opponents of the policy of protection which he introduced, but of his financial ability and grasp of detail there is no doubt.

His *Life*, by James Hannay (1907), forms one of the "Makers of Canada" series.

TILLODONTIA, a group of mammals of uncertain position, typified by *Tillotherium* from the Middle Eocene of Wyoming,

(From Marsh.)

Skull of *Tillotherium fodiens.* (½ nat. size.)

and perhaps including *Esthonyx* from the Lower Eocene of the same district, and other genera from the same horizon in both North America and Europe. In *Tillotherium* the skull is decidedly rodent-like, with an elongated cranial and a short facial portion, and a small brain-cavity; the jugal bone occupying the middle of the zygomatic arch. The dentition, of which the formula is *i.* $\frac{2}{2}$, *c.* $\frac{1}{1}$, *p.* $\frac{3}{2}$, *m.* $\frac{3}{3}$, also approximates to the rodent type, the canines being minute and functionless, and the first pair of incisors large and chisel-like. On these and other grounds it has been suggested that *Tillotherium* (of which the greater part of the skeleton is known) indicates the ancestral form of the Rodentia. Professor Max Weber considers, however, that such a view has but little justification. Relationship with the Ungulata and Carnivora has also been suggested; if there be any with the latter, it must have been with the most primitive forms, as the plantigrade feet are furnished with five toes carrying long pointed claws.

Possibly *Platychoerops richardsoni*, from the Lower Eocene London Clay, belongs to the group. (R. L.*)

TILLOTSON, JOHN (1630–1694), English archbishop, was the son of a Puritan clothier in Sowerby, Yorkshire, where he was born in October 1630. He entered as a pensioner of Clare Hall, Cambridge, in 1647, graduated in 1650 and was made fellow of his college in 1651. In 1656 he became tutor to the son of Edmond Prideaux, attorney-general to Cromwell. About 1661 he was ordained without subscription by T. Sydserf, a Scottish bishop. Tillotson was present at the Savoy Conference in 1661, and remained identified with the Presbyterians till the passing of the Act of Uniformity in 1662. Shortly afterwards he became curate of Cheshunt, Herts, and in June 1663, rector of Kedington, Suffolk. He now devoted himself to an exact study of biblical and patristic writers, especially Basil and Chrysostom. The result of this reading, and of the influence of John Wilkins, master of Trinity College, Cambridge, was seen in the general tone of his preaching, which was practical rather than theological. He was a man of the world as well as a divine, and in his sermons he exhibited a tact which enabled him at once to win the ear of his audience. In 1664 he became preacher at Lincoln's Inn. The same year he married Elizabeth French, a niece of Oliver Cromwell; and he also became Tuesday lecturer at St Lawrence, Jewry. Tillotson employed his controversial weapons with some skill against atheism and popery. In 1663 he published a characteristic sermon on "The Wisdom of being Religious," and in 1666 replied to John Sergeant's *Sure Footing in Christianity* by a pamphlet on the "Rule of Faith." The same year he received the degree of D.D. In 1670 he became prebendary and in 1672 dean of Canterbury. In 1675 he edited John Wilkins's *Principles of Natural Religion*, completing what was left unfinished of it, and in 1682 his *Sermons.* Along with Burnet, Tillotson attended Lord Russell on the scaffold in 1683. He afterwards enjoyed the friendship of Lady Russell, and it was partly through her that he obtained so much influence with Princess Anne, who followed his advice in regard to the settlement of the crown on William of Orange. He possessed the special confidence of William and Mary, and was made clerk of the closet to the king in March 1689. It was chiefly through his advice that the king appointed an ecclesiastical commission for the reconciliation of the Dissenters. In August of this year he was appointed by the chapter of his cathedral to exercise the archiepiscopal jurisdiction of the province of Canterbury during the suspension of Sancroft. He was also about the same time named dean of St Paul's. Soon afterwards he was elected to succeed Sancroft; but accepted the promotion with extreme reluctance, and it was deferred from time to time, at his request, till April 1691. In 1693 he published four lectures on the Socinian controversy. His attempts to reform certain abuses of the Church, especially that of clerical non-residence, awakened much ill-will, and of this the Jacobites took advantage, pursuing him to the end of his life with insult and reproach. He died on the 22nd of November 1694.

For his manuscript sermons Tillotson's widow received 2500 guineas. Ralph Barker edited some 250 of them together with the "Rule of Faith" (1695-1704). In 1752 an edition appeared in 3 vols., with *Life* by Thomas Birch, compiled from Tillotson's original papers and letters. Various selections from his sermons and works have been published separately, *e.g.* by G. W. Weldon in 1886.

TILLY, JOHANN TZERCLAES, COUNT OF (1559–1632), general of the Catholic League in the Thirty Years' War, was born in 1559 at the château of Tilly in Brabant. He was destined for the priesthood and received a strict Jesuit education. But, preferring the career of a soldier, he entered a Spanish foot regiment about 1574 as a volunteer, and in the course of several campaigns rose to the command of a company. This being reduced, he again became a simple pikeman, and as such he took part in the famous siege of Antwerp by Parma, whose army afforded the best training in the art of war then obtainable. He distinguished himself by his bravery, and the duke of Lorraine gave him the governorship of Dun and Villefranche, which he held from 1590 to 1594. Henry IV. made tempting offers, which were refused, to induce him to enter the service of France. Somewhat later he left the Spanish service for that of Austria to fight against the Turks. In 1602 he became colonel in the imperial army, and raised a regiment of Walloon infantry, which he commanded in the assault on Budapest, receiving a severe wound. In 1604 he was made general of artillery, and handled his new force with conspicuous success; the campaign of this year showed Tilly as a soldier of great capacity, and in 1605 he was made a field-marshal. His part in the dissensions in Austria, which preluded the Thirty Years' War, was marked by unswerving loyalty and devotion to the emperor and the Catholic religion. In 1610 he left the service of the emperor to enter that of Maximilian, duke of Bavaria, the head of the Catholic League. It was not, however, until 1620 that he became lieutenant-general to Maximilian and commander-in-chief of the field forces.

With the great victory of the Weisser Berg near Prague (1620) the new army and its leader became celebrated throughout Germany, and the long and weary campaigns against Christian, Mansfeld and the Protestant princes of the north-west established their reputation. The chief battles were Wimpfen (1622), Stadtlohn (1623), Wiesloch (1622), Höchst (1622), the last being a great victory for the Catholic forces, and winning for Tilly the title of count, which was given by the emperor himself (1622). The military operations of the Thirty Years' War will be found described under that heading. With the intervention of the king of Denmark, the struggle entered upon a new phase, and on the imperial side a new army, that of Wallenstein, appeared on the scene, though it was the army of the League which won the great success of the war at Lutter-am-Barenberge (1626). Throughout these arduous campaigns Tilly had other than military difficulties with which to contend. The military superiority of his veterans, trained as they were to his own ideal of "a ragged soldier and a bright musket," may be held to explain his victories over superior numbers, but the energy which he displayed in the midst of political difficulties was not less conspicuous than his leadership and strategy. On two occasions, at least, he was thwarted by orders from the League; once the Protestants were allowed to escape into Holland, once the army of Wallenstein was left to its own resources in the presence of the enemy. That the League achieved the successes which it actually did, was to the credit of Tilly and his men rather than to any action of the allied princes. It may be that Tilly cannot be considered as great a soldier as Wallenstein; it should, however, be borne in mind that the League army never possessed the prestige of an imperial force: that Tilly was repeatedly thwarted by political considerations, and that, even so, the hardest part of the task was achieved by the League army.

The defeat of King Christian was soon followed by the intervention of Gustavus Adolphus, a great captain at the head of the finest troops in Europe. But Tilly was the best general of the old school; the League troops were trained after the Spanish model, and the opening stages of the campaign did not display any marked superiority of the Swedes. At this time Tilly was commander of the imperial forces as well as of his own army. The first great contest was for the possession of Magdeburg (1631). After one of the fiercest struggles of the war the town was taken by storm on the 20th of May, and the sack which followed was accompanied with every sort of atrocity. For this the old general has been held responsible, yet it was rather the magnitude of the catastrophe than its special cruelties which made it the most striking example of military barbarity in modern history. Tilly's personal exertions saved the cathedral and other religious buildings from pillage and fire. Four months later Tilly and Gustavus, the representatives of the old and the new art of war, met in the battle of Breitenfeld (*q.v.*). The victory of Gustavus was complete, though the imperial general, severely wounded as he was, managed to draw off his men in good order. A few more months of campaigning brought the two armies to the Lech, where Gustavus was again victorious, and Tilly received a mortal wound. He died on the 30th of April 1632, in Ingolstadt, and was buried in the church at Altenötting in Bavaria.

See O. Klopp, *Tilly im 30-jährigen Krieg* (Stuttgart, 1861); K. Wittich, *Magdeburg, Gustav Adolf und Tilly*; also memoir of Tilly in *Allg. deutsche Biographie*; Keym-Marcour, *Johann Tzerclaes, Graf v. Tilly*; Count Villermont, *Tilly, ou La Guerre de trente ans* (Tournay, 1859).

TILSIT, a town of Germany, in the Prussian province of East Prussia, situated on the left bank of the Memel or Niemen, here crossed by an iron railway bridge, 57 m. S.E. of Memel and 72 N.E. of Königsberg by rail. Pop. (1905), 37,148. The town has a number of handsome modern buildings, including a town hall, a post office, law courts, and a large hospital. It contains four Protestant churches, among them the German church, with a handsome steeple, and the curious circular Lithuanian church, a Roman Catholic church, a Jewish synagogue and a classical school (*Gymnasium*). The manufactures include machinery, chemicals, soap, leather, shoes, glass and other articles, and there are iron-foundries, breweries, and steam flour and saw-mills. Tilsit carries on trade in timber, grain, hemp, flax, herrings and coal; but its trade with Russia, at one time considerable, has fallen off since the construction of the railway from Königsberg to Kovno. The river is navigable above the town, and there is a steamboat communication with Königsberg, Memel and Kovno.

Tilsit, which received civic rights in 1552, grew up around a castle of the Teutonic order, known as the "Schalauner Haus," founded in 1288. It owes most of its interest to the peace signed here in July 1807, the preliminaries of which were settled by the emperors Alexander and Napoleon on a raft moored in the Memel. This treaty, which constituted the kingdom of Westphalia and the duchy of Warsaw, registers the nadir of Prussia's humiliation under Napoleon. The poet Max von Schenkendorf (1784–1817) was born at Tilsit.

See *Aus Tilsits Vergangenheit* (5 vols., Tilsit, 1888–1892); and R. Thimm, *Beiträge zur Geschichte von Tilsit* (Tilsit, 1893).

TIMAEUS (*c.* 345–*c.* 250 B.C.),[1] Greek historian, was born at Tauromenium in Sicily. Driven out by Agathocles, he migrated to Athens, where he studied rhetoric under a pupil of Isocrates and lived for fifty years. During the reign of Hiero II. he returned to Sicily (probably to Syracuse), where he died. While at Athens he completed his great historical work. The *Histories*, in at least 38 (Bury says 33) books, was divided into unequal sections, containing the history of Italy and Sicily in early times; of Sicily alone; of Sicily and Greece; of the cities and kings of Syria (unless the text of Suïdas is corrupt); the lives of Agathocles and Pyrrhus, king of Epirus. The chronological sketch (Ὀλυμπιονῖκαι, the victors at Olympia) perhaps formed an appendix to the larger work. Timaeus was bitterly attacked by other historians, especially by Polybius, and indeed his unfairness towards his predecessors, which gained him the nickname of *Epitimaeus* (fault-finder), laid him open to retaliation. Polybius was a practical soldier and statesman, Timaeus a bookworm without military experience or personal knowledge of the places he described. The most serious charge against Timaeus is that he wilfully distorted the truth, when influenced by personal considerations: thus, he was less than fair to Dionysius and Agathocles, while loud in praise of his favourite Timoleon. On the other hand, as even Polybius admits, Timaeus consulted all available authorities and records. His attitude towards the myths, which he claims to have preserved in their simple form (hence probably his nickname γραοσυλλεκτρία, "collector of old wives' tales," though some authorities render this "old rag-woman," in allusion to his fondness for trivial details), is preferable to the rationalistic interpretation under which it had become the fashion to disguise them. Timaeus also devoted much attention to chronology, and introduced the system of reckoning by Olympiads, with which he compared the years of the Attic archons, the Spartan ephors, and the priestesses of Argos. This system, although not adopted in everyday life, was afterwards generally used by the Greek historians. Although a pupil of Philiscus of Miletus, a disciple of Isocrates, Timaeus is a representative of the Asiatic style of Hegesias of

[1] J. E. Sandys, *c.* 350–*c.* 260; J. B. Bury, 340–256.

Mognesia rather than of the Attic (see Norden, *Griech. Kunstprosa* i. 136). Both Dionysius of Halicarnassus and the pseudo-Longinus characterized him as a model of "frigidity" (ψυχρόν), although the latter admits that in other respects he is a competent writer. Cicero, who was a diligent reader of Timaeus, expresses a far more favourable opinion, specially commending his copiousness of matter and variety of expression. Timaeus was one of the chief authorities used by Trogus Pompeius, Diodorus Siculus and Plutarch in his life of Timoleon.

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TIMANTHES, of Cythnus or Sicyon, a Greek painter of the 4th century B.C. The most celebrated of his works was a picture representing the sacrifice of Iphigenia, in which he finely depicted the emotions of those who took part in the sacrifice; but despairing of rendering the grief of Agamemnon, he represented him as veiling his face. A painting discovered at Pompeii, and now in the Museum at Naples, has been regarded as a copy or echo of this painting (Helbig, *Wandgemälde Campaniens*, No. 1304).

TIMARU, a seaport of Geraldine county, New Zealand, on the E. coast of South Island, 100 m. S.W. of Christchurch by rail. Pop. (1906), 7615. The slight inward sweep of the coast forms the Canterbury Bight, and the shore-line northward from Timaru is called the Ninety-mile Beach. The harbour is formed by breakwaters enclosing a space of 50 acres. Chief exports are wool, flour and frozen meat, and the industries are in connexion with these. Opals are found in the district. The Anglican church of St Mary is built of Oamaru and bluestone, with a roof of kauri wood. Caroline Bay, to the north, is a bathing resort. The volcanic soil is highly fertile. Timaru is the chief town in South Canterbury district, and the seat of the supreme and district courts. A branch railway traverses the inland agricultural district.

TIMBER, the term given to wood cut and shaped for building purposes, or growing wood suitable for such purposes; in English law the tenant for life may not cut such trees (see WASTE). The word appears in many forms in various Teutonic languages, meaning originally material to be used for building purposes; in the case of Ger. *zimmer*, and Du. *timmer*, both meaning "room," the word has been transferred to the structures made of this material. The root is seen in Gr. δέμειν, to build, and Lat. *domus*, house.

The wood used in building is obtained from trees of the class known to botanists as *exogens*, or those trees which grow larger by the addition each year of a layer of new wood on their outer surface. A transverse section of a tree of this class shows it to consist of three distinct parts: the pith or medulla, the wood, made up of annual rings or layers, and the bark. The pith is in the centre of the tree and around it the wood is disposed in approximately concentric rings; that part near the pith is hard and close in grain, and from its position is termed heart-wood. The sap-wood is made up of the outer layers or rings, and these are softer than the heart and generally of more open grain. Each annual ring is made up of two parts—an inner soft portion light in colour, and a hard, dark-coloured outer portion. The inner portion is formed early in the season and is termed "spring wood," the darker part being called "autumn wood." The medullary rays extend radially from the centre of the tree to the bark at right angles to the grain of the wood, and serve during life to bind the whole together as well as to convey nourishment from one part of the tree to another.

The greatest care should be exercised in the selection of trees for felling. If the tree is too young the proportion of sap-wood is large, and the heart-wood is not so hard as that of a tree of mature age. The wood of an old tree, on the other hand, has lost a great part of its toughness, and is of bad colour, brittle and often predisposed to decay. In trees that have arrived at a mature age the heart-wood is in its largest proportion and the sap-wood is firm and elastic; and the timber from such trees is of the strongest, toughest and most durable character. The age at which the northern pine and Norway fir arrive at maturity is between seventy and one hundred years. The larch, elm and ash should be felled when the trees are between the ages of fifty and one hundred years. The oak should be about one hundred years old when it is cut. The best time of the year for felling timber is in midsummer or midwinter, when the sap of the tree is at rest; it is not desirable to cut timber in the spring or autumn. By some authorities it is considered a good plan to remove the bark in the early spring and fell the tree in the ensuing winter.

Felling Timber.

As soon as possible after felling, logs should be converted by sawing into scantling sizes, for if the log is left to dry or season, it is liable on shrinking to split. The usual method is to saw a log into planks or boards by cutting it into slices longitudinally as shown in fig. 1; this is called bastard sawing, and is the most economical method, but, as will be seen in the diagram, the quality of the boards will vary very much, some consisting almost entirely of sap-wood cut at a tangent to the annular rings such as *a*, *b*, *c*, whilst the centre boards contain the heart-wood cut in the best way at right angles across the annual rings as *d*, *e*, *f*. For oak and other hard woods another method of conversion is often adopted, called quarter sawing. The log is first cut into quarters and then sawn diagonally (fig. 2). In oak this develops the beautiful silver grain by cutting longitudinally through the medullary rays. Timber is now generally sawn into marketable sizes in the country of its growth, and shipped as scantling timber.

Conversion of Timber.

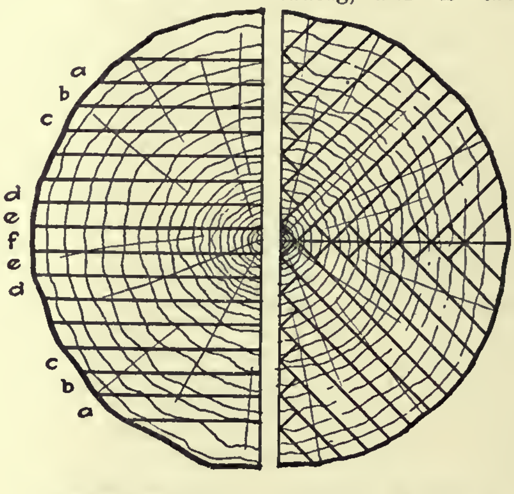

FIG. 1. FIG. 2.

Definitions and sizes are given below of the most usual forms of sawn timber:—

A *log* is the trunk of a tree with the bark removed and branches lopped.

A *balk* is a log hewn or sawn to a square section, and varying in size from 11 to 18 in. square.

Planks are parallel-sided pieces of timber from 2 to 6 in. thick, 11 or more ins. wide, and from 8 to 21 ft. long.

Deals are similar pieces 9 in. wide, and 2 to 4 in. thick.

Battens are similar to deals, but not more than 7 in. wide. Pieces of planks, deals and battens under 8 ft. long are called ends. Many of the soft woods, such as pine and fir, are sold by the standard. The standard of measurement most in use is the St Petersburg standard, which contains 165 cubic ft. or 720 lineal ft. of 11 in. by 3 in.

A *load* of sawn or hewn timber contains 50 cub. ft., and a load of unhewn timber 40 cubic ft.

A *square* is a superficial measurement, used chiefly for boarding, and contains 100 sq. ft.

Norwegian timber is stencilled with the shipper's initials in blue letters painted on the ends. Swedish timber is stencilled with red letters or devices, the inferior qualities in blue. Prussian timber is scribed on the sides near the middle. By scribing is meant that the distinguishing letters are roughly cut in with a gouge. Russian timber is dry-stamped or hammer-branded on the ends. American (Canadian) timber is stencilled in black and white. United States timber is marked with red chalk on the sides.

Seasoning.

To fit timber for use in building construction the superfluous sap and moisture contained in the green wood must be evaporated, either by natural or artificial means. During this process the wood shrinks considerably, and unless much care and attention are given to the drying wood it will warp and shake sufficiently to unfit it for practical uses. After the log is converted into scantlings, or "lumber," as it is termed in America, it is stacked in the timber yard under covered sheds with open sides to enable it to "season." The wood is carefully piled in tiers or courses, with strips of wood about an inch thick between each layer, so as to allow of the free circulation of air all round each piece. This is the natural and best method of seasoning, and timber treated in this way is more durable than that seasoned by artificial methods; the time taken, however, is much longer. For joiners' work the drying of the wood is often hastened by stacking the timber in well-ventilated rooms kept at a temperature of from 80° to 150° F. The time taken in seasoning wood by this desiccating process is not more than one-tenth of that occupied in the natural or open-air method. Where it is convenient, timber is sometimes treated with a water seasoning process which enables it to be more easily dried. The wood is placed in a running stream and so tied or chained down as to be entirely submerged. The water enters the pores of the wood (which should be placed with the butt end pointing up stream) and dissolves and forces out the sap. After about two weeks in this position it is taken out and stacked in open sheds to be dried in the natural way, or treated by warm air in special chambers. Steaming and boiling are sometimes resorted to as artificial means of seasoning, but not to any great extent, as the timber deteriorates under such treatment, and the cost of the process is in many cases prohibitive. When wood is required to be bent, however, this is often the method that is adopted to soften the material, so as to allow it to be bent easily. The time allowed in the English government dockyards for the natural process of seasoning for hard woods such as oak is, for pieces 24 in. sq. and upwards, 26 months; from 16 in. to 20 in. sq., 18 months; from 8 in. to 12 in. sq., 10 months; from 4 in. to 8 in. sq., 6 months. Soft woods are allowed half these periods. When the wood is required in a "dry" state for joiners' work, twice the length of time is given. Planks are allowed from a half to two-thirds of the above time, according to their thickness.

Defects in Timber.

Deals with coarse annual rings (*i.e.* coarse grain) should be rejected for good work, as also should those with waney or naturally bevelled edges. The wide annual rings show that the tree was grown too quickly, probably in marshy ground. Timber with waney edges has a large proportion of sap-wood, and is cut either from a small tree or from the outer portion of a large one, the waney edge being obviously due to irregularities in the surface of the tree. "Cup shake" is a natural splitting in the interior of the tree between two of the annular rings. It is supposed to be caused in severe weather by the freezing of the ascending sap. "Heart shake" is often found in old trees and extends from the pith or heart of the tree towards the circumference. When there are fissures radiating in several directions it is called "star shake." "Upsets" are the result of some crushing force or violent shock to the balk or log. "Foxey" timber is tinged with dull red or yellow stains, indicating incipient decay. "Doatiness," similarly, is a speckled or spotted stain denoting decay in certain varieties of timber, such as beech and some kinds of oak.

Decay in Timber.

The primary causes of decay in timber are the presence of sap, exposure to conditions alternately wet and dry, and want of efficient ventilation, especially if accompanied by a warm and moist atmosphere. Timber is most durable when it is kept quite dry and well ventilated, but some varieties last an indefinite period when kept continually under water. When, on the other hand, the wood becomes alternately wet and dry, "wet rot" results. The wood affected shrivels up and becomes reduced after a time to a fine brown powder. It is only by actual contact that wet rot affects the surrounding good wood, and if the decayed timber is cut out the remainder of the wood will be found to be unaffected.

"Dry rot," which usually attacks the sap-wood, generally starts in a warm damp unventilated place, and is caused by the growth of fungi, some of which are visible to the naked eye, some microscopic. The spores from the fungi on the decayed wood float in the air and alight on any adjacent timber, infecting this also if the conditions be favourable. In this way the disease is spread rapidly, continually eating into the timber, which is first rendered brittle, and then reduced to powder. A strong growth of the fungus gives the appearance of mildew on the wood, and produces an unpleasant musty smell. The spores of the fungus will find a way through brickwork, concrete and similar material, in order to reach woodwork that may be on the other side. Dampness and a close atmosphere are essential to the growth of dry rot, and it is under these conditions that it spreads most quickly, the fungus soon dying when exposed to the fresh air.

Preservation of Timber.

There will be little danger of the decay of timber used in the construction of ordinary buildings if care has been taken, in the first place, to have it well seasoned, and, in the second, to ensure its being well ventilated when fixed in position. There are, however, several preservative processes to which timber may be subjected when it is to be fixed in positions which favour its decay (see also DRY ROT). In creosoting, which was invented by J. Bethell and patented by him in 1838, the timber is impregnated with oil of tar. This may be done by soaking the wood in the hot oil for several hours, but the better way is to place the seasoned timber in an iron chamber in which a partial vacuum is created by exhausting the air. The creosote is then forced in at a pressure of from 100 lb to 160 lb to the sq. in., according to the size of the timber. In warm weather the pressure need not be so great as in winter. The whole process only occupies from two to three hours. Soft woods take up from 10 to 12 lb to the cub. ft.; hard woods are not usually treated by this process. Kyan's process, patented in 1832, consists in impregnating the timber with corrosive sublimate which, acting on the albumen in the wood, converts it into an indecomposable substance. Boucherie, a Frenchman, originated a system in which the sap is expelled from the timber under pressure, and a strong solution of copper sulphate is then injected at the end of the wood. In Blythe's process the timber is dried, and crude carbolic acid injected. In Burnett's process a solution of zinc chloride is forced into the pores of the wood. A new process of preserving timber by means of steam heat has been tried and seems to be effectual. The wood is placed in closed chambers and steam admitted at high pressure (200 lb to the sq. in.). The heat and pressure together exert a chemical action upon the sap, which becomes insoluble and itself preserves the wood from decay.

Posts that are to be fixed in the ground should have their buried ends either charred or else well tarred. External woodwork may be protected by painting or oiling.

Varieties.

The timber used in building is obtained from trees which may be classed under two heads: (1) Coniferous or needle-leaved trees; (2) the non-coniferous or broad-leaved trees.

Coniferous Trees.—This class includes most of the soft woods which furnish timber for the framing and constructional portions of nearly all building work. They are also used for the finishing joinery of the ordinary class of building. The numerous varieties of pine which are used more extensively than any other kind of wood are included in this class.

The northern pine (*Pinus sylvestris*) has a number of other names and may be referred to under any of the following: Scotch fir, red deal, red fir, yellow deal, yellow fir, Baltic pine, Baltic fir. It grows in Sweden, Norway, Russia, Germany and Great Britain, and often gets a name from the port of shipment, such as Memel fir, Danzig fir, Riga fir, and so on. The colour of the wood of the different growths of northern pine varies considerably, the general characteristics being a light reddish yellow colour. The annual rings are well defined, each ring consisting of a hard and a soft portion, respectively dark and light in colour. No medullary rays are visible; the wood is straight in the grain, durable, strong and elastic, easy to work, and is used by the carpenter for internal and external constructional work, and by the joiner for his fittings. Tar, pitch and turpentine are obtained from the wood of this tree, which weighs from 30 to 38 lb per cub. ft.

The white fir, or Norway spruce (*Abies excelsa*), is exported from Russia, Sweden and Norway, where it grows in enormous quantity. It is the tallest and straightest of European firs, growing with a slender trunk to a height of from 80 to 100 ft. Like the northern pine, it is called by several names, such as "spruce," "white deal," "white wood," "Norway fir." The colour of the cut wood is a very light yellowish or brownish white, the hard parts of the annual rings being of a darker shade. A characteristic feature is the large number of very hard black knots which the wood contains. It is easy to work, but rather inferior in all respects to the northern pine. Its weight per cubic foot averages about 33 ℔.

The red pine (*Pinus resinosa* or *P. rubra*) is also known as "Canadian pine" and "American deal." It grows in the northern parts of North America, where the tree attains a height of 60 or 70 ft. with a diameter of from 12 to 30 in. It weighs about 36 ℔ to the cubic foot. In Canada it is called "Norway pine" and "red pine" from the colour of the bark. The wood is white, tinged with yellow or red, of fine grain, and works to a smooth lustrous surface remarkably free from knots.

The white pine (*Pinus strobus*) is exported from the northern parts of the United States of America and from Canada. Other names for this timber are "yellow pine" and "Weymouth pine," the last name originating in the fact that the earl of Weymouth first introduced it into England. The tree attains a height of from 150 to 200 ft. with a thickness of trunk at 5 ft. from the bottom of from 5 to 10 ft. The wood when cut is white or yellowish white, straight in grain and easily worked, but is not so tough, elastic or durable as the northern pine, and therefore is not so suitable for constructional work. For joiners' work, however, it is well adapted, and glue adheres strongly to it, though nails do not hold well. It weighs about 30 ℔ per cub. ft.

The Kauri pine (*Dammara australis*) is a native of New Zealand. It grows to a height of from 80 to 140 ft., with a straight stem 4 to 8 ft. in diameter. The wood is a light yellowish brown in colour, fine in grain and of even texture, the annular rings being marked by a darker line. It is strong, elastic and resinous. A cubic foot weighs about 35 to 40 ℔.

The pitch pine (*Pinus rigida*) is a native of Canada and is common throughout the United States of America. It is remarkable for the large quantity of resin it contains, the weight of the wood, which is about 48 ℔ per cub. ft., and the strong red markings of the grain, usually straight but sometimes exhibiting a beautiful figure. Its weight and strength, and the large size of the balks, make it very valuable for heavy constructional works and piling, and its fine figure makes it equally valuable for joinery.

Of the larch the best known variety is the European larch (*Larix europaea*), which grows in Switzerland, Italy, Russia and Germany. The larch frequently attains a height of 100 ft. but the average height is about 50 ft. and diameter 3 ft. The wood is extremely durable and lasts well where exposed alternately to wet and dry; indeed, the larch is useful for every purpose of building, internal and external. It is the hardest and toughest of the cone-bearing trees and weighs 30 to 40 lb per cub. ft.; it has a straight grain free from many knots; in colour it is of a rather deep yellow or brownish tint, with the hard portions of the annular rings marked in a darker red. The American black larch (*Larix pendula*) and the American red larch (*Larix microcarpa*) are native to North America. The latter tree is of comparatively little service. The black larch yields timber of good quality, nearly equal to that of the European tree.

The cedar used in building work is really a species of juniper. The Virginian red cedar (*Juniperus virginiana*) grows in the United States, Canada and the West Indies. The tree produces excellent timber, and is much used for furniture, its strong acrid taste driving away insects. It weighs about 40 ℔ per cub. ft. The Bermuda cedar (*Juniperus bermudiana*) is used for internal joinery and is extremely durable.

Hard Woods.—The timbers in the second class are obtained from non-coniferous trees, containing no turpentine or resin, and are given the general name of hard woods. Their initial expense and the high cost of working preclude their general use, and they are consequently reserved to a great extent for specially heavy constructional work and ornamental finishing joinery.

The oak (*Quercus*), of which some sixty distinct species are known, grows freely in Europe and America. Several kinds yield valuable timber: in England the two best-known varieties are *Quercus pedunculata* and *Quercus sessiliflora*. There is little difference between the quality of the two woods, the variation being in the foliage and fruit. The wood is very hard, tough, with fine regular grain and close texture, the annular rings being distinct and the medullary rays well marked. When it is cut along these rays beautiful markings are revealed, called silver grain. The colour is a light brown, and its weight is about 50 to 56 ℔ per cub. ft. Oak is very durable either in a dry or a wet situation, or in a position where it will be alternately dry and wet. It is very suitable for constructional and engineering works, and it supplies one of the finest woods for ornamental joinery work. The Durmast oak grows in France and the south of England; it is not so strong or durable as the English oak. Baltic oak is grown in Norway, Russia and Germany, and is exported from the Baltic ports. Though inferior to the English oak, it is very straight in the grain and free from knots. Austrian oak is light in colour, and is much used for joinery work. White oak comes principally from Canada, under the name of American oak. It is straight in grain but subject to warping, and is not so durable as British oak.

The common walnut (*Juglans regia*) grows in Great Britain. On account of its scarcity it is little used for building purposes, except for ornamental joinery, being more used by the cabinet and furniture maker. A cubic foot weighs about 45 ℔. The white walnut (*Juglans alba*) or hickory is common in North America, and is very tough, hard and elastic. The black walnut (*Juglans nigra*) is also native to America. It has a fine grain with beautiful figure, and takes a fine polish. It weighs 56 ℔ per cub. ft.

Of the elm (*Ulmus*) there are five common varieties, the two most cultivated being the rough-leaved elm (*Ulmus campestris*), which is grown in large quantities in England and North America, and the smooth-leaved wych elm (*Ulmus glabra*). The colour of the wood is brown; it is hard, heavy, strong and very tough, and when kept either always wet or always dry is durable. Elm is very liable to warp and shake, is porous and usually cross-grained. The piles of old London Bridge were of elm, and after six centuries of immersion were but little decayed. The wood is not much used in building operations. It weighs about 40 ℔ per cub. ft.

The common ash (*Fraxinus excelsior*) is a native of Europe and Northern Asia, and is grown extensively in Great Britain. Its colour is light brown, sometimes with a greenish tint, with the annular rings of darker colour. The wood is very tough and strong, and superior to most wood in elasticity; and it weighs 40 to 55 ℔ per cub. ft.

Beech (*Fagus sylvatica*) grows in the temperate districts of Europe. The wood is heavy, strong and hard; white to light reddish-brown in colour; and durable if kept either dry or wet; is porous and works easily; it weighs about 40 to 48 ℔ per cub. ft. The red beech (*Fagus ferrugina*) is common in North America.

Sycamore (*Acer pseudo-platanus*), sometimes mistakenly called the plane tree, is common in Germany and Britain and in the eastern states of North America. It is a large tree of rapid growth. The wood is light brown or yellowish white, with annular rings not very distinct, often cross-grained and of uniformly coarse texture. It warps and cracks rather badly, and weighs from 35 to 42 ℔ per cub. ft.

Teak (*Tectona grandis*) is a native of southern India and Burma. It grows rapidly to a great height, often exceeding 150 ft., with a straight trunk and spreading branches. Teak wood is straight in the grain and exceptionally strong and durable, its oily nature enabling it to resist the attacks of insects and to preserve iron nails and fastenings. It weighs from 45 to 56 ℔ per cub. ft.

Mahogany (*Swietenia mahogani*) is a native of the West Indies and Central America, the best-known varieties being Cuban or Spanish and Honduras. The Spanish wood has a darker colour and richer figure than the Honduras, and is therefore preferred for ornamental joinery work. The colour of mahogany is reddish brown, and in the Cuban wood the pores are often filled with a white chalky substance which is usually absent in the Honduras variety; the latter, however, may be obtained in larger sizes, and is straighter in the grain and easier to work. Spanish mahogany weighs about 56 ℔ to the cubic ft., and the Honduras variety about 36 ℔.

Greenheart (*Nectandra rodiaei*) is a very heavy, hard and durable wood from the East Indies. It ranges in colour from pale yellow to a deep brown, and the grain is very compact and of close texture. The wood contains an oil which enables it to resist the attack of sea worms, and this quality makes it suitable for use in marine construction. The average weight of a cubic foot is about 61 ℔.

Basswood (*Tilia americana*) is common in Canada and in the northern United States. It is soft and easy to work, and of even texture and straight grain. It may be obtained in wide boards, and thus is fitted for use in large panels. It weighs about 30 ℔ per cub. ft.

There are several varieties of maple growing in Canada and the United States, but the one in most common use is the sugar maple, also called rock maple, which grows freely in the districts around the Great Lakes. The wood is fine-grained, frequently with a beautiful wavy figure, yellowish white to light brown in colour; it is very hard, tough and durable. Birds'-eye maple has a peculiar curly grain, and is much in request for ornamental joinery.

Strength of Timber.

The numerous tests of the strength of timber which have been made by various authorities from time to time vary so much, both as regards the conditions under which they were carried out and the results obtained, that great discretion is required in using them for any practical purpose. An important series of tests was made in 1883 and 1887 at Munich by Professor Johann Bauschinger. He reduced all the specimens submitted for test to a standard of moisture, the percentage selected being 15%. This was necessary on account of the great difference in strength found to exist between specimens cut from the same piece of timber but differing in the amount of moisture they contained.

In America, Professor J. B. Johnson made a large number of tests for the Forest Department of the Board of Agriculture of the United States between 1891 and 1895. More than 300 trees were cut down and experimented with, the species under test embracing ten different kinds of pine and five different varieties of hard-wood trees. Records were made as to the nature of the soil and climate where the trees were grown; their conditions of growth, their age and size, and the season of felling. As in the tests made by Bauschinger, the percentage of moisture contained in the wood was very carefully observed, and it was found that this amount of moisture has a very great influence upon the resisting power of the wood, the strength increasing with the dryness of the material up to 3 or 4% of moisture, at which point the greatest strength of the wood is reached. Wood in such a dry condition, however, is never found in actual practice, timber in an ordinary well-warmed and well-ventilated situation probably containing at least 10%.

One general conclusion arrived at both by Bauschinger and Johnson was that the strength is much affected by the specific gravity of the timber. In all cases the strength increases proportionately with the density of the wood. A most complete series of tests upon the physical characteristics of the hard woods of Western Australia was completed for the government of Western Australia by G. A. Julius in 1907. This work was carried out in a most thorough manner, and as many as 16,000 tests were made, the conditions of test being based upon those laid down by Johnson. The results serve to show the great value of Australian timbers, and the comparisons made with the typical timbers of many other countries emphasize the fact that the Australian woods are equal to any in the world for hardness, strength and durability.

For use under special conditions a wood suited to the particular requirements must be selected. The following is a list of the best timbers for different situations: for general construction, spruce and pine of the different varieties; for heavy constructions, pitch pine, oak (preferably of English growth), teak, jarrah; for constructions immersed in water, Baltic pine, elm, oak, teak, jarrah; for very dry situations, spruce, pines, mahogany, teak, birch, sycamore.

There are no regulations in England limiting the working stresses that may safely be placed upon timber, although in some districts the least sizes that may be used for timbers in roofs and floors are specified. In some European and other countries, however, the safe working stresses of timber used for constructional purposes are defined. The building by-laws of the municipality of Johannesburg, in South Africa, contain the following table:—

Safe Working Stresses for Timber. In tons per square inch.

Material.	Tensional.	Compressive.	Bending. Extreme Fibre Stress.
Timber	—	—	—
Fir and Pine . . .	½	½	⅓
Hardwood . . .	½	⅓	½

Note.—The compression stresses are for short struts and columns where the length does not exceed for timber 15 times the least transverse dimension, and where the ends are fixed. Where the ratio of the length to the least transverse dimension is higher, the load per square inch shall be proportionately reduced. No post of timber shall exceed in length 30 times its least transverse dimension.

REFERENCES.—T. Tredgold, *Principles of Carpentry*, § xii.; R. E. Grandy, *Timber Importer's Guide*; G. A. Julius, *Report of a Series of Tests upon the Physical Characteristics of the Hardwoods of Western Australia* (1906–1907); J. B. Johnson, *Report of Tests upon Timber made for the Forest Department of the Board of Agriculture of the United States* (1891–1895); J. Bauschinger, "Report of Tests made upon Timber at Munich," *Mittheilungen aus dem Mechanisch-Technischen Laboratorium der K. Technischen Hochschule in München*; F. E. Kidder, *Building Construction and Superintendence*, vol. ii.; Rivington, *Notes on Building Construction*, vol. iii.; T. Laslett, *Timber and Timber Trees*; H. Stone, *The Timbers of Commerce and their Identification*; H. M. Ward, *Timber and some of its Diseases*; R. Hartig, *Timbers and How to know them*; J. Brown, *The Forester*; G. S. Boulger, *Wood*. (J. BT.)

TIMBER-LINE, in physical geography, the line of elevation above sea-level above which trees do not grow. In any hilly locality, which is not of too high latitude to allow of trees growing near the sea-level, this line is generally clearly marked. It varies not only with general but also with local conditions of climate, just as does the snow-line.

TIMBER-WOLF (*Canis occidentalis*), or grey wolf, an American species, or, perhaps, a geographical race of the European *C. lupus* (see WOLF). The length of good specimens is about 64 in., of which the tail forms nearly a quarter, and the range of colour is from black to white. Cattle ranchers and shepherds have established a war of extermination against this wolf and the coyote; several states offer bounties ranging from $2 to $10 on wolf-scalps. In Montana in 1901 during a month in the saddle an observer saw no wolves, which have become so scarce that the occupation of the professional wolf-hunter is almost gone. These animals are, however, far from being exterminated, the "bad lands" forming an absolutely secure refuge.

TIMBREL, or TABRET (the *tof* of the ancient Hebrews, the *deff* of Islam, the *adufe* of the Moors of Spain), the principal musical instrument of percussion of the Israelites, identical with the modern tambourine. The word timbrel is used in the Old Testament in both singular and plural form, so as to suggest that the former referred to a hoop of wood or metal over which was stretched a parchment head; while the plural was perhaps used to designate the tambourine with bells or jangles fixed at intervals in hoops. The Israelites learnt to use the timbrel during their sojourn in Egypt, and it has been suggested that as the Egyptians used it to scare away their evil spirit Typhon, the word *tof* is derived from the latter. The tabret or timbrel was a favourite instrument of the women, and was used with dances, as by Miriam, to accompany songs of victory, or with the harp at banquets and processions; it was one of the instruments used by King David and his musicians when he danced before the Ark. It was also used in the valley of Hinnom at the sacrificial rites, when human victims were "passed through the fire" to Moloch. (K. S.)

TIMBS, JOHN (1801–1875), English antiquary, was born in Clerkenwell, London, on the 17th of August 1801. He was educated at a private school at Hemel Hempstead, and in his sixteenth year apprenticed to a druggist and printer at Dorking. He had early shown literary capacity, and when nineteen began to write for the *Monthly Magazine*. A year later he became secretary to Sir Richard Phillips, its proprietor, and permanently adopted literature as a profession. He was successively editor of the *Mirror of Literature*, the *Harlequin*, the *Literary World*, and sub-editor of the *Illustrated London News*. He was also founder and first editor of *Year-Book of Science and Art*. His published works amounted to more than one hundred and fifty volumes. In 1834 he was elected a fellow of the Society of Antiquaries. He died in London on the 6th of March 1875.

TIMBUKTU (French spelling Tombouctou), chief town of the territory of Timbuktu, French West Africa, 9 m. N. of the main stream of the Niger in 16° N. and 5° W.

Timbuktu lies on a terrace formed by the southern scarp of the Sahara, about 800 ft. above sea-level, and overlooking a chain of *dhayas* or marshy hollows, fringed here and there with a few mimosas and palm thickets, amid the surrounding sandy wastes. These dhayas, which are flooded every three or four years, converting the lowland tracts between the terrace and the main stream into a labyrinth of channels and backwaters, mark the bed of a navigable creek which formerly branched from the Niger northwards to the foot of the scarp, and which in 1640 inundated a low-lying quarter of the city. It is conjectured that the main stream followed this course before it took its present easterly curve to Burrem, where it bends southwards to the coast. Here also it was probably joined at some remote period by the now dried-up Wadi Messaura from the Tuat oases south of Algeria, although the rough levels taken by Oscar Lenz and others make it uncertain whether the flow through this depression was northwards or southwards. In any case Timbuktu has been left, so to say, high and dry by the general process of desiccation going on throughout the Saharan region.

Timbuktu has been described as "the meeting point of the camel and the canoe," "the port of the Sahara in the Sudan," and (more correctly) "the port of the Sudan in the Sahara." It is a great "exchange" for the produce of North Africa and that of the rich countries south and west of the Niger. It was formerly a much larger place than it was found to be at the time of its occupation by the French in 1893–1894. Extensive ruins exist north and west of the present town. The great mosque which at one time stood in the centre of the town now lies near the western outskirts, where its high but unsightly earth tower forms a striking landmark. The mosque of Sidi Yaia (in the centre of the town) and that of Sankoré in the north-east also possess prominent towers. Two forts, built by the French and placed, one on the northern the other (Fort Bonnier) on the southern side of the town, protect the roads to the desert and the river respectively. Whereas in 1895 the town was little more than a vast ruin, under French protection the inhabitants, relieved from the fear of Tuareg oppression, set about repairing and rebuilding their houses; trade revived; new streets were built; European schools, churches and other establishments were opened.

The industries of Timbuktu—cotton-weaving, earthenware, leather-work and embroidery—are of subordinate importance, and the great bulk of the people are occupied exclusively with trade. The whole traffic of the surrounding lands converges on Timbuktu, which has a transit trade estimated at over £800,000 per annum. Considerable quantities of British and German fabrics, hardware, beads, &c., are conveyed across the Sahara from Mogador (Morocco), while two great caravans of 3000 or 4000 camels are yearly charged with salt from the Taudeni district, salt being an article which the Niger countries lack. The imports via the Sahara average about £50,000 annually, and by way of Senegal goods of equal value are received. From the south come cereals, gold, wax, ivory and coarse native cotton goods, now brought to Kabara (the port of Timbuktu) by steamers plying on the upper Niger. Cowries, the former currency (2500=5 francs), have been generally replaced by French money. It is proposed to connect the city with the Niger by a canal.

Timbuktu, which possesses some valuable Arabic manuscripts —notably the *Tarik es-Sudan*, a 17th-century history of the Sudan written by Abderrahman Sadi of Timbuktu—and is a centre of Moslem teaching, is a converging point of the chief west Sudanese and Saharan races—Arabs or Arabized Berbers to the west; Songhoi in the immediate vicinity, and thence south-eastwards along the Niger; Ireghenaten or "mixed" Tuareg southwards across the Niger as far as the Hombori Hills and in the fertile Libbako plains beyond them; Fula, Mandingos, and Bambara in and about the city; and Imoshagh (Tuareg) belonging to the Awellimiden confederation mainly to the north and east.

The local administration—preserved under French rule—is in the hands of an hereditary *kahia*, a kind of mayor, descended from one of the Ruma families (see below). The kahia, during the greater part of the 19th century, was more or less under the control of the powerful Bakhai (Backay) family, who, as "sherifs" and marabouts, were revered throughout the western Sahara.

History.—The history of Timbuktu[1] is intimately connected with that of the city of Jenné and the Songhoi Empire. The Songhoi (*q.v.*) are a negro race reported to have come to the Niger countries from the Nile valley. In the 8th century they made themselves masters of a considerable tract of country within the bend of the Niger, and built the city of Gao (*q.v.*) 200 m. in a direct line S.S.E. of Timbuktu, making it their capital. In the 11th century they were converted to Islam. Besides Gao, the Songhoi founded Jenné (*q.v.*), which early attained considerable commercial importance. Meantime (11th century) a settlement had been made at Timbuktu by Tuareg. Perceiving the advantages for trade with the north offered by this desert rendezvous, the merchants of Jenné sent agents thither (12th century), and Timbuktu shortly afterwards became known to the inhabitants of the Sahara and Barbary as the best market in which to dispose of their salt and other goods, and also for the purchase of the many commodities of the western Sudan. In the 12th or 13th century Timbuktu fell under the power of the Mandingo kings of Melle or Mali, a country lying west and south of Jenné. Its fame as a mart for gold and salt spread to Europe, "Timboutch" being marked on a Catalan map dated 1373. In 1353 it had been visited by the famous traveller Ibn Batuta. In 1434 the Tuareg made themselves masters of the city, which in 1469 was captured by the Songhoi king Sunni Ali. In the days of Sunni's successor Askia (1494–1529), who completed the conquest of Melle begun by Sunni Ali, the Songhoi empire reached its highest development, and Timbuktu rose to great splendour. The "university" of Sankoré became a chief centre of Mahommedan culture for the peoples of the western Sudan. One of the sheikhs of Sankoré, Ahmad Baba, was among the most learned of Moslems. Some of his writings are still extant. The riches of Timbuktu excited the cupidity of El Mansur, sultan of Morocco, who, in 1590, sent an army across the Sahara under an "Andalusian" Moor (that is, a Moor descended from those expelled from Spain), which captured Timbuktu (1591) and completely broke up the Songhoi empire. The Moors made Timbuktu their capital city. For about twenty years after the conquest the pasha who ruled at Timbuktu was nominated from Morocco, but the distance of the Niger countries from Marrakesh enabled this vast viceroyalty to throw off all allegiance to the sultan of Morocco.

The Niger Moors, known as *Rumas* after El Mansur's musketeers, quarrelled continually among themselves, and oppressed the negro tribes. By the end of the 18th century two hundred years of oppression had reduced Timbuktu to comparative desolation and poverty. By this time the whole country was in a state of anarchy, and in 1800 the Tuareg swooped down from the desert and captured the place. They were in turn (1813) dispossessed by the Fula, who in 1840 gave place to the Tukulor, led by El Haj Omar, the first great opponent of the extension of French influence in the Niger bend. When the French reached Timbuktu in December 1893 they found that the town had again fallen beneath the rule of the Tuareg. The townsfolk, indeed, from the time of the decay of the Ruma power being at the mercy of all comers, were content to pay tribute to each in turn and sometimes to more than one simultaneously, for which they indemnified themselves by peaceful intervals of trade whenever the land routes were open and the upper and lower reaches of the Niger clear of pirates. But at times even the short tract separating the town from Kabara was so beset with marauders that it bore the ominous name of "Ur-immandess," that is, "He (God) hears not." Little wonder then that the townsfolk, wearied by the extortions and internecine strife of their Fula and Tuareg masters, freely opened their gates to the French as soon as Lieut. Boiteux reached Kabara in command of a small flotilla.

The occupation of the town, against orders, was a daring exploit of a handful of marines. The force which "garrisoned" Timbuktu consisted of but seven Europeans and twelve Senegalese, a somewhat larger body being left with the gunboats at Kabara. On the 28th of December the Tuareg attacked the boat party, killing Naval Ensign Aube, another officer, and eighteen black sailors. Colonel T. P. E. Bonnier, who was at Mopti, 200 m. to the south-west, marched to the relief of Boiteux and entered Timbuktu without opposition on the 10th of January 1894. Leaving part of his force in the town the colonel set out with about 100 men to chastize the nomads. In the night of the 14th–15th January his camp was surprised and the colonel and nearly all his men perished. The enemy did not follow up their victory, and within a short period French rule was firmly established in Timbuktu.

Apart from some Christian captives, the place was reached during the 19th century, previous to its capture by the French, by four Europeans—Major Gordon Laing from Tripoli (1826), who was murdered by order of the Fula; René Caillié from the south (1828), Heinrich Barth from Central Sudan (1853) and Oskar Lenz from Morocco (1880). (In 1903 the French authorities placed commemorative tablets on the houses occupied by

[1] Tin-Buktu in Arabic may stand for "the well of Buktu"; in the Songhoi tongue the word means a hollow.

these four men during their stay in Timbuktu. The tablets bear simply the name of the explorer and the date of his visit.) In 1895 Felix Dubois made a stay of some duration in the town, investigating its history and that of the surrounding country. In 1904 Timbuktu became part of the colony of Upper Senegal and Niger.

The British connexion with Timbuktu may be briefly stated. Barth went to West Africa as the officially credited representative of the British government, empowered to enter into relations with the native princes. At Timbuktu he stayed under the protection of the sheikh Sidi Mahommed El Backay (Bakhai), and took back to England letters from the sheikh professing friendship with the British. In reply Lord Clarendon, secretary of state for foreign affairs, wrote a letter dated the 15th of April 1859, to El Backay, stating that "the friendship binding us shall not diminish through the centuries" and "as our government is very powerful we will protect your people who turn to us." A nephew of the sheikh went to Tripoli where he received presents for his uncle and other chieftains from the British consul, who also wrote a letter to El Backay, saying, among other things, "The English government has sent a steamer up the river which flows out of your country and has recommended those on board to make every effort to reach you." The steamer did not ascend the Niger to Timbuktu, and no further efforts appear to have been made in England to maintain political relations with Timbuktu. Moreover the power of El Backay seems not to have been so great as was believed in England, or at least did not long continue after the departure of Barth.

AUTHORITIES.—The chief original authorities are the *Tarik es-Sudan* (trans. Houdas, Paris, 1901); and Ahmad Baba's "Chronicle" (trans. Barth) in *Zeitsch. der morgenländ. Gesellsch.* ix. 826. Among medieval writers, see especially Ibn Batuta and Leo Africanus. Of early European records Barth's *Travels* are the most important. The best popular account is F. Dubois, *Timbuctoo the Mysterious* (London, 1896). Consult also H. N. Frey, *Sénégal et Soudan* (Paris, 1888); Lieut. Hourst, *The Exploration of the Niger* (London, 1898); O. Lenz, *Timbuktu* (Leipzig, 1884); W. D. Cooley, *Negroland of the Arabs* (London, 1841); A. Lebon, *Rapport de la mission au Sénégal et au Soudan* (Paris, 1898); Commandant Toutée, *Dahomé, Niger, Touareg* (Paris, 1897), *Du Dahomé au Sahara* (Paris, 1899); Lady Lugard, *A Tropical Dependency* (London, 1905). (F. R. C.)

TIME (O. Eng. *tima*, cf. Icel. *timi*, Swed. *timme*, hour, Dan. *time*; from the root also seen in "tide," properly the time of between the flow and ebb of the sea, cf. O. Eng. *getidan*, to happen, "even-tide," &c.; it is not directly related to Lat. *tempus*), the general term for the experience of duration or succession, either in whole or in part. For time in its psychological sense see SPACE AND TIME; for time in music, see RHYTHM; for the methods of reckoning time see CALENDAR; DAY; MONTH; and the articles TIME, MEASUREMENT OF, and TIME STANDARD, below. Generally in English law, where any particular time is mentioned in acts of parliament or legal instruments, it is to be defined as meaning, in Great Britain, Greenwich mean time, and in Ireland, Dublin mean time. At common law, where parties enter into legal relations, and specify their intention of being bound by any particular arbitrary system, the courts will, as a rule, give effect to their intentions.

TIME, MEASUREMENT OF. Time is measured by successive phenomena recurring at regular intervals. The only astronomical phenomenon which rigorously fulfils this condition, and the most striking one—the apparent daily revolution of the celestial sphere caused by the rotation of the earth—has from the remotest antiquity been employed as a measure of time. The interval between two successive returns of a fixed point on the sphere to the meridian is called the sidereal day; and sidereal time is reckoned from the moment when the "first point of Aries" (the vernal equinox) passes the meridian, the hours being counted from 0 to 24. Clocks and chronometers regulated to sidereal time are only used by astronomers, to whom they are indispensable, as the sidereal time at any moment is equal to the right ascension of any star just then passing the meridian. For ordinary purposes solar time is used. The solar day, as defined by the successive returns of the sun to the meridian, does not furnish a uniform measure of time, owing to the slightly variable velocity of the sun's motion and the inclination of its orbit to the equator, so that it becomes necessary to introduce an imaginary mean sun moving in the equator with uniform velocity. The equation of time is the difference between apparent (or true) solar time and mean solar time. The latter is that shown by clocks and watches used for ordinary purposes. Mean time is converted into apparent time by applying the equation of time with its proper sign, as given in the *Nautical Almanac* and other ephemerides for every day at noon. As the equation varies from day to day, it is necessary to take this into account, if the apparent time is required for any moment different from noon. The ephemerides also give the sidereal time at mean noon, from which it is easy to find the sidereal time at any moment, as 24 hours of mean solar time are equal to $24^h\ 3^m\ 56{\cdot}5554^s$ of sidereal time. About the 21st of March of each year a sidereal clock agrees with a mean time clock, but it gains on the latter $3^m\ 56{\cdot}5^s$ every day, so that in the course of a year it has gained a whole day. For a place not on the meridian of Greenwich the sidereal time at noon must be corrected by the addition or subtraction of $9{\cdot}8565^s$ for each hour of longitude, according as the place is west or east of Greenwich.

While it has for obvious reasons become customary in all civilized countries to commence the ordinary or civil day at midnight, astronomers count the day from noon, being the transit of the mean sun across the meridian, in strict conformity with the rule as to the beginning of the sidereal day. The hours of the astronomical day are also counted from 0 to 24. An international conference which met in 1884 at Washington to consider the question of introducing a universal day (see below), recommended that the astronomical day should commence at midnight, to make it coincide with the civil day. The great majority of astronomers, however, expressed themselves very strongly against this proposal, and it has not been adopted.

Determination of Time.—The problem of determining the exact time at any moment is practically identical with that of determining the apparent position of any known point on the celestial sphere with regard to one of the fixed (imaginary) great circles appertaining to the observer's station, the meridian or the horizon. The point selected is either the sun or one of the standard stars, the places of which are accurately determined and given for every tenth day in the modern ephemerides. The time thus determined furnishes the *error* of the clock, chronometer or watch employed, and a second determination of time after an interval gives a new value of the error and thereby the *rate* of the timekeeper.

The ancient astronomers, although they have left us very ample information about their dials, water or sand clocks (*clepsydrae*), and similar timekeepers, are very reticent as to how these were controlled. Ptolemy, in his *Almagest*, states nothing whatever as to how the time was found when the numerous astronomical phenomena which he records took place; but Hipparchus, in the only book we possess from his hand, gives a list of 44 stars scattered over the sky at intervals of right ascension equal to exactly one hour, so that one or more of them would be on the meridian at the commencement of every sidereal hour. H. C. F. C. Schjellerup[1] has shown that the right ascensions assumed by Hipparchus agree within about 15′ or one minute of time with those calculated back to the year 140 B.C. from modern star-places and proper motions. The accuracy which, it thus appears, could be attained by the ancients in their determinations of time was far beyond what they seem to have considered necessary, as they only record astronomical phenomena (*e.g.* eclipses, occultations) as having occurred "towards the middle of the third hour," or "about 8⅔ hours of the night," without ever giving minutes.[2] The Arabians had a

[1] "Recherches sur l'astronomie des Anciens: I. Sur le chronomètre céleste d'Hipparque," in *Copernicus: An International Journal of Astronomy*, i. 25.

[2] For astronomical purposes the ancients made use of mean-time hours—ὧραι ἰσημεριναί, *horae equinoctiales*—into which they translated all indications expressed in civil hours of varying length—ὧραι καιρικαί, *horae temporales.* Ptolemy counts the mean day from noon.

clearer perception of the importance of knowing the accurate time of phenomena, and in the year 829 we find it stated that at the commencement of the solar eclipse on the 30th of November the altitude of the sun was 7° and at the end 24°, as observed at Bagdad by Ahmed ibn Abdallah, called Habash.[1] This seems to be the earliest determination of time by an altitude; and this method then came into general use among the Arabians, who, on observing lunar eclipses, never failed to measure the altitude of some bright star at the beginning and end of the eclipse. In Europe this method was adopted by Purbach and Regiomontanus apparently for the first time in 1457 Bernhard Walther, a pupil of the latter, seems to have been the first to use for scientific purposes clocks driven by weights: he states that on the 16th of January 1484 he observed the rising of the planet Mercury, and immediately attached the weight to a clock having an hour-wheel with fifty-six teeth; at sunrise one hour and thirty-five teeth had passed, so that the interval was an hour and thirty-seven minutes. For nearly two hundred years, until the application of the pendulum to clocks became general, astronomers could place little or no reliance on their clocks, and consequently it was always necessary to fix the moment of an observation by a simultaneous time determination. For this purpose Tycho Brahe employed altitudes observed with quadrants; but he remarks that if the star is taken too near the meridian the altitude varies too slowly, and if too near the horizon the refraction (which at that time was very imperfectly known) introduces an element of uncertainty. He sometimes used azimuths, or with the large "armillary spheres" which played so important a part among his instruments, he measured hour-angles or distances from the meridian along the equator.[2] Transits of stars across the meridian were also observed with the meridian quadrant, an instrument which is alluded to by Ptolemy and was certainly in use at the Marāgha (Persia) observatory in the 13th century, but of which Tycho was the first to make extensive use. But he chiefly employed it for determining star-places, having obtained the clock error by the methods already described.

In addition to these methods, that of "equal altitudes" was much in use during the 17th century. That equal distances east and west of the meridian correspond to equal altitudes had of course been known as long as sundials had been used; but, now that quadrants, cross-staves and parallactic rules were commonly employed for measuring altitudes more accurately, the idea naturally suggested itself to determine the time of a star's or the sun's meridian passage by noting the moments when it reached any particular altitude on both sides of the meridian. But Tycho's plan of an instrument fixed in the meridian was not forgotten, and from the end of the 17th century, when Römer invented the transit instrument, the observation of transits across the meridian became the principal means of determining time at fixed observatories, while the observation of altitudes, first by portable quadrants, afterwards by reflecting sextants, and during the 19th century by portable alt-azimuths or theodolites, has been used on journeys. Since about 1830 the small transit instrument, with what is known as a "broken telescope," has also been much employed on scientific expeditions; but great caution is necessary in using it, as the difficulties of getting a perfectly rigid mounting for the prism or mirror which reflects the rays from the object glass through the axis to the eyepiece appear to be very great, for strange discrepancies in the results have often been noticed. The gradual development of astronomical instruments has been accompanied by a corresponding development in timekeepers. From being very untrustworthy, astronomical clocks are now made to great perfection by the application of the pendulum and by its compensation, while the invention of chronometers has placed a portable and equally trustworthy timekeeper in the hands of travellers.

We shall now give a sketch of the principal methods of determining time.

[1] Caussin, *Le Livre de la grande table Hakémite*, p. 100 (Paris, 1804).

[2] See his *Epistolae astronomicae*, p. 73.

In the spherical triangle ZPS between the zenith, the pole and a star the side $ZP=90°-\phi$ (ϕ being the latitude), $PS=90°-\delta$ (δ being the declination), and ZS or $z=90°$ minus the observed altitude. The angle $ZPS=t$ is the star's hour-angle or, in time, the interval between the moment of observation and the meridian passage of the star. We have then

$$\cos t = \frac{\cos z - \sin\phi\sin\delta}{\cos\phi\cos\delta},$$

which formula can be made more convenient for the use of logarithms by putting $z+\phi+\delta=2S$, which gives

$$\tan^2 \tfrac{1}{2}t = \frac{\sin(S-\phi)\ \sin(S-\delta)}{\cos S\cos(S-z)}.$$

According as the star was observed west or east of the meridian, t will be positive or negative. If α be the right ascension of the star, the sidereal time $=t+\alpha$, α as well as δ being taken from an ephemeris. If the sun had been observed the hour-angle t would be the apparent solar time. The latitude observed must be corrected for refraction, and in the case of the sun also for parallax, while the sun's semi-diameter must be added or subtracted according as the lower or upper limb was observed. The declination of the sun being variable, and being given in the ephemerides for noon of each day, allowance must be made for this by interpolating with an approximate value of the time. As the altitude changes very slowly near the meridian, this method is most advantageous if the star be taken near the prime vertical, while it is also easy to see that the greater the latitude the more uncertain the result. If a number of altitudes of the same object are observed, it is not necessary to deduce the clock error separately from each observation, but a correction may be applied to the mean of the zenith distances. Supposing n observations to be taken at the moments $T_1, T_2, T_3, \ldots$, the mean of all being T_0, and calling the z corresponding to this Z, we have

$$z_1 = Z + \frac{dZ}{dt}(T_1 - T_0) + \frac{1}{2}\frac{d^2Z}{dt^2}(T_1 - T_0)^2;$$

$$z_2 = Z + \frac{dZ}{dt}(T_2 - T_0) + \frac{1}{2}\frac{d^2Z}{dt^2}(T_2 - T_0)^2;$$

and so on, t being the hour-angle answering to T_0. As $\Sigma(T-T_0)=0$, these equations give

$$Z = \frac{z_1+z_2+z_3+\ldots}{n} - \frac{1}{2}\frac{d^2Z}{dt^2}\frac{(T_1-T_0)^2+(T_2-T_0)^2+\ldots}{n};$$

$$= \frac{z_1+z_2+z_3+\ldots}{n} - \frac{d^2Z}{dt^2}\frac{\Sigma 2\sin^2\frac{1}{2}(T-T_0)}{n}.$$

But, if in the above-mentioned triangle we designate the angles at Z and S by $180°-A$ and p, we have

$$\sin z\sin A = \cos\delta\sin t;$$
$$\sin z\cos A = -\cos\phi\sin\delta + \sin\phi\cos\delta\cos t;$$

and by differentiation

$$\frac{d^2Z}{dt^2} = \frac{\cos\phi\cos\delta\cos A\cos p}{\sin Z},$$

in which A and p are determined by

$$\sin A = \frac{\sin t}{\sin Z}\cos\delta \text{ and } \sin p = \frac{\sin t}{\sin Z}\cos\phi.$$

With this corrected mean of the observed zenith distances the hour-angle and time are determined, and by comparison with T_0 the error of the timekeeper.

The method of equal altitudes gives very simply the clock error equal to the right ascension minus half the sum of the clock times corresponding to the observed equal altitudes on both sides of the meridian. When the sun is observed, a correction has to be applied for the change of declination in the interval between the observations. Calling this interval $2t$, the correction to the apparent noon given by the observations x, the change of declination in half the interval $\Delta\delta$, and the observed altitude h, we have

$$\sin h = \sin\phi\sin(\delta-\Delta\delta) + \cos\phi\cos(\delta-\Delta\delta)\cos(t+x)$$

and $\sin h = \sin\phi\sin(\delta+\Delta\delta) + \cos\phi\cos(\delta+\Delta\delta)\cos(t-x)$,

whence, as $\cos x$ may be put $=1$, $\sin x = x$, and $\tan\Delta\delta = \Delta\delta$,

$$x = -\left(\frac{\tan\phi}{\sin t} - \frac{\tan\delta}{\tan t}\right)\Delta\delta,$$

which, divided by 15, gives the required correction in seconds of time. Similarly an afternoon observation may be combined with an observation made the following morning to find the time of apparent midnight.

The observation of the time when a star has a certain azimuth may also be used for determining the clock error, as the hour-angle can be found from the declination, the latitude and the azimuth. As the azimuth changes most rapidly at the meridian, the observation is most advantageous there, besides which it is neither necessary to know the latitude nor the declination accurately. The observed time of transit over the meridian must be corrected for the deviations of the instrument in azimuth, level and collimation. This corrected time of transit, expressed in sidereal time, should then be equal to the right ascension of the object observed, and the difference is the clock error. In observatories the determination of a clock's error (a necessary operation during a night's work with a transit circle) is generally founded on observations of four or five "clock stars," these being standard stars not near the pole, of which the absolute right ascensions have been determined with great care, besides observation of a close circumpolar star for finding the error of azimuth and determination of level and collimation error.[1]

Observers in the field with portable instruments often find it inconvenient to wait for the meridian transits of one of the few close circumpolar stars given in the ephemerides. In that case they have recourse to what is known as the method of time determination in the vertical of a pole star. The alt-azimuth is first directed to one of the standard stars near the pole, such as α or δ Ursae Minoris, using whichever is nearest to the meridian at the time. The instrument is set so that the star in a few minutes will cross the middle vertical wire in the field. The spirit-level is in the meantime put on the axis and the inclination of the latter measured. The time of the transit of the star is then observed, after which the instrument, remaining clamped in azimuth, is turned to a cock star and the transit of this over all the wires is observed. The level is applied again, and the mean of the two results is used in the reductions. In case the collimation error of the instrument is not accurately known, the instrument should be reversed and another observation of the same kind taken. The observations made in each position of the instrument are separately reduced with an assumed approximate value of the error of collimation, and two equations are thus derived from which the clock error and correction to the assumed collimation error are found. This use of the transit or alt-azimuth out of the meridian throws considerably more work on the computer than the meridian observations do, and it is therefore never resorted to except when an observer during field operations is pressed for time. The formulae of reduction as developed by Hansen in the *Astronomische Nachrichten* (xlviii. 113 seq.) are given by Chauvenet in his *Spherical and Practical Astronomy* ii. 216 seq. (4th ed., Philadelphia, 1873) The subject has also been treated at great length by Döllen in two memoirs: *Die Zeitbestimmung vermittelst des tragbaren Durchgangsinstrument im Verticale des Polarsterns* (4to, St Petersburg, 1863 and 1874).

Longitude.—Hitherto we have only spoken of the determination of local time. But in order to compare observations made at different places on the surface of the earth a knowledge of their difference of longitude becomes necessary, as the local time varies proportionally with the longitude, one hour corresponding to 15°. Longitude can be determined either geodetically or astronomically. The first method supposes the earth to be a spheroid of known dimensions. Starting from a point of departure of which the latitude has been determined, the azimuth from the meridian (as determined astronomically) and the distance of some other station are measured. This second station then serves as a point of departure to a third, and by repeating this process the longitude and latitude of places at a considerable distance from the original starting-point may be found. Referring for this method to the articles EARTH, FIGURE OF THE, and GEODESY, we shall here only deal with astronomical methods of determining longitude.

The earliest astronomer who determined longitude by astronomical observations seems to have been Hipparchus, who chose for the first meridian that of Rhodes, where he observed; but Ptolemy adopted a meridian laid through the "Insulae Fortunatae" as being the farthest known place towards the west.[2] When the voyages of discovery began the peak of Teneriffe was frequently used as a first meridian, until a scientific congress, assembled by Richelieu at Paris in 1630, selected the island of Ferro for this purpose. Although various other meridians (*e.g.* that of Uraniburg and that of San Miguel, one of the Azores, 29° 25′ W. of Paris) continued to be used for a long time, that of Ferro, which received the authorization of Louis XIII. on the 25th of April 1634, gradually superseded the others. In 1724 the longitude of Paris from the west coast of Ferro was found by Louis Feuillée, who had been sent there by the Paris Academy, to be 20° 1′ 45″; but on the proposal of Guillaume de Lisle (1675–1726) the meridian of Ferro was assumed to be exactly 20° W. of the Paris observatory. Modern maps and charts generally give the longitude from the observatory of either Paris or Greenwich according to the nationality of the constructor; the Washington meridian conference of 1884 recommended the exclusive use of the meridian of Greenwich. On the same occasion it was also recommended to introduce the use of a "universal day," beginning for the whole earth at Greenwich midnight, without interfering with the use of local time. This proposal has, however, not been adopted, but instead of it the system of "Standard Time" (see below) has been accepted in most countries. Already in 1883 four standard meridians were adopted in the United States, 75°, 90°, 105°, 120° west of Greenwich, so that clocks showing "Eastern, Central, Mountain or Pacific time" are exactly five, six, seven or eight hours slower than a Greenwich mean time clock. In Europe Norway, Sweden, Germany, Austro-Hungary, Switzerland and Italy use mid-European time, one hour fast on Greenwich. In South Africa the legal time is two hours fast on Greenwich, &c.[3]

[1] The probable error of a clock correction found in this way from one star is about $\pm 0{\cdot}04^s$, if a modern transit circle and chronograph is used.

[2] This was first done early in the 2nd century by Marinus of Tyre.

The simplest method for determining difference of longitude consists in observing at the two stations some celestial phenomenon which occurs at the same absolute moment for the whole earth. Hipparchus pointed out how observations of lunar eclipses could be used in this way, and for about fifteen hundred years this was the only method available. When Regiomontanus began to publish his ephemerides towards the end of the 15th century, they furnished other means of determining the longitude. Thus Amerigo Vespucci observed on the 23rd of August 1499, somewhere on the coast of Venezuela, that the moon at $7^h\ 30^m$ p.m. was 1°, at midnight 5½° east of Mars; from this he concluded that they must have been in conjunction at $6^h\ 30^m$, whereas the ephemeris announced this to take place at midnight. This gave the longitude of his station as roughly equal to 5½ hours west of Cadiz. The instruments and the lunar tables at that time being very imperfect, the longitudes determined were very erroneous. The invention of the telescope early in the 17th century made it possible to observe eclipses of Jupiter's satellites; but there is to a great extent the same drawback attached to these as to lunar eclipses: that it is impossible to observe with sufficient accuracy the moments at which they occur.

Eclipses of the sun and occultations of stars by the moon were also much used for determining longitude before the invention of chronometers and the electric telegraph offered better means for fixing the longitude of observatories. These methods are now hardly ever employed except by travellers, as they are very inferior as regards accuracy. For the necessary formulae see Chauvenet's *Spherical and Practical Astronomy*, i. 518–542 and 550–557.

We now proceed to consider the four methods for finding the longitudes of fixed observatories, viz. by (1) moon culminations, (2) rockets or other signals, (3) transport of chronometers and (4) transmission of time by the electric telegraph.

1. *Moon Culminations.*—Owing to the rapid orbital motion of the moon the sidereal time of its culmination is different for different meridians. If, therefore, the rate of the moon's change of right ascension is known, it is easy from the observed time of culmination at two stations to deduce their difference of longitude. In order to be as much as possible independent of instrumental errors, some standard stars nearly on the parallel of the moon are observed at the two stations; these "moon-culminating stars" are given in the ephemerides in order to secure that both observers take the same stars. As either the preceding or the following limb, not the centre, of the moon is observed, allowance must be made for the time the semi-diameter takes to pass the meridian and for the change of right ascension during this time. This method was proposed by Pigott towards the end of the 18th century, and has been much used; but, though it may be very serviceable on journeys and expeditions to distant places where the chronometric and telegraphic methods cannot be employed, it is not accurate enough for fixed observatories. Errors of four to six seconds of time have frequently been noticed in longitudes obtained by this method from a limited number of observations: *e.g.* $4{\cdot}47^s$ in the case of the Madras observatory.[4]

[3] For a complete list of the standard times adopted in all countries see *Publications of the U.S. Naval Observatory*, vol. iv. app. iv. (Washington, 1906).

[4] For field stations the photographic method first proposed and carried out by Captain Hills, R.E., in 1895, may be found advantageous. A camera of rigid form is set up and some instantaneous moon-exposures are made, after which the camera is left untouched until a few exposures can be made of a couple of bright stars, which are allowed to impress their trails on the plate for 15 or 30 seconds. If the exact local time of each exposure be known, such a plate gives the data necessary for computing the moon's position at the time of each exposure, and hence the Greenwich time and longitude (*Memoirs Roy. Astr. Soc.*, 1899, liii. 117).

2. *Signals.*—In 1671 Picard determined the difference of longitude between Copenhagen and the site of Tycho Brahe's observatory by watching from the latter the covering and uncovering of a fire lighted on the top of the observatory tower at Copenhagen. Powder or rocket signals have been in use since the middle of the 18th century; they are nowadays never used for this purpose, although several of the principal observatories of Europe were connected in this manner early in the 19th century.[1]

3. *Transport of Chronometers.*—This means of determining longitude was first tried in cases where the chronometers could be brought the whole way by sea, but the improved means of communication on land led to its adoption in 1828 between the observatories at Greenwich and Cambridge, and in the following years between many other observatories. A few of the more extensive expeditions undertaken for this object deserve to be mentioned. In 1843 more than sixty chronometers were sent sixteen times backwards and forwards between Altona and Pulkowa, and in 1844 forty chronometers were sent the same number of times between Altona and Greenwich. In 1844 the longitude of Valentia on the south-west coast of Ireland was determined by transporting thirty pocket chronometers via Liverpool and Kingstown and having an intermediate station at the latter place. The longitude of the United States naval observatory has been frequently determined from Greenwich. The following results will give an idea of the accuracy of the method.[2]

Previous to 1849, 373 chronometers . . .	$5^h\ 8^m\ 12{\cdot}52^s$
Expedition of 1849, Bond's discussion . .	$11{\cdot}20^s$
,, ,, Walker's ,, . . .	$12{\cdot}06^s$
,, ,, Bond's second result .	$12{\cdot}26^s \pm 0{\cdot}20^s$
,, 1855, 52 chronometers, 6 trips, Bond	$13{\cdot}49^s \pm 0{\cdot}19^s$

The value now accepted from the telegraphic determination is $5^h\ 8^m\ 12{\cdot}09^s$. The probable errors of the results for Pulkowa-Altona and Altona-Greenwich were supposed to be $\pm\ 0{\cdot}039^s$ and $\pm 0{\cdot}042^s$. It is of course only natural that the uncertainty of the results for the transatlantic longitude should be much greater, considering the length of time which elapsed between the rating of the chronometers at the observatories of Boston, Cambridge Massachusetts) and Liverpool. The difficulty of the method consists in determining the "travelling rate." Each time a chronometer leaves the station A and returns to it the error is determined, and consequently the rate for the time occupied by the journeys from A to B and from B to A and by the sojourn at B. Similarly a rate is found by each departure from and return to B, and the time of rest at A and B is also utilized for determining the stationary rate. In this way a series of rates for overlapping intervals of time are found, from which the travelling rates may be interpolated. It is owing to the uncertainty which necessarily attaches to the rate of a chronometer during long journeys, especially by land, where they are exposed to shaking and more or less violent motion, that it is desirable to employ a great number. It is scarcely necessary to mention that the temperature correction for each chronometer must be carefully investigated, and the local time rigorously determined at each station during the entire period of the operations.

4. *Telegraphic Determination of Longitude.*—This was first suggested by the American astronomer S. C. Walker, and owed its development to the United States Coast Survey, where it was employed from about 1849. Nearly all the more important public observatories have now been connected in this way on the continent of Europe, chiefly at the instigation of the "Europäische Gradmessung," while the determinations in connexion with the transits of Venus and those carried out in recent years by the American, French, British and Colonial governments have completed the circuit of the greater part of the globe. The telegraphic method compares the local time at one station with that at the other by means of electric signals. If a signal is sent from the eastern station A at the local time T, and received at the western station B at the local time T_1, then, if the time taken by the current to pass through the wire is called z, the difference of longitude is

$$\lambda = T - T_1 + x,$$

and similarly, if a signal is sent from B at the time T_2 and received at A at T_3, we have $\lambda = T_3 - T_2 - x$,
from which the unknown quantity x can be eliminated.

The operations of a telegraphic longitude determination can be arranged in two ways. Either the local time is determined at both stations and the clocks are compared by telegraph, or the time determinations are marked simultaneously on the two chronographs at the two stations, so that further signals for clock comparison are unnecessary. The first method has to be used when the telegraph is only for a limited time each night at the disposal of the observers, or when the climatic conditions at the two stations are so different that clear weather cannot often be expected to occur at both simultaneously, also when the difference of longitude is so considerable that too much time would be lost at the eastern station waiting for the arrival of the transit record of one star from the western station before observing another star. The independent time determination also offers the advantage that the observations may be taken either by eye and ear or by the chronograph, but as the observations made with the chronograph are somewhat more accurate than those made by eye and ear, the chronograph should be used wherever possible. This method is the one generally adopted. The method of simultaneous registration at both stations of transits of the same stars has one advantage. Each transit observed at both stations furnishes a value of the difference of longitude, so that the final result is less dependent on the clock rate than in the first method, which necessitates the combination of a series of clock errors determined during the night to form a value of the clock error for the time when the exchange of signals took place. When using this method it is advisable to select the stars in such a manner that only one station at a time is at work, so that the intensity of the current can be readjusted (by means of a rheostat) between every despatch and receipt of signals. This attention to the intensity of the current is necessary whatever method is employed, as the constancy of the transmission time (x in the above equations) chiefly depends on the constancy of the current. The probable error of a difference of longitude deduced from one star appears to be[3]

for eye and ear transits $\pm 0{\cdot}08^s$,
for chronograph transits $\pm 0{\cdot}07^s$;

while the probable error of the final result of a carefully planned and well executed series of telegraphic longitude operations is generally between $\pm 0^s{\cdot}010$ and $\pm 0{\cdot}020^s$.

Wireless telegraphy was for the first time employed in 1906 in a determination of the difference of longitude between Potsdam and Brocken, the signals being sent from Nauen, 32 km. from the former and 183 km. from the latter station. The resulting clock-differences were found to be quite independent of the energy of the electric waves. Wireless telegraphy will no doubt in future be much used in places where it may be desirable to determine the longitudes of a number of stations at the same time.

It is evident that the success of a determination of longitude depends to a very great extent on the accurate determination of time at the two stations, and great care must therefore be taken to determine the instrumental errors repeatedly during a night's work. But in addition to the uncertainty which enters into the results from the ordinary errors of observation, there is another source of error which becomes of special importance in longitude work, viz. the so-called personal error. The discovery of the fact that all observers differ more or less in their estimation of the time when a star crosses one of the spider lines in the transit instrument was made by F. W. Bessel in 1820;[4] and, as he happened to differ fully a second of time from several other observers, this remarkably large error naturally caused the phenomenon to be carefully examined. Bessel also suggested what appears to be the right explanation, viz. the co-operation of two senses in observing transits by eye and ear, the ear having to count the beats of the clock while the eye compares the distance of the star from the spider line at the last beat before the transit with the distance at the first beat after it, thus estimating the fraction of second at which the transit took place. It can easily be conceived that one person may first hear and then see, while to another these sensations take place in the reverse order; and to this possible source of error may be added the sensible time required by the transmission of sensations through the nerves to the brain and for the latter to act upon them. As the chronographic method of observing dispenses with one sense (that of hearing) and merely requires the watching of the star's motion and the pressing of an electric key at the moment when the star is bisected by the thread, the personal errors should in this case be much smaller than when the eye and ear method is employed. And it is a fact that in the former method there have never occurred errors of between half and a whole second such as have not infrequently appeared in the latter method.

In transit observations generally this personal error does not cause any inconvenience, so long as only one observer is employed at a time, and unless the amount of the error varies with the magnitude of the star (which is often the case); but when absolute time has to be determined, as in longitude work, the full amount of the personal equation between the two observers must be carefully ascertained and taken into account. And an observer's error has often been found to vary very considerably not only from year to year but even within much shorter intervals; the use of a new instrument, though perhaps not differing in construction from the accustomed one, has also been known to affect the personal error. For a number of years this latter circumstance was coupled with another which seemed perfectly incomprehensible, the personal error appearing to vary with the reversal of the instrument, that is, with the position of the illuminating lamp east or west. But in 1869–1870 Hirsch noticed during the longitude operations in Switzerland that this was

[1] For instance, Greenwich and Paris in 1825 (*Phil. Trans.*, 1826). The result, $9^m\ 21{\cdot}6^s$, is only about $0{\cdot}6^s$ too great.

[2] Gould, *Transatlantic Longitude*, p. 5 (Washington, 1869).

[3] Albrecht, *Bestimmung von Längendifferenzen mit Hülfe des electrischen Telegraphen*, p. 80 (4to Leipzig, 1869).

[4] Maskelyne had in 1795 noticed that one of his assistants observed transits more than half a second later than himself, but this was supposed to arise from some wrong method of observing adopted by the assistant, and the matter was not further looked into.

caused by a shifting of the reflector inside the telescope, by means of which the field is illuminated, which produced an apparent shifting of the image of the spider lines, unless the eyepiece was very accurately focused for the observer's sight. The simplest and best way to find the equation between two observers is to let one observe the transits of stars over half the wires in the telescope, and the other observe the transits over the remainder, each taking care to refocus the eyepiece for himself in order to avoid the above-mentioned source of error. The single transits reduced to the middle wire give immediately the equation; and, in order to eliminate errors in the assumed wire-intervals, each observer uses alternately the first and the second half of the wires. In longitude work, the two observers generally after the completion of a certain number of nights' work exchange stations and commence a new set of observations; the mean of the two results thus obtained should be free from the effect of personal error, provided that the errors of both observers have remained constant the whole time. It is therefore advisable to let the observers compare themselves, at the beginning, middle and end of the operations, and, if possible, at both the instruments employed. A useful check on the results is afforded by simultaneous experiments with one of the instruments contrived by C. Wolf, Kaiser and others, by which the absolute personal error of an observer can be determined. Though differing much in detail, these instruments are all constructed on the same principle: an artificial star (a lamp shining through a minute hole in a screen mounted on a small carriage moved by clockwork) passes in succession across a number of lines drawn on oiled paper, while an electric contact is made at the precise moment when the star is bisected on each line by the carriage passing a number of adjustable contact makers. The currents thus made register the transits automatically on a chronograph, while the observer, viewing the apparatus through his telescope, can observe the transits in the usual manner either by eye and ear or by chronograph, thus immediately finding his personal error. These contrivances have sometimes been used to educate pupils learning to observe, and experience has shown that a considerable personal error can be generally somewhat diminished through practice. By using Repsold's self-registering micrometer, which enables the observer to follow the motions of the star with a movable vertical wire which automatically registers its passage over certain fixed points in the eyepiece, the effect of personal error is almost completely eliminated. In the determination of the difference of longitude between Potsdam and Greenwich in 1903 the two observers with their instruments exchanged stations in the middle of the operations, and the sum of their personal and instrumental equation was $0{\cdot}000^s$ with a probable error of $\pm 0{\cdot}003^s$.

LITERATURE.—General treatises on spherical astronomy, such as Brünnow's *Lehrbuch der sphärischen Astronomie* (3rd ed., Berlin, 1871; trans. into English and several other languages) and Chauvenet's *Manual*, treat very fully of the numerous methods of determining time by combination of altitudes or azimuths of several stars. For telegraphic longitude work see the *Publicationen des kön. preussischen geodätischen Instituts*; the *Reports* of the United States Coast and Geodetic Survey; vol. ix. of the *Account of the Great Trigonometrical Survey of India*; and *Report of the Chief Astronomer, 1905* (Ottawa, 1906), which gives a useful review of recent longitude work in the Pacific and adjacent countries. On personal errors see Dreyer, *Proc. Roy. Irish Acad.* (1876), 2nd series, vol. ii. p. 484, and "Recherches sur l'équation personelle par M. F. Gonnesiat" in the *Trav. de l'observ. de Lyon* (1892), vol. ii. (J. L. E. D.)

TIME, STANDARD. Local time is determined by the relation of the meridian of a place to the sun. Noon at any place is defined as the moment when either the true or mean sun passes the meridian of that place, according as apparent or mean time is used. Practically, the use of mean time is now universal, so that we may regard the mean sun as that by which noon is determined. As the earth revolves, all its meridians are brought under the sun in succession or, relative to the earth, noon continually travels around the earth, making the circuit in twenty-four hours. It follows that noon, and therefore any other hour of the day, is later by four minutes for every degree of longitude towards the west, so that a watch carried east or west will be found to deviate from local time by an amount proportional to the change of longitude. Before the time of railways this deviation was not productive of inconvenience. But when railway travelling became common, train schedules had to be more exact than those of a mail coach, and the traveller was rapidly carried to places where the local time continually deviated from that shown by his watch. The use of such time thus had to be modified in places where intercommunication with others of a different longitude was frequent. Thus arose a practice on the part of railways of using the time of some central or important city on its line for all places not too distant, which time would naturally be adopted by the inhabitants of the region through which it passed. For a similar reason, in countries which did not extend through a large fraction of an hour of longitude, it was natural to use the time of the capital throughout all or a large part of its extent. Thus Greenwich time has long been in use throughout England, and all the railways of France are run by Paris time. But inconvenience was still unavoidable in passing from one country to another, or in travelling through long stretches in the same country. The inconvenience was especially felt in the United States, where every railway, and even every long stretch of several great railways, had its own time system. Thus it happened not infrequently that in a single station clocks would be found set to the time of three different meridians, one for the road toward the east, another for the road toward the west, and a third for the meridian of the place, or local use.

A device now being generally adopted to do away with this confusion was planned in 1878–1879 by Mr (afterwards Sir) Sandford Fleming, and published in the *Journal of the Canadian Institute of Toronto* for 1879. On the initiative of this organization, Mr Fleming's proposals were officially communicated to the leading governments of the world with a view of securing an international unification of the method of designating the hour of the day for common use. Naturally connected with the proposal was that of a prime meridian, from which all longitudes should be reckoned. United States invited an international conference, which was held in Washington in 1884, for the purpose of proposing a standard meridian to which longitudes and times should be referred.

Before this conference was called the railway managers of the United States, after long discussion, adopted the system. Its fundamental idea was that twenty-four standard meridians should be established 15° apart in longitude, starting from the meridian of Greenwich and extending round the globe. Then on each meridian the local time would differ from Greenwich time by some entire number of hours. At every point of the globe the time to be adopted for common use was that of the nearest standard meridian. These meridians would therefore mark the central lines of twenty-four zones, within each of which the time to be adopted would be uniform, but which would change by an hour on passing from one zone into another. The inhabitants of each zone naturally use the time of the zone instead of their local time, the maximum difference between the two being half an hour.

When the system was first established in the United States a delicate legal question arose as to whether the business of banks and courts should be legally adjusted to the new time. This was soon settled by state laws making the standard time legal within the limits of each zone. A similar system is being adopted in Europe, the standard meridians being those of 15°, 30°, &c., east of Greenwich. France, however, still adheres to Paris time,[1] but Belgium and Holland use Greenwich time, and Switzerland, Italy and central Germany use the time of 15° E., and therefore one hour in advance of that of Greenwich. This is termed mid-European time.

The system we have described is that adopted for the purposes of the railways and of daily life. For scientific and for some international purposes yet other modifications are desirable. An important distinction must be made between the cases in which convenience requires that the time have some relation to the hour of the day, and those where no such relation is required. The former is the case in designating acts or occurrences which depend upon our daily routine of rest and wakefulness. But if nothing is necessary except the designation of some moment of absolute time, irrespective of our daily routine of life, then only a single measure for the whole world is necessary. At the Washington Meridian Conference of 1884 it was proposed that Greenwich time should be adopted as a standard for the whole world in all matters of this class, especially in astronomical practice and in cable despatches. But this system does not seem to have been extensively adopted outside of astronomy, the

[1] A bill adopting Greenwich time in France, which had already passed the Chamber of Deputies, was favourably reported on in the Senate in December 1910.

cultivators of which are most accustomed to the conversion of local into standard or Greenwich time. An unavoidable inconvenience associated with the system is the uncertainty in many cases whether local or Greenwich mean time is understood. This must be especially the case with magnetic and seismic phenomena, the designation of which should be uniform for the whole earth; at present, however, we cannot invariably expect local observers to convert their observations from local into Greenwich mean time.

Associated with this question is that of the moment when the day should begin, or from which the hours should be counted. The civil division of the day into a.m. (*ante meridiem*, before mid-day) and p.m. (*post meridiem*, after mid-day), now practically universal in household and ordinary civil life, is impracticable for scientific purposes, where a count of the hours from 0 up to 24 is necessary. In railway schedules the necessity of distinguishing a.m. from p.m. when our civil time is used is found so troublesome that in some countries, especially Italy and Canada, the 24-hour system is used. Hours after noon are there designated as 13, 14, &c., up to midnight, at which moment a new day begins. On the other hand, with some few exceptions, astronomers have almost from time immemorial begun their day at noon, and navigators have very generally adopted the same practice, but for a quite different reason. In astronomy the day begins at noon for two reasons of convenience. One is that as the day is fixed by the transit of the sun over the meridian, it is more natural to start the count of the hours from this moment than from that when the sun is on the invisible antimeridian at midnight. This practice also coincides with that of counting the hours of sidereal time from the transit of the vernal equinox, and leads to the simple rule that the local mean time is equal to the hour angle of the mean sun. The other reason is that, as the astronomer makes most of his observations at night, and often after midnight, it is inconvenient to begin a new day at the latter hour. This consideration is however reversed in day observations, especially those on the sun, but these are few in number.

Navigators began the day at noon because their latitude is determined by observations of the sun, while the longitude is also generally determined during the daytime. Thus, in doing the " day's work " in the log, the position of the ship was always computed for noon. Such being the case, it was found more convenient to begin the count of a new day at this hour, to be continued through the night until the following noon. But the navigator's count of days was one day in advance of that of the astronomers; for example, March the 10th, astronomical time, begins on the 10th day of March at noon, and this count continues until noon of the day following, so that the forenoon of March the 11th, civil time, is still March the 10th, astronomical time. But the navigator begins March the 11th at noon on March the 10th. This difference is worthy of mention because a widespread misapprehension exists that the navigator was forced to count his days from noon owing to the adoption of the same system in the *Nautical Almanac*. The fact is that the practice of the navigator, like that of the astronomer, was adopted purely for his own convenience, and for the reasons just set forth. It is, however, being changed so as to conform to civil time, but as yet no general law prescribes the change.

At the Meridian Conference of 1884, it was proposed that the practice of beginning the day at midnight should be adopted universally in astronomy and navigation, and that the hours should be counted from that moment in all the nautical and astronomical ephemerides. The question of adopting this system became a subject of international correspondence. The views of the directors of the astronomical ephemerides, so far as elicited, were strongly against the change. The considerations which determined them were the confusion which the change would introduce into the tables and the count of time in the ephemerides, including the relation of sidereal and solar time; the unavoidable doubt as to whether the one or the other system was used in astronomical publications; and the danger of placing in the hands of the navigator an ephemeris in which the hours should have a different meaning from that to which he was accustomed. On the other hand, the reasons of convenience which led to the practice of beginning the day at noon still continued, so that nothing could be shown to counterbalance these drawbacks. Still, in works to be used by the public, especially almanacs and other astronomical annuals, it is necessary to convert astronomical into civil time. This must continue to be done, but offers no difficulty to the authors of such works, who are acquainted with the difference, nor to the public, which has no interest in the ephemerides and measures of time used by the professional astronomer. (S. N.)

TIME BARGAINS, a financial or commercial term for operations in securities or commodities which are to be completed at a future date, as opposed to bargains which are settled immediately. (See MARKET.)

TIMGAD, a ruined city 23 m. S.E. of Batna in the department of Constantine, Algeria. Timgad, the Thamugas of the Romans, was built on the lower slopes of the northern side of the Aures Mountains, and was situated at the intersection of six roads. It was traversed by two main streets, the Cardo Maximus running north and south, and the Decumanus Maximus east and west. The residential part of the town was on a lower level than the capitol and most of the other public buildings. The ruins of the capitol occupy a prominent position in the south-west of the city. Some of the columns of the façade (which are of the Corinthian order and 45 ft. high) have been re-erected. The dimensions of the capitol correspond with those of the Pantheon at Rome. Immediately north of the capitol are the remains of a large market; to the east are the ruins of the forum, basilica and theatre. The auditorium of the theatre, which held nearly 4000 persons, is complete. A little west of the theatre are baths, containing paved and mosaic floors in perfect preservation. Ruins of other and larger thermae are found in all four quarters of the city, those on the north being very extensive. Across the Decumanus Maximus just north-east of the market is the arch of Trajan—still erect, and restored in 1900. The arch is of the Corinthian order, and has three openings, the central one being 11 ft. wide. Each façade has four fluted columns 19 ft. high. The chief material used in building the arch was sandstone. The fluted columns are of fine white limestone and smaller columns are of coloured marble. At the other (eastern) end of the street are the remains of another triumphal arch. West of the capitol are the ruins of a large church, a square building with circular apse, built in the 7th century. There are also remains of six other churches. About 400 yds. south of the city, the walls nearly entire, is a ruined citadel, a quadrangular building 360 ft. by 295 ft., with eight towers. It was built (or rebuilt) by the Byzantine army in the 6th century. Near the northern thermae is the house of the director of the excavations and a museum containing small objects found in the ruins.

Numerous inscriptions have been found on the ruins, and from them many events in the history of Thamugas have been learnt. In the year A.D. 100 the emperor Trajan gave orders to build a city on the site of a fortified post on the road between Theveste and Lambaesis. This city, called Colonia Marciana Trajana Thamugas (Marciana in honour of Trajan's sister) appears from the inscriptions to have been completed, as far as the principal buildings were concerned, in seventeen years. A legion of Parthian veterans was stationed in the newly founded city. From the time of its foundation to the 4th century Thamugas seems to have enjoyed a peaceful and prosperous existence. Numerous inscriptions testify to the manner of life of the citizens. In the 3rd century Thamugas became a centre of Christian activity, and in the next century espoused the cause of the Donatists. The city declined in importance after the Vandal invasion in the 5th century, and was found in a ruinous condition by the Byzantine general Solomon, who occupied it A.D. 535. It is believed that the Berbers from the neighbouring mountains destroyed the city, hoping thus to prevent it being used as a stronghold from which to harry them. Thamugas was, however, repeopled, and in the 7th century was a Christian city. After the defeat of Gregorius, governor of Africa, by the Arabs in 647, Thamugas passes from history. After centuries of neglect James Bruce, the African traveller, visited the spot (1765), made careful drawings of the monuments and deciphered some of the inscriptions. Bruce was followed, more than a century later (1875), by Sir R. Lambert Playfair, British consul-general at Algiers, and soon afterwards (1875–1876) Professor Masqueray published a report on the state of the ruins. Since 1881 Thamugas has been systematically explored, and the ruins excavated under the direction of the *Service des monuments historiques*. Among the objects discovered are a series of standard measures—five cavities hollowed out of a stone slab.

Seventeen miles west of Timgad, on the site of the Roman city Lambaesis, is Lambessa (*q.v.*).

See G. Boeswillwald, R. Cagnat and A. Ballu, *Timgad, une cité africaine sous l'empire romain*; and A. Ballu, *Guide illustré de Timgad* (Paris, 1903).

TIMOCREON, of Ialysus in Rhodes, Greek lyric poet, flourished about 480 B.C. During the Persian wars he had been banished on suspicion of "medism." Themistocles had promised to procure his recall, but was unable to resist the bribes of Timocreon's adversaries and allowed him to remain in exile. Timocreon thereupon attacked him most bitterly (see Plutarch, *Themistocles*, 21); and Simonides, the friend of Themistocles, retorted in an epigram (*Anth. Pal.* vii. 348). Timocreon was also known as a composer of *scolia* (drinking-songs) and, according to Suïdas, wrote plays in the style of the old comedy. His gluttony and drunkenness were notorious, and he was an athlete of great prowess.

TIMOLEON (*c.* 411–337 B.C.), of Corinth, Greek statesman and general. As the champion of Greece against Carthage he is closely connected with the history of Sicily, especially Syracuse (*q.v.*). When his brother Timophanes, whose life he had saved in battle, took possession of the acropolis of Corinth and made himself master of the city, Timoleon, after an ineffectual protest, tacitly acquiesced while the friends who accompanied him put Timophanes to death. Public opinion approved his conduct as patriotic; but the curses of his mother and the indignation of some of his kinsfolk drove him into retirement for twenty years. In 344 envoys came from Syracuse to Corinth, to appeal to the mother-city for relief from the intestine feuds from which the Syracusans and all the Greeks of Sicily were suffering. Carthage too, their old and bitter foe, was intriguing with the local despots. Corinth could not refuse help, though her chief citizens declined the responsibility of attempting to establish a settled government in the factious and turbulent Syracuse. Timoleon, being named by an unknown voice in the popular assembly, was chosen by a unanimous vote to undertake the mission, and set sail for Sicily with a few of the leading citizens of Corinth and a small troop of Greek mercenaries. He eluded a Carthaginian squadron and landed at Tauromenium (Taormina), where he met with a friendly reception. At this time Hicetas, tyrant of Leontini, was master of Syracuse, with the exception of the island of Ortygia, which was occupied by Dionysius, still nominally tyrant. Hicetas was defeated at Adranum, an inland town, and driven back to Syracuse. In 343 Dionysius surrendered Ortygia on condition of being granted a safe conduct to Corinth. Hicetas now received help from Carthage (60,000 men), but ill-success roused mutual suspicion; the Carthaginians abandoned Hicetas, who was besieged in Leontini, and compelled to surrender. Timoleon was thus master of Syracuse. He at once began the work of restoration, bringing new settlers from the mother-city and from Greece generally, and establishing a popular government on the basis of the democratic laws of Diocles. The citadel was razed to the ground, and a court of justice erected on its site. The amphipolos, or priest of Olympian Zeus, who was annually chosen by lot out of three clans, was invested with the chief magistracy. The impress of Timoleon's reforms seems to have lasted to the days of Augustus. Hicetas again induced Carthage to send (340–339) a great army (70,000), which landed at Lilybaeum (Marsala). With a miscellaneous levy of about 12,000 men, most of them mercenaries, Timoleon marched westwards across the island into the neighbourhood of Selinus and won a great and decisive victory on the Crimissus. The general himself led his infantry, and the enemy's discomfiture was completed by a blinding storm of rain and hail. This victory gave the Greeks of Sicily many years of peace and safety from Carthage. Carthage made, however, one more effort and despatched some mercenaries to prolong the conflict between Timoleon and the tyrants. But it ended (338) in the defeat of Hicetas, who was taken prisoner and put to death; by a treaty the dominion of Carthage in Sicily was confined to the west of the Halycus (*Platani*). Timoleon then retired into private life without assuming any title or office, though he remained practically supreme, not only at Syracuse, but throughout the island. Notwithstanding the many elements of discord Sicily seems to have been during Timoleon's lifetime tranquil and contented. He became blind some time before his death, but persisted in attending the assembly and giving his opinion, which was usually accepted as a unanimous vote. He was buried at the cost of the citizens of Syracuse, who erected a monument to his memory in their market-place, afterwards surrounded with porticoes, and a gymnasium called Timoleonteum.

Lives by Plutarch and Cornelius Nepos; see also Diod. Sic. xvi. 65–90; monograph by J. F. Arnoldt (1850), which contains an exhaustive examination of the authorities; also SICILY: *History*; and SYRACUSE, with works quoted.

TIMOMACHUS, a Greek painter of the 1st century B.C. He was noted especially for two pictures, one of which represented Ajax during his madness, the other Medea meditating the slaying of her children. Both of these works were remarkable for their power of expression, especially in the face, and so belong to the latest phase of Greek art. Of the Medea we may form some notion from paintings found at Pompeii, representing that heroine standing with a sheathed sword in her hand, and watching the children at play (Helbig, *Wandgemälde Campaniens*, Nos. 1262–1265).

TIMON, of Athens, the noted misanthrope, celebrated in Shakespeare's play, lived during the Peloponnesian War. He is more than once alluded to by Aristophanes and other comedians. Plutarch introduces a short account of his life in his biography of Mark Antony (ch. 70), who built a retreat called Timonium (Strabo xvii. 794) at Alexandria. Timon also gave his name to one of Lucian's dialogues. Shakespeare probably derived his knowledge of Timon mainly from Plutarch; but the Timon of Shakespeare so resembles the Timon of Lucian that Shakespeare (or whoever wrote the first sketch of the play) may have had access to the dialogue.

TIMON (*c.* 320–230), of Phlius, Greek sceptic philosopher and satirical poet, a pupil of Stilpo the Megarian and Pyrrho of Elis. Having made a fortune by teaching and lecturing in Chalcedon he spent the rest of his life chiefly at Athens, where he died. His writings (Diogenes Laërtius, ix. ch. 12) were numerous both in prose and in verse: besides the Σίλλοι, he is said to have written epic poems, tragedies, comedies and satyric dramas. But he is best known as the author of the Σίλλοι, three books of sarcastic hexameter verses, written against the Greek philosophers.

The fragments that remain (about 140 lines or parts of lines, printed in F. W. A. Mullach, *Frag. phil. graec.* i. 84–98) show that Timon possessed some of the qualities of a great satirist, together with a command of the hexameter; but he had no loftier aim than to awaken laughter. Philosophers are "excessively cunning murderers of many wise saws" (*v.* 96); the only two whom he spares are Xenophanes, "the modest censor of Homer's lies" (*v.* 29), and Pyrrho, against whom "no other mortal dare contend" (*v.* 126). Besides the Σίλλοι we have some lines preserved from the Ἰνδαλμοί, a poem in elegiac verse, which appears to have inculcated the tenets of scepticism, and one or two fragments which cannot be with certainty assigned to either poem. There is a reference to Timon in Eus. *Praep. Ev.* xiv. (Eng. trans. by E. H. Gifford, 1903, p. 761). Fragments of his poems have been collected by Wölke, *De graecorum syllis* (Warsaw, 1820), Paul, *Dissertatio de syllis* (Berlin, 1821), and Wachsmuth, *Sillographorum graec. reliquiae* (Leipzig, 1885).

TIMOR, an island of the Malay Archipelago, the easternmost and largest of the Lesser Sunda Islands, stretching S.W. and N.E.

for 300 m. between 8° 40′ and 10° 40′ S., and between 123° 30′ and 127° E. It has a mean breadth of 60 m., and an area of about 12,500 sq. m. Politically its north-eastern half is Portuguese, as are two small enclaves in the south-western half, the remainder being Dutch. Timor lies in deep water a little to the west of the hundred fathom line, which marks in this direction the proper limit of the shallow Arafura Sea, extending between it and northern Australia. It differs considerably from the other members of the Sundanese group both in the direction of its main axis and in the prevalence of old rocks and slighter volcanic character. It comes, however, within the great volcanic zone which stretches from the north of Sumatra, through Java and the other Sundanese islands, round to Amboyna, Tidore, Ternate, Halmahera and the Philippines. There appear to be volcanic centres in both the east and the west of the island, and the surface is everywhere extremely rugged, with ridges from 4000 to 8000 ft. high, forming a confused orographic system, which is by no means fully understood. Mount Kabalaki in the north rises above 10,000 ft.; the culminating point appears to be Mt Alas (over 12,000 ft.) near the east coast. Owing to the prevalent dry easterly winds from the arid plains of north Australia, Timor, like Ombay, Flores and other neighbouring islands, has a much drier climate, and a poorer vegetation, than islands further west, and has few perennial streams and no considerable rivers. Hence, apart from almost untouched mineral wealth, such as iron, copper and gold, the island is poor in natural resources. Coal and petroleum have been found. At Kupang, on the south coast, the number of rainy days per month in the six months May to October dwindles from 4 to 0, while the monthly rainfall gradually sinks from a little less than 2 in. to nil; the northern districts are better watered. Though the mineral products are varied, the supply of ores has hitherto proved scanty; besides which their exploitation is rendered difficult by the lack of labourers, water and wood. The uplands yield fairly under cultivation, while the woodlands, which nowhere form true forests, contain much excellent sandalwood. This and a noted breed of hardy ponies form the chief articles of export. Owing to the deep water between Timor and the Arafura Sea, the fauna of Timor presents scarcely any Australian types beyond a marsupial cuscus. The few mammals, such as deer, civet, pigs, shrews and monkeys, as well as the birds and insects, resemble ordinary Malayan forms.

Timor consists of a core of ancient rocks (Archean?) upon which rest Permian and later deposits of sedimentary origin. Volcanic rocks are also present but they are not so extensively developed as in the islands of the Javan arc. The Permian beds consist chiefly of limestone and contain numerous fossils similar to those of the middle and upper divisions of the Productus limestone of northern India and the Artinsk stage of the Urals. The best-known locality is the bed of the Ayer Mati near Kupang. These rocks were originally referred to the Carboniferous system, and similar limestones have been recorded in many parts of the island. Triassic beds with *Halobia* and *Monotis* are well-developed in Rotti and appear also to occur in Timor. The fauna is similar to that of the Mediterranean Trias. Fragments of Jurassic rock have been found amongst the volcanic material on the island of Rotti, but they have not yet been discovered *in situ*. The Tertiary deposits form a fringe around the older rocks, and in some places this fringe extends far up into the interior of the island.

The bulk of the population is certainly Papuan, but intermingled with Malayan, Polynesian and other elements; hence it presents an extraordinary diversity of physical types, as is clearly shown by the portraits figured in H. O. Forbes's *Naturalist's Wanderings in the Eastern Archipelago*. The natives, still mainly independent of their nominal Dutch and Portuguese rulers, are divided into many hostile tribes, speaking as many as forty distinct Papuan and Malayan languages or dialects. Some are addicted to head-hunting, at least during war, and to other barbarous practices. In their *uma-luli*, or sacred (tabooed) enclosures, rites are performed resembling those of the Polynesian islanders.

Portuguese Timor includes the neighbouring isle of Pulo Kambing, and has an area of about 7450 sq. m. Estimates of the population vary from 300,000 to over half a million. Dilli, on the north coast, the administrative headquarters and chief settlement, is a poor little place of some 3000 inhabitants, containing hardly any Europeans apart from the officials. Macao was administratively united to Portuguese Timor till 1896, and still pays a contribution to the revenue. The estimated revenue for 1901–1902 was £25,196 (£7200 from Macao), and in 1905–1906 it was £26,968; the estimated expenditure was £36,532 in the earlier and £43,320 in the later period. Few ships visit the colony, except Dutch vessels trading in the archipelago, which call regularly at Dilli. Exports (principally coffee and wax) are valued at about £55,000 annually, and imports at about the same amount.

Dutch Timor has an area of a little over 5000 sq. m. Kupang, the chief town of the residency, contains some 8000 inhabitants, of whom 145 are Europeans living in well-built houses, 594 Chinese, and 43 Arabs. In agriculture, European plants have not been successful, and of native products the supply is only sufficient for the home consumption. The export of sandalwood, ponies, cattle, pinang nuts, &c., amounts in a year to only about £8500. Dutch Timor gives its name to a residency comprising, besides its own territory, the small adjacent islands, Rotti, Peman, &c., the Savu islands, Sumba or Sandalwood island, the Solor and Allor group of islands, and the eastern half of Flores, all lying between 8° 5′ and 11° 5′ S. and 119° 3′ and 125° 15′ E., the total area being 17,698 sq. m. It is divided into four administrative districts—Timor, Rotti and Savu, Larantuka (eastern Flores) and Sumba. Pop. of the residency (1905), 308,500.

It is possible that the Portuguese visited Timor before the Spaniards did so in 1522. They were, at any rate, established on the island when the Dutch expelled them from Kupang in 1613. During the 18th century the two powers came frequently into conflict; and in 1859 their boundaries were settled by treaty. This treaty was replaced by one signed at Lisbon in June 1893. The old treaty had proved irksome in many ways, especially as it left portions of the territory belonging to protected chieftains of each power as enclaves within the boundaries of the other. This led to frequent disputes, and a mixed boundary commission was therefore appointed under the new treaty and determined more satisfactory boundaries. The new treaty, moreover, stipulates that all future disputes shall be referred to arbitration. Equally important is the declaration, signed at the same time, that either power would favour the subjects of the other in granting concessions, &c., to the exclusion of all others. Thus Portugal and Holland secured the exclusive possession of Timor to themselves.

See P. A. van der Lith, *Nederlands-Indië* (Leiden, 1893–1894). H. O. Forbes, *A Naturalist's Wanderings in the Eastern Archipelago* (London, 1885); and other general works (cf. Malay Archipelago). Some of the problems connected with the physical features of Timor are discussed in H. Zondervan's "Timor en de Timoreezen," *Tijdschr. Aardr. Gen.* (1888), vol. v. (with bibliography); K. Martin and A. Wichmann, *Sammlungen des geologischen Reichsmuseums* (Leiden, 1881–1884); A. Wichmann, "Bericht über eine Reise nach dem indischen Archipel," *Tijdschr. Aardr. Gen.* (1890–1892), with sketches of Timor, map, &c.; A. Rothpletz, *Die Perm-, Trias-, und Jura-Formation auf Timor und Rotti im indischen Archipel, Palaeontographica* (1892) pp. 57–106. There is a summary of Rothpletz's results in *American Naturalist* (1891), xxv. 959–962. For the remarkable flying survey of the south coast by the commandant of the Siboga expedition, exploring the deep seas and fauna of the archipelago, see *Bulletin* (No. 35) of the *Maatschappij ter bevordering van het natuurkun onderzoëk der N.I. Koloniën*; R. Dores, "Apontamentos para um diccionario chorographico de Timor," *Bol. Soc. Geogr. Lisbon* (1901), vol. xix.

TIMOR LAUT ("Seaweed Timor"; Dutch, *Timor Laoet*), Tenimber or Tenimbar, a group of islands in the Malay Archipelago, S.W. of the Aru Islands, between 6° 20′ and 8° 30′ S., and 130° 40′ and 132° 5′ E. By the Dutch, in whose residency of Amboyna they are included, they are politically divided into two districts; Larat, including the inhabited islands of Larat, Vordate, Molu, and Maro, together with many uninhabited islands; and Sera, including the Sera Islands, Selaru, and the southern part of Yamdena, all inhabited. Only Yamdena and Selaru are by the natives called Timor Laut; all the others they call Tenimbar. The group is in the main coralline. Vordate, Molu and south-eastern Yamdena have a maximum height of 820 ft.; the rest are low and flat, except Laibobar, apparently a volcanic islet on the west, which has an extinct crater 2000 ft. high. Yamdena, the largest island, has an area of about 1100 sq. m.; the rest together about 1000. Ritabel in Larat is the only safe roadstead during the east and west monsoons. The fauna includes buffaloes, a marsupial cuscus, some bats, the beautiful scarlet lory, rare varieties of the ground-thrush, honey-eater and oriole. The population is estimated at about 19,000. The aborigines are Papuans, but much mixed with Malayan and perhaps Polynesian elements. They are a fine race, often over 6 ft. tall, noted for their artistic sense. In other respects they are pagans in a low state of culture, mostly divided into hostile communities and addicted to piracy. The only means of subsistence is primitive agriculture on a poor soil, turtle and trepang fishery and cattle-rearing. The yearly export (trepang, turtle and kamuning wood) is valued at only £850 to £1650.

See H. O. Forbes, "Three Months' Explorations in the Tenimbar Islands," in *Proc. of Roy. Geog. Soc.* (1884); J. G. Riedel, *De sluik en kroesharige rassen tusschen Selebes en Papua* (1886); W. R. van Hoëvell, "Tanimbar en Timor Laoet-Eilanden," in *Tijdschrift Batavian Genootschap* (1889), vol. xxxiii.; J. D. Garson, "On Cranial Characters of the Natives of Timor-Laut," *Journ. Anthrop. Instit.* xiii. 386.

TIMOTHEUS, Athenian statesman and general, son of Conon, the restorer of the walls of Athens. From 378–356 B.C. he frequently held command in the war between Athens (in alliance with Thebes), and Sparta. The object of Athens was to revive the old confederacy (see DELIAN LEAGUE, § B), and to regain command of the sea, and in 375 Timotheus was sent with a fleet to sail round Peloponnesus by way of demonstration against Sparta. He gained over Cephallenia, secured the friendship of the Acarnanians and Molossians, and took Corcyra, but used his victory with moderation. Want of funds and jealousy of the Thebans led to a short peace. In 373 Timotheus was appointed to the command of a fleet for the relief of Corcyra, then beleaguered by the Spartans. But his ships were not fully manned, and to recruit their strength he cruised in the Aegean. The delay excited the indignation of the Athenians, who brought him to trial; but, thanks to the exertions of his friends—Jason, tyrant of Pherae, and Alcetas, king of the Molossians, both of whom went to Athens to plead his cause—he was acquitted. He had previously been superseded in his command by Iphicrates. Being reduced to great povery—for he had pledged his private property in order to put the fleet in an efficient state—he left Athens and took service with the king of Persia. We next hear of him about 366, when, having returned to Athens, he was sent to support Ariobarzanes, satrap of Phrygia. But, finding that the satrap was in open revolt against Persia, Timotheus, in conformity with his instructions, abstained from helping him and turned his arms against Samos, then occupied by a Persian garrison, and took it after a ten months' siege (366–65). He then took Sestus, Crithote, Torone, Potidaea, Methone, Pydna and many other cities; but two attempts upon Amphipolis failed. An action was brought against him by Apollodorus, the son of the banker Pasion, for the return of money lent by the father. The speech for the plaintiff is still extant, and is attributed (though not unanimously) to Demosthenes. It is interesting as showing the manner in which Timotheus had exhausted the large fortune inherited from his father and the straits to which he was reduced by his sacrifices in the public cause. In 358 or 357, the Athenians, in response to a spirited appeal of Timotheus, crossed over to Euboea and expelled the Thebans in three days. In the course of the Social War Timotheus was despatched with Iphicrates, Menestheus, son of Iphicrates, and Chares to put down the revolt. The hostile fleets sighted each other in the Hellespont; but a gale was blowing, and Iphicrates and Timotheus decided not to engage. Chares, disregarding their opposition, lost many ships, and in his despatches he complained so bitterly of his colleagues that the Athenians put them on their trial. The accusers were Chares and Aristophon, both men of notoriously bad character. Iphicrates, who had fewer enemies than Timotheus, was acquitted; but Timotheus, who had always been disliked for his arrogance, was condemned to pay a very heavy fine. Being unable to pay, he withdrew to Chalcis, where he died soon afterwards. The Athenians showed their repentance by remitting the greater part of the fine to his son Conon. His remains were buried in the Ceramicus and statues erected to his memory in the agora and the acropolis.

See Life by Cornelius Nepos; Diodorus Siculus xv., xvi.; Isocrates, *De permutatione*; Pseudo-Demosthenes, *Adversus Timotheum*; C. Rehdantz, *Vitae Iphicratis, Chabriae, Timothei* (1845); and especially Holm, *Hist. of Greece* (Eng. trans., vol. iii.).

TIMOTHEUS, an Athenian sculptor of the 4th century B.C., and one of the artists employed on the Mausoleum of Halicarnassus. An inscription at Epidaurus shows that he was employed to furnish models for the pedimental sculptures of the temple of Aesculapius on that site, and to execute in marble the external decorations (acroteria) for one of the gables. Considerable remains of the acroteria and the pedimental figures have been discovered (see GREEK ART, fig. 44; and EPIDAURUS).

TIMOTHEUS, of Miletus (*c.* 446–357 B.C.), Greek musician and dithyrambic poet. He added one or more strings to the lyre, whereby he incurred the displeasure of the Spartans and Athenians (E. Curtius, *Hist. of Greece*, bk. v. ch. 2). He composed musical works of a mythological and historical character.

Fragments in T. Bergk, *Poetae lyrici graeci*. A papyrus-fragment of his *Persians* (the oldest papyrus in existence), discovered at Abusir has been edited by U. von Wilamowitz-Möllendorff (1903), with discussion of the nome, metre, the number of strings of the lyre, date of the poet and fragment. See V. Strazzulla, *I. Persiani di Eschilo ed il nomo di Timoteo* (1904); S. Sudhaus in *Rhein. Mus.*, lviii. (1903), p. 481; and T. Reinach and M. Croiset in *Revue des études grecques*, xvi. (1903), pp. 62, 323.

TIMOTHY or TIMOTHEUS, in the Bible (Acts xvi. 1, xvii. 14, &c.), a Lycaonian, the son of a Gentile father and a Jewish mother, Eunice (2 Tim. i. 5), was born at Lystra, and was already a member of the Christian Church there at the time of Paul's second visit. He took the place formerly occupied by John Mark in Paul's company, and in deference to Jewish feeling was circumcised. He accompanied the apostle on many of his journeys, and was employed by him on important missions (1 Thess. iii. 2; 1 Cor. iv. 17, xvi. 10). Paul speaks of him as his "son," and this (see Phil. ii. 22) refers to loyal service rather than to spiritual parentage. He was especially interested in the Macedonian churches, which he helped to found. His name is associated with that of Paul in the opening salutations of both epistles to the Thessalonians, the second epistle to the Corinthians, and those to the Philippians and Colossians. He was, therefore, with Paul at Rome. At a later date he is mentioned in Heb. xiii. 23 as having undergone imprisonment, but as having been released. On the basis of the epistles of Paul to Timothy, Timothy is traditionally represented as bishop of Ephesus, and tradition also tells that he suffered under Domitian. His martyrdom is celebrated on the 24th of January in the Latin Church, on the 22nd in the Greek.

The apocryphal *Acta Timothei* (Greek and Latin) have been edited by Usener (Bonn, 1877); cf. Lipsius, *Apokr. Apostelgeschichten* (1884), ii. 2.

TIMOTHY, FIRST EPISTLE TO. This book of the New Testament is really a pastoral letter upon church order, addressed by the apostle Paul to the Asiatic Christian communities in and round Ephesus (i. 3).[1] The object of the writing is stated in iii. 15: πῶς δεῖ ἐν οἴκῳ θεοῦ ἀναστρέφεσθαι. It is thrown into the literary form[2] of a letter from Paul to his lieutenant Timothy, but, as the closing salutation indicates (vi. 21, "grace be with you," ὑμῖν), the writer really has the Church in his mind all through. The Pauline standard of doctrine is set up (i. 3–20) as the norm of thought and practice. This trust and tradition is to be maintained throughout the churches. It involves, the writer proceeds to argue, the proper conduct of public worship (ii. 1 seq., 8 seq.), and the proper qualification for *episcopi* (iii. 2 seq.) and *diaconi* (iii. 8 seq.). The finale of this section (iii. 15–16) leads, by way of contrast, to a sharp prophetic warning against contemporary errorists (iv. 1 seq.), with advice upon the proper management of various classes of people within the Church (v. 1 seq.). Special attention is given to the ecclesiastical "widows" (3 seq.) and to presbyters (17 seq.). After a word on slaves and masters (vi. 1–2), the epistle recurs to the errorists (vi. 3 seq.), passing into a warning against wealth (6 seq.) and an impressive closing charge (11 seq.). The writing closes with the ἡ χάρις μεθ' ὑμῶν of verse 21. The context and contents of vi. 17–21a suggest that it is a later interpolation, such as writings on church discipline were

[1] The same motive occurs in the preface to Irenaeus's treatise, *Adv. haer.*

[2] The opposite view, which insists upon the definite character of the pastorals, is ably stated by A. Ruegg in *Aus Schrift und Geschichte* (1898), pp. 59–108. Otto and Kölling attempt to refer πορευόμενος (i. 3) to Timothy, not to Paul, and in this way to refer the situation to Acts xix. 22; but this is exegetically untenable.

particularly exposed to (Harnack). Their inorganic character naturally permitted later generations to bring them up to date, and accretions of this kind may be suspected in 1 Tim. iii. 1–13, v. 17–20 (22a), vi. 17–21, as well as in Tit. i. 7–9. Other verses, like iii. 11 and v. 23, have all the appearance of misplaced glosses, perhaps from the margin. When vi. 20–21 is thus taken as a later addition, it becomes possible[1] to see in the reference to ἀντιθέσεις τῆς ψευδωνύμου γνώσεως an allusion to Marcion's well-known volume.

Attempts have been made by some critics, particularly Hesse (*Die Entstehung der neutest. Hirtenbriefe*, 1889: i. 1–10, 18–20, iv. 1–16, vi. 3–16, 20 seq.) and Knoke (*Prakt. theol. Kommentar*, 1887, 1889: *a*=i. 3 seq., 18–20, ii. 1–10, iv. 12, v. 1–3, 4c–6, 11–15, 19–23, 24 seq., written to Timothy from Corinth; *b*=i. 12–17, iii. 14–16, iv. 1–11, 13–16, ii. 12–15, v. 7 seq., vi. 17–19, i. 5–11, vi. 2c–16, 20 seq., written from Caesarea), to disentangle one or more original notes of Paul from the subsequent additions, but the comparative evenness of the style does not favour such analyses.[2] They have more relevance and point in 2 Tim. than in 1 Tim. P. Ewald, in his *Probabilia betr. d. Text des 1 Tim.* (1901), falls back upon the hypothesis of the papyri leaves or sheets having been displaced, and conjectures that i. 12–17 originally lay between i. 2 and i. 3, while iii. 14–iv. 10 has been misplaced from after vi. 2. But his keen criticism of Hesse and Knoke is more successful than his positive explanation of the textual phenomena, and a more thorough-going process of literary criticism is necessary in order to solve the problems of the epistle. Its irregular character, abrupt connexions and loose transitions[3] are due to the nature of the subject rather than to any material disarrangement of its paragraphs.

The phenomena of style have to be viewed in a broad light. Allowance must be made for the difference of vocabulary produced by change of subject. The evidence of ἅπαξ εὑρημένα is always to be received with caution and strict scrutiny; no hard and fast rule must be set up to judge the language of a man like Paul. Yet such considerations do not operate against the literary judgment that the pastorals did not come from Paul's pen. The words and phrases which are common to the pastorals and the rest of the Pauline epistles are neither so characteristic nor so numerous as those peculiar to the former, and the data of style may be summed up in the verdict that they point to a writer who, naturally reproducing Paul's standpoint as far as possible, and acquainted with his epistles, yet betrays the characteristics of his later *milieu* in expressions as well as in ideas.[4] Thus, of 174 words which occur in the pastorals alone (of all the New Testament writings), 97 are foreign to the Septuagint and 116 to the rest of the Pauline letters. This proportion of ἅπαξ εὑρημένα is extremely large, when the size of the pastorals is taken into account, and its significance is heightened by the further fact that several of Paul's characteristic expressions tend to be replaced by others (*e.g.* περιπατεῖν and στοιχεῖν by ἀναστρέφειν, &c., κύριος by δεσπότης, παρουσία by ἐπιφάνεια), while a large number of Pauline words are entirely absent (*e.g.* ἄδικος, ἐλευθερία, καυχᾶσθαι, μείζων, μικρός, μωρία, παράδοσις, πείθειν, περισσεύειν, σῶμα, &c.). Nor is this by any means all. "Difference in vocabulary may be partially explained (though only partially in this case) by difference of subject-matter and of date; but the use of particles is one of the most unfailing of literary tests. The change in the use of particles and the comparative rarity of the definite article form, together with the startling divergence in vocabulary, the chief ground of our perplexity" (*Church Quarterly Review*, 1903, pp. 428 seq.). Pauline particles like ἄρα, διό, διότι, ἔπειτα, ἔτι, ἴδε and ἰδού disappear; the Pauline σύν is replaced by μετά, while prepositions like ἄντι, ἄχρι, ἔμπροσθεν and παρά (accus.) drop out entirely. A number of Latinisms, unexampled in the rest of Paul's epistles, occur within the pastorals; whole families of new words, especially composite words (often compounded with ἀ-privative, θεο-, οἰκο-, καλο-,[5] σωφρο-, φιλο-), emerge with others, *e.g.* εὐσέβεια, πιστὸς ὁ λόγος, &c.; and the very greeting is un-Pauline (1 Tim. i. 2; 2 Tim. i. 2). The peculiarities of syntax corroborate the impression made by such features of the vocabulary. There is less flow than in the rest of the Pauline letters; "the syntax is stiffer and more regular . . . the clauses are marshalled together, and there is a tendency to parallelism" (Lightfoot, *Biblical Essays*, p. 402). An increase of sententious imperative clauses is also to be noted. Doubtless, some of these features might be set down to Paul's amanuensis.[6] But not all of them, more especially when the characteristic conceptions and ideas of the pastorals are taken into account. Nor can it be argued that the characteristics of the pastorals are those of private letters; they are not private, nor even semi-private as they stand; besides, the only private note from Paul's hand (Philemon) bears no traces of the special diction exhibited in the epistles to Timothy and Titus.

Furthermore, throughout the pastorals, and especially in 1 Tim., there are traces of a wider acquaintance with Greek literature[7] than can be detected in the letters of Paul. Affinities to Plutarch (cf. J. Albani in *Zeitschrift für wiss. Theologie*, 1902, 40–58) and to 4 as well as to 2 Maccabees are not improbable.

1 Tim. also gives clearest expression to the author's ecclesiastical and doctrinal views. The objective sense of πίστις has begun to overpower the subjective. Christianity is becoming more and more a "form of sound words," a crystallized creed, whose teaching is the vital point. The deep conceptions of Paul, viz. the fatherly love of God, the faith-mysticism of the Christian's relation to Christ, and the inward witness of the Spirit, fall into the background, while unusual prominence is assigned to the more tangible and practical tests of Christianity.

Of all the pastorals, 1 Tim. is furthest from Paul.[8] The author writes more out of his own mind, evidently with little or no special material to fall back upon. The epistle is not a compilation from the two others (as Schleiermacher thought), but it seems to denote a slightly later stage.[9] Many critics therefore (*e.g.* De Wette, Mangold, Reuss, Bruckner, Pfleiderer, von Soden, McGiffert, S. Davidson, Bourquin, Clemen and Jülicher) conclude that the pastorals were written in this order (2 Tim., Titus, 1 Tim.). When the epistles were arranged for the canon, it was natural to put 2 Tim. later than the other two, since its setting seemed to imply the close of Paul's career. Its literary priority is confirmed by several resemblances between it and Philippians, the last of Paul's epistles (*e.g.* ἀνάλυσις iv. 6 = ἀναλύειν Phil. i. 23, and σπένδεσθαι iv. 6 = Phil. ii. 17).

LITERATURE.—The following special monographs on 1 Tim. are noteworthy: Melanchthon's *Enarratio epist. I. Pauli ad Timotheum et duorum capitum secunda* (1561), Heshusius, *Commentarius in priorem epist. Pauli ad Timotheum* (1582), Gerhard, *Annotationes ad I. Pauli ad Tim. epistolam* (1643) and M. G. E. Leo, *Pauli epistola I. ad Tim. cum perpetuo commentario* (Leipzig, 1837; full and exact). More modern essays are published by Kölling, *Der I. Brief Paulus an Tim. aufs neue untersucht und ausgelegt* (1882 seq.) and, from a conservative standpoint, by Liddon (1897). Two other essays appeared in the early part of last century, by Beckhaus, *Specimen observationum de verbis ἅπαξ λεγόμ. et rarioribus dicendi formulis in prima ad Tim. epistola Paulina obviis* (1810) and A. Curtius, *De tempore quo prior epist. Tim. exarata sit* (1828). In the difficult passage (v. 18), both quotations seem to be ranked as from ἡ γραφή, in which case the

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[1] When the literary integrity of the epistle is maintained this allusion naturally drops to the ground, since the use of the epistle by Polycarp rules the earlier conjectures of Baur and others (who made the pastorals anti-Marcionite) out of court; besides, passages like i. 7 (Titus i. 10, 14) would not apply to the Marcionites. Dr Hort (*Judaistic Christianity*, pp. 113 seq.) prefers to group both the false γνῶσις (cf. Rom. ii. 20) and the ἀντιθέσεις as Jewish casuistical decisions, the γενεαλογίαι of i. 4 and Tit. iii. 9 being the legendary pedigrees of Jewish heroes, such as are prominent in Philo and the Book of Jubilees. Cf. Wohlenberg, pp. 30–36, and on the other side Klöpper in *Zeits. für wiss. Theologie* (1902), pp. 339 seq.

[2] Hesse's, in particular, is shipwrecked on the assumption that the Ignatian epistles must be dated under Marcus Aurelius.

[3] Thus ii. 11–15 seems almost like a gloss (Hesse, Knoke), iv. 1–8 parts easily from its context, and the οὖν of ii. 1 indicates a very loose relationship to the preceding paragraphs.

[4] So the philologist T. Nägeli (*Der Wortschatz des Apostels Paulus*, 1905, pp. 85 seq.), whose opinion is all the more significant on this point that he refuses to admit any linguistic features adverse to the Pauline authorship of the other epistles.

[5] Καλός, which Paul never uses as an attribute, is mainly employed in this way by the author. On σωτήρ as applied to God, cf. Wagner in *Zeits. f. neut. Wiss.* (1905), pp. 221 seq.

[6] The so-called "Lucan" features (cf. Holtzmann, pp. 92 seq., and Von Soden in *Theologische Abhandlungen*, 1892, pp. 133–135) have suggested that Luke may have been the amanuensis (cf. 2 Tim. iv. 11), or even the author of the pastorals.

[7] *E.g.* Tit. i. 11 (cf. Plut. *Moral.* 967, 13), ii. 3 (cf. Thuc. ii. 61; Xen. *Mem.* i. 5, 5, 6, 8); 2 Tim. ii. 17 (cf. Plut. *Moral.* 65 D ὁ δὲ καρκίνος πολυδιάχυτον ἐν τῷ σώματι πάθος); 1 Tim. i. 6 (cf. Plut. *Moral.* 414 Εἰ ἀστοχοῦσι τοῦ μετρίου καὶ πρέποντος), i. 10 (cf. Plut. *De educ. lib.* 5 A τοῦ ὑγιαίνοντος καὶ τεταγμένου βίου καταφρονεῖν, for ὑγιής = "normal"; cf. Plato's *Protagoras*, 346 C), i. 19 (cf. Galen, x. 307, ἐν οἷς ἐναύγησαν οἱ πρόσθεν ἰατροί = "came to grief"), vi. 5 (cf. Plut. *Cato major*, 25, *Moral.* 92 B with Plato's *Protagoras*, 313).

[8] Even linguistically Titus and 1 Tim. are closer to one another than either to 2 Tim. The latter has no allusion to the καλὸν ἔργον, the ἑτεροδιδασκαλεῖν, the διαβεβαιοῦσθαι, &c., of the others, and contains one or two specific phrases of its own. 1 Tim., like Ephesians, is a writing whose lack of greetings and general tone point to the functions of an encyclical or Catholic epistle.

[9] For details, cf. *Ency. Bib.* 5093–5094. Of the five "faithful sayings," three occur in 1 Tim.; these condensed aphorisms tally with liturgical fragments such as the famous quotation in 1 Tim. iii. 16, a formula of confession written in small short cola (cf. Klöpper in *Zeitschrift für wiss. Theologie*, 1902, pp. 336 seq.).

second (cf. Luke x. 7) goes back to either Luke's gospel or its source at this particular point. The hypothesis that a saying of Jesus is loosely added here to an Old Testament citation is very forced, and the inference is that by the time the author wrote, Luke's gospel was reckoned as γραφή. This would be explicable if Luke could be assumed to have been the author, in whole or part, of the pastorals. (J. Mt.)

TIMOTHY, SECOND EPISTLE TO. In this book of the New Testament, after a brief thanksgiving for the faith of Timothy (i. 1–5), Paul is represented as warning him against false shame (6 seq.), adducing his own example and that of Onesiphorus. The need and the reward of endurance are then urged (ii. 1–13), and Timothy is bidden to adhere in his work to the Pauline gospel against the seductions of controversial and immoral heretics (ii. 14 seq.).[1] The practices of the latter are pungently depicted[2] (iii. 1–9); Paul reiterates his opening counsels (10 seq.) and then closes with a solemn charge to personal faithfulness. A note of personal matters concludes the epistle (iv. 6–22).

The last verse, with its two-fold greeting (ὁ κύριος μετὰ τοῦ πνεύματός σου, ἡ χάρις μεθ' ὑμῶν), shows unconsciously but plainly that, while the epistle professes to be a private letter to Timothy, it is in reality addressed to a wider circle, like 1 Tim. and Titus. But its composite origin is also clear.[3] Thus iv. 6–22a, which is certainly authentic, is not homogeneous in itself, the situation of verses 6–8 hardly agreeing with that of 9 seq., while verse 11 ("Luke alone is with me") cannot have been written at the same time as verse 21. Various schemes of analysis have been proposed to account for this and other passages of the same nature in the epistle, *e.g.* i. 15–18, iii. 10 seq. But the general result of such reconstructions is tentative. All that criticism has succeeded in establishing is the fact that the author had some *reliquiae Paulinae* at his disposal, notes written either before or during his last imprisonment in Rome,[4] and that these have been worked up into the present letter by one who rightly believed that his master would stoutly oppose the current errors of the age.

2 Timothy, like 1 Timothy, reveals with fair precision the period and aim of the writer of the pastorals. Evidently (cf. Acts xx. 29–30) the Pauline Christianity of Ephesus was imperilled seriously during the last quarter of the 1st century. Its very growth invited attempts to weave ascetic, theosophic, semi-Jewish fancies round the faith, not unlike the attempts often made in modern India to assimilate Christian and local philosophies of religion. Against such the writer argues in Paul's name, as Luke had already done. From the composition of a speech in Paul's name (for, though the farewell in Acts goes back to first-hand tradition, it represents the author's standpoint as well as Paul's), it was but a step to compose letters in his name, especially on the basis of some of his extant notes. A genuine concern for local Christianity is the writer's justification for his work, and any idea of fraudulent aims must be dismissed at once.[5] "To a writer of this period, it would seem as legitimate an artifice to compose a letter as to compose a speech in the name of a great man whose sentiments it was desired to reproduce and record; the question which seems so important to us, whether the words and even the sentiments are the great man's own or only his historian's, seems then hardly to have occurred either to writer or readers" (W. H. Simcox, *Writers of the New Testament*, p. 38). The address at Miletus is Paul's last word to the Christian elders of Ephesus, warning them against heresies (Acts xx. 29 seq.) and solemnly bidding them exercise their disciplinary duties. The Second Epistle to Timothy carries on this line of advice. Here Paul, being dead, yet speaks through Timothy to the local Christians who are exposed to such mischievous tendencies in their environment.

Where the writer has hardly succeeded in representing Paul is in his relations to Timothy. One may admit that, strictly speaking, the latter at the age of about thirty-five or forty could still be called νέος, and that Paul might conceivably have termed him still his τέκνον. But the counsels addressed to him seem rather out of place when one recollects the position which he occupied. To a writer who desired a situation for such advice on church life and doctrine from the lips of Paul to his lieutenant, it was natural to think of a temporary absence.[6] But many of the directions are much too serious and fundamental to have been given in this form; one can hardly imagine that Paul considered Timothy (or Titus) still in need of elementary advice and warning upon such matters, and especially on personal purity. When they are regarded as typical figures of the later *episcopi* of the Church, the point of this emphasis upon elementary principles and duties is at once clear; they outline graphically the qualifications for the church offices in question.

The pressing need of the Church, as the writer conceives it, is to maintain the true Pauline tradition (2 Tim. i. 13, &c.) against certain moral and speculative ideas. This maintenance takes the twofold practical form of (*a*) adherence to formulated statements of the "sound teaching" and (*b*) insistence on a succession of church officials (2 Tim. ii. 1–2) who are not merely to preside but to teach. The last point is significant in view of Didachê xv. 1. The standpoint of the author is practically that of Clemens Romanus (xlii. seq.), who asserts that the apostles preached "everywhere in country and town, appointing their first-fruits, when they had proved them by the Spirit, to be bishops and deacons." The interests of discipline and doctrine were thus to be conserved.[7] Paul's lieutenants possess the central deposit of the apostolic faith, and have the duty as well as the right of exercising the authority with which that position invests them.

The occasional coincidences between the pastorals and Barnabas or Clemens Romanus do not prove anything more than a common *milieu* of thought, but the epistles were plainly familiar to Polycarp, who alludes to 1 Tim. ii. 1, vi. 7, 10, and 2 Tim. ii. 11, 25, iv. 10 (for this and the other passages from Polycarp, see *The New Testament in the Apostolic Fathers*, 1905, pp. 95 seq.). This indubitable use of the pastorals in Polycarp[8] throws the *terminus ad quem* of their composition back into the first decade of the 2nd century, and additional confirmation of this would be forthcoming were the evidence for their use in Ignatius more

[1] Bahnsen gives an ingenious analysis of this section in the epistle. In ii. 8–13, ii. 6 is developed; in ii. 14–26, ii. 4; and in iii. 1–4 (8), ii. 5. But this is as artificial as Otto's attempt to classify the contents of the epistle under the three notes of the πνεῦμα in i. 7.

[2] On iii. 6 see the fragment from Philo quoted in Euseb. *Praep. Evang.* viii. 11.

[3] "If the epistle was an integral as we have it, its genuineness could scarcely be maintained" (Laughlin, p. 26).

[4] Bacon (*Story of St Paul*, p. 198) and Clemen both assign part of the epistle to the Caesarean imprisonment, the former disentangling iv. 9, 11–18, 20–21a, 22b, the latter iv. 9–18. Hitzig had already found a Caesarean letter in i. 15, iv. 13–16, 20–22a. One great point in favour of such theories is that they give a natural sense to iv. 16, Paul's first defence being that before the Jews or before Felix.

[5] Cf. the present writer's *Historical New Testament* (2nd ed., 1901, pp. 619 seq.), where the relevant literature is cited. An adequate monograph on ancient pseudonymous literature remains to be written; meantime, further reference may be made to the older essays of Mosheim (*Dissertatio de caussis suppositorum librorum inter Christianos saeculi primi et secundi*, 1733); Bentley's *Dissertation on Phalaris*, pp. 80 seq.; K. R. Köstlin's article in *Theol. Jahrbücher* (1851), pp. 149–221, on "Der pseud. Litteratur der ältesten Kirche"; and A. Güdemann, in *Classical Studies in Honour of H. Drissler*, pp. 52–74 (New York, 1894).

[6] The drawback was that, if Paul was soon to see his colleagues again (Titus i. 5; 1 Tim. i. 3), such detailed advice was hardly necessary; but this imperfection was inevitable.

[7] The post-Pauline atmosphere of the ecclesiastical regulations is felt most plainly in the references to such sub-apostolic features as the organized register of "widows." The ἐπίσκοπος, the διάκονος and the χήρα are also forbidden to contract a second marriage. Such, at any rate, seems the fairest interpretation of 1 Tim. iii. 2 (ἐπίσκοπος) in the light of early Christian tradition, for although the phrase "husband of one wife" might conceivably be intended as a prohibition of polygamy or vice (=faithful husband, or sober, married man), the antipathy to second marriages (cf. Jacoby, *Neutest. Ethik*, pp. 378 seq.) is quite in accord with sub-apostolic practice. It is almost as un-Pauline as the assumption that every ἐπίσκοπος must be married. Cf. on this whole subject Hilgenfeld (*Zeitschrift für wiss. Theologie*, 1886, pp. 456 seq.) and Schmiedel (*Encycl. Biblica*, 3113 seq.); the opposite position is stated excellently by Hort (*Christian Ecclesia*, 1898, 189 seq.) and Dr T. M. Lindsay (*Hibbert Journal*, i. 166 seq., and in *The Church and the Ministry in the early Centuries*, 1903, pp. 139 seq.).

[8] The pastorals soon passed into great favour in the early Church. Their method and aim were entirely congenial to the rising Catholic Church, and one is not surprised to find from writers in the East (Theophilus of Antioch, Justin Martyr) and West (Irenaeus, Tertullian and the author of 2 Clement) that they were widely read and valued. Absent from Marcion's canon, they were included in the Muratorian, where they appear as private letters ("pro affectu et dilectione"). See, on the external evidence in general, Zahn's *Geschichte der neutest. Kanons*, i. 634 seq.

secure. The occasional similarities of thought and expression between them and the Lucan writings suggest that the period of their origin lies within a quarter of a century after Paul's death, and, when one or two later accretions are admitted, the internal evidence, either upon the organization of the church[1] or upon the errors controverted, tallies with this hypothesis.

Literature.—Special monographs on this epistle by Leo (1850) and Bahnsen (*Die sogenannten Pastoralbriefe, I., der 2 Tim.*, 1876) are to be noted. For a textual discussion of ii. 19, cf. Resch's *Paulinismus*, pp. 258–259. The allusion to the βιβλία, μάλιστα τὰς μεμβράνας (iv. 13) has produced a wealth of discussion; the latter were probably *pugillares membranei*, sheets for private memoranda. The books may have included the Logia or Evangeli Scriptures from which 1 Tim. v. 18 is quoted (so Resch), but this is a mere conjecture. Cf., on the whole question, Birt's *Das antike Buchwesen*, pp. 50 seq., 65, 88 seq., and Nestle's *Einführung in das griechische N. T.* (1899), pp. 39 seq. (J. Mt.)

TIMŪR (*Timur i Leng*, the lame Timūr), commonly known as Tamerlane, the renowned Oriental conqueror, was born in 1336 at Kesh, better known as Shahr-i-Sabz, "the green city," situated some 50 m. south of Samarkand in Transoxiana. His father Teragai was head of the tribe of Berlas. Great-grandson of Karachar Nevian (minister of Jagatai, son of Jenghiz Khan, and commander-in-chief of his forces), and distinguished among his fellow-clansmen as the first convert to Islamism, Teragai might have assumed the high military rank which fell to him by right of inheritance; but like his father Burkul he preferred a life of retirement and study. Under the paternal eye the education of young Timūr was such that at the age of twenty he had not only become an adept in manly outdoor exercises but had earned the reputation of being an attentive reader of the Koran. At this period, if we may credit the *Memoirs* (*Malfūẓāt*), he exhibited proofs of a tender and sympathetic nature.

About 1358, however, he came before the world as a leader of armies. His career for the next ten or eleven years may be thus briefly summarized from the *Memoirs*. Allying himself both in cause and by family connexion with Kurgan, the dethroner and destroyer of Kazan, chief of the western Jagatai, he was deputed to invade Khorasan at the head of a thousand horse. This was the second warlike expedition in which he was the chief actor, and the accomplishment of its objects led to further operations, among them the subjection of Khwarizm and Urganj. After the murder of Kurgan the contentions which arose among the many claimants to sovereign power were arrested by the invasion of Toghluk Timūr of Ḳashgar, a descendant of Jenghiz. Timūr was despatched on a mission to the invader's camp, the result of which was his own appointment to the government of Māwarā-'lnahr (Transoxiana). By the death of his father he was also left hereditary head of the Berlas. The exigencies of his quasi-sovereign position compelled him to have recourse to his formidable patron, whose reappearance on the banks of the Sihon created a consternation not easily allayed. Māwarā'lnahr was taken from Timūr and entrusted to a son of Toghluk; but he was defeated in battle by the bold warrior he had replaced at the head of a numerically far inferior force. Toghluk's death facilitated the work of reconquest, and a few years of perseverance and energy sufficed for its accomplishment, as well as for the addition of a vast extent of territory. During this period Timūr and his brother-in-law, Hosain—at first fellow-fugitives and wanderers in joint adventures full of interest and romance—became rivals and antagonists. At the close of 1369 Hosain was assassinated and Timūr, having been formally proclaimed sovereign at Balkh, mounted the throne at Samarkand, the capital of his dominions.

The next thirty years or so were spent in various wars and expeditions. Timūr not only consolidated his rule at home by the subjection of intestine foes, but sought extension of territory by encroachments upon the lands of foreign potentates. His conquests to the west and north-west led him among the Mongols of the Caspian and to the banks of the Ural and the Volga; those to the south and south-west comprehended almost every province in Persia, including Bagdad, Kerbela and Kurdistan. One of the most formidable of his opponents was Toktamish, who after having been a refugee at the court of Timūr became ruler both of the eastern Kipchak and the Golden Horde, and quarrelled with Timūr over the possession of Khwarizm. It was not until 1395 that the power of Toktamish was finally broken (see Mongols; Golden Horde).

In 1398, when Timūr was more than sixty years of age, Farishta tells us that, "informed of the commotions and civil wars of India," he "began his expedition into that country," and on the 12th of September "arrived on the banks of the Indus." His passage of the river and upward march along the left bank, the reinforcement he provided for his grandson Pir Mahommed (who was invested in Multan), the capture of towns or villages accompanied, it might be, with destruction of the houses and the massacre of the inhabitants, the battle before Delhi and the easy victory, the triumphal entry into the doomed city, with its outcome of horrors—all these circumstances belong to the annals of India. In April 1399, some three months after quitting the capital of Mahmūd Toghluk, Timūr was back in his own capital beyond the Oxus. It need scarcely be added that an immense quantity of spoil was conveyed away. According to Clavijo, ninety captured elephants were employed merely to carry stones from certain quarries to enable the conqueror to erect a mosque at Samarkand. The war with the Turks and Egyptians which succeeded the return from India was rendered notable by the capture of Aleppo and Damascus, and especially by the defeat and imprisonment of Sultan Bayezid I. (see Turkey: *History*, and Egypt: *History*, Mahommedan period). This was Timūr's last campaign. Another was projected against China, but the old warrior was attacked by fever and ague when encamped on the farther side of the Sihon (Syr-Daria) and died at Atrār (Otrar) on the 17th of February 1405. Markham, in his introduction to the narrative of Clavijo's embassy, states that his body "was embalmed with musk and rose water, wrapped in linen, laid in an ebony coffin and sent to Samarkand, where it was buried." Timūr had carried his victorious arms on one side from the Irtish and the Volga to the Persian Gulf and on the other from the Hellespont to the Ganges.

Timūr's generally recognized biographers are—'Alī Yazdī, commonly called Sharifu 'd-Dīn, author of the Persian *Zafarnāma*, translated by Petis de la Croix in 1722, and from French into English by J. Darby in the following year; and Ahmad ibn Mohammed ibn Abdallah, al Dimashki, al 'Ajmi, commonly called Ibn 'Arabshāh, author of the Arabic *'Ajaibu 'l Makhlnkāt*, translated by the Dutch Orientalist Golius in 1636. In the work of the former, as Sir William Jones remarks, "the Tartarian conqueror is represented as a liberal, benevolent and illustrious prince"; in that of the latter he is "deformed and impious, of a low birth and detestable principles." But the favourable account was written under the personal supervision of Timūr's grandson, Ibrāhīm, while the other was the production of his direst enemy. Few indeed, if any, original annals of this class are written otherwise than to order, under patronage, or to serve a purpose to which truth is secondary. Among less reputed biographies or materials for biography may be mentioned a second *Zafarnāma*, by Maulānā Nizāmu 'd-Dīn Shanab Ghāzāni (Nizām Shāmī), stated to be "the earliest known history of Timūr, and the only one written in his lifetime"; and vol. i. of the *Matla'u's-Sa'dain*—a choice Persian MS. work of 1495—introduced to Orientalists in Europe by Hammer, Jahrbücher, Dorn and (notably) Quatremère. There are also the *Memoirs* (*Malfūẓāt*) and *Institutes* (*Tuzukāt*), of which an important section is styled *Designs and Enterprises* (*Tadbīrāt wa Kangāshahā*). Upon the genuineness of these doubt has been thrown. The circumstance of their alleged discovery and presentation to Shah Jahān in 1637 was of itself open to suspicion. Alhazen, quoted by Purchas in his quaint notice of Timūr and referred to by Sir John Malcolm, can hardly be accepted as a serious authority. His assumed memoir was printed for English readers in 1597 by William Ponsonby under the title of a *Historie of the Great Emperor Tamerlan, drawn from the ancient monuments by Messire Jean du Bec, Abbot of Mortimer*; and another version of the same book is to be found in the *Histoire du Grand Tamerlan*, by De Sainctyon, published at Amsterdam in 1678. But, although the existence of this Alhazen of Jean de Bec has been believed by many, the more trustworthy critics consider the history and historian to be equally fictitious.

Reference may be made to two more sources of information.

[1] The pastorals in this aspect are closer to Clemens Romanus than to Ignatius.

(1) Supposed likenesses of Timūr are to be found in books and in the splendid collection of Oriental manuscripts and drawings in the British Museum. One contained in the *Shah Jahān Nāma* —a gorgeous specimen of illuminated Persian manuscript and exquisite calligraphy—represents a most ordinary, middle-aged Oriental, with narrow black whisker fringing the cheek and meeting the tip of the chin in a scanty, pointed beard; a thin moustache sweeps in a semicircle from above the upper lip; the eyebrow over the almond-shaped eye is marked but not bushy. But it were vain to seek for an expression of genius in the countenance. Another portrait is included in a set of sketches by native artists, some of which, taken probably from life, show great care and cleverness. Timūr is here displayed as a stoutish, long-bodied man, below the middle-height, in age and feature not unlike the first portrait, but with thicker and more straggling hair, and distincter, though not more agreeable character in the facial expression, yet not a sign of power, genius, or any elements of grandeur or celebrity. The uncomfortable figure in the Bodleian Library does not give much help. Sir John Malcolm has been at some pains to invest his portrait of Timūr with individuality. But an analysis of his results leaves the reader in more perplexity than satisfaction at the kind of information imparted, and he reverts insensibly to the sources from which his instructor has himself been instructed. (2) As regards plays, in Marlowe's *Tamburlaine* Timūr is described as tall of stature, straightly fashioned, large of limb, having joints strongly knit, long and sinewy arms, a breadth of shoulders to "bear old Atlas's burden," pale of complexion, and with "amber hair wrapp'd in curls." The outline of this description might be from Sharifu 'd-Dīn, while the colours are the poet's own. A Latin memoir of Tamerlane by Perondinus, printed in 1600, entitled *Magni Tamerlanis scytharum imperatoris vita*, describes Timūr as tall and bearded, broad-chested and broad-shouldered, well-built but lame, of a fierce countenance and with receding eyes, which express cruelty and strike terror into the lookers-on. But Jean du Bec's account of Timūr's appearance is quite different. Now *Tamburlaine* was written in 1586. The first English translation of Jean du Bec is dated in 1595, the *Life* by Perondinus in 1600, and Petis de la Croix did not introduce Sharifu 'd-Dīn or 'Alī Yazdī to European readers till 1722. The dramatist must have heard of Timūr in other quarters, equally reliable it may be with those available in the present stage of Oriental research. At the beginning of the 18th century Timūr was represented in Rowe's *Tamerlane* as a model of valour and virtue. The plot, however, has little to do with history, and is improbable and void of interest. By Matthew Gregory Lewis again "Timour" is depicted as the conventional tyrant of a gorgeous melodrama, slaying, burning, slaughtering and committing every possible atrocity until checked by a violent death and a poetical climax.

Apart from modern European *savants* and historians, and the more strictly Oriental chroniclers who have written in Persian, Turkish or Arabic, the following authorities may be cited—Laonicus Chalcondylas, Joannes Leunclavius, Joachimus Camerarius, Petrus Perondinus, Lazaro Soranzo, Simon Mairlus, Matthew Michiovius. A score or so of other names are given by Samuel Purchas. See also Sir Clements Markham's *Clavijo*, in the Hakluyt Society's publications; White's edition of Davy's translation of the *Institutes* (1783); Stewart's translation of the *Malfūẓāt*; Malcolm's *History of Persia*; and *Trans. Roy. Soc.* (1885); Horn, "Gesch. Irans in islam. Zeit," in Geiger and Kuhn, *Grundr. der iranisch. Philol.* (1904); works quoted, *s.v.* MONGOLS. (F. J. G.)

TIN (Lat. *stannum*, whence the chemical symbol "Sn"; atomic weight=117·6, O=16), a metallic chemical element. Being a component of bronze, it was used as a metal thousands of years prior to the dawn of history; but it does not follow that prehistoric bronzes were made from metallic tin. When the unalloyed metal was first introduced cannot be ascertained with certainty. The "tin" of the Bible (κασσίτερος in the Septuagint) corresponds to the Hebrew *bedhil*, which is really a copper alloy known as early as 1600 B.C. in Egypt. All we know is that about the 1st century the Greek word κασσίτερος designated tin, and that tin was imported from Cornwall into Italy after, if not before, the invasion of Britain by Julius Caesar. From Pliny's writings it appears that the Romans in his time did not realize the distinction between tin and lead: the former was called *plumbum album* or *candidum* to distinguish it from *plumbum nigrum* (lead proper). The word *stannum* definitely assumed its present meaning in the 4th century (H. Kopp). By the early Greek alchemists the metal was named Hermes, but at about the beginning of the 6th century, it was termed Zeusor Jupiter, and the symbol ♃ assigned to it; it was also referred to as *diabolus metallorum*, on account of the brittle alloys which it formed.

Occurrence.—Grains of metallic tin occur intermingled with the gold ores of Siberia, Guiana and Bolivia, and in a few other localities. Of minerals containing this element mention may be made of cassiterite (*q.v.*) or tinstone, SnO_2, tin pyrites, $Cu_4SnS_4+(Fe,Zn)_2SnS_4$; the metal also occurs in some epidotes, and in company with columbium, tantalum and other metals. Of these "tinstone" is of the greatest commercial importance. It occurs in its matrix, either in or closely associated with fissure veins or disseminated through rock masses. It is also found in the form of rolled lumps and grains, "stream tin," in alluvial gravels; the latter are secondary deposits, the products of the disintegration of the first-named primary deposits. Throughout the world, primary deposits of tinstone are in or closely connected with granite or acid eruptive rocks of the same type, its mineral associates being tourmaline, fluorspar, topaz, wolfram and arsenical pyrites, and the invariable gangue being quartz: the only exception to this mode of occurrence is to be found in Bolivia, where the tin ore occurs intimately associated with silver ores, bismuth ores and various sulphides, whilst the gangue includes barytes and certain carbonates. Over five-sixths of the world's total production is derived from secondary alluvial deposits, but all the tin obtained in Cornwall (the alluvial deposits having been worked out) and Bolivia is from vein mining, while a small portion of that yielded by Australasia comes from veins and from granitic rocks carrying disseminated tinstone.

Production.—During the 18th century the world's supply of tin was mainly drawn from the deposits of England, Saxony and Bohemia; in 1801 England produced about 2500 tons, while the supplies of Saxony and Bohemia had been greatly diminished. The English supply increased, with some oscillations, to between six and seven thousand tons annually in the period 1840–1860, when it suddenly rose to about 10,000 tons, and this figure was fairly well sustained until about 1890, when a period of depression set in; the yield for 1900 was 4336 tons, and for 1905 about 4200 tons. In the opening decades of the 19th century supplies began to be drawn from Banka; in 1820 this island contributed 1200 tons; the production was increased to 12,000 tons in 1900, when a diminution set in, 9960 tons being the output during 1905. Billiton became of note in 1853 with a production of 40 tons, which increased to 6000 in 1900 and has since declined to about 3000 tons in 1905. The Straits Settlements ranked as an important producer in 1870 with 2337 tons; it now supplies the greater part of the world's supply, contributing 46,795 tons in 1900, and over 60,000 tons in 1905. Australian deposits were worked in 1872, and in the following year the production was 3000 tons; the maximum outputs were in 1881–1883, averaging 10,000 tons annually; but the supply declined to 2420 tons in 1898 and has since increased to about 5028 tons in 1905. Bolivia produced 501 tons in 1883, 10,245 in 1900 and 12,500 in 1905.

The world's supply in 1900 was 72,911 long tons; this increased in 1904 to 97,790 tons, but in 1905, principally owing to a shortage in the supplies from the Straits and Banka, the yield fell to 94,089 tons.

Metallurgy.—The operations in the metallurgy of tin may be enumerated as: (1) mining and dressing, (2) smelting, (3) refining. The first stage has for its purpose the production of a fairly pure tinstone; the second the conversion of the oxide into metallic tin; and the third preparing a tin pure enough for commercial purposes.

Mining and Dressing.—The alluvial deposits are almost invariably worked opencast, those of the Malay Peninsula and Archipelago chiefly by Chinese labour: in a few instances hydraulic mining has been resorted to, and in other cases true underground mining is carried on; but the latter is both exceptional and difficult. The alluvial extracted, which in the Malay Peninsula and Archipelago carries from 5 to 60 lb of tinstone (or "black tin," as it is termed by Cornish miners) to the cubic yard of gravel, is washed in various simple sluicing appliances, by which the lighter clay, sand and stones are removed and tinstone is left behind comparatively pure, containing usually 65 to 75% of metallic tin (chemically pure tinstone contains 78·7%).

Lode tin, as tinstone derived from primary deposits is often termed, is mined in the ordinary method, the very hard gangue in which it occurs necessitating a liberal use of explosives. The veinstuff is broken small either by hand or in rock-breakers, and stamped to fine powder in stamp mills, which are practically large mechanically-worked pestles and mortars, the stamp proper weighing from 500 to 1000 lb. The mineral, crushed small enough to pass a sieve with perforations $\frac{1}{40}$ in. in diameter, leaves the stamps in suspension in water, and passes through a series of troughs in which the heavier mineral is collected; this then passes through a series of washing operations, which leaves a mixture consisting chiefly of tinstone and arsenical pyrites, which is calcined and washed again, until finally black tin containing about 60 to 65% of metal is left. The calcination is preferably effected in mechanical roasters, it being especially necessary to agitate the ore continually, otherwise it cakes. The crude tinstuff raised in Cornwall carries on an average a little over 2% of black tin. The Bolivian tin ore is treated by first extracting the silver by amalgamation, &c., and afterwards concentrating the residues; there are, however, considerable difficulties in the way of treating the poorer of these very complex ores, and several chemical processes for extracting their metallic contents have been worked out. Of the impurities of the ore the wolframite (tungstate of iron and manganese) is the most troublesome, because on account of its high specific gravity it cannot be washed away as gangue. To remove it, Oxland fuses the ore with a certain proportion of carbonate of soda, which suffices to convert the tungsten into soluble alkaline tungstate, without producing noteworthy quantities of soluble stannate from the oxide of tin; the tungstate is easily removed by treatment with water.

2. *Smelting.*—The dressed ore is smelted with carbon by one of two main methods, viz. either in the shaft furnace or the reverberatory; the former is the better suited to stream tin, the latter to lode tin, but either ore can be smelted in either way, although reverberatory practice yields a purer metal. Shaft furnace smelting is confined to those parts of the world where charcoal can still be obtained in large quantities at moderate prices. The furnace consists of a shaft, circular (or more rarely rectangular) in plan, into which alternate layers of fuel and ore are charged, an air blast being generally injected near to the bottom of the furnace through one or more tuyeres. This was the primitive process all over the world; in the East, South America and similar regions it still holds its own. In Europe, Australasia and one large works at Singapore it has been practically replaced by the reverberatory furnace process, first introduced into Cornwall about the year 1700. In this process the purified ore is mixed with about one-fifth of its weight of a non-caking coal or anthracite smalls, the mixture being moistened to prevent it from being blown off by the draught, and is then fused on the sole of a reverberatory furnace for five or six hours. The slag and metal produced are then run off and the latter is cast into bars; these are in general contaminated with iron, arsenic, copper and other impurities.

3. *Refining.*—All tin, except a small quantity produced by the shaft furnace process from exceptionally pure stream tin ore, requires refining by liquation and "boiling" before it is ready for the market. In the English process the bars are heated cautiously on an inclined hearth, when relatively pure tin runs off, while a skeleton of impure metal remains. The metal run off is further purified by *poling*, *i.e.* by stirring it with the branch of a tree—the apple tree being preferred traditionally. This operation is no doubt intended to remove the oxygen diffused throughout the metal as oxide, part of it perhaps chemically by reduction of the oxide to metal, the rest by conveying the finely diffused oxide to the surface and causing it to unite there with the oxide scum. After this the metal is allowed to rest for a time in the pot at a temperature above its freezing point and is then ladled out into ingot forms, care being taken at each stage to ladle off the top stratum. The original top stratum is the purest, and each succeeding lower stratum has a greater proportion of impurities; the lowest consists largely of a solid or semi-solid alloy of tin and iron.

To test the purity of the metal the tin-smelter heats the bars to a certain temperature just below the fusing point, and then strikes them with a hammer or lets them fall on a stone floor from a given height. If the tin is pure it splits into a mass of granular strings. Tin which has been thus manipulated and proved incidentally to be very pure is sold as grain tin. A lower quality goes by the name of block tin. Of the several commercial varieties Banka tin is the purest; it is indeed almost chemically pure. Next comes English grain tin.

For the preparation of chemically pure tin two methods are employed. (1) Commercially pure tin is treated with nitric acid, which converts the tin proper into the insoluble metastannic acid, while the copper, iron, &c., become nitrates; the metastannic acid is washed first with dilute nitric acid, then with water, and is lastly dried and reduced by fusion with black flux or potassium cyanide. (2) A solution of pure stannous chloride in very dilute hydrochloric acid is reduced with an electric current. According to Stolba, beautiful crystals of pure tin can be obtained as follows: A platinum basin, coated over with wax or paraffin outside, except a small circle at the very lowest point, is placed on a plate of amalgamated zinc, lying on the bottom of a beaker, and is filled with a solution of pure stannous chloride. The beaker also is cautiously filled with acidulated water up to a point beyond the edge of the platinum basin. The whole is then left to itself, when crystals of tin gradually separate out on the bottom of the basin.

Properties.—An ingot of tin is pure white (except for a slight tinge of blue); the colour depends, however, upon the temperature at which it is poured—if too low, the surface is dull, if too high, iridescent. It exhibits considerable lustre and is not subject to tarnishing on exposure to normal air. The metal is pretty soft and easily flattened out under the hammer, but almost devoid of tenacity. That it is elastic, with narrow limits, is proved by its clear ring when struck with a hard body in circumstances permitting of free vibration. The specific gravity of cast tin is 7·29, of rolled tin 7·299, and of electrically deposited tin 7·143 to 7·178. A tin ingot is distinctly crystalline; hence the characteristic crackling noise, or "cry" of tin, which a bar of tin gives out when being bent. This structure can be rendered visible by superficial etching with dilute acid; and as the minuter crystals dissolve more quickly than the larger ones, the surface assumes a frosted appearance (*moirée métallique*). The metal is dimorphous: by cooling molten tin at ordinary air temperature tetragonal crystals are obtained, while by cooling at a temperature just below the melting point rhombic forms are produced. When exposed for a sufficient time to very low temperatures (to −39° C. for 14 hours), tin becomes so brittle that it falls into a grey powder, termed the *grey modification*, under a pestle; it indeed sometimes crumbles into powder spontaneously. At ordinary temperatures tin proves fairly ductile under the hammer, and its ductility seems to increase as the temperature rises up to about 100° C. At some temperature near its fusing point it becomes brittle, and still more brittle from −14° C. downwards. Iron renders the metal hard and brittle; arsenic, antimony and bismuth (up to 0·5%) reduce its tenacity; copper and lead (1 to 2%) make it harder and stronger but impair its malleability; and stannous oxide reduces its tenacity. Tin fuses at about 230° C.; at a red heat it begins to volatilize slowly; at 1600° to 1800° C. it boils. The hot vapour produced combines with the oxygen of the air into white oxide, SnO_2. Its coefficient of linear expansion between 0° and 100° is 0·002717; its specific heat 0·0562; its thermal and electrical conductivities are 145 to 152 and 114·5 to 140·1 respectively compared to silver as 1000.

Industrial Applications.—Commercially pure tin is used for making such apparatus as evaporating basins, infusion pots, stills, &c. It is also employed for making two varieties of tin-foil—one for the silvering of mirrors (see MIRROR), the other for wrapping up chocolate, toilet soap, tobacco, &c. The mirror foil must contain some copper to prevent it from being too readily amalgamated by the mercury. For making tin-foil the metal is rolled into thin sheets, pieces of which are beaten out with a wooden mallet. As pure tin does not tarnish in the air and is proof against acid liquids, such as vinegar, lime juice, &c., it is utilized for culinary and domestic vessels. But it is expensive, and tin vessels have to be made very heavy to give them sufficient stability of form; hence it is generally employed merely as a protecting coating for utensils made essentially of copper or iron. The tinning of a copper basin is an easy operation. The basin, made scrupulously clean, is heated to beyond the fusing point of tin. Molten tin is then poured in, a little powdered sal-ammoniac added, and the tin spread over the inside with a bunch of tow. The sal-ammoniac removes the last unavoidable film of oxide, leaving a purely metallic surface, to which the tin adheres firmly. For tinning small objects of copper or brass (*i.e.* pins, hooks, &c.) a wet-way process is followed. One part of cream of tartar, two of alum and two of common salt are dissolved in boiling water, and the solution is boiled with granulated metallic tin (or, better, mixed with a little stannous chloride) to produce a tin solution; and into this the articles are put at a boiling heat. In the absence of metallic tin there is no visible change; but, as soon as the metal is introduced, an electrolytic action sets in and the articles get coated over with a firmly adhering film of tin. Tinning wrought iron is effected by immersion. The most important form of the operation is making tinned from ordinary sheet iron (making what is called "sheet tin"). This process was mentioned by Agricola; it was practised in Bohemia in 1620, and in England a century later. The iron plates, having been carefully cleaned with sand and hydrochloric or sulphuric acid, and lastly with water, are plunged into heated tallow to drive away the water without oxidation of the metal. They are next steeped in a bath, first of molten ferruginous, then of pure tin. They are then taken out and kept suspended in hot tallow to enable the surplus tin to run off. The tin of the second bath dissolves iron gradually and becomes fit for the first bath. To tin cast-iron articles they must be decarburetted superficially by ignition within a bath of ferric oxide (powdered haematite or similar material), then cleaned with acid, and tinned by immersion, as explained above. (See TIN-PLATE.) By far the greater part of the tin produced metallurgically is used for making tin alloys (see PEWTER, BRONZE).

Compounds of Tin.

Tin forms two well-marked series of salts, in one of which it is divalent, these salts being derived from stannous oxide, SnO, in the other it is tetravalent, this series being derived from stannic oxide, SnO_2.

Stannous Oxide, SnO, is obtained in the hydrated form $Sn_2O(OH)_2$ from a solution of stannous chloride by addition of sodium carbonate; it forms a white precipitate, which can be washed with air-free water and dried at 80° C. without much change by oxidation; if it be heated in carbon dioxide the black SnO remains. Precipitated stannous hydrate dissolves readily in caustic potash; if the solution is evaporated quickly it suffers decomposition, with formation of metal and stannate, $2SnO+2KOH=K_2SnO_2+Sn+H_2O$. If it is evaporated slowly, anhydrous stannous oxide crystallizes out in forms which are combinations of the cube and dodecahedron. Dry stannous oxide, if touched with a glowing body, catches fire and burns to stannic oxide, SnO_2. Stannous oxalate when heated by itself in a tube leaves stannous oxide.

Stannic Oxide, SnO_2.—This, if the term is taken to include the hydrates, exists in a variety of forms. (1) *Tinstone* (see above and also CASSITERITE) is proof against all acids. Its disintegration for analytical purposes can be effected by fusion with caustic alkali in silver basins, with the formation of soluble stannate, or by fusion with sulphur and sodium carbonate, with the formation of a soluble thiostannate. (2) A similar oxide (*flores jovis*) is produced by burning tin in air at high temperatures or exposing any of the hydrates to a strong red heat. Such *tin-ash*, as it is called, is used for the polishing of optical glasses. *Flores stanni* is a finely divided mixture of the metal and oxide obtained by fusing the metal in the presence of air for some time. (3) *Metastannic acid* (generally written $H_{10}Sn_5O_{15}$, to account for the complicated composition of metastannates, *e.g.* the sodium salt $H_8Na_2Sn_5O_{15}$) is the white compound produced from the metal by means of nitric acid. It is insoluble in water and in nitric acid and apparently so in hydrochloric acid; but if heated with this last for some time it passes into a compound, which, after the acid mother liquor has been decanted off, dissolves in water. The solution when subjected to distillation behaves very much like a physical solution of the oxide in hydrochloric acid, while a solution of orthostannic acid in hydrochloric acid behaves like a solution of $SnCl_4$ in water, *i.e.* gives off no hydrochloric acid, and no precipitate of hydrated SnO_2. Metastannic acid is distinguished from orthostannic acid by its insolubility in nitric and sulphuric acids. The salts are obtained by the action of alkalies on the acid. (4) Orthostannic acid is obtained as a white precipitate on the addition of sodium carbonate or the exact quantity of precipitated calcium carbonate to a solution of the chloride. This acid, H_2SnO_3, is readily soluble in acids forming stannic salts, and in caustic potash and soda, with the formation of orthostannates. Of these sodium stannate, Na_2SnO_3, is produced industrially by heating tin with Chile saltpetre and caustic soda, or by fusing very finely powdered tinstone with caustic soda in iron vessels. A solution of the pure salt yields fine prisms of the composition $Na_2SnO_3+10H_2O$, which effloresce in the air. The salt is used as a mordant in dyeing and calico-printing. Alkaline and other stannates when treated with aqueous hydrofluoric acid are converted into fluostannates (*e.g.* K_2SnO_3 into K_2SnF_6), which are closely analogous to, and isomorphous with, fluosilicates.

A *colloidal* or *soluble stannic acid* is obtained by dialysing a mixture of tin tetrachloride and alkali, or of sodium stannate and hydrochloric acid. On heating it is converted into colloidal metastannic acid.

A hydrated *tin trioxide*, SnO_3, was obtained by Spring by adding barium dioxide to a solution of stannous chloride and hydrochloric acid; the solution is dialysed, and the colloidal solution is evaporated to form a white mass of $2SnO_3 \cdot H_2O$.

Stannous Chloride, $SnCl_2$, can only be obtained pure by heating pure tin in a current of pure dry hydrochloric acid gas. It is a white solid, fusing at 250° C. to an oily liquid which boils at 606°, and volatilizing at a red heat in nitrogen, a vacuum or hydrochloric acid, without decomposition. The vapour density below 700° C. corresponds to Sn_2Cl_4, above 800° C. to nearly $SnCl_2$. The chloride readily combines with water to form a crystallizable hydrate $SnCl_2 \cdot 2H_2O$, known as "tin salt" or "tin crystals." This salt is also formed by dissolving tin in strong hydrochloric acid and allowing it to crystallize, and is industrially prepared by passing sufficiently hydrated hydrochloric acid gas over granulated tin contained in stoneware bottles and evaporating the concentrated solution produced in tin basins over granulated tin. The basin itself is not attacked. The crystals are very soluble in cold water, and if the salt is really pure a small proportion of water forms a clear solution; but on adding much water most of the salt is decomposed, with the formation of a precipitate of oxychloride, $2Sn(OH)Cl \cdot H_2O$. According to Michel and Kraft, one litre of cold saturated solution of tin crystals weighs 1827 grammes and contains 1333 grammes of $SnCl_2$. The same oxychloride is produced when the moist crystals, or their solution, are exposed to the air. Hence all tin crystals as kept in the laboratory give with water a turbid solution, which contains stannic in addition to stannous chloride. The complete conversion of stannous into stannic chloride may be effected by a great many reagents—for instance, by chlorine (bromine, iodine) readily; by mercuric chloride in the heat, with precipitation of calomel or metallic mercury; by ferric chloride in the heat, with formation of ferrous chloride; by arsenious chloride in strongly hydrochloric solutions, with precipitation of chocolate-brown metallic arsenic. All these reactions are available as tests for "stannosum" or the respective agents. In opposition to stannous chloride, even sulphurous acid (solution) behaves as an oxidizing agent. If the two reagents are mixed a precipitate of yellow stannic sulphide is produced. A strip of metallic zinc when placed in a solution of stannous chloride precipitates the tin in crystals and takes its place in the solution. Stannous chloride is largely used in the laboratory as a reducing agent, in dyeing as a mordant.

Stannic Chloride, $SnCl_4$, named by Andreas Libavius in 1605 *Spiritus argenti vivi sublimati* from its preparation by distilling tin or its amalgam with corrosive sublimate, and afterwards termed *Spiritus fumans Libavii*, is obtained by passing dry chlorine over granulated tin contained in a retort; the tetrachloride distils over as a heavy liquid, from which the excess of chlorine is easily removed by shaking with a small quantity of tin filings and re-distilling. It is a colourless fuming liquid of specific gravity 2·269 at 0°; it freezes at −33° C., and boils at 113·9°. The chloride unites energetically with water to form crystalline hydrates (*e.g.* $SnCl_4 \cdot 3H_2O$), easily soluble in water. With one-third its weight of water it forms the so-called "butter of tin." It combines readily with alkaline and other chlorides to form double salts, *e.g.* M_2SnCl_6, analogous to the chloroplatinates; the salt $(NH_4)_2SnCl_6$ is known industrially as "pink salt" on account of its use as a mordant to produce a pink colour. The *oxymuriate of tin* used by dyers is $SnCl_4 \cdot 5H_2O$. The plain chloride solution is similarly used. It is usually prepared by dissolving the metal in aqua regia.

Stannous Fluoride, SnF_2, is obtained as small, white monoclinic tables by evaporating a solution of stannous oxide in hydrofluoric acid in a vacuum. *Stannic Fluoride*, SnF_4, is obtained in solution by dissolving hydrated stannic oxide in hydrofluoric acid; it forms a characteristic series of salts, the stannofluorides, M_2SnF_6, isomorphous with the silico-, titano-, germano- and zirconofluorides. *Stannous bromide*, $SnBr_2$, is a light yellow substance formed from tin and hydrobromic acid. *Stannic bromide*, $SnBr_4$, is a white crystalline mass, melting at 33° and boiling at 201°, obtained by the combination of tin and bromine, preferably in carbon bisulphide solution. *Stannous iodide*, SnI_2, forms yellow red needles, and is obtained from potassium iodide and stannous chloride. *Stannic iodide*, SnI_4, forms red octahedra and is prepared similarly to stannic bromide. Both iodides combine with ammonia.

Stannous sulphide, SnS, is obtained as a lead-grey mass by heating tin with sulphur, and as a brown precipitate by adding sulphuretted hydrogen to a stannous solution; this is soluble in ammonium polysulphide, and dries to a black powder. *Stannic sulphide*, SnS_2, is obtained by heating a mixture of tin (or, better, tin amalgam), sulphur and sal-ammoniac in proper proportions in the beautiful form of *aurum musivum* (mosaic gold)—a solid consisting of golden yellow, metallic lustrous scales, and used chiefly as a yellow "bronze" for plaster-of-Paris statuettes, &c. The yellow precipitate of stannic sulphide obtained by adding sulphuretted hydrogen to a stannic solution readily dissolves in solutions of the alkaline sulphides to form *thiostannates* of the formula M_2SnS_3; the free acid, H_2SnS_3, may be obtained as an almost black powder by drying the yellow precipitate formed when hydrochloric acid is added to a solution of a thiostannate.

Analysis.—Tin compounds when heated on charcoal with sodium carbonate or potassium cyanide in the reducing blowpipe flame yield the metal and a scanty ring of white SnO_2. Stannous salt solutions yield a brown precipitate of SnS with sulphuretted hydrogen, which is insoluble in cold dilute acids and in real sulphide of ammonium, $(NH_4)_2S$; but the yellow, or the colourless reagent on addition of sulphur, dissolves the precipitate as SnS_2 salt. The solution on acidification yields a yellow precipitate of this sulphide. Stannic salt solutions give a yellow precipitate of SnS_2 with sulphuretted hydrogen, which is insoluble in cold dilute acids but readily soluble in sulphide of ammonium, and is re-precipitated therefrom as SnS_2 on acidification. Only stannous salts (not stannic) give a precipitate of calomel in mercuric chloride solution. A mixture of stannous and stannic chloride, when added to a sufficient quantity of solution of chloride of gold, gives an intensely purple precipitate of gold purple (purple of Cassius). The test is very delicate, although the colour is not in all cases a pure purple. Tin is generally quantitatively estimated as the dioxide. The solutions are oxidized, precipitated with ammonia, the precipitate dissolved in hydrochloric acid, and re-thrown down by boiling with sodium sulphate. The precipitate is filtered, washed, dried and ignited.

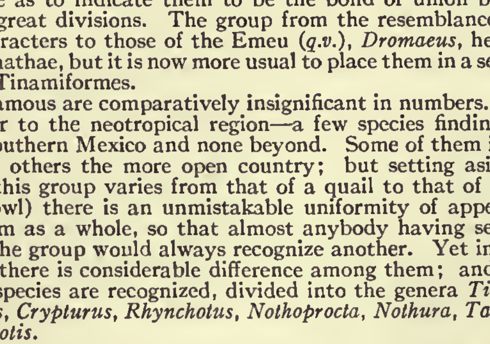
BIBLIOGRAPHY.—For the history of tin and statistics of its production, &c., see Bernard Neumann, *Die Metalle* (1904); A. Rossing, *Geschichte der Metalle* (1901). For its chemistry see Roscoe and Schorlemmer, *Treatise on Inorganic Chemistry*, vol. ii.; H. Moissan, *Traité de chimie minérale*; O. Dammer, *Handbuch der anorganischen Chemie*. For its production and metallurgy see Sydney Fawns, *Tin Deposits of the World*; A. G. Charleton, *Tin Mining*; Henry Louis, *The Production of Tin*, and C. Schnabel, *Handbook of Metallurgy* (English trans. by Louis, 1907). General statistical information, and improvements in the metallurgy, &c., are recorded annually in *The Mineral Industry*.

TINAMOU, the name given in Guiana to a certain bird, as stated in 1741 by P. Barrère (*France équinoxiale*, p. 138), from whom it was taken and used in a more general sense by Buffon (*Hist. nat. oiseaux*, iv. 502). In 1783 J. Latham (*Synopsis*, ii. 724) adopted it as English, and in 1790 (*Index*, ii. 633) Latinized it *Tinamus*, as the name of a new and distinct genus. The "Tinamou" of Barrère has been identified with the "Macucagua" described and figured by Marcgrav in 1648, and is the *Tinamus major* of modern authors.[1]

Buffon and his successors saw that the Tinamous, though passing among the European colonists of South America as "Partridges," could not be associated with those birds, and Latham's step, above mentioned, was generally approved. The genus he had founded was usually placed among the Gallinae, and by many writers was held to be allied to the bustards, which, it must be remembered, were then thought to be "struthious." Indeed the likeness of the Tinamou's bill to that of the Rhea (*q.v.*) was remarked in 1811 by Illiger. On the other hand L'Herminier in 1827 saw features in the Tinamou's sternum that in his judgment linked the bird to the Rallidae. In 1830 J. Wagler (*Nat. Syst. Amphibien*, &c., p. 127) placed the Tinamous in the same order as the ostrich and its allies; and, though he did this on very insufficient grounds, his assignment has turned out to be not far from the mark, as in 1862 the great affinity of these groups was shown by W. K. Parker's researches, which were afterwards printed in the Zoological *Transactions* (v. pp. 205–232, 236–238, pls. xxxix.–xli.), and was further substantiated by him in the *Philosophical Transactions* (1866, pp. 174–178, pl. xv.). Shortly after this T. H. Huxley in his often-quoted paper in the Zoological *Proceedings* (1867, pp. 425, 426) was enabled to place the whole matter in a clear light, urging that the Tinamous formed a very distinct group of birds which, though not to be removed from the Carinatae, presented so much resemblance to the Ratitae as to indicate them to be the bond of union between those two great divisions. The group from the resemblance of its palatal characters to those of the Emeu (*q.v.*), *Dromaeus*, he called Dromaeognathae, but it is now more usual to place them in a separate order, the Tinamiformes.

The Tinamous are comparatively insignificant in numbers. They are peculiar to the neotropical region—a few species finding their way into southern Mexico and none beyond. Some of them inhabit forests and others the more open country; but setting aside size (which in this group varies from that of a quail to that of a large common fowl) there is an unmistakable uniformity of appearance among them as a whole, so that almost anybody having seen one species of the group would always recognize another. Yet in minor characters there is considerable difference among them; and about sixty-four species are recognized, divided into the genera *Tinamus*, *Nothocercus*, *Crypturus*, *Rhynchotus*, *Nothoprocta*, *Nothura*, *Taoniscus* and *Tinamotis*.

To the ordinary spectator Tinamous have much the look of partridges, but the more attentive observer will notice that their



Rufous Tinamou (*Rhynchotus rufescens*).

elongated bill, their small head and slender neck, clothed with very short feathers, give them a different air. The plumage is generally inconspicuous: some tint of brown, ranging from rufous to slaty, and often more or less closely barred with a darker shade or black, is the usual style of coloration; but some species are characterized by a white throat or a bay breast. The wings are short and rounded, and in some forms the feathers of the tail, which in all are hidden by their coverts, are soft. In bearing and gait the birds show some resemblance to their distant relatives the Ratitae, and A. D. Bartlett showed (*Proc. Zool. Soc.*, 1868, p. 115, pl. xii.) that this is especially seen in the newly hatched young. He also noticed the still stronger Ratite character, that the male takes on himself the duty of incubation. The eggs are very remarkable objects, curiously unlike those of other birds; and their shell looks as if it were of highly-burnished metal or glazed porcelain, presenting also various colours, which seem to be constant in the particular species, from pale primrose to sage-green or light indigo, or from chocolate brown to pinkish orange. All who have eaten it declare the flesh of the Tinamou to have a most delicate taste, as it has a most inviting appearance, the pectoral muscles being semi-opaque. Of their habits not much has been told. Darwin (*Journ.* ch. iii.) has remarked upon the silliness they show in allowing themselves to be taken, and this is wholly in accordance with what W. K. Parker observes of their brain capacity and is an additional testimony to their low morphological rank. At least one species of Tinamou has bred not infrequently in confinement, and partly successful attempts to naturalize the species *Rhynchotus rufescens* have been made in England. (A. N.)

[1] Brisson and after him Linnaeus confounded this bird, which they had never seen, with the Trumpeter (*q.v.*).

TINCTURE (Fr. *teinture*, Lat. *tinctura*, *tingere*, to dye, stain), the colour with which a substance is dyed; hence, metaphorically, distinctive character or quality. The term is used in heraldry of the metals, *argent*, *or*, of the colours, *gules*, *azure*, *sable*, *vert*, &c., or of the furs, *ermine*, *vair*, &c. Since the 16th century a conventional arrangement of lines and dots gives the equivalents of these tinctures in black and white (see HERALDRY). In medicine, a tincture is a fluid solution of the essential properties of some substance, animal, vegetable or mineral; the menstruum being either alcohol, ether or ammonia; the various kinds are accordingly distinguished as alcoholic, etherial or ammoniated tinctures.

TINDAL, MATTHEW (d. 1733), English deist, the son of a clergyman, was born at Beer Ferrers (Ferris), Devonshire, probably in 1653. He studied law at Lincoln College, Oxford, under the high churchman George Hickes, dean of Worcester; in 1678 he was elected fellow of All Souls College. About 1685 he saw "that upon his High Church notions a separation from the Church of Rome could not be justified," and accordingly he joined the latter. But discerning "the absurdities of popery," he returned to the Church of England at Easter 1688. His early works were an *Essay of Obedience to the Supreme Powers* (1694); an *Essay on the Power of the Magistrate and the Rights of Mankind in Matters of Religion* (1697); and *The Liberty of the Press* (1698). The first of his two larger works, *The Rights of the Christian Church associated against the Romish and all other priests who claim an independent power over it*, pt. i., appeared anonymously in 1706 (2nd ed., 1706; 3rd, 1707; 4th, 1709). The book was regarded in its day as a forcible defence of the Erastian theory of the supremacy of the state over the Church, and at once provoked criticism and abuse. After several attempts to proscribe the work had failed, a case against the author, publisher and printer succeeded on the 12th of December 1707, and another against a bookseller for selling a copy the next day. The prosecution did not prevent the issue of a fourth edition and gave the author the opportunity of issuing *A Defence of the Rights of the Christian Church*, in two parts (2nd ed., 1709). The book was, by order of the House of Commons, burned, along with Sacheverell's sermon, by the common hangman (1710). It continued to be the subject of denunciation for years, and Tindal believed he was charged by Dr Gibson, bishop of London, in a *Pastoral Letter*, with having undermined religion and promoted atheism and infidelity—a charge to which he replied in the anonymous tract, *An Address to the Inhabitants of London and Westminster*, a second and larger edition of which appeared in 1730. In this tract[2] he makes a valiant defence of the deists, and anticipates

[2] *A Second Address to the Inhabitants*, &c., with replies to some of the critics of that book, bears the same date (1730), though some of the works it refers to appeared in 1731.

here and there his *Christianity as Old as the Creation; or, the Gospel a Republication of the Religion of Nature* (London, 1730, 2nd ed., 1731; 3rd, 1732; 4th, 1733), which was regarded as the "Bible" of deism. It was really only the first part of the whole work, and the second, though written and entrusted in manuscript to a friend, never saw the light. The work evoked many replies, of which the ablest were by James Foster (1730), John Conybeare (1732), John Leland (1733) and Bishop Butler (1736). It was translated into German by J. Lorenz Schmidt (1741), and from it dates the influence of English deism on German theology. Tindal had probably adopted the principles it expounds before he wrote his essay of 1697. He claimed the name of "Christian deist," holding that true Christianity is identical with the eternal religion of nature. He died at Oxford on the 16th of August 1733.

The religious system expounded in *Christianity as Old as the Creation*, unlike the earlier system of Lord Herbert of Cherbury, was based on the empirical principles of Locke. It assumed the traditional deistic antitheses of external and internal, positive and natural, revelations and religions, and perpetuated at the same time the prevalent misconceptions as to the nature of religion and revelation. The system was worked out by the a priori method, with an all but total disregard of the facts of religious history. It starts from the assumptions that true religion must, from the nature of God and things, be eternal, universal, simple and perfect; that this religion can consist of nothing but the simple and universal duties towards God and man, the first consisting in the fulfilment of the second—in other words, the practice of morality. The author's moral system, somewhat confused and inconsistent, is essentially utilitarian. True revealed religion is simply a republication of the religion of nature or reason, and Christianity, if it is the perfect religion, can only be that republication, and must be as old as creation. The special mission of Christianity, therefore, is simply to deliver men from the superstition which had perverted the religion of nature. True Christianity must be a perfectly "reasonable service," reason must be supreme, and the Scriptures as well as all religious doctrines must submit; only those writings can be regarded as divine Scripture which tend to the honour of God and the good of man. The strength of Tindal's position was the conviction of the essential harmony between man's religious and rational nature. Its weakness from the standpoint of modern theology was that, like the whole religious philosophy of the time, it was founded on a misconception of religion and revelation, and on a disregard of the course of man's religious development.

See works quoted under Deism.

TINDER (O. Eng. *tyndre*, from *tindan, tendan*, to *kindle*, cf. Dan. *tonder*, Ger. *anzünden*), a term applied to any dry substance that will readily take light from a spark and so be used for kindling a fire. Before the invention of matches (see Match) fire or light was procured by the ignition of tinder through sparks obtained by the striking of flint against steel, the whole apparatus of tinder, flint and steel being contained in a metal box, which was an essential utensil of all households and was also carried on the person of everyone who might require a light in an emergency. The usual material of "tinder" was a mass of charred linen, but the term was also applied to "touchwood," or wood converted into an easily ignitible consistency by the action of certain fungi. Another form of "tinder" was "touchpaper," paper dipped in nitre and used as a slow-match for igniting gunpowder. In both these words "touch" stands for an earlier *tach, tache* or *tasshe*, tinder, of which the origin is unknown. It may be related to Du. *tak*, bough, twig, and would thus mean dried twigs used as tinder.

TINEO, a town of northern Spain, in the province of Oviedo; on a small tributary of the river Narcea, among the northern outliers of the Cantabrian Mountains, and on the high road from Cangas de Tineo to the Biscayan port of Cudillero. Pop. (1900), 21,865. Mining, agriculture and stock-rearing are the principal industries.

TINKER, an itinerant mender of kettles, pots, pans, &c. The name means simply one who makes a tinkling sound as he mends the vessels, and the word is found as "tinkler" in the 16th century. From early times "tinkers" were looked on as vagabonds, and were so classed in the act of Elizabeth against vagrancy.

TINNÉ, ALEXANDRINE PETRONELLA FRANCINA (1839–1869), Dutch traveller in Africa, born at the Hague on the 17th of October 1839, was the daughter of Philip F. Tinné, a Dutch merchant who settled in England during the Napoleonic wars, but afterwards returned to his native land, and of his wife, Baroness Van Steengracht-Capellan. Her father died when she was five years old, leaving her the richest heiress in the Netherlands. After travelling in Norway, Italy and the East, and visiting Egypt, when she ascended the Nile to near Gondokoro, Miss Tinné left Europe again in 1861 for the Nile regions. Accompanied by her mother and her aunt, she set out from Cairo on the 9th of January 1862. After a short stay at Khartum the party ascended the White Nile to a point above Gondokoro, and explored a part of the Sobat, returning to Khartum in November. Baron Theodor von Heuglin (*q.v.*) and Dr H. Steudner having meantime joined the ladies at Khartum, the whole party set out in February 1863 for the Bahr-el-Ghazal. The intention was to explore that region and ascertain how far westward the Nile basin extended; also to investigate the reports of a vast lake in Central Africa eastwards of those already known—reports referring in all probability to the lake-like expanses of the middle Congo.

Ascending the Bahr-el-Ghazal the limit of navigation was reached on the 10th of March. From Meshra-er-Rek a journey was made overland, across the Bahr Jur and south-west by the Bahr Kosango, to Jebel Kosango, on the borders of the Niam-Niam country. During the journey all the travellers suffered severely from fever. Steudner died in April and Madame Tinné in June, and after many fatigues and dangers the remainder of the party reached Khartum in July 1864, where Miss Tinné's aunt died. Miss Tinné returned to Cairo by Berber and Suakin. The geographical and scientific results of the expedition were highly important, as will be seen in Heuglin's *Die Tinnésche Expedition im westlichen Nilgebiet* (*1863–1864* (Gotha, 1865), and *Reise in das Gebiet des Weissen Nils* Leipzig, 1869). A description, by T. Kotschy and J. Peyritsch, of some of the plants discovered by the expedition was published at Vienna in 1867 under the title of *Plantes Tinnéennes.* At Cairo Miss Tinné lived in Oriental style during the next four years, visiting Algeria, Tunisia and other parts of the Mediterranean. In January 1869 she started from Tripoli with a caravan, intending to proceed to Lake Chad, and thence by Wadai, Darfur and Kordofan to the upper Nile. On the 1st of August, however, on the route from Murzuk to Ghat, she was murdered, together with two Dutch sailors, by Tuareg in league with her escort, who believed that her iron water tanks were filled with gold.

See John A. Tinné's *Geographical Notes of an Expedition in Central Africa by three Dutch Ladies* (Liverpool, 1864), and Sir H. H. Johnston, *The Nile Quest*, ch. xvi. (London, 1903).

TINNEVELLY, a town and district of British India, in the Madras presidency. The town is on the left bank of the Tambraparni river, on the other side of which is Palamcottah, the administrative headquarters of the district. Pop. (1901), 40,469. It is the terminus of a branch of the South Indian railway, 444 m. S.W. of Madras. Its most noteworthy building is a beautifully sculptured temple of Siva.

The District of Tinnevelly has an area of 5389 sq. m. It is for the most part a plain with an average elevation of 200 ft., sloping to the east with slight undulations. It is watered by numerous short streams, the principal being the Tambraparni with a length of 80 m. The chief irrigation work is the Srivaikuntam anicut or dam on this river. In the north the scenery is unattractive and the soil poor; in the south red sandy soil prevails in which little save the Palmyra palm will grow. This palm yields toddy as well as a coarse sugar. Along the banks of the rivers are rice-fields and a variety of trees and crops; and coffee is grown on the slopes of the Travancore hills. The district contains many ancient and magnificent buildings. But the most interesting antiquities are the large sepulchral earthen urns of prehistoric races, which have been found at several places, especially along the course of the Tambraparni; they contain bones, pottery, beads and bronze ornaments, iron weapons, implements, &c. The South Indian railway has its maritime terminus at Tuticorin, the chief seaport. The principal exports are rice to Ceylon and cotton to Japan and Europe. In 1901 the population was 2,059,607, showing an increase of 8% in the decade. The number of native Christians was 159,213, Tinnevelly being the most Christian district in India. The Society for the Propagation of the Gospel and the Church Missionary Society have important and flourishing stations at Tinnevelly town and Palamcottah, as also have the Jesuits. It was here that St Francis Xavier began his preaching in India. The Shanans, or caste of toddy-drawers, have supplied many converts to Christianity. In 1899 their treatment by the Vellalars, or cultivating caste, led to serious riots and bloodshed.

The early history of Tinnevelly is mixed up with that of Madura and Travancore. Down to 1781 it is a confused tale of anarchy and bloodshed. In that year the nawab of Arcot assigned the revenues to the East India Company, which then undertook the internal administration. Several risings subsequently took place, and in 1801 the whole Carnatic, including Tinnevelly, was ceded to the British.

TIN-PLATE and **TERNE-PLATE.** Tin-plate consists of sheets of iron or steel which have been thinly coated with tin by being dipped in a molten bath of that metal. Terne-plate is a similar product, but the bath is not of tin, but of tin and lead mixed, the latter metal constituting from 75–90% of the whole; it has not the bright lustre of tin-plate, whence its name, from *terne*, dull, tarnished. The sheets employed in the manufacture are known as "black plates," and are now of steel, either Bessemer or open-hearth. Formerly iron was used, and was of two grades, coke-iron and charcoal-iron; the latter, being the better, received a heavier coating of tin, and this circumstance is the origin of the terms "coke plates" and "charcoal plates" by which the quality of tin-plate is still designated, although iron is no longer used. Tin-plate is consumed in enormous quantities for the manufacture of the tin cans in which preserved meat, fish, fruit, biscuits, cigarettes and numerous other products are packed, and also for the household utensils of various kinds made by the tinsmith or silversmith; terne-plates, which began to be produced in England about the middle of the 19th century, are widely employed in America for roofing purposes.

The manufacture of tin-plate was long a monopoly of Bohemia, but about 1620 the industry spread to Saxony. In 1665 Andrew Yarranton (1616–1684?), an English engineer and agriculturist, was commissioned to go to Saxony and if possible discover the methods employed. According to his own account (*England's Improvement*, pt. ii. 1681), he was "very civilly treated" and was allowed to see the whole process. On his return to England his friends undertook the manufacture on an experimental scale, but though they were successful they had to abandon it, because their method became known and a patent for it was "trumpt up" by a rival, who, however, from lack of technical skill was unable to work it. Half a century later the manufacture was revived by Major John Hanbury (1664–1734) at Pontypool; the "method of rolling iron plates by means of cylinders," said to have been devised by him, enabled more uniform black plates to be produced than was possible with the old plan of hammering, and in consequence the English tin-plate became recognized as superior to the German. During the next hundred years or so the industry spread steadily in England and Wales, and after 1834 its expansion was rapid, especially in Wales, Great Britain becoming the chief source of the world's supply. In that year her total production was 180,000 boxes of 108 ℔ each (in America a box is 100 ℔), in 1848 it was 420,000 boxes, in 1860 it reached 1,700,000 boxes, in 1870 nearly 3,460,000 boxes, and in 1890 it exceeded 9,500,000 boxes. In the United States the manufacture of tin- and terne-plates did not make much way until about 1890, and up to 1892 the bulk of the supply was imported from Great Britain. But subsequently the advance was rapid, and the production, which was about 2,236,000 ℔ in 1891, had by 1900 increased to more than 849,000,000 ℔, of which over 141,000,000 ℔ were terne-plates. The total imports in that year were only 135,264,881 ℔. In later years, again, there was a decline in the American production, and in 1907 only 20% of the American tin-plate mills were at work, while the British production reached 14 million boxes.

There are two processes for the tinning of the black plates. In the "palm-oil" process, which is the older, the plates, after being properly annealed, are scoured with sand and water and pickled in dilute sulphuric acid alternately until they are perfectly clean and bright. They are then washed in water, and after being boiled in palm oil to remove all traces of acid and water are dipped into a bath of molten tin, covered with oil to prevent oxidation. They are then taken to a second bath containing purer tin than the first. After this they are scoured with a hempen rubber and dipped in a third bath containing the purest tin of all; then they are passed through rolls to finish the surface and regulate the thickness of the coating. As the tin in the third bath becomes alloyed with iron from the operation, it is removed into the second, pure fresh tin being substituted; and similarly the metal of the second, as the amount of iron in it increases, is removed to the first. In the "acid process" only a single bath of tin is required. The molten metal is covered with a layer of muriate of zinc, which acts as the flux, and by means of rolls the plates are passed through this down into the tin, to be brought out at another point in the bath where there is a layer of oil on the surface.

TINTAGEL, or Trevena, a village in the Launceston parliamentary division of Cornwall, England, on the north coast, 4½ m. from Camelford. Pop. (1901), 868. It stands on a bare upland, close to the sea; and below it is Tintagel Haven, or Porth, a small cove surrounded by cliffs of almost black slate. The scanty ruins of a castle are built partly on the mainland, partly on a rugged promontory spoken of as the Island, but united by a narrow peninsula to the shore. They have been celebrated as the birthplace of King Arthur, or as the stronghold of King Mark, in a host of medieval romances, and in the poems of Tennyson and Swinburne. The Norman walls are so darkened and weathered that, from a little distance, they seem a part of the rock itself. Portions of a chapel remain, dating from the 13th century, and including a porch and a stone altar; while beside it are traces of a tomb hewn out of the slate, and of some domestic building which had a staircase and a pointed arch above the door. The cruciform parish church of St Marcelliana stands on a high cliff, west of the castle. Although it has been restored, there remain traces of Saxon workmanship in the chancel, besides two Norman doorways, a font of the same period, a stone altar bearing five crosses and a fine 15th-century brass. In the churchyard the graves are buttressed, storms being frequent and violent on this unprotected coast. For a time the church belonged to Fontevrault Abbey in Normandy; but it was made over by Edward IV. to the collegiate church of Windsor. A 9th-century roodstone stands in the village. Portions of the vicarage date from the 14th century, and in its garden there is a stone dovecote of great age. A little slate is quarried, being taken from the rocks below the church, and exported in the small vessels which can visit Tintagel Haven in calm weather. The magnificence of the coast has inspired more than one famous painting.

Tintagel (Tintajol, Dundagel) is a parish a portion of which appears in the Domesday Survey as Bossiney (Botcinnu). The latter was held in the time of the Confessor by a thegn of St Petrock and at the time of the survey by Robert, count of Mortain, of the same saint. The castle probably existed in pre-Saxon times. Under the Norman earls of Cornwall this was rebuilt, embattled and furnished with munitions of war. Its officers included a constable and a chaplain. It was in a ruinous condition in Leland's time (*c.* 1540). Queen Elizabeth abolished the office of constable. In the parish of Tintagel is the hamlet of Bossiney which under the name of Tintagel received a charter (undated) from Richard king of the Romans, granting freedom to the borough and to the burgesses freedom from pontage and stallage throughout Cornwall, a market on Wednesdays and a three days' fair at Michaelmas. This charter was confirmed in 1386. In 1333 the burgesses, those who held tenements within the borough, numbered 100. The borough, which apparently owed its existence to the castle, shared its fortunes. Leland calls attention to the decay of a great number of houses. Its charter was surrendered to Charles II. and a new one obtained from his brother in 1685. Under the latter a mayor, recorder, six common councillors, a coroner, six freemen and a common clerk were to constitute the corporation. For supplying vacancies in it the votes of those only who were members of it were required. Provision was made for the administration of the borough. Bossiney acquired the right of electing two members of parliament in 1553, the franchise being originally vested in the freeholders within the borough. By the middle of the

18th century the franchise had become restricted to the freemen or burgesses. In 1784 the vicar of Tintagel, as mayor and only qualified elector, enjoyed the probably unique privilege of returning two members to the House of Commons. In 1832 there were ten resident legal voters within the borough and nine out-voters. The Reform Act transferred their votes to the county. There is now no market, and the only fair is held on the 21st of October.

See *Victoria County History: Cornwall;* Sir J. Maclean, *History of Trigg Minor.*

TINTERN ABBEY, in Monmouthshire, one of the most famous ecclesiastical ruins in England. It is beautifully situated on the right bank of the river Wye. The abbey was founded by Walter de Clare in 1131 for Cistercian monks. The existing church, however, dates from the later part of the 13th century; it is unroofed, and the nave is imperfect, but many of the finest details of a style transitional from Early English to Decorated are preserved. The church is cruciform. Cloisters and other monastic buildings, of which there are considerable remains, lay to the north of the church. The foundation was dissolved by Henry VIII. At the neighbouring village of Tintern Parva there is a station on a branch of the Great Western railway.

TINTORETTO, JACOPO ROBUSTI (1518–1594), one of the greatest painters of the Venetian school, was born in Venice in 1518, though most accounts say in 1512. His father, Battista Robusti, was a dyer, or " tintore "; hence the son got the nickname of " Tintoretto," little dyer, or dyer's boy, which is Englished as Tintoret. In childhood Jacopo, a born painter, began daubing on the dyer's walls; his father, noticing his bent, took him round, still in boyhood, to the studio of Titian, to see how far he could be trained as an artist. We may suppose this to have been towards 1533, when Titian was already (according to the ordinary accounts) fifty-six years of age. Ridolfi is our authority for saying that Tintoret had only been ten days in the studio when Titian sent him home once and for all. The reason, according to the same writer, is that the great master observed some very spirited drawings, which he learned to be the production of Tintoret; and it is inferred that he became at once jealous of so promising a scholar. This, however, is mere conjecture; and perhaps it may be fairer to suppose that the drawings exhibited so much independence of manner that Titian judged that young Robusti, although he might become a painter, would never be properly a pupil. From this time forward the two always remained upon distant terms—Robusti being indeed a professed and ardent admirer of Titian, but never a friend, and Titian and his adherents turning the cold shoulder to Robusti. Active disparagement also was not wanting, but it passed unnoticed by Tintoret. The latter sought for no further teaching, but studied on his own account with laborious zeal; he lived poorly, collecting casts, bas-reliefs, &c., and practising by their aid. His noble conception of art and his high personal ambition were evidenced in the inscription which he placed over his studio—" Il disegno di Michelangelo ed il colorito di Tiziano " (Michelangelo's design and Titian's colour). He studied more especially from models of Michelangelo's " Dawn," " Noon," " Twilight " and " Night," and became expert in modelling in wax and clay—a method (practised likewise by Titian) which afterwards stood him in good stead in working out the arrangement of his pictures. The models were sometimes taken from dead subjects dissected or studied in anatomy schools; some were draped, others nude, and Robusti was wont to suspend them in a wooden or cardboard box, with an aperture for a candle. Now and afterwards he very frequently worked by night as well as by day. The young painter Schiavone, four years Robusti's junior, was much in his company. Tintoret helped Schiavone gratis in wall-paintings; and in many subsequent instances he worked also for nothing, and thus succeeded in obtaining commissions. The two earliest mural paintings of Robusti—done, like others, for next to no pay—are said to have been " Belshazzar's Feast " and a " Cavalry Fight," both long since perished. Such, indeed, may be said to have been the fate of all his frescoes, early or later. The first work of his which attracted some considerable notice was a portrait-group of himself and his brother—the latter playing a guitar—with a nocturnal effect; this also is lost. It was followed by some historical subject, which Titian was candid enough to praise. One of Tintoret's early pictures still extant is in the church of the Carmine in Venice, the " Presentation of Jesus in the Temple "; also in S. Benedetto are the " Annunciation " and " Christ with the Woman of Samaria." For the Scuola della Trinità (the scuole or schools of Venice were more in the nature of hospitals or charitable foundations than of educational institutions) he painted four subjects from Genesis. Two of these, now in the Venetian Academy, are " Adam and Eve " and the " Death of Abel," both noble works of high mastery, which leave us in no doubt that Robusti was by this time a consummate painter—one of the few who have attained to the highest eminence by dire study of their own, unseconded by any training from some senior proficient.

Towards 1546 Robusti painted for the church of the Madonna dell' Orto three of his leading works—the " Worship of the Golden Calf," the " Presentation of the Virgin in the Temple," and the " Last Judgment "—now shamefully repainted; and he settled down in a house hard by the church. It is a Gothic edifice, looking over the lagoon of Murano to the Alps, built in the Fondamenta de' Mori, still standing, but let out cheap to artisans. In 1548 he was commissioned for four pictures in the Scuola di S. Marco—the " Finding of the body of St Mark in Alexandria " (now in the church of the Angeli, Murano), the " Saint's Body brought to Venice," a " Votary of the Saint delivered by invoking him from an Unclean Spirit " (these two are in the library of the royal palace, Venice), and the highly and justly celebrated " Miracle of the Slave." This last, which forms at present one of the chief glories of the Venetian Academy, represents the legend of a Christian slave or captive who was to be tortured as a punishment for some acts of devotion to the evangelist, but was saved by the miraculous intervention of the latter, who shattered the bone-breaking and blinding implements which were about to be applied. These four works were greeted with signal and general applause, including that of Titian's intimate, the too potent Pietro Aretino, with whom Tintoret, one of the few men who scorned to curry favour with him, was mostly in disrepute. It is said, however, that Tintoret at one time painted a ceiling in Pietro's house; at another time, being invited to do his portrait, he attended, and at once proceeded to take his sitter's measure with a pistol (or a stiletto), as a significant hint that he was not exactly the man to be trifled with. The painter having now executed the four works in the Scuola di S. Marco, his straits and obscure endurances were over. He married Faustina de' Vescovi, daughter of a Venetian nobleman. She appears to have been a careful housewife, and one who both would and could have her way with her not too tractable husband. Faustina bore him several children, probably two sons and five daughters.

The next conspicuous event in the professional life of Tintoret is his enormous labour and profuse self-development on the walls and ceilings of the Scuola di S. Marco, a building which may now almost be regarded as a shrine reared by Robusti to his own genius. The building had been begun in 1525 by the Lombardi, and was very deficient in light, so as to be particularly ill-suited for any great scheme of pictorial adornment. The painting of its interior was commenced in 1560. In that year five principal painters, including Tintoret and Paul Veronese, were invited to send in trial-designs for the centre-piece in the smaller hall named Sala dell' Albergo, the subject being S. Rocco received into Heaven. Tintoret produced not a sketch but a picture, and got it inserted into its oval. The competitors remonstrated, not unnaturally; but the artist, who knew how to play his own game, made a free gift of the picture to the saint, and, as a by-law of the foundation prohibited the rejection of any gift, it was retained *in situ*—Tintoret furnishing gratis the other decorations of the same ceiling. (This is one version of the anecdote: there is another version, which, though differing in incident, has the like general bearing.) In 1565 he resumed work at the scuola, painting the magnificent " Crucifixion," for which a sum of

250 ducats was paid. In 1576 he presented gratis another centre-piece—that for the ceiling of the great hall, representing the "Plague of Serpents"; and in the following year he completed this ceiling with pictures of the "Paschal Feast" and "Moses striking the Rock"—accepting whatever pittance the confraternity chose to pay. Robusti next launched out into the painting of the entire scuola and of the adjacent church of S. Rocco. He offered in November 1577 to execute the works at the rate of 100 ducats per annum, three pictures being due in each year. This proposal was accepted and was punctually fulfilled, the painter's death alone preventing the execution of some of the ceiling-subjects. The whole sum paid for the scuola throughout was 2447 ducats. Disregarding some minor performances, the scuola and church contain fifty-two memorable paintings, which may be described as vast suggestive sketches, with the mastery, but not the deliberate precision, of finished pictures, and adapted for being looked at in a dusky half-light. "Adam and Eve," the "Visitation," the "Adoration of the Magi," the "Massacre of the Innocents," the "Agony in the Garden," "Christ before Pilate," "Christ carrying His Cross," and (this alone having been marred by restoration) the "Assumption of the Virgin" are leading examples in the scuola; in the church, "Christ curing the Paralytic."

It was probably in 1560, the year in which he began working in the Scuola di S. Rocco, that Tintoret commenced his numerous paintings in the ducal palace; he then executed there a portrait of the doge, Girolamo Priuli. Other works which were destroyed in the great fire of 1577 succeeded—the "Excommunication of Frederick Barbarossa by Pope Alexander III." and the "Victory of Lepanto." After the fire Tintoret started afresh, Paul Veronese being his colleague; their works have for the most part been disastrously and disgracefully retouched of late years, and some of the finest monuments of pictorial power ever produced are thus degraded to comparative unimportance. In the Sala dello Scrutinio Robusti painted the "Capture of Zara from the Hungarians in 1346 amid a Hurricane of Missiles"; in the hall of the senate, "Venice, Queen of the Sea"; in the hall of the college, the "Espousal of St Catherine to Jesus"; in the Sala dell' Anticollegio, four extraordinary masterpieces—"Bacchus, with Ariadne crowned by Venus," the "Three Graces and Mercury," "Minerva discarding Mars," and the "Forge of Vulcan"—which were painted for fifty ducats each, besides materials, towards 1578; in the Antichiesetta, "St George and St Nicholas, with St Margaret" (the female figure is sometimes termed the princess whom St George rescued from the dragon), and "St Jerome and St Andrew"; in the hall of the great council, nine large compositions, chiefly battle-pieces. We here reach the crowning production of Robusti's life, the last picture of any considerable importance which he executed, the vast "Paradise," in size 74 ft. by 30, reputed to be the largest painting ever done upon canvas. It is a work so stupendous in scale, so colossal in the sweep of its power, so reckless of ordinary standards of conception or method, so pure an inspiration of a soul burning with passionate visual imagining and a hand magical to work in shape and colour, that it has defied the connoisseurship of three centuries, and has generally (though not with its first Venetian contemporaries) passed for an eccentric failure; while to a few eyes (including those of the present writer) it seems to be so transcendent a monument of human faculty applied to the art pictorial as not to be viewed without awe nor thought of without amazement. While the commission for this huge work was yet pending and unassigned Robusti was wont to tell the senators that he had prayed to God that he might be commissioned for it, so that paradise itself might perchance be his recompense after death. Upon eventually receiving the commission in 1588 he set up his canvas in the Scuola della Misericordia and worked indefatigably at the task, making many alterations and doing various heads and costumes direct from nature. When the picture had been brought well forward he took it to its proper place and there finished it, assisted by his son Domenico for details of drapery, &c. All Venice applauded the superb achievement, which has in more recent times suffered from neglect, but fortunately hardly at all from restoration. Robusti was asked to name his own price, but this he left to the authorities. They tendered a handsome amount; Robusti is said to have abated something from it, which is even a more curious instance of ungreediness for pelf than earlier cases which we have cited where he worked for nothing at all.

After the completion of the "Paradise" Robusti rested for a while, and he never undertook any other work of importance, though there is no reason to suppose that his energies were exhausted had his days been a little prolonged. He was seized with an attack in the stomach, complicated with fever, which prevented him from sleeping and almost from eating for a fortnight, and on the 31st of May 1594 he died. A contemporary record states his age to have been seventy-five years and fifteen days. If this is accurate, the 16th of May 1519 must have been the day of his birth; but we prefer the authority of the register of deaths in S. Marciliano, which states that Tintoret died of fever, aged seventy-five years, eight months and fifteen days—thus bringing us to the 16th of September 1518 as the true date of his birth. He was buried in the church of the Madonna dell' Orto by the side of his favourite daughter Marietta, who had died in 1590, aged thirty; there is a well-known tradition that as she lay dead the heart-stricken father painted her portrait. Marietta had herself been a portrait-painter of considerable skill, as well as a musician, vocal and instrumental; but few of her works are now traceable. It is said that up to the age of fifteen she used to accompany and assist her father at his work, dressed as a boy; eventually she married a jeweller, Mario Augusta. In 1866 the grave of the Vescovi and Robusti was opened, and the remains of nine members of the joint families were found in it; a different locality, the chapel on the right of the choir, was then assigned to the grave.

Tintoret painted his own portrait at least twice, one of the heads being in the Uffizi Gallery of Florence and the other, done when his age was advanced, in the Louvre. It is a very serious face, somewhat blunt and rugged, but yet refined without the varnish of elegance—concentrated and resolute, its native ardours of frankness and energy welded down into lifelong laboriousness, with a pent look as of smouldering fire. The eyes are large, dark and round; the grizzled hair close and compact. The face has been held to bear some resemblance to that of Michelangelo, but this does not go very far. Robusti appears also as one of the figures in the two vast pictures by Paul Veronese—the "Marriage in Cana" and the "Feast in the House of Levi."

Audacious and intrepid, though not constantly correct, as a draughtsman, majestically great as a colourist, prodigious as an executant, Tintoret was as absolute a type of the born painter as the history of art registers or enables us to conceive. Whatever he did was imaginative—sometimes beautiful and suave (and he was eminently capable of painting a lovely female countenance or an heroic man), often imposing and romantic, fully as often turbulent and reckless, sometimes trivial, never unpainter-like or prosaic. When he chose—which was not always—he painted his entire personages characteristically; but, like the other highest masters of Venice, he conceded and attended little to the expression of his faces as evincing incidental emotion. In several of his works—as especially the great "Crucifixion" in S. Rocco—there is powerful central thought, as well as inventive detail; but his imagination is always concrete: it is essentially that of a painter to whom the means of art—the form, colour, chiaroscuro, manipulation, scale, distribution—are the typical and necessitated realities. What he imagines is always a visual integer, a picture—never a treatise, however thoughtfully planned or ingeniously detailed. Something that one could see—that is his ideal, not something that one could narrate, still less that one could deduce and demonstrate. In his treatment of action or gesture the most constant peculiarity is the sway and swerve of his figures: they bend like saplings or rock like forest-boughs in a gale; stiffness or immobility was entirely foreign to his style, which has therefore little of the monumental or severe character. Perhaps he felt that there was no other way for combining "the colour of Titian with the design of Michelangelo." The knitted strength and the transcendent fervour of energy of the supreme Florentine might to some extent be emulated; but, if they were to be united with the glowing fusion of hue of the supreme Venetian, this could only be attained by a process of relaxing the excessive tension and modifying muscular into elastic force. In this respect he was a decided innovator; but he had many imitators, comparatively feeble if we except Paul Veronese.

Tintoret scarcely ever travelled out of Venice. He loved all the arts, played in youth the lute and various instruments, some of them of his own invention, and designed theatrical costumes and properties, was versed in mechanics and mechanical devices, and was a very agreeable companion. For the sake of his work he lived in a most retired fashion, and even when not painting was wont to remain in his working room surrounded by casts. Here he hardly admitted any, even intimate friends, and he kept his modes of work secret, save as regards his assistants. He abounded in pleasant witty sayings whether to great personages or to others, but no smile hovered on his lips. Out of doors his wife made him wear the robe of a Venetian citizen; if it rained she tried to induc him with an outer garment, but this he resisted. She would also when he left the house wrap up money for him in a handkerchief, and on his return expected an account of it; Tintoret's accustomed reply was that he had spent it in alms to the poor or to prisoners. In 1574 he obtained the reversion of the first vacant broker's patent in a fondaco, with power to bequeath it—an advantage granted from time to time to pre-eminent painters. For his phenomenal energy in painting he was termed "Il Furioso." An agreement is extant showing that he undertook to finish in two months two historical pictures each containing twenty figures, seven being portraits. The number of his portraits is enormous; their merit is unequal, but the really fine ones cannot be surpassed. Sebastiano del Piombo remarked that Robusti could paint in two days as much as himself in two years; Annibale Caracci that Tintoret was in many pictures equal to Titian, in others inferior to Tintoret. This was the general opinion of the Venetians, who said that he had three pencils—one of gold, the second of silver and the third of iron. The only pictures (if we except his own portrait) on which he inscribed his name are the "Miracle of Cana" in the church of the Salute (painted originally for the brotherhood of the Crociferi), the "Miracle of the Slave," and the "Crucifixion" in the Scuola di S. Rocco; the last was engraved in 1589 by Agostino Caracci. Generally he painted at once on to the canvas without any preliminary. Some of his dicta on art have been recorded as follows by Ridolfi: "the art of painting remains increasingly difficult"; "painters in youth should adhere to the best masters, these being Michelangelo and Titian, and should be strict in representing the natural forms"; "the first glance at a picture is the crucial one"; "black and white, as developing form, are the best of colours"; "drawing is the foundation of a painter's work, but drawing from life in the nude should only be essayed by well-practised men, as the real is often wanting in beauty."

Of pupils Robusti had very few; his two sons and Martin de Vos of Antwerp were among them. Domenico Robusti (1562–1637), whom we have already had occasion to mention, frequently assisted his father in the groundwork of great pictures. He himself painted a multitude of works, many of them on a very large scale; they would at best be mediocre, and, coming from the son of Tintoret, are exasperating; still, he must be regarded as a considerable sort of pictorial practitioner in his way.

We conclude by naming a few of the more striking of Tintoret's very numerous works not already specified in the course of the article. In Venice (S. Giorgio Maggiore), a series of his later works, the "Gathering of the Manna," "Last Supper," "Descent from the Cross," "Resurrection," "Martyrdom of St Stephen," "Coronation of the Virgin," "Martyrdom of St Damian"; (S. Francesco del Vigna) the "Entombment"; (the Frari) the "Massacre of the Innocents"; (S. Cassano) a "Crucifixion," the figures seen from behind along the hill slope; (St Mark's) a mosaic of the "Baptism of Christ"—the oil-painting of this composition is in Verona. In Milan (the Brera), "St Helena and other saints." In Florence (Pitti Gallery), "Venus," "Vulcan" and "Cupid." In Cologne (Wallraff-Richarts Museum), "Ovid and Corinna." In Augsberg (the town-hall), some historical pictures, which biographers and tourists alike have unaccountably neglected—one of the siege of a fortified town is astonishingly fine. In England (Hampton Court), "Esther and Ahasuerus," and the "Nine Muses"; (the National Gallery), "The Origin of the Milky Way," a memorable *tour de force*, "Christ washing Peter's Feet," a grand piece of colour and execution, not greatly interesting in other respects, also a spirited smallish work, "St George and the Dragon."

The writer who has done by far the most to establish the fame of Tintoret at the height which it ought to occupy is Ruskin in his *Stones of Venice* and other books; the depth and scope of the master's power had never before been adequately brought out, although his extraordinarily and somewhat arbitrarily used executive gift was acknowledged. Ridolfi (Meraviglie dell' Arte) gives interesting personal details; the article by Dr Janitschek in *Kunst und Künstler* (1876) is a solid account. For an English reader the most handy narrative is that of W. R. Osler (*Tintoretto*, 1879), in the series entitled "The Great Artists." Here the biographical facts are clearly presented; the aesthetic criticism is enthusiastic but not perspicuous. Other works deserving of mention are: L. Mesnard, *Étude sur Tintoret* (1881); T. P. Stearns, *Four Great Venetians* (1901); H. Thode, *Tintoretto* (1901); Stoughton Holborn, *Jacopo Robusti* (1903). (W. M. R.)

TIPASA. (1) A town and commune on the coast of Algeria, in the department of Algiers, 30 m. W. of the capital. Pop. of the commune (1906), 2725. The modern town, founded in 1857, is remarkable chiefly for its pleasant situation and sandy beach. The roadstead is exposed to the N.E. and N.W. There is a mole about 90 ft. long and anchorage in six fathoms. A considerable trade is done. The Roman city of Tipasa was built on three small hills which overlooked the sea. Of the houses, most of which stood on the central hill, no traces remain; but there are ruins of three churches—the Great Basilica and the Basilica Alexander on the western hill, and the Basilica of St Salsa on the eastern hill—two cemeteries, the baths, theatre, amphitheatre and nymphaeum. The line of the ramparts can be distinctly traced and at the foot of the eastern hill the remains of the ancient harbour. The basilicas are surrounded by cemeteries, which are full of coffins, all of stone and covered with mosaics. The basilica of St Salsa, which has been excavated by S. Gsell, consists of a nave and two aisles, and still contains a mosaic. The Great Basilica served for centuries as a quarry, but it is still possible to make out the plan of the building, which was divided into seven aisles. Under the foundations of the church are tombs hewn out of the solid rock. Of these one is circular, with a diameter of 60 ft. and space for 24 coffins.

Tipasa was founded by the Phoenicians, was made a Roman military colony by the emperor Claudius, and afterwards became a municipium. Commercially it was of considerable importance, but it was not distinguished in art or learning. Christianity was early introduced, and in the third century Tipasa was a bishop's see. Most of the inhabitants continued heathens until, according to the legend, Salsa, a Christian maiden, threw the head of their serpent idol into the sea, whereupon the enraged populace stoned her to death. The body, miraculously recovered from the sea, was buried, on the hill above the harbour, in a small chapel which gave place subsequently to the stately basilica. Salsa's martyrdom took place in the 4th century. In 484 the Vandal king Huneric (477–484) sent an Arian bishop to Tipasa; whereupon a large number of the inhabitants fled to Spain, while many of the remainder were cruelly persecuted. After this time the city disappears from history; and, whether or not its ruin was caused by the Arabs, they seem to have made no settlement there.

(2) Another town which in Roman times was called Tipasa is in the department of Constantine, Algeria, 55 m. due south of Bona, 3140 ft. above the sea; it is now called Tifesh. The chief ruin is that of an extensive fortress, the walls of which are 9 ft. thick.

TIP-CAT (also called *Cat* and *Cat and Dog*), a pastime which consists in tapping with a stick a short billet of wood with sharpened ends upon one of these ends, so that it jumps in the air, and then hitting it to the greatest possible distance. There are many varieties of the game, but in the most common the batter, having placed the billet, or *cat*, in a small circle on the ground, *tips* it into the air and hits it to a distance. His opponent then offers him a certain number of points, based upon his estimate of the number of hops or jumps necessary to cover the distance. If the batter thinks the distance underestimated he is at liberty to decline the offer and measure the distance in jumps, and score the number made. The game is one or more hundreds.

TIPPERA (*Tripura*), a native state and also a British district of India, in Eastern Bengal and Assam. The state, which is known as Hill Tippera (*q.v.*), represents that portion of the raja's territory that was never conquered by the Mahommedans. The dynasty, which is of great antiquity, was converted to Hinduism many centuries ago; but the people still profess an aboriginal religion, similar to that of the neighbouring hill tribes. The raja owns an estate of 570 sq. m., yielding an income of more than £40,000, in the British district, where he ranks as an ordinary *zamindar*. His residence is at Agartalla, just within the boundary of Hill Tippera.

The British district of Tippera, with administrative headquarters at Comilla, has an area of 2499 sq. m. It has a flat and open surface, with the exception of the isolated Lālmāi range

(100 feet), and is for the most part laid out in well-cultivated fields, intersected by rivers and *khals* (creeks) partially affected by the tides. In the lowlands the soil is light and sandy; but in the higher parts a deep alluvial soil alternates with bands of clay and sand. The principal rivers are the Meghna, or estuary of the Brahmaputra; and the Gumti, Dākātiā, and Titās, which are also navigable for a considerable portion of their course. There are many marshes or *bils*. The wild animals include tigers, leopards, wild boars and buffaloes. The climate is mild and healthy. In 1901 the population was 2,117,991, showing an increase of 19% in the decade, being the highest rate in the province. Mahommedans form nearly three-fourths of the total. Rice is the staple crop, followed by jute; betel-nut and betel-leaf and chillies are also grown. The chief exports are rice, jute and betel-nuts; and the principal imports cotton goods, salt and kerosene oil.

The eastern border of the district is traversed by the Assam-Bengal railway, with branches from Laksham to Chandpur and Noakhali; but waterways remain the chief means of communication.

Tippera came under the East India Company in 1765; but more than a fifth of its present area was under the immediate rule of the raja of Hill Tippera, who paid a tribute of ivory and elephants. At that time Tippera with Noakhali formed part of Jalalpur, one of Shuja-ud-Din's divisions of the province of Bengal; but in 1822 it was separated, and since then great changes have been made in its boundaries. With the exception of a serious raid in 1860 by the Kukīs or Lushāis, nothing has disturbed the peace of the district.

TIPPERARY, a county of Ireland in the province of Munster, bounded N.W. by Galway, N.E. by King's County, E. by Queen's County and Kilkenny, S. by Waterford, and W. by Cork, Limerick, Clare and Galway. The county is the sixth in size of the Irish counties, having an area of 1,062,963 acres, or about 1661 sq. m. The surface is varied and picturesque. The Knockmealdown Mountains on the southern border reach an elevation of 2609 ft. To the north of this range are the picturesque Galty or Galtee Mountains (Galtymore 3015 ft.). To the east, bordering Kilkenny, are the Slieveardagh Hills, and near Templemore the Devil's Bit Mountains (1583 ft.) with a curious gap on the summit. In the north-west is Keeper Hill, 2278 ft. The greater part of the county, however, is a gently undulating plain. From the rich level country the Rock of Cashel rises boldly. Tipperary has only one considerable river, the Suir, which has its source in the Devil's Bit Mountains, and flows southward and eastward by Templemore, Thurles, Caher, and Clonmel. The Nore, which also rises in the Devil's Bit Mountains, soon passes into Queen's County, and the Shannon forms part of the western border. The Mitchelstown stalactite caverns, discovered accidentally in 1833, attract a large number of visitors. They are in the extreme south-west of the county; take their name from the neighbouring town of Mitchelstown, 6 m. distant in County Cork; and were explored and surveyed by M. Martel, the French speleologist, in 1895.

Geology.—In this county the Carboniferous Limestone is escaping, as it were, from confinement between the Old Red Sandstone ridges of the south, and spreading out northward into the great plain. Its folded character is seen in the anticlinal boss on which the acropolis of Cashel stands; but generally its level surface is covered by boulder-drift. A great denuded dome of Old Red Sandstone, with Silurian exposed across the centre, divides the north of the county, and another similar mass, the Arra Mountains, rises between Nenagh and Lough Derg. The same rocks form the Galtees, Slievenaman and the Knockmealdown Mountains. In the east, Upper Carboniferous shales and sandstones lie along a synclinal axis, from Cashel to Kilkenny, and anthracite is mined on a Coal Measure plateau at Killenaule. The lead-ore mined for many centuries at Silvermines south of Nenagh is silver-bearing, and is associated with zinc blende. Indications of ore have been traced along the junction of the limestone with the older rocks for thirty miles. Good slates are quarried in the Silurian area in Clashnasmuth townland on Slievenaman.

Industries.—Tipperary ranks among the best agricultural districts of Ireland. The subsoil in the lower grounds is limestone, which is overlaid by a rich calcareous loam, capable of yielding the finest crops. The centre of the county is occupied by the Golden Vale, the most fertile district in Ireland, which stretches from Cashel to the town of Limerick. On the higher districts the soil is light and thin, partaking much of the character of the clay slate and sands on which it rests. Detached portions of the Bog of Allen encroach on the north-east of the county. The proportion of tillage to pasture is roughly as 1 to 2½, and the area under the standard crops of oats and potatoes decreases. The area under barley, however, is well maintained, as distillation causes a steady demand for this grain. Turnips are also an important and steady crop. The numbers of cattle, sheep, pigs, goats and poultry also increase generally; and butter-making occupies considerable attention. A few persons are employed in mining, but the occupation of the inhabitants is chiefly agricultural. There is a considerable number of meal and flour mills.

Communications are supplied by the Great Southern & Western railway, the main line of which crosses the county from north-east to south-west by Templemore and Thurles. The Ballybrophy (Queen's County) & Limerick branch from this line serves the north of the county by Roscrea (junction for Birr) and Nenagh. The Waterford & Limerick line passes through the south of the county by way of Clonmel and Tipperary, crossing the main line at Limerick junction. The two lines are also connected by the Thurles, Fethard and Clonmel branch.

Population and Administration.—The population (175,217 in 1891; 160,232 in 1901) shows a serious decrease (though much less so than formerly), and emigration is very heavy. Of the total about 94% are Roman Catholics, and about 76% constitute the rural population. The principal towns are Clonmel (the county town, pop. 10,167), Tipperary (6281), Carrick-on-Suir (5406), Nenagh (4704), Thurles (4411), Cashel (a cathedral city, 2938), Roscrea (2325), Caher (2058), Templemore (2774) and Fethard (1498). Tipperary is divided into a north and south riding, each consisting of six baronies. For parliamentary purposes it is separated into four divisions—East, Mid, North and South—each returning one member. Before the Union in 1800 the county returned two members to the Irish parliament, and the boroughs of Cashel, Clonmel and Fethard two each; afterwards, until the Redistribution Act of 1885, the county returned two members and Cashel and Clonmel one each. Assizes for the north riding are held in Nenagh and for the south riding in Clonmel. Quarter-sessions are held at Cashel, Clonmel, Nenagh, Roscrea, Thurles and Tipperary. Ecclesiastically the county belongs to the Protestant dioceses of Cashel and Killaloe, and the Roman Catholic dioceses of Cashel, Killaloe, Waterford and Lismore.

History and Antiquities.—Tipperary is one of the counties generally considered to have been formed by King John in 1210; in 1328 Edward III. made it a county palatine in favour of the earl of Ormonde; and, though the king shortly afterwards resumed his regal prerogative, the county was regranted in 1337. In 1372 the grant was confirmed to James Butler, earl of Ormonde, the lands belonging to the Church retaining, however, a separate jurisdiction, and being known as the county of Cross Tipperary, or the Cross of Tipperary. In 1621 James I. took the county palatine into his own hands. It was, however, restored in 1664 to James, 12th earl and 1st duke, whose regalities were further made to include the county of the Cross. On the attainder of James, 2nd duke, in 1715, the jurisdiction reverted to the Crown, and the last of the Irish palatinates thus ceased to exist.

There are two round towers within the county—one at Roscrea and the other on the Rock of Cashel. The county is rich in possession of remains of several ecclesiastical foundations of the highest interest. Of these the following are described under the names of the respective towns: the remarkable collection of buildings on and adjacent to the Rock of Cashel; the Cistercian abbey of Holy Cross near Thurles, one of the finest monastic ruins in Ireland; and the abbey and Franciscan friary at Roscrea. The stronghold of Caher, occupied as a barrack, is in good preservation. At Roscrea one of the towers of the castle built by King John remains, and the stronghold of the Ormondes, erected in the reign of Henry VIII., forms the dépot attached to the barracks. The other principal ecclesiastical ruins are the priory of Athassel, founded for Augustinian monks about 1200; and Fethard Abbey, founded in the 14th century, now used as a chapel.

TIPPERARY, a market town of Co. Tipperary, Ireland. Pop. (1901), 6281. It is beautifully situated near the base of the Slieve na muck or Tipperary Hills, a branch of the Galtee range, on the Waterford & Limerick line of the Great Southern & Western railway, 3 m. S.E. of Limerick Junction and 110½ S.W. of Dublin. It is governed by an urban district council. It is situated in the centre of a fine agricultural district, and its butter market ranks next to that of Cork. Condensed milk is manufactured. The town is of great antiquity, but first acquired importance by the erection of a castle by King John, of which there are no remains. A monastery founded for Augustinians by Henry III. gave a second impulse to its growth. The gatehouse, all that remains of this foundation, is the only building of antiquity in the town. Formerly Tipperary was a corporation from a grant made in 1310 by Edward II. New Tipperary was founded outside the town by Mr William O'Brien in 1890 during the "Plan of Campaign" inaugurated to boycott the Smith-Barry estate, in order to accommodate the tenants who vacated their holdings, but the scheme was a failure, and the place was abandoned and sold.

TIPPOO SAHIB (1753–1799), sultan of Mysore, son of Hyder Ali (*q.v.*), was born in 1753. He was instructed in military tactics by French officers in the employment of his father. In 1767 in the invasion of the Carnatic he commanded a corps of cavalry, and he distinguished himself in the Mahratta War of 1775–79. On the outbreak of the first Mysore War in 1780 he was put at the head of a large body of troops, and defeated Brathwaite on the banks of the Coleroon in February 1782. He succeeded his father in December 1782, and in 1784 concluded peace with the British, and assumed the title of sultan. In 1787–88 he subjugated the Nairs of Malabar, and in 1789 provoked British invasion by ravaging the territories of the raja of Travancore. When the British entered Mysore in 1790, he retaliated by a counter-invasion, but was compelled by Cornwallis's victory near Seringapatam to cede half his dominions (March 16, 1792). The British having deemed it necessary to renew hostilities in March 1799, he was shut up in Seringapatam and finally killed during the storm (May 4, 1799). Tippoo was of cruel disposition, and inferior in military talents to his father.

See L. B. Bowring, *Haidar Ali and Tipu Sultan* ("Rulers of India series," 1893).

TIPSTAFF (Mid. Eng. *tipped staf*), a staff of office mounted with a tip or cap of metal, or with a crown, carried by a constable or sheriff's officer, the term being hence applied to such an officer. Tipstaffs are attached to the king's bench and chancery divisions of the High Court of Justice in England; their duty is to arrest or take into custody any person on an order of committal, if within the precincts of the court, and convey him to the king's prison at Holloway. The tipstaff for the common law courts was originally appointed by the marshal of the king's bench, and the tipstaff of the lord chancellor by the marshal of the Fleet prison. Since the abolition of these prisons the tipstaffs have been appointed by the lord chancellor and lord chief justice respectively.

TIPTON, an urban district of Staffordshire, England, in the parliamentary borough of Wednesbury, adjacent to Dudley (1½ m. S.), served by the London & North Western and Great Western railways. Pop. (1901), 30,543. Its streets are interspersed with coal-mines and iron works. Heavy iron goods are the principal products, anchors and cables being a speciality; there are numerous furnaces and rolling mills; also cement-works, brick-works and maltings. The village round which the modern town sprang up is mentioned in Domesday as Tibbington; its ancient church was undermined and collapsed in 1797.

TIRABOSCHI, GIROLAMO (1731–1794), the first historian of Italian literature, was born at Bergamo on the 18th of December 1731. He studied at the Jesuit college at Monza, entered the order, and was appointed in 1755 professor of eloquence in the university of Milan. Here he produced (1766–1768) *Vetera humiliatorum monumenta* (3 vols.), a history of the extinct order of the Humiliati, which made his literary reputation. Nominated in 1770 librarian to Francis III., duke of Modena, he turned to account the copious materials there accumulated for the composition of his *Storia della letteratura italiana*. This vast work, in which Italian literature from the time of the Etruscans to the end of the 17th century is traced in detail, occupied eleven years, 1771–1782, and the thirteen quarto volumes embodying it appeared successively at Modena during that period. A second enlarged edition (16 vols.) was issued from 1787 to 1794, and was succeeded by many others, besides abridgments in German, French and English. Tiraboschi died at Modena on the 3rd of June 1794, leaving a high reputation for virtue, learning and piety.

Tiraboschi wrote besides *Biblioteca modenese* (6 vols., 1781–1786); *Notizie de' pittori, scultori, incisori, ed architetti modenesi* (1786); *Memorie storiche modenesi* (5 vols., 1793–1794), and many minor works. He edited the *Nuovo giornale dei letterati d'Italia* (1773–1790), and left materials for a work of great research entitled *Dizionario topografico-storico degli stati estensi* (2 vols. 4to, Modena, 1824–1825).

TIRAH, a mountainous tract of country on the Peshawar border of the North-west Province of India. It lies between the Khyber Pass and the Khanki Valley, and is inhabited by the Afridi and Orakzai tribes. It is chiefly notable as the scene of the Tirah Campaign of 1897 (see below). It is a cul-de-sac in the mountains, lying off all the roads to India, and the difficulty of its passes and the fierceness of its inhabitants had hitherto preserved it inviolable from all invaders. Tirah comprises an area of some six to seven hundred square miles and includes under this general name all the valleys lying round the source of the Bara river. The five chief valleys are Maidan, Rajgul, Waran, Bara and Mastura.

Maidan, the summer home of the Afridis, lies close under the snow-bound ridges of the Safed Koh at an elevation of about 6400 ft. It is an oval plain about seven to eight miles long, and three or four wide, and slopes inwards towards the centre of its northern side, where all the drainage gathered from the four corners of the plain is shot into a narrow corkscrew outlet leading to the Bara Valley. Centuries of detritus accumulated in this basin have filled it up with rich alluvial soil and made it one of the most fertile valleys on the frontier. All its alluvial slopes are terraced and revetted and irrigated till every yard is made productive. Here and there dotted about in clusters all over the plain are square-built two storeyed mud and timber houses, standing in the shade of gigantic walnut and mulberry trees. Up on the hillsides surrounding the Maidan basin are wild olives in wide-grown clumps, almost amounting to forest, and occasional pomegranates. Higher still are the blue pines; but below on the shelving plains are nothing but fruit trees. Rajgul Valley lies north of Maidan, from which it is separated by a steep valley and well-wooded spur, eight to nine thousand feet high, and west of the Bara Valley, which it joins at Dwatoi. It is ten miles long, four to five miles at its widest, and has an elevation of 5000 ft. It is inhabited by the Kuki Khel Afridis. The Waran Valley is another valley about the same size as Maidan, lying east of it, and separated from it by the Tseri-Kandao Pass. It was the home of the Afridi mullah Sayad Akbar, and is the country of the Aka Khels. After the junction of the Rajgul and Maidan drainage at Dwatoi, the united stream receives the name of Bara, and the valley through which it flows down to its exit in the Peshawar Valley is also known by this name. The elevation of the valley is from 5000 ft. at Dwatoi to 2000 at Kajurai; on the north side it is hemmed in by the Surghar range, which divides it from the Bazar Valley; on the south lies another range dividing it from Maidan and the Waran Valley. The heat of the Bara Valley in summer is said to be excessive, malaria is prevalent, and mosquitoes very troublesome, so the hamlets are deserted and the Afridis migrate to the pleasant heights of Maidan. The Mastura Valley occupies the southern half of Tirah, and is inhabited by the Orakzais. It is one of the prettiest valleys on the frontier, lying at an elevation of 6000 ft. The Orakzais live, for the most part, in the Miranzai Valley, in the winter, and retreat to Mastura, like the Afridis, during the summer months. The chief passes in Tirah are the Sampagha Pass (6500 ft.), separating the Khanki Valley from the Mastura Valley; the Arhanga Pass (6995 ft.), separating Mastura Valley from Maidan; Saran Sar (8650 ft.), leading from the Zakka Khel portion of Maidan into the Bara Valley; the Tseri Kandao (8575 ft.), separating Maidan from the Waran Valley, and the Sapri Pass (5190 ft.), leading from the east of the Mastura Valley into the Bara Valley in the direction of Mamanai. The whole of Tirah was thoroughly explored and mapped at the time of the Tirah Expedition.

TIRAH CAMPAIGN, an Indian frontier war in 1897–98. The Afridis had for sixteen years received a subsidy from the Indian government for the safeguarding of the Khyber Pass, in addition to which the government had maintained for this purpose a local regiment entirely composed of Afridis, who were stationed in the pass. Suddenly, however, the tribesmen rose, captured all the posts in the Khyber held by their own countrymen, and attacked the forts on the Samana Ridge near Peshawar. It was estimated that the Afridis and Orakzais could, if united, bring from 40,000 to 50,000 men into the field. The preparations for the expedition occupied some time, and meanwhile the Mohmand rising north-west of the Khyber Pass was first dealt with (see MOHMAND).

The general commanding was General Sir William Lockhart (*q.v.*) commanding the Punjab Army Corps; he had under him 34,882 men, British and native, in addition to 20,000 followers. The frontier post of Kohat was selected as the base of the campaign, and it was decided to advance along a single line. On the 18th of October the operations commenced, fighting ensuing immediately. The Dargai heights, which commanded the line of advance, were captured without difficulty, but abandoned owing to the want of water. On the 20th the same positions were gallantly stormed, with a loss of 199 killed and wounded. The progress of the expedition, along a wretched track through the mountains, was obstinately contested on the 29th of October at the Sampagha Pass leading to the Mastura valley, and on the 31st at the Arhanga Pass from the Mastura to the Tirah valley. The force, in detached brigades, now proceeded to traverse the Tirah district in all directions, and to destroy the walled and fortified hamlets of the Afridis. The two divisions available for this duty numbered about 20,000 men. A force about 3200 strong commanded by Brigadier-General (afterwards Major-General Sir Richard) Westmacott was first employed to attack Saran Sar, which was easily carried, but during the retirement the troops were hard pressed by the enemy and the casualties numbered sixty-four. On the 11th of November Saran Sar was again attacked by the brigade of Brigadier-General (afterwards Sir Alfred) Gaselee. Experience enabled better dispositions to be made, and the casualties were only three. The traversing of the valley continued, and on the 13th of November Brigadier-General Kempster's brigade visited the Waran valley via the Tseri Kandao Pass. Little difficulty was experienced during the advance, and several villages were destroyed; but on the 16th, during the return march, the rearguard was hotly engaged all day, and had to be relieved by fresh troops next morning. The casualties numbered seventy-two. Almost daily the Afridis, too wise to risk general engagements, waged a perpetual guerrilla warfare, and the various bodies of troops engaged in foraging or survey duties were constantly attacked. On the 21st of November a brigade under Brigadier-General Westmacott was detached to visit the Rajgul valley. The road was exceedingly difficult and steady opposition was encountered. The objects were accomplished, and the casualties during the retirement alone numbered twenty-three. The last important work undertaken was the punishment of the Chamkannis, Mamuzais and Massozais. This was carried out by Brigadier-General Gaselee, who joined hands with the Kurram movable column ordered up for the purpose. The Mamuzais and Massozais submitted immediately, but the Chamkannis offered resistance on the 1st and 2nd of December, the British casualties numbering about thirty. The Kurram column then returned to its camp, and Sir W. Lockhart prepared to evacuate Tirah, despatching his two divisions by separate routes—the 1st under Major-General W. Penn Symons (d. 1899) to return via the Mastura valley, destroying the forts on the way, and to join at Bara, within easy march of Peshawar; the 2nd division under Major-General Yeatman Biggs (d. 1898), and, accompanied by Sir W. Lockhart, to move along the Bara valley. The base was thus to be transferred from Kohat to Peshawar. The return march began on the 9th of December. The cold was intense, 21 degrees of frost being registered before leaving Tirah. The movement of the 1st division though arduous was practically unopposed, but the 40 miles to be covered by the 2nd division were contested almost throughout. The actual march down the Bara valley (34 miles) commenced on the 10th, and involved four days of the hardest fighting and marching of the campaign. The road crossed and recrossed the icy stream, while snow, sleet and rain fell constantly. On the 10th the casualties numbered about twenty. On the 11th some fifty or sixty casualties were recorded among the troops, but many followers were killed or died of exposure, and quantities of stores were lost. On the 12th the column halted for rest. On the 13th the march was resumed in improved weather, though the cold was still severe. The rearguard was heavily engaged, and the casualties numbered about sixty. On the 14th, after further fighting, a junction with the Peshawar column was effected. The 1st division, aided by the Peshawar column, now took possession of the Khyber forts without opposition. Negotiations for peace were then begun with the Afridis, who under the threat of another expedition into Tirah in the spring at length agreed to pay the fines and to surrender the rifles demanded. The expeditionary force was broken up on the 4th of April 1898. A memorable feature of this campaign was the presence in the fighting line of the Imperial Service native troops under their own officers, while several of the best known of the Indian princes served on Sir W. Lockhart's staff. (C. J. B.)

TIRANA, a town of Albania, European Turkey, in the vilayet of Scutari; 20 m. E. by N. of Durazzo, at the southern extremity of the plain of Kroïa. Pop. (1905) about 12,000. Tirana is beautifully situated on the border of the richly wooded highlands inhabited by the Mirdite Albanians. It is a picturesque town with a large bazaar and many mosques, gardens and olive groves. It was founded early in the 17th century and was long the see of a Greek bishop, although the majority of its inhabitants have always been Moslems. Kroïa, the ancient stronghold of Scanderbeg (*q.v.*), is 14 m. north.

TIRARD, PIERRE EMANUEL (1827–1893), French politician, was born of French parents at Geneva on the 27th of September 1827, and, after studying in his native town, became a civil engineer. After five years of government service he resigned to become a jewel merchant. His determined opposition to the empire, culminating in 1869 in a campaign in favour of the radical candidate opposed to Ollivier, was rewarded by his election as mayor of the 11th arrondissement of Paris and as deputy for the Seine. Nominated a member of the Commune, he protested against the tyranny of the central committee, and escaped from Paris to resume his place among the extreme Left in the National Assembly at Versailles. In 1876 he was returned for the 1st arrondissement of Paris to the Chamber of Deputies, and was re-elected next year. He specially devoted himself to finance, being for a short time president of the customs commission before his appointment as minister of agriculture and commerce in March 1879 in the Waddington cabinet. He held the same portfolio in the first Freycinet ministry (1879–1880) and in the Jules Ferry cabinet (1880–1881). He was minister of commerce in Freycinet's second cabinet (1882), of finance under E. Duclerc (1882–1883), and under A. Fallières (1883), retaining the same office in the second Jules Ferry ministry (1883–1885). When Carnot became president of the Republic in 1887 he asked Tirard to form a ministry. He had to deal with the Wilson scandal which had led to President Grévy's downfall, and with the revisionist agitation of General Boulanger. His refusal to proceed to the revision of the constitution of 1875 led to his defeat on the 30th of March 1888. He returned to power next year, and decided to bring Boulanger and his chief supporters before the High Court, but the general's flight effectively settled the question. He also arrested Philip, duke of Orleans, who had visited France in disguise. He resigned office on the 15th of March 1890 on the question of the Franco-Turkish commercial treaty. He replaced M. Rouvier in the Ribot cabinet (1892–1893) as minister of finance, and died in Paris on the 4th of November 1893.

TIRE, an homonymous word, of which the meanings are (1) to weary out, (2) to adorn, or, as a substantive, a head-dress, (3) the outer rim of a wheel. "Tire" in sense (1) is from the Old English *teorian*, to weary, transitive and intransitive. Ultimately this word is connected with "tear," to rend, the stages of meaning being to rend apart, to wear out, to be or make exhausted.

In sense (2) the word is a shortened form of "attire," dress, equipment; this is from the Old French *atirer*, to put in order, *tire*, a row, hence the word now spelled in English *tier*, but earlier found as *tire* or *lyre*. "Tire" (3) is somewhat obscure etymologically. It may be connected with "attire," especially with reference to a similarity to the band of a woman's head-dress, or it may be a corruption of "tie-r," meaning that which "ties" or fastens together, though this is rejected by Skeat. The spelling "tyre" is not now accepted by the best English authorities, and is unrecognized in America.

The tire of a wheel is the outer circumferential portion that rolls on the ground or the track prepared for it. When the track is smooth and level, as in a railway, the principal functions of the tire are to provide a hard, durable surface for the wheel, and to reduce to a minimum the resistance to rolling. Railway vehicle wheels usually have hard steel tires, this combination with the hard steel rail giving the maximum endurance and the minimum rolling resistance. For road vehicles also, in which durability is the prime consideration, the tires are usually rings of iron or steel shrunk on the wooden wheels.

In bicycles, motor-cars, and other road vehicles in which freedom from vibration and shock from uneven road surface is desired, rubber or pneumatic tires are employed. These elastic tires are capable of absorbing small irregularities in the road surface without transmitting much vibration to the frame of the vehicle. Their range of yield is, however, too limited to absorb the larger irregularities met with on rough roads, so that their use does not obviate the necessity of spring support of the carriage body on the wheel axles. The pneumatic tire has a very much smaller rolling resistance than a solid rubber tire. Where the driving power is limited, as in bicycles, this consideration is by far the most important. A pneumatic tired bicycle requires less power to drive it at a given speed than does one with solid rubber tires—in popular language, it is much faster; hence pneumatic tires are now almost universally used on bicycles.

Rolling Resistance.—Professor Osborne Reynolds, in his investigations on the nature of rolling resistance, found that it is due to actual sliding of the surfaces in contact. Fig. 1 shows an iron roller resting on a flat, thick sheet of india-rubber. A series of equidistant parallel lines drawn on the india-rubber are distorted by the pressure, as shown in the figure. The distance between the marks on the periphery of the roller corresponds to that between the lines on the undistorted sheet of rubber. The motion of the roller being from left to right, actual contact takes place between C and D. The surface of the rubber is depressed at P, is bulged up in front at D, and behind at C. The vertical compression of the rubber at P causes it to bulge laterally, this causing a lateral contraction at D, which in turn causes a vertical extension at D. There is thus created a tendency to relative creeping motion between the roller and rubber. Between f and e there is no relative sliding, but over the portions eD and Cf there is slipping, with a consequent expenditure of energy. The action causes the actual distance traversed by the roller to be different from the geometric distance calculated from the diameter and number of revolutions of the roller. A certain amount of energy is expended in distorting the rubber between P and D; part of this energy is restored as the rear portion of the roller passes over this and the rubber gets back to its original unstrained state.

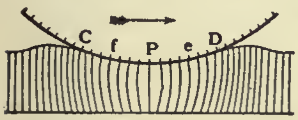


FIG. 1.

With a solid rubber tire rolling on a hard, smooth surface the action is similar. Fig. 2 shows a portion of the tire flattened out: p_1 and p_2 are the intensities of the pressures at points a_1 and a_2 at equal distances in front of and behind c, the geometrical point of contact: p_1 opposes, p_2 assists the rolling of the wheel. At usual speeds the opposing force, p_1, will be greater than the force of restitution, p_2, the difference being a measure of the elastic hysteresis of the material, H, at that speed. If the vertical compression cd of the tire be denoted by y, the energy lost may be said to be proportional to Hy. Comparing three tires of steel, solid rubber and air respectively rolling on a smooth, hard surface, H is probably smallest for steel and largest for rubber, y is least for steel, greater for a pneumatic tire pumped hard, greater still for solid rubber and for a pneumatic tire insufficiently inflated. The rolling resistance of the steel tire will therefore be least; next in order come the pneumatic tire inflated hard, and the pneumatic tire inflated soft, while the solid rubber tire has the greatest resistance.

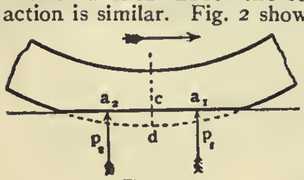


FIG. 2.

Pneumatic Tires. Weight Supported.—Let a pneumatic tire inflated to p lb per square inch support a load W lb. The portion

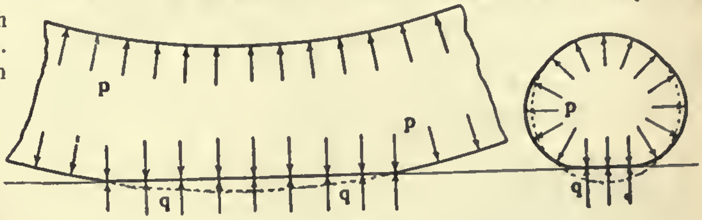


FIG. 3.

near the ground is flattened (fig. 3). If the tire fabric is assumed to be perfectly flexible, then, since the part in contact with the ground is quite flat, the pressure p and q on the opposite sides must be equal; that is, the tire presses on the ground with an intensity p lb per square inch. The area of the flattened portion

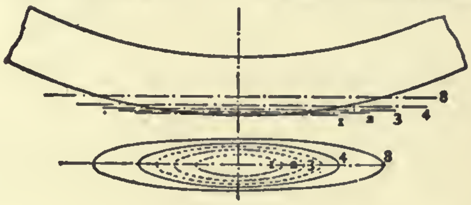


FIG. 4.

is therefore W/p. Fig. 4 shows the shapes of the areas of contact of a bicycle tire 28 in. by $1\frac{1}{2}$ in., for various amounts of vertical flattening, the figures annexed to the curves in plan and to the corresponding lines in elevation indicating the amount of vertical flattening in sixteenth parts of an inch. Let y be the vertical flattening, a the semi-major axis, and b the semi-minor axis of the curve of contact. For small values of y, corresponding to a tire pumped hard, the curves of contact may be considered plane sections of a circular ring. The area of the curve may be taken equal to that of an ellipse having the same axes, *i.e.* πab. But

$$a=\sqrt{R^2-(R-y)^2}=\sqrt{2Ry-y^2}=\sqrt{y}\,\sqrt{2R-y},$$

and

$$b=\sqrt{r^2-(r-y)^2}=\sqrt{y}\,\sqrt{2r-y},$$

R and r being the principal radii of section of the tire longitudinally and transversely. Therefore, approximately,

$$A=\pi ab=\pi y\sqrt{2R-y}\sqrt{2r-y}.$$

For small values of y, y may be neglected in comparison with $2R$ and $2r$ respectively, and the above equation becomes

$$A=2\pi y\sqrt{Rr}=\pi y\sqrt{Dd},$$

and therefore

$$W=2\pi yp\sqrt{Rr}=\pi yp\sqrt{Dd}.$$

For larger values of y, A is smaller than that given by the above formula, as shown in fig. 5, which gives the areas of contact plotted with respect to the vertical flattenings for a tire 28 in. by $1\frac{1}{2}$ in. The same curve may serve to show values of W, thus corresponding to the load-deflection curve of a spring. The curve clearly shows the small value of the pneumatic tire as a spring device. Thus, when pumped hard, so that the normal load is carried with $\frac{1}{4}$ in. vertical flattening, when the bicycle is travelling quickly, a lump on the road equivalent to $\frac{3}{8}$ in. further flattening nearly doubles the upward reaction on the wheel. With the normal load carried with $\frac{5}{8}$ in. vertical flattening the same lump on the road increases the upward reaction by only 23%, the area of contact of the tire being increased from 6·5 to 8 sq. in. The above brief investigation, involving a few approximations, is yet sufficiently accurate to afford a clear idea of the usual conditions of a tire.

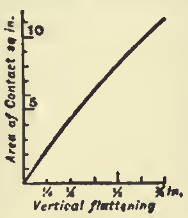


FIG. 5.

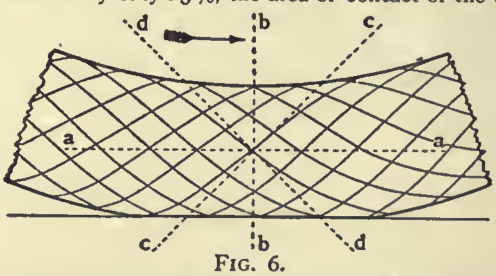


FIG. 6.

Outer Cover.—The outer cover has to be strong enough to withstand the air-pressure inside the tire and to transmit the driving or the braking effort from the wheel to the road surface. For the latter purpose, the threads of the fabric are best disposed spirally, as shown in fig. 6. While driving in the direction of the arrow the tension on the fibres *cc* will be slightly increased, that on fibres *dd* decreased. The distortion of the fabric due to driving is thus reduced to a minimum. A woven fabric is sometimes used, but one made up of two or more layers of parallel threads embedded in rubber is better. This construction makes the outer cover more flexible, and consequently less energy is wasted in distorting the fabric as the tire rolls on and off the ground, while greater durability is also secured. Fig. 7 shows a plain woven fabric, from which it is seen that each thread takes the form of a sinuous line. As the air-pressure inside the tire is increased the threads tend to become straighter, thus pressing together with a cutting action. The total thickness is greater than that of two layers of parallel threads, while on the latter the threads can be placed closer together. The woven fabric is therefore stiffer, weaker and less durable than that built up of parallel layers. The average tensile stress per inch width, t_1, on the longitudinal section of the cover is given by the formula $pd=2t_1$; that on the transverse section, t_2, by $pd=4t_2$, d being the diameter of the tire in transverse section; consequently the stress on the longitudinal section is twice that on the transverse. With the spiral disposition of the threads, as shown in fig. 6, this inequality of stress in the two principal directions has the effect of tending to enlarge the transverse section of the tire, while at the same time tending to contract the tire on the rim.

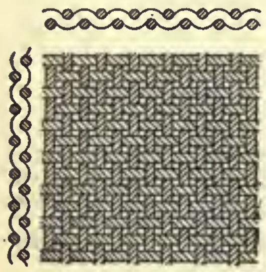


FIG. 7.

Single tube, Double tube and Tubeless Tires.—A tire, beside being strong enough to resist the stresses to which it is subjected, must be air-tight. In most tires for cycles and motor-cars an inner tube of india-rubber is made separate from the outer cover. In these double-tube tires the outer cover is more or less easily detachable from the rim. The air under pressure is pumped inside the inner tube, which is supported by the outer cover. In case of puncture of a bicycle tire, the inner tube is repaired by cementing a patch of rubber on the outside of the inner tube, a solution of india-rubber in naphtha or bisulphide of carbon being the cementing agent employed. Motor-car tires are best repaired by vulcanizing, as solution patches usually come loose owing to the heating of the tire. In a single-tube tire, as its name indicates, the outer cover and the air-tight tube are vulcanized together to form a single hollow ring. To repair a simple puncture of a single-tube tire it is not necessary to detach it from the rim. Single-tube tires are not often used now, except for path-racing bicycles. A tubeless tire, such as the "Fleuss" (fig. 8), consists of the outer cover, as used in a double-tube tire, to the inner surface of which an air-tight layer of sheet-rubber has been cemented. A continuous flap projects from one edge of the tire, and when in position on the rim this flap is pressed against the other edge, forming an air-tight seal. A slight moistening of the flap with soft soap tends to remove any imperfection in the tightness of the air seal. The repair of a puncture of a tubeless tire can be very quickly done. Since the inner surface of the air-tight layer is accessible, after placing the patch in position the tire can be inflated and the bicycle ridden at once; whereas in the double-tube tire sufficient time must elapse between the patching and the inflation to allow the rubber solution to set.

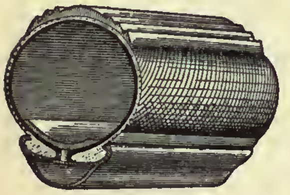


FIG. 8.

Attachment of Tires to Rims.—A single-tube tire can be cemented directly to the rim. For detachable double-tube tires on bicycles, two methods, the Dunlop-Welch endless wire (fig. 9) and the "beaded edge" (fig. 11), account for by far the greater proportion. In the Dunlop-Welch tire the endless wires are embedded in the two edges of the outer cover respectively, the transverse tension of the fabric being transmitted to them. Each endless wire is formed of three coils, so as to give flexibility to the edge of the cover. The ring formed by each endless wire is smaller in diameter than the edge of the rim. The middle portion of the rim is deepened, its diameter being less than that of the ring of endless wire. To detach the tire after deflation, one part of the edge of the outer cover is depressed into the bottom of the rim, the opposite part then projects slightly beyond the edge of the rim and is pulled outside; one portion being got outside, the rest easily follows. Fig. 10 shows the nature of the mutual action between outer cover C, rim R, and endless wire W in a Dunlop-Welch tire. The transverse tension T on the outer cover is transmitted to the endless wire W, which is also subjected to the reaction N of the rim. The resultant Q must lie in the plane of the endless wire W, and constitutes a radially outward force acting at all points, which in turn causes a longitudinal pull, P, on the wire. Let d be the diameter of the inner air-tube, D the diameter of the ring formed by the endless wire W, p the air pressure, and θ the angle

FIG. 9.

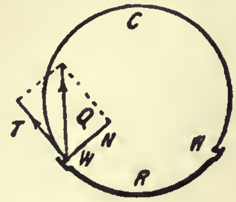


FIG. 10.

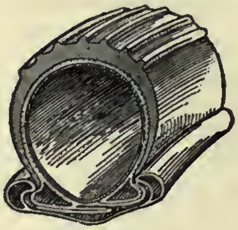


FIG. 11.

between T and Q. Then for each inch length of wire $T=pd/2$, $Q=T/\cos\theta$; while $P=QD/2$. Combining these results, we get $P=pdD/4\cos\theta$. If $\theta=30°$, $P=0{\cdot}29pdD$, from which the section of wire for a tire of any size can be calculated.

In the "beaded edge" fastening, thickened edges on the outer cover take into corresponding edges formed on the rim, and are securely held therein when the tire is inflated.

Prevention of Punctures.—The outside of the tire is covered with a thick layer of rubber, which protects the fabric from injury by contact with the rough road surfaces. In full roadster tires this outer layer of rubber is thinner at the sides than at the tread (the part which actually rolls on the ground), but still completely covers the fabric. In light roadster and racing tires the sides are not covered, and an appreciable gain in speed or ease of driving is due to the greater flexibility of the cover thus obtained. Numerous puncture-proof bands and other devices have been tried with the object of absolutely preventing punctures, or making the tire self-sealing after puncture; but they increase the rolling resistance, and therefore the effort necessary to drive the bicycle at a given speed.

Valve for Pneumatic Tire.—A non-return valve is permanently attached to the inner tube of the tire, which allows the air forced from the inflater to pass inside the inner tube. The most commonly used, the Dunlop-Woods valve, consists of a short piece of rubber tubing mounted on a brass stem, which has a small hole communicating from its outer end to the inner surface of the rubber tube. Normally, the tubing closes the mouth of this hole, preventing the air from escaping from the tire, but lifts freely when air is being forced from the inflater. The arrangement of the parts for deflating and for getting access to the rubber tubing is very simple and effective. The cyclist should be careful that the small piece of valve tubing, and the two fibre washers at the ends of the flexible connecter which serve to make air-tight the two joints between the latter and the pump and valve stem respectively, are always in good condition. If either of these seemingly small details is out of order it may be impossible to pump the tires hard enough; the bicycle being ridden, the tires may be nipped in many places between the rim and sharp edges on the road surface, and practically ruined.

Tires for Motor Cars.—In the cost of upkeep of a motor car the tires are the most expensive item. For a slow speed vehicle an ordinary steel tire, shrunk or hydraulically pressed on a wooden wheel, is cheap and durable. At higher speeds over uneven roads it is less satisfactory; the wheel, forming with the tire one rigid body, receives violent accelerations vertically, due to the uneven road, and is being continually shot upwards into the air out of contact with the ground. Thus excessive noise and vibration are caused at all but very moderate speeds, and for passenger cars an elastic tire is a necessity. The solid rubber tire, not being liable to puncture, is trustworthy if made of sufficient sectional area, but it is expensive and lacks the comfort and easy running of the pneumatic. The motor car pneumatic tire is made on the same lines as the cycle tire, but the air-tube is thicker, and the outer cover is built up with several layers of canvas or fabric to give the necessary strength (fig. 14). To provide for wear, the outer protective layer of rubber is considerably thickened at the tread, where it is also reinforced with two or three layers of canvas. The Palmer cord tire is built up of two layers of cord (fig. 12) arranged spirally, each cord being composed of four strands of six threads. The cords are flattened

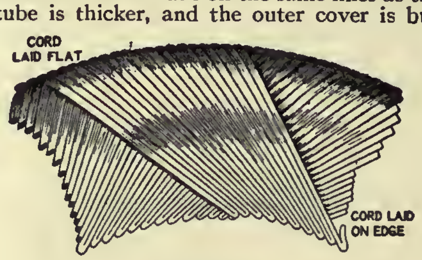


FIG. 12.

somewhat, their narrow surfaces being together at the tread of the tire, and their wide ones at the beaded edge. The anchorage of the cord to the beaded edge is obtained by steel pins passing through the loops of the cord and into the canvas beads (fig. 13). The cords, tread and beads being all vulcanized together, the tire is practically impervious to moisture, and has therefore less tendency to rot than a canvas tire. Further, the threads, by the process of manufacture, are insulated each from the others by a layer of rubber, and there is thus less tendency for them to fray or saw each other as the tire yields during continuous running. These features of construction tend to greater durability.

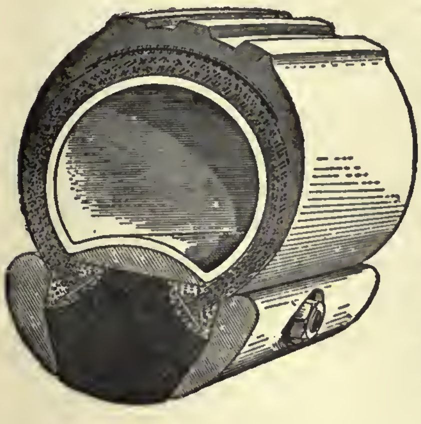


FIG. 13.

Strains on Fabric of Pneumatic Tire.—As each portion of the tread comes in contact with the ground it is flattened, while the rest of the transverse section has its radius of curvature slightly decreased (fig. 3). Thus the transverse section is repeatedly undergoing flexure through a range extending from flatness (radius of curvature infinity) to a radius of curvature slightly less than that of the normal section. On the longitudinal section the range of flexure is from flat to a radius of curvature equal to that of the normal section. The latter range is therefore much less than the former. The necessary thickness of the fabric and rubber to resist the air pressure and punctures involves a certain amount of stiffness; consequently the energy expended in the flexure of the tire is much greater than in a thin cycle tire. This energy appears as heat; the temperature of the cover rises until the heat carried away by the air is equal to that generated by flexure. At very high speeds this heating becomes so great as to have an injurious action on the rubber and fabric. Unfortunately, the solid rubber tire is worse off in this respect, its elastic hysteresis, and therefore the heating effect, being greater than that of a pneumatic tire. It is evident that increase of the diameter of the tire-section lessens the heating action, while reduction of diameter of the wheel has no effect, so long as the range of longitudinal flexure is less than the transverse. Nearly all tire fabrics are equally stiff longitudinally and transversely; but probably greater durability would be obtained from a fabric more flexible transversely, even if somewhat stiffer longitudinally.

Pneumatic Tires for Heavy Loads.—From the formula for load supported, $W=\pi y p\sqrt{Dd}$, for a given air pressure p and vertical flattening y, the load supported is proportional to the square root of the product of the longitudinal and transverse diameters; thus a tire 36″×4″ is equivalent to one 24″×6″. But the latter can be subjected to a much greater vertical flattening y than the former, with a less range of flexure of the cover, probably twice the amount. In this event, with the same air pressures, the 24″×6″ tire could carry a load twice that of the 36″ ×4″ tire. Or, if both tires carried the same load, the air pressure in the former might be half that in the latter, and, its vertical flattening under normal load being twice as great, its value as a spring in absorbing vertical unevenness of the road would be double. Since the first use of pneumatic tires for motor cars, they have been steadily reduced in diameter, and probably they can be made still smaller with advantage, if the transverse section be proportionately increased.

The following table gives the maximum loads and minimum air pressures for a few sizes of tires, as recommended by the Dunlop Pneumatic Tire Company. The corresponding vertical flattening has been calculated from the formula given above.

	Diameter.	Section.	Maximum Load per Wheel.	Minimum Air Pressure.	Vertical Flattening.
	In.	In.	lb	lb per sq. in.	In.
Light Car Tires	28	2½	360	70	·19
	28	3	400	75	·19
	28	3½	700	80	·25
Heavy Car Tires	32	3½	900	80	·33
	32	4	1000	85	·33
	32	5	1300	95	·34

Fastenings of Motor Tires to Rims.—The "beaded edge" type of fastening is most largely used, supplemented by security bolts (fig. 14). Fig. 13 shows a flange fastening as used for the Palmer cord tire, the two flanges being secured by a number of bolts passing through the rim of the wheel.

Solid Rubber Tires for Heavy Vehicles.—Fig. 15 shows a section of a solid rubber tire and rim, the rubber being forced under pressure on the beaded rim. For very heavy loads, as in motor omnibuses, a twin tire gives the best results. The two tires are fastened on the same rim, at a sufficient distance apart to allow each to bulge laterally as it rolls on the ground.

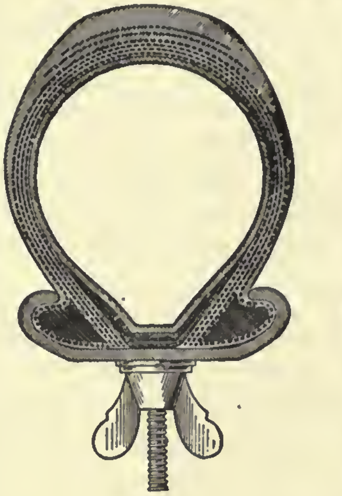


FIG. 14.

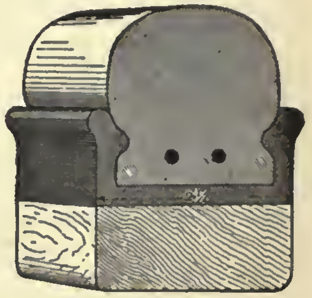


FIG. 15.

Non-Skid Devices.—As a pneumatic tire flattens where it is in contact with the road, under certain conditions of road surface a semi-liquid film of mud gets interposed, and frictional contact is reduced to a minimum. The vehicle has then no lateral constraint, and side-slipping or skidding may occur. On a bicycle this means a dismount, probably a severe fall; on a three or four-wheeled vehicle the steering control is temporarily lost. Cycle tires are usually provided with longitudinal ridges at the tread (figs. 8, 9, 11); the narrow surfaces of the ridges penetrate the mud and get a better grip on the solid road surface. Motor car tires are sometimes left with a smooth tread (fig. 14); fig. 13 shows a non-slipping tread with longitudinal ridges. The Dunlop non-slipping tread is formed by a series of lateral grooves about 2 in. apart all round the tread. Fig. 16 shows a tire fitted with a non-skid leather band, to which hard steel studs are fastened. This type of non-skid band can be either vulcanized to the tire or independently fastened to the rim at the beaded edges. The Parsons "non-skid" device consists of chains crossing the tire at right angles and fitting loosely over its surface; they are fastened at intervals to two chain rings one on each side of the wheel, and can be easily adapted to any tire. (A. Sp.)

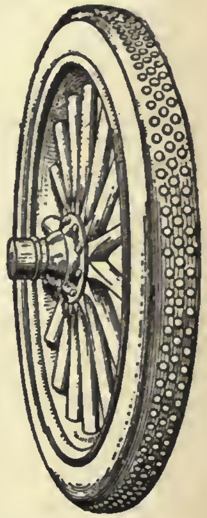


FIG. 16.

TIREH (anc. *Teira*), a town of Asia Minor, situated in the valley of the Küchük Menderes (*Caystrus*) at the foot of Mt Messogis. It was the capital of the amirate of Aidin in the 14th century, and is described by Ibn Batuta as a fine city with streams and gardens. Pop. over 14,000, the larger half Moslems. It is connected with Smyrna by a branch of the Aidin railway, and has a trade in raisins, wheat, rice, tobacco and cotton.

TÎRGOVISHTEA (Rumanian *Tîrgoviştea*, or *Târgovişlea*, sometimes incorrectly written *Tergovista* or *Tirgovist*), the capital of the department of Dimbovitza, Rumania; situated at the foot of the Carpathians, on the right bank of the river Jalomitza, 48 m. N.N.W. of Bucharest. Pop. (1900), 9398. A branch line connects Tîrgovishtea with the main Walachian system, and is prolonged northwards into the hills, where there are rich deposits of petroleum, salt and lignite. Coal is also found but not worked. Apart from the scanty ruins of a 14th-century palace, the most interesting building in the town is the Metropolitan church, still one of the finest in the country, with its nine towers and monuments of the princely house of Cantacuzino. It was founded in 1515 by Neagoe Basarab, builder of the famous cathedral of Curtea de Argesh. Tîrgovishtea is a garrison town, with a cavalry training school and an artillery depot and repairing arsenal.

Under Mircea the Old (1383–1419) Tîrgovishtea became the third capital of Walachia. In the 15th century it was sacked by the Szeklers. Michael the Brave defeated the Turks under its walls in 1597. In the 16th century it had a population of 60,000 and contained 70 churches and 40 convents. After Constantine Brancovan moved the seat of government to Bucharest in 1698, Tîrgovishtea lost its importance and the population decreased.

TÎRGU JIU (often incorrectly written Tergu Jiu), the capital of the department of Gorjiu, Rumania; situated among the lower slopes of the Carpathians, on the left bank of the river Jiu, and at the terminus of a branch railway which joins the main Walachian line between Turnu Severin and Craiova. Pop. (1900), 6634. The town has a small trade in timber, petroleum and farm produce. Anthracite coal is found in the neighbourhood.

TÎRGU OCNA (Rumanian also *Targul Ocna*), a town of Rumania, on the left bank of the river Trotosh, an affluent of the Sereth, and on a branch railway which crosses the Ghimesh Pass into Transylvania. Pop. (1900), 8033. Tîrgu Ocna is built among the Carpathian Mountains, on bare hills formed of rock salt. Outside the town stands the largest prison in Rumania; beyond this are the mines, worked, since 1870, by convicts, who receive a small wage. The thickness of the salt is unknown; the mines yield about 11,000 tons annually.

TIRHUT, or Tirhoot, the historic name of a tract in northern India, being that portion of Behar which lies north of the Ganges. It corresponds roughly with the ancient Hindu kingdom of Mithila (*q.v.*). Down to 1873 it formed a single district, which was then divided into the two districts of Darbhanga and Muzaffarpur. In 1908, when the division of Patna was subdivided, the name of Tirhut was again officially given to a new division, containing the four districts of Darbhanga, Muzaffarpur, Saran and Champaran: total area, 12,588 sq. m.; total pop. (1901), 9,867,373. It is a continuous alluvial plain, traversed by many winding rivers, and it supports the densest population in all India. It is the main centre of the indigo industry, conducted by European planters, which is now in a declining condition. Other crops are rice, millets, wheat, maize, oilseeds, sugar-cane and tobacco. Apart from indigo there are no large industries. Since the famine of 1874 the whole country has been saved from its former isolation by the construction of the Bengal & North-Western railway, with numerous branches; but the Ganges is nowhere bridged.

TIRIDATES, or Teridates, a Persian name, given by Arrian in his *Parthica* (preserved by Photius, *cod.* 58, and Syncellus, p. 539 seq.) to the brother of Arsaces I., the founder of the Parthian kingdom, whom he is said to have succeeded. But Arrian's account seems to be quite unhistorical (cf. Parthia).

The king commonly called Tiridates II. was set up by the Parthians against Phraates IV. in 32 B.C., but expelled when Phraates returned with the help of the Scythians (Dio Cass. li. 18; Justin xlii. 5 seq.; cf. Horace, *Od.* i. 26). Tiridates fled to Syria, where Augustus allowed him to stay, but refused to support him. During the next years Tiridates invaded Parthia again; some coins dated from March and May, 26 B.C., with the name of a king "Arsaces Philoromaios," belong to him; on the reverse they show the king seated on the throne, with Tyche stretching out a palm branch towards him. He was soon expelled again, and brought a son of Phraates into Spain to Augustus. Augustus gave the boy back to his father, but declined to surrender "the fugitive slave Tiridates" (Justin xlii. 5; Dio liii. 33; cf. *Mon. Ancyr.* 5, 54; in li. 18 Dio has wrongly placed the surrender of the son in 30 B.C.).

Tiridates III., grandson of Phraates IV., lived as a hostage in Rome and was educated there. When the Parthians rebelled against Artabanus II. in A.D. 35 they applied for a king to Tiberius, who sent Tiridates. With the assistance of L. Vitellius Tiridates entered Seleucia, but could not maintain himself long (Tacitus, *Ann.* vi. 32 sqq.; Dio Cass. lviii. 26).

The name Tiridates is also borne by some local kings of Persis, and by some Arsacid kings of Armenia and Georgia. The best known of the Armenian kings is the Tiridates (A.D. 238–314) who was baptized by Gregory the Illuminator (see Armenian Church). (Ed. M.)

TIRLEMONT (Flemish *Thienen*), a town of Belgium in the province of Brabant, 11 m. S.E. of Louvain. Pop. (1904), 18,340. It still preserves its enceinte, 6 m. in circumference. The principal church, Notre Dame du Lac, begun in the 12th and enlarged in the 15th centuries, is still unfinished. The church of St Germain also dates from the 12th century, and contains a fine altar-piece by Wappers. John Bolland, the Jesuit who began the collection of the *Acta sanctorum*, was born here in 1596. The principal industries are brewing, soap manufacture and tanning.

TIRMIDHĪ [Abū 'Isā Mahommed ibn 'Isā ut-Tirmidhī] (d. 892), Arabian traditionalist, was born at Tirmidh on the Jiḥūn. He was a scholar of the traditionalist Bukhārī, and in his search for traditions travelled through Khorasan, Irak and Hejaz. His *al-Jāmi' us-Ṣaḥīḥ* is one of the six canonical collections of traditions. In it he admitted every tradition that had ever been used to support a legal decision, indicating the doctrine it supported and mentioning the doctrines opposed to it. It was published at Bulaq in 1875. He also wrote the *Kitāb ush-Shama'il* on the character and life of Mahomet (printed at Calcutta, 1846). (G. W. T.)

TIROL (or Tyrol[1]), the most southerly province of the Austrian Empire. It makes a great bend southwards towards Italy, by which it is bounded on the S.E., S. and S.W., while on the W. it adjoins part of present Switzerland (till 1652 the Lower Engadine was Tirolese, and not Swiss) and also the Austrian province of Voralberg; to the N. it borders on Bavaria and to the E. the province of Upper Austria. It is traversed from west to east by the main chain of the Alps, which rises in various snow-covered summits, the more important being the Ortler (12,802 ft., the loftiest peak in Tirol and in the Eastern Alps generally), the Wildspitze (12,382 ft., Oetzthal group), the Zuckerhütl (11,520 ft., Stubai group), the Hochfeiler (11,559 ft., Zillerthal group), the Gross Venediger (12,008 ft.) and the Gross Glockner (12,461 ft., both in the Tauern range), while more to the south are the Dolomites, which culminate in the Marmolata (10,972 ft.). It is divided into two very distinct portions by the Brenner Pass (4495 ft.), connecting the Stubai and the Zillerthal groups; over this pass a splendid railway was built in 1864–1867 from Innsbruck to Verona, while the highway over the pass has from the earliest times been of immense importance from every point of view. The Brenner, too, being on the main watershed of the Alps, separates the two main river systems of which Tirol is composed. To the north this province comprises the middle portion of the Inn Valley, with its tributaries, as well as the upper portion of the Lech valley, all flowing towards the Danube and so to the Black Sea, while south of the pass is the great upper valley of the Adige or Etsch, with many tributaries, as well as (since 1500) a portion of the upper Drave valley, which physically belongs to Carinthia—all these (save the Drave) flow to the Adriatic Sea. The area of Tirol is 10,204 sq. m. In 1900 its population was 852,712 (all but wholly Romanist), of whom more than half were German-speaking, and many in the south Italian-speaking, while in certain side valleys of the Adige system the quaint old Ladin dialect, still surviving also in the Swiss Engadine, is the prevailing tongue; in the southern half of the region there are a few German-speaking among the Italian-speaking folk. The capital is Innsbruck, while other important towns are Trent, Botzen and Rovereto.

The present very irregular shape of the district is due to historical causes. The original Tirol consisted of part of the middle Inn valley and of the uppermost portion (the Vintschgau) of the Adige valley. In 1500, by inheritance from the counts of Görz, the Pusterthal and upper Drave valley (east) were added; in 1505 the lower portion of the Zillerthal, with the Inn

[1] To speak, as is commonly done, of "the Tirol" is as absurd as speaking of "the England." As regards the English spelling of the name adopted throughout the *Ency. Brit.*, it should, however, be stated that the writer of this article regards "Tyrol" as more correct.—(Ed.)

valley from its entrance to Kufstein, and the Kitzbühel region (north-east) were all won from Bavaria; in 1517 Rovereto and several other places on the present south-eastern frontier were acquired from Venice; in 1803 many fiefs in the bishoprics of Trent and Brixen were annexed on the secularization of those two bishoprics; while finally the rest of the Zillerthal, with Windisch Matrei, was obtained in 1816 from the archbishopric of Salzburg. Besides the great railway line over the Brenner, there are other lines from Botzen past Meran to Mals, from Franzensfeste up the Pusterthal to Lienz in the Drave valley, and from Innsbruck, by a tunnel beneath the Arlberg Pass to the Vorarlberg and the Rhine valley.

The majority of the population is devoted to pastoral, and in some degree to agricultural pursuits, the cattle, as in other Alpine lands, being the mainstay of the peasants. In summer they are driven up to the mountain pastures (called here *Almen*, but *Alpen* in Switzerland), which are, however, less carefully looked after than in Switzerland, partly because in many cases they have been alienated by the neighbouring hamlets to far distant places. Forestry also employs a certain proportion of the population, but the felling of trees is carried on wastefully, though less so than in former years. A few minerals are found in the district, but in this department the saltworks of Hall, near Innsbruck, take the first place. In southern Tirol, silk-spinning is still one of the principal industries, while good local wines are produced near Meran and Botzen. There are also some factories of preserved fruits and tobacco. But, save in the towns, Tirol is above all a pastoral land.

The peasants are famous for their devotion to the Roman Catholic religion, their fervent loyalty to the House of Austria, their excellent marksmanship, and their love of singing and music, the zither being the national instrument. There is a university at Innsbruck, but primary education, though compulsory, does not attain any very high degree of excellence, as in summer the schools are closed, for all hands are then required in the fields or on the mountain pastures. The picturesque local costumes have nearly altogether disappeared, save in the Passeyerthal, near Meran, while the increasing crowds of summer visitors have largely spoilt the simplicity of the natives. Ecclesiastically, Tirol is ruled by the archbishop of Salzburg and his two suffragans, the bishops of Trent and of Brixen. The country is divided into 21 administrative districts (*Bezirke*), each composed of a number of *communes* or civil parishes. Tirol sends 25 representatives to the Austrian parliament at Vienna. Locally it is ruled by an Imperial governor (the *Statthalter*) who resides at Innsbruck, where, too, meets annually the local legislature or Diet (the *Landtag*), composed (according to the constitution of 1861) of 68 members; the archbishop of Salzburg, the bishops of Trent and Brixen, and the rector of the university of Innsbruck sit in person, while the great ecclesiastical corporations send four deputies, the chambers of commerce of Innsbruck, Trent and Rovereto each one, the nobles ten, the towns 13, and the peasants 34.

History.—By far the greater portion of the region later called Tirol was inhabited, when it makes its appearance in history, by the Raetians (perhaps a Celtic race, though some still hold that they were connected with the Etruscans), who were conquered (14 B.C.) by Drusus and Tiberius, and were later organized into the Roman province of Raetia. In the 5th and following centuries the north portion was Teutonized, first by the Ostrogoths, mainly by the Baiouarii, but the Teutonic Langobardi who pressed up from the south became Romanized themselves, so that the double character of the inhabitants of the land appears quite early. In 774 the Carolingians conquered the Langobardi or Lombards, and in 788 the Baiouarii. But the officials charged with the rule of these parts gradually became semi-independent, particularly the Bavarian dukes in the region north of Trent. Some time after the break-up of that duchy in 976, the emperor Conrad II. entrusted all temporal powers in the northern region to the bishop of Brixen, and in the southern portion to the bishop of Trent, detaching these southern districts from Italy (to which they had always belonged, save from 951 to 962, when the march of Verona was annexed to the duchy of Carinthia) and incorporating them with Germany. The bishops, in their turn, had to exercise their temporal rights through lay vassals, of whom the most powerful in the course of the 12th century were the lords of Andechs, near Munich. On the extinction of this family in 1248, most of their fiefs were given by the two bishops to the father-in-law of the last lord of Andechs, Albert, count of Tirol. This new family took its name from the still existing castle of Tirol (Later Roman, *Teriolis*), above Meran, in the upper Adige valley, and is mentioned for the first time in 1140. Albert's elder daughter, Adelaide, married Meinhard, count of Görz (north of Trieste); their elder son Meinhard (d. 1295) took Tirol, and the younger Görz; but in 1500 the latter's line became extinct, and the elder line inherited its possessions. Long before that time the senior branch of the elder line had ended in Margaret, nicknamed *die Maultasche* (the Pocket-mouth), who, in 1342, married Louis of Brandenburg (d. 1361), and whose only child Meinhard died in her lifetime in 1363; Tirol accordingly passed by agreement in the latter year of the junior branch of the elder line, the Habsburgers, dukes of Austria since 1282. In this way Tirol came to the dynasty which has ever since held it (save 1805–1814). From that time onwards till 1665 Tirol was generally entrusted to a cadet of the Austrian house, who ruled first at Meran, and from about 1420 at Innsbruck, as a nearly independent prince; but since 1665 the province has been governed from Vienna. We have noted above the manner in which the limits of Tirol were gradually extended. Several of these additions were due to the archduke Maximilian, who ruled Tirol from 1490 onwards, becoming emperor in 1493 and dying in 1519. His memory is still cherished in the district, for he conferred on it the title of *Gefürslele Grafschaft*, spent much time in it, and erected in the chief church of Innsbruck a sumptuous monument as his tomb.

Owing to its position astride of the Alps, and so commanding the road across them, Tirol has often been the scene of sharp fighting. In 1499 the Swiss won a victory in the Calven gorge (near the head of the Adige valley) against Maximilian, which resulted in the Swiss gaining their practical independence of the empire. In 1703 the Bavarians and French, during the War of the Spanish Succession, took Innsbruck, but were then driven back. In 1805, by the peace of Pressburg, Napoleon forced Austria to hand over Tirol to his ally, Bavaria, which held it till 1814. On the outbreak of war (1809) between France and Bavaria, the people rose in revolt. Their leader was Andreas Hofer (b. 1767), a small innkeeper of the Passeyerthal, and under him the peasants repeatedly defeated the Bavarian, French and Saxon troops. Three times (April 13, May 29 and Aug. 13) did they drive the foe out of Innsbruck. On the 15th of August, Hofer, yielding to the popular wish, assumed the government of Tirol. But in October the ill-success of the Austrians against the French elsewhere forced them to conclude the peace of Vienna, by which Tirol was definitely secured to Bavaria. The peasants refused to believe in the bad news, and continued to resist the French, but were at last overpowered by numbers. The French occupied the Passeyerthal on the 23rd of November, and Hofer was obliged to seek shelter in a hut on the mountain pastures. Here he was betrayed by a neighbour to the French (Jan. 27, 1810), who took him captive to Mantua, where, by express order of Napoleon, he was shot (Feb. 20, 1810) for the sole offence of being loyal to his emperor and his native land. His bones now lie in the great church at Innsbruck, side by side with those of his two chief supporters, the Capuchin friar and army chaplain, Joachim Haspinger (d. 1858), and the peasant, Joseph Speckbacher.

See in general vol. xiii., *Tirol* (Vienna, 1893), of the great official work entitled *Die oesterreichisch-ungarische Monarchie in Wort und Bild*. The following more special works may be consulted: A. Achleitner and E. Ubl, *Tirol und Vorarlberg* (Leipzig, 1895); J. Alton, *Die ladinischen Idiomen in Ladinien, Gröden, Fassa, Buchenstein, Ampezzo* (Innsbruck, 1879); F. Arens, *Das tiroler Volk in seinen Weisthümern* (Gotha, 1904); W. A. Baillie-Grohman, *Tirol and the Tirolese* (London, 1876), *Gaddings with a Primitive People* (2 vols., London, 1878), *Sport in the Alps* (London, 1896); and *The Land in the Mountains* (1907); Miss R. H. Busk, *The Valleys of Tirol* (London, 1874); E. H. Compton and W. A. Baillie-Grohman, *Tyrol* (London, 1908); J. Egger, *Geschichte Tirols* (3 vols., Innsbruck, 1872–1880); J. Gilbert and G. C. Churchill, *The Dolomite Mountains* (London, 1864); Max Haushofer, *Tirol* (Bielefeld and Leipzig, 1899); J. Hirn, *Tirols Erhebung im Jahre 1809* (Innsbruck, 1909); Alfons Huber, *Geschichte d. Vereinigung Tirols mit Oesterreich* (Innsbruck, 1864); A. Jäger, *Geschichte d. landständischen Verfassung von Tirol* (3 vols., Innsbruck, 1882–1885); W. D. McCrackan, *The Tyrol* (London, 1905); E. Oefele, *Geschichte der Grafen von Andechs* (Innsbruck, 1877); L. Purtscheller and H. Hess, *Der Hochtourist in den Ostalpen*, 3rd ed., 3 vols. (Leipzig and Vienna, 1903); E. Richter

Die Erschliessung der Ostalpen (3 vols., Berlin, 1893–1894); A. Schaubach, *Deutsche Alpen* (2nd ed., 5 vols., Jena, 1865–1871); Chr. Schneller, *Landeskunde von Tirol* (Innsbruck, 1872); F. A. Sinnacher, *Beiträge zur Geschichte der bischöfl. Kirche Säben und Brixen* (really a special territorial history of Tirol) (10 vols., Brixen, 1821–1837); J. Staffler, *Tirol und Vorarlberg*, (2 vols., Innsbruck, 1839–1846); A. Steinitzer, *Geschichtliche und kulturgeschichtliche Wanderungen durch Tirol und Vorarlberg* (Innsbruck, 1905); Th. Vernaleken, *Alpensagen* (largely Tirolese; Vienna, 1858); Beda Weber, *Das Land Tirol* (3 vols., Innsbruck, 1837–1838); Martin Wilckens, *Die Alpenwirthschaft der Schweiz, des Algäu, und der westoesterreichischen Alpenländer* (Vienna, 1874); I. V. Zingerle, *Sagen, Märchen, und Gebräuche aus Tirol* (Innsbruck, 1859); I. V. Zingerle and K. Th. von Inama-Sternegg, *Die tirolischen Weisthümer* (4 vols., Vienna, 1875–1888). (W. A. B. C.)

TIRSO DE MOLINA, the pseudonym of Gabriel Tellez (1571–1648), Spanish dramatist. Born at Madrid in October 1571, he studied at the Alcalá de Henares, joined the Order of Mercy on the 4th of November 1600, and made his religious profession in the Monastery of San Antolín at Guadalajara on the 21st of January 1601. He was a dramatist of ten years' standing when he was sent by his superiors on a mission to the West Indies in 1615; returning to Europe in 1617, he resided at the Mercenarian monastery in Madrid, took part in the proceedings of the *Academia poëtica de Madrid*, founded by Sebastián Francisco de Medrano, competed in the literary tournaments then in vogue, and wrote copiously for the stage. His first publication, the incomplete *Cigarrales de Toledo* (licensed in 1621, but apparently not published till 1624), is a miscellany, containing short tales, novels, verses and three plays; one of the novels, *Los Tres maridos burlados*, probably derived from Il Cieco da Ferrara's *Mambriano*, and the play entitled *El Vergonzoso en palacio* are admirable examples of witty contrivance. The preface to the *Cigarrales de Toledo* (the second part of which was never printed) states that Tirso de Molina had already written three hundred plays, and at this period of his career he was second only to his friend Lope de Vega in popularity. He avowed himself hostile to *culteranismo* in the *Cigarrales de Toledo*, and made numerous enemies by his attacks on the new school in such pieces as *Amar por arte mayor* and *La Celosa de sí misma*. The realistic character of some of his productions provided his unsuccessful rivals with an excuse for denouncing him as a corrupter of public morals to the council of Castile in 1625, and, though no legal action was taken against him, he appears to have been reprimanded privately. In 1626 it was deemed advisable to transfer him to Salamanca, and Tirso de Molina left Madrid determined to write no more for the stage. Though one of his plays, *La Huerta de San Juan*, is dated 1626, there is no proof that it was begun after his departure from Madrid, and he seems to have kept to his resolution for eight years. But he had not lost his interest in the theatre, and felt justified in publishing twelve representative pieces as the first part of his dramatic works (1626). This may be taken as a formal protest against the weakness of those who had sacrificed him to hypocritical clamour. In other respects he was submissive, and worked zealously on behalf of his order in which he rose to important positions; he became superior of the monastery at Trujillo in 1626, was elected later to the posts of reader in theology and *definidor general*, and in May 1632 was appointed chronicler of the Order of Mercy. His *Deleitar aprovechado* (1635) is a devout counterpart of the *Cigarrales de Toledo*, much inferior to its predecessor in interest; a sequel was promised to this collection of pious tales, pious lyrics, and *autos*, but, as in the case of the *Cigarrales de Toledo*, the continuation never appeared. Twelve plays constitute the third part of his dramatic works which was published (before the second) in 1634 under the nominal editorship of the writer's nephew Francisco Lucas de Ávila, but the existence of this nephew is doubtful. The second part (1635), the printing of which was paid for by the confraternity of St Jerome, contains four plays by Tirso de Molina, and eight written by him in collaboration with other dramatists; one of these collaborators was Ruiz de Alarcon (*q.v.*), but the internal evidence goes to show that Tirso de Molina was the predominant spirit in these literary partnerships. The fourth part of Tirso's dramatic works (1635) and the fifth (1636) each contain twelve plays; the haste with which these five volumes were issued indicates the natural desire of a great author to save some part of his work from destruction, and the appearance of a supposititious nephew's name on the title-pages of the last four volumes indicates the equally natural desire of a prominent monk to avoid conflict with the authorities. A sixth volume of dramatic pieces, consisting of light comedies, was announced; but the project was abandoned. That dramatic composition still entertained the scanty leisure of Tirso's old age is shown by the fact that the fragmentary autograph copy of *Las Quinas de Portugal* is dated the 8th of March 1638; but his active career as a dramatist ended two years earlier. He was absorbed by other duties. As official chronicler of his order, he compiled the elaborate *Historia de la merced*, which occupied him till the 24th of December 1639, and still survives in manuscript. As a tribute to the count de Sástago, who had accepted the dedication of the fourth part of the plays, and who had probably helped to defray the publishing expenses, Tirso de Molina is said to have compiled the *Genealogía de la casa de Sástago* (1640), but the ascription of this genealogical work is disputed. On the 29th of September 1645 Tirso de Molina became superior of the monastery at Soria, and died there on the 12th of March 1648.

It is only within the last few years that it has become possible to give an outline of his life; it will always be impossible for posterity to do justice to his genius, for but a fraction of his plays have been preserved. The earliest of his extant pieces is dated 1605 and bears no sign of immaturity; in 1624 he had written three hundred plays, and in 1634 he stated that he had composed four hundred within the previous twenty years; of this immense production not more than eighty plays are in existence. Tirso de Molina is universally known as the author of *El Burlador de Sevilla y convidado de piedra*, the piece in which Don Juan is first presented on the stage; but *El Burlador de Sevilla* represents only one aspect of his genius. No less remarkable than his representation of perverse depravity in *El Burlador de Sevilla* is his dramatic treatment of a philosophical enigma in *El Condenado por desconfiado*. Though manifestly attracted by exceptional cases, by every kind of moral aberration, by the infamous and the terrible, his range is virtually unlimited. He reveals himself as a master of historical interpretation in *La Prudencia de la mujer* and of tragical pathos in *La Venganza de Tamar*; his sympathetic, malicious wit finds dramatic expression in *El Vergonzoso en palacio* and *Don Gil de las calzas verdes*, and the fine divination of feminine character in *Averígüelo Vargas* and *La Villana de Vallecas* is incomparable. Tirso de Molina has neither Lope de Vega's inventive resource, nor his infinite seduction; he has neither Calderón's idealistic visions, nor his golden music; but he exceeds Lope in massive intellectual power and in artistic self-restraint, and he exceeds Calderón in humour, in creative faculty, and in dramatic intuition. That his reputation extended beyond the Pyrenees in his own lifetime may be gathered from the fact that J. Shirley's *Opportunity* is derived from *El Castigo del penséque*; but he was neglected in Spain itself during the long period of Calderón's supremacy, and his name was almost forgotten till the end of the 18th century, when some of his pieces were timidly recast by Dionisio Solís and later by Juan Carretero. The renaissance of his fame, however, dates from 1839–1842, when an incomplete but serviceable edition of his plays was published by Hartzenbusch; and he is now accepted as among the greatest dramatists of Spain.

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TIRUPATI, or Tripetty, a town of British India, in the North Arcot district of Madras, with a station on the Madras railway, 84 m. N.E. of Madras city. Pop. (1901), 15,485. It is famous for a temple on the neighbouring hill of Tirumala, 2500 ft. above the sea, which is one of the most frequented places of pilgrimage in southern India. The town contains numerous temples connected with the shrine of Tirumala, and is noted for its brass-work and wood-carving.

TIRYNS, the *Τίρυνς τειχιόεσσα* of Homer (*Il.* ii. 559), a small Peloponnesian city, in the prehistoric period of the Achaean race, long before the Dorian immigration. It stood on a small rock in the marshy plain of Argolis, about 3 m. from the sea, and was fabled to have been founded by King Proetus, the brother of Acrisius, who was succeeded by the hero Perseus. It was the scene of the early life of Heracles, who is hence called Tirynthius. The massive walls, which appear to be of earlier

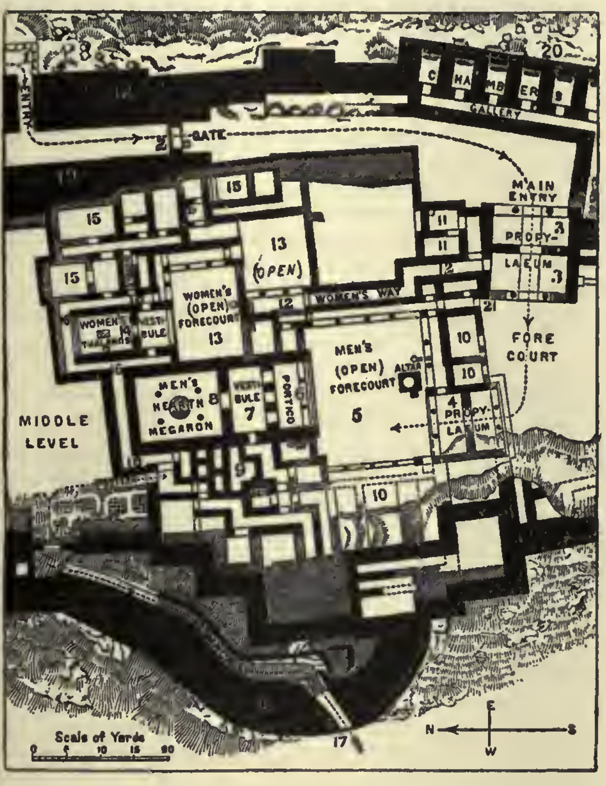

Fig. 1.—Plan of the Palace in the Upper Part of Tiryns.

1, Main gate in the outer wall.
2, Inner gate, approached between massive walls.
3, Main propylaeum.
4, Inner propylaeum.
5, Court (*αὐλή*) surrounded by a colonnade on three sides: the altar to Zeus Herceus is by the entrance.
6, *Αἴθουσα*, portico of the megaron.
7, *Πρόδομος*, inner porch.
8, Megaron, with roof supported on four columns, and the circular hearth in the middle.
9, Bath-room and small *θάλαμοι*.
10, 10, Chambers round the great court.
11, 11, Guard chambers by the main propylaeum.
12, Passage (*λαύρη*) from the main propylaeum to the second house.
13, 13, Courts of the second house.
14, Megaron.
15, Chambers (*θάλαμοι*).
16, Passage to the rock-cut stairs.
17, Small postern door in the semicircular bastion, approached by flight of rock-cut steps.
18, 18, Massive outer wall of city.
19, Inner wall to guard the entrance passage.
20, Part of outer wall, with intermediate passage and rows of chambers, as shown in fig. 2.

type than those of Mycenae, were said to have been the work of Cyclopean masons. Its period of greatest splendour was probably between the 14th and 12th centuries B.C.; in Homeric and subsequent times it was usually subject to Argos. The palace was probably burnt at the time of the Dorian conquest. After the Spartan defeat of Argos in 494 B.C. Tiryns regained temporary independence, and the Tirynthians fought on the Greek side at Plataea, while the Argives held aloof. Soon after, in 468 B.C., Tiryns was finally destroyed through the jealousy of the Argives, and the site has been deserted ever since, but for a brief occupation in Byzantine times.

Excavations made in 1884–1885 by Schliemann and Dörpfeld over part of the rock on which Tiryns stood have exposed a most interesting building, which offers the most complete example of a palace of the Mycenaean age in Greece. The rock on which Tiryns is built is of an irregular oval shape, about 330 yds. long by 112 at the widest part, and is surrounded by a very massive wall, varying from 30 to 40 ft. in thickness and averaging when complete about 50 ft. in height, measuring from its base outside. Inside, the wall was probably not more than 10 or 12 ft. high above the ground, so the masonry acts as a retaining wall to a considerable depth of earth which covers the rock (see fig. 2 below). The wall is built of very large hammer-dressed blocks, some as much as 10 ft. long by 3 ft. 3 in. or 3 ft. 6 in. wide, with smaller ones to fill up the interstices. The whole was bedded, not in mortar, but in clay, which has mostly been washed out of the joints; originally the surface was probably protected with a coating of stucco. The only important gateway, which was on the east side, away from the sea, probably resembled the "lion gate" at Mycenae. The other entrances are mere slits in the wall. One of these and the chief gate are shown in fig. 1. Internally the area of the city was divided by cross walls into three parts at successive levels. The lowest and middle divisions have not yet been excavated; the upper part at the south end of the rock was completely exposed in 1884–1885 by Schliemann and Dörpfeld, and the almost complete plan of the various structures clearly made out. This division contains the palace of the ruler of Tiryns, a building which shows careful and skilful construction, elaborate decoration, and a well-arranged plan, suitable to the wants of a wealthy autocratic chief, who lived in a manner which partly recalls the luxury of an Oriental king, and also resembled the feudal state of a medieval baron, surrounded by a crowd of vassals. From the main gate, which was defended by a tower, a strong passage led between the outer wall and an inner one to an inner gate, thence to a propylaeum or double porch, with two wooden columns on each side, adjoining which were chambers for guards. Then came another similar, but smaller propylaeum, and opposite to that was the entrance to the great court (*αὐλή*), nearly 53 by 70 ft., in which stands an altar or pit of sacrifice, in a position similar to that occupied by the altar of Zeus Herceus in the later Greek house. This court was surrounded by wooden columns supporting a roof, like a medieval cloister; on the south side are chambers for attendants (*θάλαμοι*). On the north side is the great hall (*μέγαρον*), with an outer portico supported by two columns (*αἴθουσα*) and an inner vestibule (*πρόδομος*) with three doors. The hall is about 40 by 30 ft., with a circular hearth in the centre (*ἑστία* or *ἐσχάρα*). Four columns supported the roof, the central part of which probably rose above the rest like a medieval "lantern." On the west side of the hall are a

A, Outer base of wall.
B, Inside level of city.
C, Chambers in the thickness of the wall opening out of the gallery.
D, Gallery, with roof formed of projecting courses of stone in large blocks.
E. Top of main wall, paved with clay, level with the inside.
F, Wooden columns on existing stone bases, forming a porticus or covered walk along the top of the wall.
G, Outer wall of the colonnade built of brick, now missing.
H, Probable roof of the colonnade of wood, covered with beaten clay.

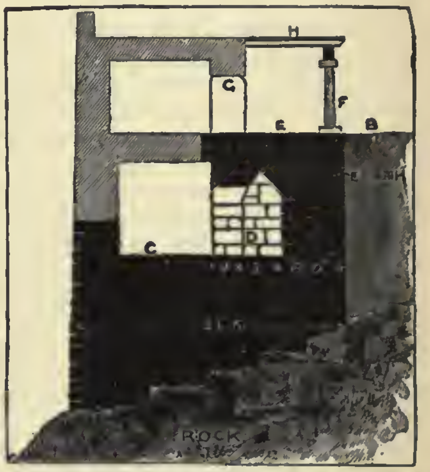

Fig. 2.—Section through the Outer Wall of the City at 20 in fig. 1.

number of small chambers (*θάλαμοι*), and a bathroom about 12 by 10 ft., with its floor formed of one great slab of stone, sloped so as to drain out at one side through a pipe which passes through the wall. In addition to this there is also a second system, with open courts, hall and chambers; this has been generally supposed to be the women's quarters, but there is no authority for such duplication, and it is possible that it should rather be explained as another house. It is approached in a very circuitous way, either by a passage (*λαύρη*) leading from a side door in the main propylaeum or by another long passage which winds round the back of the chief hall, and so leads by a long flight of steps, cut in the rock, to the little postern door in the semicircular bastion. A staircase led to an upper floor. The circuit wall round the palace is more strongly constructed than the rest. On the south is a gallery built in the thickness of the wall, and roofed by projecting courses of stone; and chambers or storehouses open out of this gallery. The wall on the east side has a similar arrangement (see fig. 2). At the top level the wall was covered by a colonnade of wooden pillars resting on circular stone blocks. This supported a flat roof and was open to the inside of the fortress. The back of the colonnade was built of brick, and is now missing, as are all the brick parts of the palace, owing to the bricks having been only sun-dried.

The methods of construction employed in the Tiryns palace are of the highest interest. The foundations and about 3 ft. of the walls above the ground are made of large blocks of stone bedded in clay; above this the wall was of brick, sun-dried, and covered with stucco. The upper storey was probably of wood. Some of the thresholds of the doors were massive blocks of stone (λάϊνος οὐδός); others were of wood (δρύϊνος οὐδός). Wood was also used for all the columns, doorposts, and antae (παραστάδες), and in some cases the walls of the rooms were lined with wood, carefully fixed by dowels, the holes for which still exist. The doors had pivots of bronze revolving in well-fitted bronze cup-like sockets let into the thresholds. In the megaron and other rooms the floors are of good concrete decorated with a simple series of incised lines, coloured blue and red. The stucco of the internal wall is decorated with bold and very effective patterns—birds and scroll-work and other decorative designs. The best preserved painting shows a scene from a bull-fight. Both subjects and style show close analogy to the paintings in the palace at Cnossus in Crete. One example of rich and costly decoration remains—part of a frieze of white alabaster, sculptured in relief with rosettes and interlacing patterns, and studded with jewel-like pieces of blue glass or enamel, the θριγκὸς κυάνοιο of *Od.* vii. 87. Further excavations in the lower parts of the city will probably bring to light the dwellings of the citizens who garrisoned the place. The great bulk of the Tirynthians must have lived in houses outside the citadel, but under the shelter of its protection, just as in medieval Italy villages grew up round the castles of any powerful lord. The relation of the palace at Tiryns to those described in the Homeric poems has given rise to much discussion. The case is somewhat altered by the discovery of several other early houses, of similar character, but not identical in plan, at Mycenae and elsewhere in Greece; these do not, for example, show the duplication of the essential parts of the house found at Tiryns. It is now generally recognized that, while the general character of the palace at Tiryns is invaluable as illustrating the type of house in the mind of the Homeric poet, it is a mistake to appeal to it for the explanation of details of arrangement such as probably varied considerably according to the conditions and requirements in different cases.

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(J. H. M.; E. Gr.)

TISCHENDORF, LOBEGOTT FRIEDRICH KONSTANTIN VON (1815–1874), German biblical critic, the son of a physician, was born on the 18th of January 1815 at Lengenfeld, near Plauen, in the Saxon Vogtland. From the gymnasium at Plauen he passed in 1834 to the university of Leipzig, where he was mainly influenced by J. G. B. Winer (1789–1858), and began to take special interest in New Testament criticism. In 1838 he took the degree of doctor of philosophy, and then became master at a school near Leipzig. After a journey through southern Germany and Switzerland, and a visit to Strassburg, he returned to Leipzig, and set to work upon a critical study of the New Testament text, following the guidance of Karl Lachmann. In 1840 he qualified as university lecturer in theology with a dissertation on the recensions of the New Testament text, the main part of which reappeared in the following year in the prolegomena to his first edition of the New Testament. These early textual studies convinced him of the absolute necessity of new and exacter collations of MSS. From October 1840 till January 1843 he was in Paris, busy with the treasures of the great library, eking out his scanty means by making collations for other scholars, and producing for the publisher, F. Didot, several editions of the Greek New Testament, one of them exhibiting the form of the text corresponding most closely to the Vulgate. The great triumph of these laborious months was the decipherment of the palimpsest *Codex Ephraemi Syri Rescriptus*, of which the New Testament part was printed before he left Paris and the Old Testament in 1845. His success in dealing with a MS. much of which, owing to the fact that it had been rewritten with the works of Ephraem Syrus, had been illegible to earlier collators, brought him into note and gained support for more extended critical expeditions. From Paris he had paid short visits to Holland (1841) and England (1842). In 1843 he visited Italy, and after a stay of thirteen months went on to Egypt, Sinai, Palestine and the Levant, returning by Vienna and Munich.[1] From Sinai he brought a great treasure, forty-three leaves of what is now known as the *Codex Sinaiticus*. He kept the place of discovery a secret, and the fragments were published in 1846 as the *Codex Friderico-Augustanus*, a name given in honour of the king of Saxony. He now became professor extraordinarius in Leipzig, and married (1845). In the same year he began to publish an account of his travels in the East (2 vols., 1845–1846). In 1850 appeared his edition of the *Codex Amiatinus* and of the Septuagint version of the Old Testament (7th ed., 1887); in 1852, amongst other works, his edition of the *Codex Claromontanus*. In 1853 and 1859 he made a second and a third voyage to the East. In the last of these, in which he had the active aid of the Russian government, he at length got access to the remainder of the precious Sinaitic codex, and persuaded the monks to present it to the tsar, at whose cost it was published in 1862 (in four folio volumes). In 1869 he was given the style of "von" Tischendorf as a Russian noble. Meanwhile, in 1859, he had been made professor ordinarius of theology and of biblical palaeography, this latter professorship being specially created for him; and another book of travel, *Aus dem heiligen Lande*, appeared in 1862. Tischendorf's Eastern journeys were rich enough in other discoveries to deserve the highest praise.[2] Side by side with his industry in collecting and collating MSS., Tischendorf pursued a constant course of editorial labours, mainly on the New Testament, until he was broken down by overwork in 1873. He died on the 7th of December 1874 at Leipzig.

The great edition, of which the text and apparatus appeared in 1869 and 1872,[3] was called by himself *editio viii.*; but this number is raised to twenty or twenty-one if mere reprints from stereotype plates and the minor editions of his great critical texts are included; posthumous prints bring up the total to forty-one. Four main recensions of Tischendorf's text may be distinguished, dating respectively from his editions of 1841, 1849, 1859 (*ed. vii.*), 1869–1872 (*ed. viii.*). The edition of 1849 may be regarded as historically the most important from the mass of new critical material it used; that of 1859 is distinguished from Tischendorf's other editions by coming nearer to the received text; in the 8th edition the testimony of the Sinaitic MS. received great (probably too great) weight. The readings of the Vatican MS. were given with more exactness and certainty than had been possible in the earlier editions, and the editor had also the advantage of using the published labours of S. P. Tregelles.

Much less important was Tischendorf's work on the Greek Old Testament. His edition of the Roman text, with the variants of the Alexandrian MS., the Codex Ephraemi and the Friderico-Augustanus, was of service when it appeared in 1850, but, being stereotyped, was not greatly improved in subsequent issues. Its imperfections, even within the limited field it covers, may be judged by the aid of C. E. Nestle's appendix to the 6th issue (1880). Besides this may be mentioned editions of the New Testament Apocrypha [*De Evangeliorum apocryphorum origine et usu* (1851); *Acta Apostolorum apocrypha* (1851); *Evangelia apocrypha* (1853; 2nd ed., 1876); *Apocalypses apocryphae* (1866)] and various minor writings, in part of an apologetic character, such as *Wann wurden unsere Evangelien verfasst?* (1865; 4th ed., 1866), *Haben wir den echten Schrifttext der Evangelisten und Apostel?* (1873), and *Synopsis evangelica* (7th ed., 1898).

See, in addition to the handbooks on New Testament criticism, Carl Bertheau's article on Tischendorf in Herzog-Hauck, *Realencyklopädie* (3rd ed., 1907).

TISIO (or Tisi), **BENVENUTO** (1481–1559), commonly called Il Garofalo, Italian painter of the Ferrarese school, was born in

[1] See his *Reise in den Orient* (Leipzig, 1845–1846).

[2] The MSS. brought to Europe on the first two journeys are catalogued in the *Anecdota sacra et profana* (Leipzig, 1855, enlarged 1861). See also the *Monumenta sacra inedita* (Leipzig, 1846), and *Nova collectio* of the same (1855–1869). The 3rd volume of the *Nova collectio* gives the results of his last Eastern journey.

[3] The prolegomena remained unfinished at his death, and have been supplied by C. R. Gregory (cf. his *Textkritik des Neuen Testamentes*, vol. i., 1900).

1481 at Garofolo, in the Ferrarese territory, and constantly used the gillyflower (*garofalo*) as a symbol with which to sign his pictures. He took to drawing in childhood, and was put to study under Domenico Panetti (or Laneto), and afterwards at Cremona under his maternal uncle Niccolò Soriani, a painter who died in 1499; he also frequented the school of Boccaccio Boccaccino. He stayed fifteen months with Giovanni Baldini in Rome, acquiring a solid style of draughtsmanship, and was two years with Lorenzo Costa at Mantua. He then entered the service of the marquis Francesco Gonzaga. Afterwards he went to Ferrara, and worked there four years. Attracted by Raphael's fame, and invited by a Ferrarese gentleman, Geronimo Sagrato, he again removed to Rome, and found the great painter very amicable; here he stayed two years, rendering some assistance in the Vatican frescoes. From Rome family affairs recalled him to Ferrara; there Duke Alphonso I. commissioned him to execute paintings, along with the Dossi, in the Villa di Belriguardo and in other palaces. Thus the style of Tisio partakes of the Lombard, the Roman and the Venetian modes. He painted extensively in Ferrara, both in oil and in fresco, two of his principal works being the "Massacre of the Innocents" (1519), in the church of S. Francesco, and the "Betrayal of Christ" (1524), accounted his masterpiece. For the former he made clay models for study and a lay figure, and executed everything from nature. He continued constantly at work until in 1550 blindness overtook him, painting on all feast-days in monasteries for the love of God. He had married at the age of forty-eight, and died at Ferrara on the 6th (or 16th) of September 1559, leaving two children.

Garofalo combined sacred inventions with some very familiar details. A certain archaism of style, with a strong glow of colour, suffices to distinguish from the true method of Raphael even those pictures in which he most closely resembles the great master—this sometimes *very* closely; but the work of Garofalo is seldom free from a certain trim pettiness of feeling and manner. He was a friend of Giulio Romano, Giorgione, Titian and Ariosto; in a picture of "Paradise" he painted Ariosto between St Catherine and St Sebastian. In youth he was fond of lute-playing and also of fencing. He ranks among the best of the Ferrarese painters; his leading pupil was Girolamo Carpi. The "Adoration of the Magi," in the church of San Giorgio near Ferrara, and a "Peter Martyr," in the Dominican church, Ferrara (sometimes assumed to have been done in rivalry of Titian), are among his principal works not already mentioned. The National Gallery, London, contains four, one of them being a Madonna and Christ enthroned, with St Francis and three other saints.

TISSAPHERNES (Pers. *Cithrafarna*), Persian soldier and statesman, son of Hydarnes. In 413 he was satrap of Lydia and Caria, and commander in chief of the Persian army in Asia Minor (Thuc. viii. 5). When Darius II. ordered the collection of the outstanding tribute of the Greek cities, he entered into an alliance with Sparta against Athens, which in 412 led to the conquest of the greater part of Ionia. But Tissaphernes was unwilling to take action and tried to achieve his aim by astute and often perfidious negotiations; Alcibiades persuaded him that Persia's best policy was to keep the balance between Athens and Sparta, and rivalry with his neighbour Pharnabazus of Hellespontic Phrygia still further lessened his energy. When, therefore, in 408 the king decided to support Sparta strenuously, Tissaphernes was removed from the generalship and limited to the satrapy of Caria, whereas Lydia and the conduct of the war were entrusted to Cyrus the Younger. On the downfall of Athens, Cyrus and Tissaphernes both claimed jurisdiction over the Ionian cities, most of which acknowledged Cyrus as their ruler; but Tissaphernes took possession of Miletus, where he was attacked by Cyrus, who gathered an army under this pretence with the purpose of using it against his brother Artaxerxes II. The king was warned by Tissaphernes, who took part in the battle of Cunaxa, and afterwards tried to destroy the Greek mercenaries of Cyrus by treachery. He was then sent back to Asia Minor to his old position as general in chief and satrap of Lydia and Caria. He now attacked the Greek cities, to punish them for their allegiance to Cyrus. This led to the war with Sparta in 399. Tissaphernes, who once again had recourse to subtle diplomacy, was beaten by Agesilaus on the Pactolus near Sardis (395); and at last the king yielded to the representations of Pharnabazus, strongly supported by the chiliarch (vizier) Tithraustes and by the queen-mother Parysatis, who hated Tissaphernes as the principal cause of the death of her favourite son Cyrus. Tithraustes was sent to execute Tissaphernes, who was lured to Colossae and slain in 395.

(Ed. M.)

TISSERAND, FRANÇOIS FÉLIX (1845–1896), French astronomer, was born at Nuits-Saint-Georges, Côte-d'Or, on the 13th of January 1845. In 1863 he entered the École Normale Supérieure, and on leaving he went for a month as professor at the lycée at Metz. Le Verrier offered him a post in the Paris Observatory, which he accordingly entered as *astronome adjoint* in September 1866. In 1868 he took his doctor's degree with a brilliant thesis on Delaunay's Method, which he showed to be of much wider scope than had been contemplated by its inventor. Shortly afterwards he went out to Malacca to observe the famous solar eclipse of the 18th of August 1868. In 1873 he was appointed director of the observatory at Toulouse, whence he published his *Recueil d'exercices sur le calcul infinitésimal*, and in 1874 became corresponding member of the Académie des Sciences. He took part in the French expeditions of 1874 to Japan, and in 1882 to Martinique to observe the transits of Venus. In 1878 he was elected a member of the Académie des Sciences in succession to Le Verrier, and became a member of the Bureau des Longitudes. In the same year he was appointed *professeur suppléant* to Liouville, and in 1883 he succeeded Puiseux in the chair of celestial mechanics at the Sorbonne. Tisserand always found time to continue his important researches in mathematical astronomy, and the pages of the *Comptes rendus* bear witness to his surprising activity. His writings relate to almost every branch of celestial mechanics, and are always distinguished by rigour and simplicity in the solution of the most difficult problems. He treated in a masterly manner (*Bulletin astronomique*, 1889) the theory of the capture of comets by the larger planets, and in this connexion published his valuable *Criterion* for establishing the identity of a periodic comet, whatever may have been the perturbations brought about in its orbit, between successive appearances, by the action of a planet. His principal work, *Traité de mécanique céleste*, is the noblest and most lasting monument to his memory, and is worthy to stand beside the *Mécanique céleste* of his fellow-countryman, Laplace. In this treatise, published in four quarto volumes, the last of which appeared only a few months before his death, he fused into one harmonious whole the researches of Laplace and those of other workers in the same field since his time. It furnishes a faithful and complete *résumé* of the state of knowledge in that department of astronomy at the end, as Laplace's great work did for the beginning, of the 19th century. In 1892 he succeeded Mouchez as director of the Paris Observatory, and as president of the committee of the photographic chart of the heavens he contributed largely to the success of that great project. Under his direction the revision of Lalande's catalogue was brought almost to completion, and four volumes of the *Annales de l'Observatoire de Paris* exhibit the progress made in this important undertaking. He was also editor of the *Bulletin astronomique* from the beginning, and contributed many important articles to its pages. He died suddenly, in the fullness of his power, of congestion of the brain, on the 20th of October 1896.

(A. A. R.)

TISSOT, JAMES JOSEPH JACQUES (1836–1902), French painter, was born at Nantes on the 15th of October 1836. He studied at the École des Beaux Arts in Paris under Ingres, Flandrin and Lamothe, and exhibited in the Salon for the first time at the age of twenty-three. In 1861 he showed "The Meeting of Faust and Marguerite," which was purchased by the state for the Luxembourg Gallery. His first characteristic period made him a painter of the charms of women. *Demi-mondaine* would be more accurate as a description of the series of studies which he called *La Femme à Paris*. He fought in the Franco-German War, and, falling under suspicion as a Communist, left Paris for London. Here he studied etching with Sir Seymour Haden, drew caricatures for *Vanity Fair*, and painted portraits as well as genre subjects. It was many years before he turned to the chief labour of his career—the production of a series of 700 water-colour drawings to illustrate the life of Christ and the Old Testament. Some sudden shock or bereavement was said to have turned his thoughts from ideals of the café and the boulevard into a more serious channel. He disappeared from Paris, whither he had returned after a stay of some years in England, and went to Palestine. In 1895 the series of 350 drawings of incidents in the life of Christ was exhibited in Paris, and the following year found them on show in London. They were then published by the firm of Lemercier in Paris, who had paid him 1,100,000 francs for them. After this he turned to the scenes of the Old Testament, upon which he was still engaged at the abbey of Buillon, in the department of Doubs, France, when he died on the 8th of August 1902. The merits of Tissot's Bible illustrations lay rather in the care with which he studied the details of scenery than in any quality of religious emotion. He seemed to aim, above all, at accuracy, and, in his figures, at a vivid realism, which was far removed from the conventional treatment of sacred types.

TISSOT, PIERRE FRANÇOIS (1768–1854), French man of letters, was born at Versailles on the 10th of March 1768. His father, a native of Savoy, was a perfumer appointed by royal warrant to the court. At the age of eighteen he entered the office of a *procureur* of the Châtelet, in order to learn the practice of the law; but he cultivated the Muses rather than the study of procedure, and, being a handsome youth, was occasionally invited to the fêtes of the Trianon. He devoted himself ardently to the cause of the Revolution, in spite of the fact that it had ruined his family. While with the *procureur* he had made the acquaintance of Alexandre Goujon, and they soon became inseparable; he married Goujon's sister, Sophie (March 5, 1793), and when his brother-in-law was elected deputy to the Convention and sent on a mission to the armies of the Moselle and Rhine, Tissot went with him as his secretary; he then returned to Paris and resumed his more modest position of *secrétaire général des subsistances*. On the 1st of Prairial he tried in vain to save his brother-in-law, who had been involved in the proscription of the "last Montagnards"; all he could do was to give Goujon the knife with which he killed himself in order to escape the guillotine, and he afterwards avenged his memory in the *Souvenirs de Prairial*. He also took under his care Goujon's widow and children. His connexion with the Jacobin party caused him to be condemned to deportation after the attempt of the 3rd Nivose in the year IX., but Bonaparte, having been persuaded to read his translation of the *Bucolics*, struck his name off the list. Though still a friend of the Republic, Tissot was henceforth an admirer of the First Consul; he celebrated in verse several of the emperor's victories, and the arrival in France of Marie-Louise (1810). So far he had lived on the income derived from a factory of horn lanterns in the Faubourg St Antoine; and, being at last in fairly comfortable circumstances he now devoted himself to literature. The abbé Delille took him as his assistant at the Collège de France; and Tissot succeeded him as head of it (1813); the emperor signed the appointment as a reward for a poem composed by Tissot on his victory at Lützen. He was removed from this post, however, in 1821, in consequence of the publication of a *Précis sur les guerres de la révolution*, in which rather colourless work he had dared to say that the Convention had saved France and vanquished the Coalition. Deprived of his post, Tissot was left still more free to attack the government in the press. He was one of the founders of the newspaper *Le Constitutionnel*, and of the review, the *Minerve*. Without laying stress on his literary works (*Traité de la poésie latine*, 1821; translation of the *Bucolics*, 3rd ed., 1823; *Études sur Virgile*, 1825) we should mention the *Mémoires historiques et militaires sur Carnot*, which he based on the papers left by the "Organizer of Victory" (1824), the *Discours du Général Foy* (1826) and a *Histoire de la guerre de la Péninsule* also inspired by Général Foy (1827). On the overthrow of Charles X., Tissot made a successful effort to regain his position at the Collège de France; he was also elected as a member of the French Academy on the death of Dacier (1833). It was then that he published his chief works: *Histoire de Napoléon* (2 vols., 1833), and *Histoire complète de la révolution française de 1789 à 1806* (6 vols., 1833–1836), full of inconsistencies and omissions, but containing a number of the author's reminiscences; in some places they become practically memoirs, and are consequently of real value. In 1840 a carriage accident almost cost him his sight; he had to find an assistant, and passed the last years of his life in circumstances of increasing suffering, amid which, however, he preserved his cheerfulness and goodness of heart. He died at Paris on the 7th of April 1854.

See an excellent essay on Tissot by P. Fromageot in the *Revue de Versailles et de Seine-et-Oise*, in 1901.

TISSUE (Fr. *tissu*, *tissue*, participle of *tisser*, Lat. *texere*, to weave), properly the name of a fine textile fabric interwoven with gold and silver threads, hence used of any delicate or gauzy fabric (see GOLD AND SILVER THREAD). It was also early applied, as in French, to a ribbon, fillet or various forms of woven ligaments. In biology the word is of general use for an aggregate of cells forming a texture or fabric; in animal anatomy it is thus applied to the primary layers of which the parts are composed, and named by some qualifying word denoting its substance or its use (see CONNECTIVE TISSUE and EPITHELIAL, ENDOTHELIAL AND GLANDULAR TISSUE).

TISTA, a river of northern India, which rises on the edge of the Tibetan plateau, and flows through the mountain gorges of Sikkim and Darjeeling, till it spills itself over the plain of Eastern Bengal. In the 18th century its course was due south to join the Ganges; but in 1787 great floods diverted the stream towards the south-east, and it now enters the Brahmaputra, the whole district of Rangpur being scored by various interlacing channels. Its total length in British territory is about 170 m.

TISZA, KÁLMÁN [KOLOMAN] (1830–1902), Hungarian statesman, was born at Geszt on the 10th of December 1830, the son of Lajos Tisza and the countess Julia Teleki, and was educated at his father's castle. In 1848 he obtained a post in the ministry of instruction of the revolutionary government which he accompanied to Debreczen. After the war he went abroad with most of his family, and carefully studied foreign institutions. On returning home he devoted himself to the improvement of the family estates, and in 1855 was elected assistant curator of the Calvinist church at Nagyszalonta, in succession to his father. When, on the 1st of September 1859, the Austrian government issued the "Patent" which struck at the very roots of Protestant autonomy in Hungary, Tisza, at the congress of the Calvinist Church beyond the Theiss, held at Debreczen, publicly repudiated the Patent on behalf of the Calvinist laity. He renewed his opposition in the most uncompromising terms at the ensuing congress (Jan. 11, 1860), shrewdly guessing that the Patent was directed as much against the Hungarian constitution as against the Calvinist confession. His fears were justified by the October Diploma (see HUNGARY: *History*), which he attacked with equal vehemence. In August 1860 Tisza married the countess Helen Degenfeld-Schomburg, a union which brought him into close connexion with the Karolyis, the Podmaniczkys and the Odescalchis. He was unanimously elected to represent Debreczen at the 1861 Diet, and was elected vice-president of the house at its second session. The Diet was divided between the Addressers, led by Deák, and the "Resolutionists," led by Count László Teleki, and on the death of the latter Tisza succeeded him as the leader of the more radical party. During the Provisorium (1861–1865) Tisza fought for constitutional reform in the columns of the *Hon* and the *Magyar Sajtó*, his leading articles, afterwards collected and published under the title of *Alföldi Levelek* (Letters from the Alföld), being by far the most important contribution to the controversy. When the Diet was again summoned by royal decree (Dec. 10, 1865), Tisza once more represented Debreczen and formed, with Kálmán Ghyczy (1808–1888), the Left-centre party. From 1867 onwards his influence continued to increase, despite the rupture of his party, which he reconstructed at the conference of Nagyvárad (March 17, 1868), when the famous *Bihari pontok*, or articles of Bihar, were subscribed. The *Bihari pontok* started from the assumption that Hungary was a free and independent state. They bound the Tisza party to repeal all laws or institutions contrary to, and to promote all measures necessary for, the national independence. Thus the delegation system and the common ministries were marked out for attack, while every effort was to be made to procure for Hungary a separate army, a separate diplomacy and a separate financial system. It was chiefly owing to the efforts of Tisza and his party that Austria remained neutral during the Franco-German War. His speech on the 3rd of March 1875 led to the resignation of Istoan Bittó's administration and the welding of Deák's followers and the Left-centre into a new party, the *Szabadelvü párt* or Free Principles Party, which took office under Bela Wenckheim (1811–1879), whom (Oct. 2) Tisza succeeded as prime minister, a post he held, with a few interruptions, for the next fifteen years (1875–1890). In 1877 he resigned on the discussion of the question of the Composition (Ausgleich), but he returned to office on his own terms. The same thing happened the following year, when his brief resignation compelled the Magyar Diet to agree to the occupation of Bosnia. In 1879 he materially contributed to the formation of the Austro-German alliance. Not till 1888, when the national army bill was introduced, did he encounter any serious opposition, but thenceforth his position became precarious. On the 13th of March 1890, on the occasion of the revision of the Indigenat Act, he resigned office, but continued, as deputy for Nagyvárad to place his vast political experience at the disposal of the house. It is no exaggeration to say that Hungary owes to Klámán Tisza a consolidated government, the formation of a parliamentary majority, a healthy public spirit, public credit, the reform of the Upper House, an admirable educational system, economical, and particularly railway, development, and administrative and judicial reconstruction on modern lines. His opponents have accused him of unscrupulousness and party spirit, but not one of them can deny that he reshaped Hungary and made her the leading partner of the dual monarchy. As to his personal integrity and disinterestedness there has never been the slightest doubt. It is an open secret that, on the retirement of Andrassy, he was offered the chancellorship. He refused it because, to use his own expression, "I am as wholly and solely Hungarian as the river (Theiss, Hung. *Tisza*) whose name I bear."

See Imre Visi, *Kálmán Tisza, a political appreciation* (Hung.; Budapest, 1885); Kornel Abrányi, *Kálmán Tisza Life and Political Career* (Hung.; Budapest, 1878); G. Gratz, *Kálmán Tisza* (*Modern Magyar Statesmen*, I.) (Hung.; Budapest, 1902); P. Busbach, *The Last Five Years* (Hung.; Budapest, 1895).

His youngest son, Count STEPHEN TISZA (1861–   ), was born on the 22nd of April 1861. After being educated at Berlin, Heidelberg and Budapest, he entered the ministry of the interior for the purpose of studying technical and economical questions at the fountain-head, and soon became a specialist in agrarian matters. His *Magyar agrárpolitik* (Budapest, 1897), authoritative on its subject, was translated into German the same year (Leipzig). In 1886 Tisza began his parliamentary career, speedily becoming a leading member of the principal committees on economical and educational questions. On the resignation of Kálmán Szell (June 17, 1903) he was entrusted with the formation of a ministry of pacification, but abandoned the attempt on finding it impossible to secure a majority. On the 27th of October, however, with the assistance of the Free Principles Party, he succeeded in composing a cabinet, in which he was minister of the interior as well as premier. From the first the ministry was exposed to the most unscrupulous opposition, exacerbated by the new and stringent rules of procedure which Tisza felt it his duty to introduce if any business were to be done. The motion for their introduction was made by the deputy Gábor Daniel, supported by the premier, and after scenes of unheard-of obstruction and violence (Nov. 16–18) the speaker, in the midst of an ear-splitting tumult, declared that the new regulations had been adopted by the house, and produced a royal message suspending the session. But the Andrassy group, immediately afterwards, separated from the Free Principles Party, and during the rest of the year the Opposition made legislation impossible. By January 1905 the situation had become *ex lex* or anarchical. Tisza stoutly stood by his rules, on the ground that this was a case in which the form must be sacrificed to the substance of parliamentary government. But his appeal to the country at the beginning of 1905 was unsuccessful, and his opponents triumphed by a large majority. Tisza thereupon resigned and retired from public life. (R. N. B.)

TITANIUM [symbol Ti, atomic weight 48·1 (O = 16)], a metallic chemical element. Its discovery as an element was due to William Gregor in 1789 who found in the mineral ilmenite or menachinite a new earth, which was regarded as the oxide of a new metal, menachin. Independently of him Klaproth in 1793 discovered a new metal in rutile, and called it titanium; he subsequently found that it was identical with Gregor's element. Klaproth, however, was unable to prepare the pure oxide, which was first accomplished in 1821 by Rose. The isolation of the pure metal is of much later date. Titanium, although pretty widely diffused throughout the mineral kingdom, is not found in abundance. The commonest titanium mineral is rutile or titanium dioxide, TiO_2; anatase and brookite are crystalline allotropes. Titanium is most frequently found associated with iron; ilmenite (Ger. *Titan-eisen*) is $FeTiO_3$, perofskite $(Ca,Fe)TiO_3$, and the metal occurs in most magnetic iron ores. The titanates are well marked in the mineral kingdom. Ilmenite is isomorphous with geikielite, $MgTiO_3$, and pyrophanite, $MnTiO_3$; many of the "rare minerals"—aeschynite, euxenite, polycrase, &c.—contain titanates (and also niobates). Silicates also occur; sphene or titanite, $CaTiSiO_5$, is the commonest; keilhauite is rarer.

The isolation of metallic titanium is very difficult since it readily combines with nitrogen (thus resembling boron and magnesium) and carbon. In 1822 Wollaston examined a specimen of those beautiful copper-like crystals which are occasionally met with in iron-furnace slags, and declared them to be metallic titanium. This view had currency until 1849, when Wöhler showed that the crystals are a compound, $Ti(CN)_2 \cdot 3Ti_3N_2$, of a cyanide and a nitride of the metal. An impure titanium was made by Wöhler and Sainte-Claire Deville in 1857 by heating to redness fluotitanate of potassium (see below) in the vapour of sodium in an atmosphere of dry hydrogen, and extracting the alkaline fluoride formed by water. The metal thus produced formed a dark brown amorphous powder resembling iron as obtained by the reduction of its oxide in hydrogen. In 1887 Nilson and Petersson (*Zeit. phys. Chem.* 1, p. 25) obtained a purer product by heating the chloride with sodium in a steel cylinder; it then formed yellow scales with a bluish surface colour. H. Moissan (*Compt. rend.*, 1895, 120, p. 290) obtained a still purer metal by igniting the oxide with carbon in the electric furnace. The product has a brilliant white fracture, a specific gravity of 4·87, very friable, but harder than quartz or steel. Moissan (ibid., 1906, 142, p. 673) has distilled this metal in a very intense electric furnace. When heated in air it burns brilliantly with the formation of the oxide. It combines directly with the halogens, and dissolves in cold dilute sulphuric acid, in hot strong hydrochloric acid and in aqua regia, but less readily in nitric acid. Its most curious property is the readiness with which it unites with nitrogen. Several nitrides have been described. Ti_3N_4 is a copper-coloured powder obtained by heating the ammonio-chloride $TiCl_4 \cdot 4NH_3$ in ammonia. TiN_2 is a dark blue powder obtained when the oxide is ignited in an atmosphere of ammonia; while TiN is obtained as a bronze yellow mass as hard as the diamond by heating the oxide in an atmosphere of nitrogen in the electric furnace.

In its chemical relations, titanium is generally tetravalent, and occurs in the same sub-group of the periodic classification as zirconium, cerium and thorium. It forms several oxides, TiO_2, Ti_2O_3 and TiO_3 being the best known; others (some of doubtful existence) have been described from time to time.

Titanium dioxide, TiO_2, occurs in nature as the three distinct mineral species rutile, brookite and anatase. Rutile assumes tetragonal forms isomorphous with cassiterite, SnO_2 (and also zircon, $ZrSiO_4$); anatase is also tetragonal, and brookite or thorhombic. Rutile is the most stable and anatase the least, a character reflected in the decrease in density from rutile (4·2) and brookite (4·0) to anatase (3·9). The minerals are generally found together—a feature rarely met with in the case of polymorphs. They have been obtained artificially by Hautefeuille by the interaction of titanium fluoride and steam. At a red heat rutile is produced, at the boiling point of zinc brookite, and of cadmium anatase. It is apparent that these minerals all result in nature from pneumatolytic action. Amorphous titanium oxide may be obtained in a pure form by fusing the mineral, very finely powdered, with six times its weight of potassium bisulphate in a platinum crucible, then extracting the melt with cold water and boiling the filtered solution for a long time. Titanic oxide separates out as a white hydrate, which, however, is generally contaminated with ferric hydrate and often with tin oxide. A better method is Wöhler's, in which the finely powdered mineral is fused with twice its weight of potassium carbonate in a platinum crucible, the melt powdered and treated in a platinum basin with aqueous hydrofluoric acid. The alkaline titanate first produced is converted into crystalline fluotitanate, K_2TiF_6, which is with difficulty soluble and is extracted with hot water and filtered off. The filtrate, which may be collected in glass vessels if an excess of hydrofluoric acid has been avoided, deposits the greater part of the salt on cooling. The crystals are collected, washed, pressed and recrystallized, whereby the impurities are easily removed. The pure salt is dissolved in hot water and decomposed with ammonia to produce a slightly ammoniacal hydrated oxide; this, when ignited in platinum, leaves pure TiO_2 in the form of brownish lumps, the specific gravity of which varies from 3·9 to 4·25, according to the temperature at which it was kept in igniting. The more intense the heat the denser the product. The oxide is fusible only in the oxy-hydrogen flame. It is insoluble in all acids, except in hot concentrated sulphuric, when finely powdered. If the sulphuric acid solution be evaporated to dryness the residue, after cooling, dissolves in cold water. The solution, if boiled, deposits its titanic oxide as a hydrate called meta-titanic acid, $TiO(OH)_2$, because it differs in its properties from ortho-titanic acid, $Ti(OH)_4$, obtained by decomposing a solution of the chloride in cold water with alkalis. The ortho-body dissolves in cold dilute acids; the meta-body does not. If titanic oxide be fused with excess of alkaline carbonate a titanate, R_2TiO_3, is formed. This salt is decomposed by water with the formation of a solution of alkali free of titanium, and a residue of an acid titanate, which is insoluble in water but soluble in cold aqueous mineral acids. The titanates are very similar to the silicates in their tendency to assume complex forms, *e.g.* the potassium salts are $K_2TiO_3 \cdot 4H_2O$, $K_2Ti_2O_7 \cdot 3H_2O$ and $K_2Ti_6O_{13} \cdot 2H_2O$.

Titanium monoxide, TiO, is obtained as black prismatic crystals by heating the dioxide in the electric furnace, or with magnesium powder. *Titanium sesquioxide*, Ti_2O_2, is formed by heating the dioxide in hydrogen. A hydrated form is prepared when a solution of titanic acid in hydrochloric acid is digested with copper, or when the trichloride is precipitated with alkalis. *Titanium trioxide*, TiO_3, is obtained as a yellow precipitate by dropping the chloride into alcohol, adding hydrogen peroxide, and finally ammonium carbonate or potash. When shaken with potash and air it undergoes autoxidation, hydrogen peroxide being formed first, which converts the trioxide into the dioxide and possibly pertitanic acid; this acid may contain sexavalent titanium (see W. Manchot and Richter, *Ber.*, 1906, 39, pp. 320, 488, and also Faber, *Abst. Journ. Chem. Soc.* 1907, ii. 557.)

Titanium fluoride, TiF_4, is a fuming colourless liquid boiling at 284°, obtained by distilling a mixture of titanium oxide, fluorspar and sulphuric acid; by heating barium titanofluoride, $BaTiF_6$ (Emrich, *Monats.*, 1904, 25, p. 907); and by the action of dry hydrofluoric acid on the chloride (Ruff and Plato, *Ber.*, 1904, 37, p. 673). By dissolving the dioxide in hydrofluoric acid a syrupy solution is obtained which probably contains titanofluoric acid, H_2TiF_6. The salts of this acid are well known; they are isomorphous with the silico-, stanno- and zircono-fluorides. They are obtained by neutralizing the solution of the acid, or by fusing the oxide with potassium carbonate and treating the melt with hydrofluoric acid. Potassium titanofluoride, $K_2TiF_6 \cdot H_2O$, forms white, shining, monoclinic scales. When ignited in a current of hydrogen it yields *titanium trifluoride*, TiF_3, as a violet powder.

Titanium chloride, $TiCl_4$, is obtained as a colourless fuming liquid of 1·7604 sp. gr. at 0° C., boiling at 136·4° under 753·3 mm. pressure (T. E. Thorpe), by heating to dull redness an intimate dry mixture of the oxide and ignited lamp-black in dry chlorine. In the method of A. Stähler and H. Wirthwein, the titanium mineral is fused with carbon in the electric furnace, the carbides treated with chlorine, and the titanium chloride condensed. The distillate is freed from vanadium by digestion with sodium amalgam. Other methods are due to E. Vigouroux and G. Arrivaut (*Abst. Journ. Chem. Soc.*, 1907, ii. 97, 270) and Ellis (ibid., p. 270). By passing chloroform vapour over the heated dioxide the tetra- di- and tri-chlorides are formed, together with the free metal and a gaseous hydride, TiH_4 (Renz, *Ber.*, 1906, 39, p. 249). When dropped very cautiously into cold water it dissolves into a clear solution. According to the amount of water used, $TiCl_3OH$, $TiCl_2(OH)_2$, $TiCl(OH)_3$ or titanic acid is formed. The solution when boiled deposits most of its oxide in the meta-hydrate form. It forms addition compounds similar to those formed by stannic chloride, and combines with ammonia to form $TiCl_4 \cdot 8NH_3$ and $TiCl_4 \cdot 6NH_3$, both of which with liquid ammonia give titanamide, $Ti(NH_2)_4$. *Titanium dichloride*, $TiCl_2$, obtained by passing hydrogen over the trichloride at a dull red heat, is a very hygroscopic brown powder which inflames when exposed to air, and energetically decomposes water. *Titanium trichloride*, $TiCl_3$, forms involatile, dark violet scales, and is obtained by passing the vapour of the tetrachloride mixed with hydrogen through a red-hot tube, or by heating the tetrachloride with molecular silver to 200°. It is a powerful reducing agent.

Titanium tetrabromide, $TiBr_4$, is an amber-coloured crystalline mass. The *tetraiodide*, TiI_4, is a reddish brown mass having a metallic lustre. The *di-iodide*, TiI_2, is obtained as black lamella by passing the vapour of the tetraiodide over heated mercury in an atmosphere of hydrogen (E. Defacqz and H. Copaux, *Compt. rend.*, 1908, 147, p. 65). Sulphides are known corresponding to the best-known oxides.

Titanium sesquisulphate, $Ti_2(SO_4)_3 \cdot 8H_2O$, obtained by concentrating the violet solution formed when the metal is dissolved in sulphuric acid, is interesting since it forms a caesium alum, $CsTi(SO_4)_2 \cdot 12H_2O$. It gives the normal sulphate as a yellow, deliquescent, amorphous mass when treated with nitric acid.

Acid solutions of titanates are not precipitated by sulphuretted hydrogen; but ammonium sulphide acts on them as if it were ammonia, the sulphuretted hydrogen being liberated. Titanium oxide when fused with microcosmic salt in the oxidizing flame yields a bead which is yellowish in the heat but colourless after cooling. In the reducing flame the bead becomes violet, more readily on the addition of tin; in the presence of iron it becomes blood-red. Titanic oxides when fused on charcoal, even with potassium cyanide, yield no metal. Rose determined the atomic weight to be 47·72 (H = 1). A redetermination in 1885 by T. E. Thorpe gave the value 47·7 (see *Journ. Chem. Soc.*, 1885, p. 108).

TITANOTHERIIDAE (also known as Menodontidae and Brontotheriidae), a family of large rhinoceros-like perissodactyl ungulate mammals from the Oligocene and Eocene strata of North America. The cheek-teeth are low-crowned, with the external cones of the upper molars fused into a W-like outer wall, and the inner ones retaining a regular conical form; while in the lower teeth the crown is formed of crescentic ridges, of which there are three in the last and two each in the other teeth. There is generally little gap between the canines and the premolars.

Titanotherium, of the Oligocene of the Dakotas and neighbouring districts, was a huge beast, with the hinder upper premolars similar in character to the molars, a pair of horn-cores, arising from the maxilla, overhanging the nose-cavity, four front and three hind toes, only twenty dorso-lumbar vertebrae, and an almost continuous and unbroken series of teeth, in which the canines are short; the dental formula being *i.* $\frac{2}{1}$, *c.* $\frac{1}{1}$, *p.* $\frac{4}{4}$, *m.* $\frac{3}{3}$. The muzzle probably formed a snout in life; and there is presumptive evidence that these animals were very long-lived. *Brontops* seem scarcely separated from the type genus; but the name *Brontotherium* is applied to species with two pairs of incisor teeth in both jaws. The length of the largest species was about 14 ft.; and the height about 8 ft. The alleged occurrence of remains of members of the group in the Balkans apparently rests on insufficient evidence.

A second group is typified by *Palaeosyops*, of the Bridger Eocene of North America; *P. paludosus* being an animal about the size of a tapir. The skull, which has a longer face than in *Titanotherium*, lacks horn-cores, while all the upper premolars are simpler than the molars, and the full series of 44 teeth was present. The limbs were relatively slender, and the brain was small. In the lower, or Wasatch, Eocene the group was represented by the still more primitive *Lambdotherium*. On the other hand, *Palaeosyops* is connected with *Titanotherium* by means of *Telmatotherium* of the upper

Bridger and Washakia Eocene, a larger animal, with a longer and flatter skull, showing rudiments of horn-cores, only two pairs of lower incisors, and a general approximation in dental character to *Titanotherium*. Another of these titanotheroid forms is *Diplacodon*, from the Upper or Uinta Eocene; an animal the size of a rhinoceros, with the last two upper premolars molar-like. It was probably off the direct ancestral line of *Titanotherium*. These intermediate forms render the reference of the group to a distinct family—Palaeosyopidae—unnecessary.

Professor H. F. Osborn, who recognises four genera, *Titanotherium*, *Megacerops*, *Symborodon* and *Brontotherium*, in the typical section of the family, considers that each of these represents a distinct line of descent from the *Palaeosyops*-like group. The whole assemblage forms one of the four main sections of the Perissodactyla, namely the Titanotheroidea.

See H. F. Osborn, "The Cranial Evolution of Titanotherium," *Bull. Amer. Mus.* (1896), viii., 137, and the "Four Phyla of Oligocene Titanotheres," *op. cit.* (1903), xvi. 91; C. H. Earle, "A Memoir on the Genus *Palaeosyops* and its Allies," *Journ. Acad. Philadelphia* (1892), ix. 267. (R. L.*)

TITANS (Gr. Τιτᾶνες), in Greek mythology, the children of Uranus and Gaea. According to Hesiod (*Theog.* 133), the male Titans were Oceanus, Coeus, Crius, Hyperion, Iapetus and Cronus; the female, Thea, Rhea, Themis, Mnemosyne, Phoebe and Tethys, to whom Apollodorus adds Dione. At the instigation of Gaea they rebelled against their father, who had shut them up in the bowels of the earth, and set up as ruler their youngest brother, Cronus, who in turn was dethroned by his son Zeus. A struggle then ensued between Zeus and Cronus, in which the Titans took different sides. The opponents of Zeus were finally defeated, and imprisoned in Tartarus (*Theog.* 153–210, 617 sqq.). The rebellious Titans are the representatives of the wild, disorderly forces of nature, who are defeated by the Olympian deities, who stand for law and order. The name Titans is usually explained as "avengers," referring to the vengeance taken by Cronus on his father Uranus, but A. Dieterich (*Rheinisches Museum*, 1893, xlviii., and J. E. Harrison (*Prolegomena to Greek Religion*) connect it with τίτανος (gypsum).

According to Harpocration (*s.v.* Ἀπομάττων), the Titans, when they mutilated Dionysus Zagreus (see DIONYSUS), besmeared themselves with gypsum to conceal their identity, as Artemis daubed her face with mud to escape the river-god Alpheus. The custom was practised at Bacchic and purificatory rites (Demosthenes, *De corona*, p. 313) as among savage tribes at the present day. The Titan story is probably an attempt to explain the fact that the Orphic worshippers, when about to tear the sacred animal, daubed themselves with gypsum. L. Weniger, in an article "Feralis exercitus" in *Archiv für Religionsgeschichte* (May 1906, February and March 1907), while regarding the "white colouring" as an original feature, does not accept the derivation of Τιτᾶνες from τίτανος. According to him, Zagreus is the divine hunter, in turn pursued and slain by others mightier than himself, the "snow-clad" (white) giants dwelling on Parnassus. These Titans, whose original is to be found in Pentheus and Lycurgus (for whom see DIONYSUS), had nothing to do with the Titans of Hesiod's *Theogony*. The whole has reference to the winter festival of Dionysus, when the god arrived with his Thyiades (the wind spirits) on the heights of Parnassus, there to be murdered by the Titans, to be buried and come to life again.

The standard work on the subject is M. Mayer, *Die Giganten und Titanen in der antiken Sage und Kunst* (1887).

TITE, SIR WILLIAM (1798–1873), British architect, the son of a Russian merchant, was born in London in February 1798. From 1817 to 1820 he assisted in the rebuilding of the body of the church of St Dunstan-in-the-East, and in compiling its history. Between 1827 and 1828 he built the Scottish church, Regent Square, for Edward Irving, and ten years later collaborated with Charles Robert Cockerell in designing the London & Westminster Bank, Lothbury. The rebuilding of the Royal Exchange, opened in 1844, was, however, Tite's greatest undertaking. He also designed many of the early railway stations in England, including the termini of the London & South-Western railway at Vauxhall (Nine Elms) and Southampton; the terminus at Blackwall, 1840; the citadel station at Carlisle, 1847–1848; the majority of the stations on the Caledonian and Scottish Central railways, including Edinburgh, 1847–1848; Chiswick, 1849; Windsor, 1850; and the stations on the Exeter & Yeovil railway. The stations on the line from Havre to Paris are also his work. Between 1853 and 1854 he planned the Woking Cemetery, and between 1858 and 1859 he built a memorial church in the Byzantine style at Gerrard's Cross, Buckinghamshire. Tite's active work ceased about twenty years before his death. In 1851 he visited Italy after a grave illness. In 1854 he contested Barnstaple unsuccessfully as a Liberal, but in the following year was returned to parliament for Bath, which he represented until his death. He keenly opposed Sir George Gilbert Scott's proposal to build the new foreign office and other government buildings adjacent to the treasury in the Gothic style. In 1869 he was knighted, and in 1870 was made a Companion of the Bath. He died on the 20th of April 1873. Tite had a wide knowledge of English literature and was a good linguist; he was an active citizen and a lover of old books.

TITHES, a form of taxation, secular and ecclesiastical, usually, as the name implies, consisting of one-tenth of a man's property or produce. The tax probably originated in a tribute levied by a conqueror or ruler upon his subjects, and perhaps the custom of dedicating a tenth of the spoils of war to the gods led to the religious extension of the term, the original offerings to deity being "firstfruits."

The custom was almost universal in antiquity; for Greece and Rome see Pauly-Wissowa, *Realencyclopädie*, iv. 2306, 2423; for Babylon, M. Jastrow, *Religion of Babylonia and Assyria*, p. 668; for China, J. Legge, *Chinese Classics*, i. 119; for Egypt, G. Maspero, *Struggle of Nations*, p. 312.[1] The general notion of tax or tribute often prevailed over that of "the tenth" part, so that in Dion Halicarnassus (i. 23) and Philo (*De mutat. nom.* i. 607) ἀπαρχαί and δεκάται are synonymous, and in Mahommedan law the "tithe" is sometimes only $\frac{1}{20}$th or $\frac{1}{40}$th.

Among the early Hebrews the king could exact a tithe from cornfields, vineyards and flocks (1 Sam. viii. 15, 17). On the religious side the oldest laws (*e.g.* Exod. xxxiv. 26) speak of bringing the firstfruits of the land to the house of Yahweh. In the 8th century the term "tithe" was used in Israel of religious dues (Amos iv. 4; Gen. xxviii. 22), and in the 7th century Deuteronomic legislation the word is often found. In Deuteronomy the new point emphasized is not that tithes must be paid, but that they must be consumed at the central, instead of a local, sanctuary (Deut. xii. 6, 11, xiv. 23 sqq.), apparently at the great autumn feast or feast of Tabernacles (*q.v.*).[2] Such a tithe is still nothing more than the old offering of "firstfruits" (*bikkūrīm*) made definite as regards quantity, and it was only natural that as time went on there should be some fixed standard of the due amount of the annual sacred tribute.[3] The establishment of such a standard does not necessarily imply that full payment was exacted; in Gen. xxviii. 22 Jacob vows of his own free will to pay tithes, just as the Arabs used to vow the tithe of the increase of the flock (*schol.* on Ḥārith, *Moall.* l. 69, ed. Arnold). The Arab did not always fulfil his vow, and there was no force to make him do so. A distinction is drawn in Deuteronomy between the ordinary annual tithe, which may not have been a full tenth, and the "whole" or "full tithe," paid once in three

[1] For other instances see Spencer, *De legibus hebraeorum*, lib. iii. cap. 10, § 1. Among the Semites in particular note the tithe paid by the Carthaginians to the Tyrian Melkarth (Diod. xx. 14), and the tithe of frankincense paid in Arabia to the god Sabis (Pliny, *H.N.* xii. 32; and cf. W. R. Smith, *Prophets of Israel*, p. 382 seq.). A tithe of cattle appears in Lydia (Nic. Damasc. *fr.* 24).

[2] Cf. Deut. xxvi. with 1 Sam. i. 21 (Sept.) and Jerome on Ezek. i. 3; and see Wellhausen, *Prolegomena*, p. 94 (Eng. trans., p. 92 seq.).

[3] In Deuteronomy, accordingly, the firstfruits (*bīkkūrīm*) are not mentioned; the tithe takes their place. The word translated "firstfruits" in Deut. (*rēshīth*) is a small gift to the priests, a mere basketful (xviii. 4, xxvi. 2 seq.).

years (Deut. xiv. 28, xxvi. 12), which the legislator directs to be stored at home, and spent in feeding the poor. Amos iv. 4, "Bring your sacrifices every morning and your tithes every three days" (not "years" as E.V.), hardly implies more than that occasions of sacrifice were three times as frequent as tithe-day, and so alludes to the fact that there were by old usage three annual feasts and one annual tithe. A triennial sacrificial tithe is inconceivable when it is remembered that the tithe is only an extension of the firstfruits. The triennial tithe in Deuteronomy seems to be rather an innovation necessary in the interests of the poor, when sacrificial feasts were transferred to the central sanctuary, and ceased to benefit the neighbours of the offerer, who, as stated above, had a prescriptive claim to be considered on such occasions (cf. 1 Sam. xxv. 8 sqq.; Neh. viii. 10; Luke xiv. 13).

The priests of the sanctuaries had of old a share in the sacrificial feasts,[1] and among those who are to share in the triennial tithe Deuteronomy includes the Levites, *i.e.* the priests of the local sanctuaries who had lost their old perquisites by the centralization of worship. In Ezekiel as in the Law of Holiness there is no mention of tithes; he proposes to support all public worship from the proceeds of a general tax (xlv. 13) levied by the prince, the old firstfruits being allotted to the priests. In the Persian period the tithe was converted to the use of the Temple (Mal. iii. 8–10). As Malachi speaks in Deuteronomic phrase of the "whole tithe," the payment to the Levites (now subordinate ministers of the Temple) was perhaps still only triennial; and if even this was difficult to collect, we may be sure that the minor sacrificial tithe had very nearly disappeared. The indifference complained of in Mal. i. was in great part due to the fundamental changes in the religion of Israel, which made private altar gifts and feasts almost meaningless. On the other hand, the provision of regular support for the priests and Levites, the ministers of the public ritual, was now all important, and received special attention from Ezra and Nehemiah (Neh. x. 37 sqq., xiii. 10 sqq.). They effected it by enforcing the new law of the priestly code (Num. xviii. 21 sqq.), in which it is formally laid down that the tithe is a tribute paid to the Levites, who in turn pay a tithe of it to the priests. It is doubtful whether the system ever worked. The plain intention of the priestly code is to allow the old tithe of Deuteronomy to drop; but the harmonistic interpretation of the later scribes was to the effect that two tithes were to be paid every year, and a third tithe, for the poor, on every third year (Tob. i. 7 seq.; Jos. *Ant.* iv. 8, § 22). The last change in the system was the appropriation of the Levitical tithe by the priests, which apparently was effected by John Hyrcanus, though a tradition, glaringly inconsistent with Nehemiah, ascribes it to Ezra, alleging that he deprived the Levites because so few of them were willing to return to Palestine (Mishnah, "Ma'aser Sh." v. 15; "Sota," ix. 10, and Wagenseil's note).[2]

On the whole subject of Hebrew tithes see further G. F. Moore in *Ency. Bib.* col. 5102; A. S. Peake in Hastings's *Dict. of the Bible*, iv. 780; and the works on Hebrew antiquities by H. Nowack and I. Benzinger. (A. J. G.)

Tithes in Law.

Tithes were generally regarded up to the 17th century as existing *jure divino*, and as having been payable to the support of the Church ever since the earliest days of Christianity. History, as Selden showed in his learned and exhaustive treatise (*History of Tithes* 1618), does not bear out this view.[3] In the words of Hallam, "the slow and gradual manner in which parochial churches became independent appears to be of itself a sufficient answer to those who ascribe a great antiquity to the universal payment of tithes."[4]

Long before the 8th century payment of tithes was enjoined by ecclesiastical writers and by councils of the Church; but the earliest authentic example of anything like a law of the state enforcing payment appears to occur in the Capitularies of Charlemagne at the end of the 8th or the beginning of the 9th century. Tithes were by that enactment to be applied to the maintenance of the bishop and clergy, the poor,[5] and the fabric of the Church. In course of time the principle of payment of tithes was extended far beyond its original intention. Thus they became transferable to laymen and saleable like ordinary property, in spite of the injunctions of the third Lateran Council, and they became payable out of sources of income which were not originally tithable. The canon law contains numerous and minute provisions on the subject of tithes. The *Decretum* forbade their alienation to lay proprietors, denounced excommunication against those who refused to pay, and based the right of the Church upon scriptural precedents.[6] The decretals contained provisions as to what was and what was not tithable property, as to those privileged from payment, as to sale or hypothecation to laymen, as to priority over state taxes, &c.[7] Various questions which arose later were settled by Boniface VIII.[8] The Council of Trent enjoined due payment of tithes, and excommunicated those who withheld them.[9]

In England the earliest example of legal recognition of tithes is, according to Selden, a decree of a synod in 786.[10] Other examples before the conquest occur in the *Foedus Ælfredi et Guthruni* and the laws of Athelstan, Edgar and Canute.[11]

A full discussion of their origin and history is to be found in Lord Selborne's *Ancient Facts and Fictions concerning Churches and Tithes* (1888); the *History of the Law of Tithes in England*, by G. Edwardes Jones; and the *Sacred Tenth, Ancient and Modern*, by H. Lansdell (1906). (J. W.)

Tithes in England may be best dealt with in two chronological divisions—tithes under the system existing previously to the Commutation Acts and tithes under the system then introduced.

Before the Commutation Acts.

1. Whether or not, as it is said, before the Council of Lateran in 1180, a man could have given his tithes to any church or monastery that he pleased, at any rate since that time, with the division of dioceses into parishes, they now of common right belong to the church within whose parish they arise, although by prescription they may belong elsewhere. The general rule was said to be that all lands within a parish are subject to tithes, and a layman was not allowed to prescribe generally that his lands were exempt; but he had to show a special exemption, and no length of possession was regarded in law in view of the maxim *nullum tempus occurrit ecclesiae*, although equity did take account of it. The tithes in places extra-parochial, *e.g.* forest lands, belong to the Crown, although by canon law they were to be disposed of by the bishop; but by custom a parson or vicar might be entitled to them. The tithes of tithable cattle pasturing in any waste or common ground, whereof the parish is not certainly known, were made payable to the parson of the parish where the cattle dwell by a statute of Edward VI.

Tithes were classified according to their nature as praedial, or

[1] The tithe offered to Yahweh may have originally been consumed—in whole or in representative part—on the altar, but in the rituals preserved to us the offering is symbolical, the deity ceding his tithe to the priest, so that from quite early times the tithe helped to support the priesthood who like the poor had a customary share (guest-right) in the feasts.

[2] A cattle tithe is demanded in Lev. xxvii. 32, and spoken of in 2 Chron. xxxi. 6. It is doubtful if this was ever acknowledged in practice. See Kuenen, *Godsdienst*, ii. 269 seq., and Wellhausen, *Prolegomena*, v. 1, § 2 (Eng. trans., p. 155 seq.), who argue that the passage in Leviticus is a later addition. The tendency of the Pharisees was to pay tithe on everything, and to make a self-righteous boast of this (Matt. xxiii. 23; Luke xviii. 12). The Mishna (Ma'aseroth i. 1) says "everything that is eaten and is watched over and grows out of the ground is liable to tithe."

[3] It was his denial of the divine right of tithes that brought down the wrath of the Star Chamber upon the author. He was forced to retract an opinion too liberal for the time. (See SELDEN.)

[4] Hallam, *Middle Ages*, ii. 205.

[5] See Dante, *Par.* xii. 93, "decimas quae sunt pauperum Dei."

[6] Pt. ii. 16, 7.

[7] Bk. iii. 30.

[8] *Extrav. Comm.* bk. iii. 7.

[9] Sess. xxv. 12.

[10] C. viii. § 2.

[11] The grant said to have been made by Æthelwulf in 855, to which the general payment of tithes in England has been commonly traced, appears not to rest on satisfactory evidence.

arising immediately from the ground, *e.g.* grain of all sorts, hay, wood and the like; mixed, or arising from things immediately nourished by the ground, *e.g.* colts, lambs, eggs and the like; or personal, namely, of profits arising from the honest labour and industry of man, and being the tenth part of the clear gain, *e.g.* fishing, mills and the like; or according to value, as great, *e.g.* corn, hay and wood; or little, which embraced all others. Of common right tithes were only payable of such things as yield a yearly increase by the act of God, and generally only once a year. They were not payable of the following, except by custom: things of the substance of the earth, such as coals, minerals, turf and the like; things *ferae naturae*, such as fish, deer and the like; things tame, such as fowls, hounds or fish kept for pleasure or curiosity; barren land, until it is converted into arable or meadow land, and has been so for seven years; forest land, if in the hands of the king or his lessee, unless disafforested; a park which is disparked; or glebe land in the hands of the parson or vicar, which was mutually exempted from payment by the one to the other, but not if in the hands of the vicar's lessee. Another exception to the incidence of tithes were abbey lands. These were exempted generally by Pope Pascal II. while in the hands of their owners, but the privilege was restricted by Pope Adrian IV. in the time of Henry II. to the three religious orders of Cistercians, Templars and Hospitallers (to whom the Templars' lands were given on their dissolution in 17 Edw. II.), to which Pope Innocent III. added the Praemonstratenses. The Council of the Lateran in 1215 further restricted this exemption to lands of which these orders were in possession before that council. A custom by the religious to obtain exemption for lands let to their tenants by means of bulls from the pope was put an end to by a statute of Henry IV. making the acquisition or use of such bulls henceforward a *praemunire*. When the religious houses were dissolved by Henry VIII., in the case of the greater abbeys and priories the exemptions from payment of tithes enjoyed by them passed to the Crown or the persons to whom the Crown assigned them, and thus any lands which might have been thus exempted, whether they had been actually so or not, were presumed to be exempt; and a further exemption was created by parsonages coming into the same hands as tithable lands, which lasted so long as such union continued.

A further exemption from tithes was given by an act of 1832 (2 & 3 Will. IV. c. 100), which fixed a period of prescription against claims of tithe by laymen or corporations aggregate, of thirty years during which there had been no payment of tithes or a *modus* or composition had existed, in the absence of contrary evidence, and in any case of sixty years; and against corporations sole, of sixty years or the tenures of two successive incumbents and three years after the entry of a third. The tithes which came into lay hands by the dissolution of the religious houses and the previous suppression of alien priories by Henry V. became in all respects incorporeal freehold property. Under the Limitation Act of 1833 twenty years of adverse possession of an estate in tithes gave a good title, except as against spiritual or eleemosynary corporations sole whose right to recover tithes was limited, if at all, to a period of two incumbencies and six years afterwards, or sixty years (s. 29).

Tithes were generally recovered by a writ against the owner of the tithable property usually brought in the ecclesiastical courts (questions of title to tithes being reserved to the temporal courts), the jurisdiction of which in this respect was confirmed by the statutes *Circumspecte agatis* (13 Edw. I.), *Articuli cleri* (9 Edw. II.), and others of Henry VIII. and Edward VI., and was enforced by ecclesiastical censures and the writ *De excommunicato capiendo*; and an act 2 & 3 Edw. VI. made any person refusing to set out tithes liable to pay double the value in the ecclesiastical court or treble in a common law court. Tithes of small amount or due from Quakers could be recovered by summary proceedings before justices under statutes ranging from William III. to Victoria. Tithes could also be sued for in equity, especially the equity side of the exchequer. A custom also sprang up, and was common at the time of the Commutation Acts, for a tithe-owner to accept a fixed sum of money or fixed quantity of the goods tithable in place of the actual tithes, known as a *modus decimandi*, whether in respect of a whole parish or only of particular lands within it; and this could be sued for in the ecclesiastical courts. Tithe-payers could also file bills in equity to establish a *modus* against a tithe-owner. In the City of London there were customary tithes; in other towns and places there were compositions for tithes which were confirmed by local acts of parliament; and according to a return presented to the House of Commons in 1831, there were passed between 1757 and 1830 no less than 2000 local acts containing clauses for the commutation of tithes. Enclosure Acts often gave a portion of the lands enclosed to the spiritual or lay rector and exempted the rest from tithes; and in other local acts a corn rent or yearly money payment was substituted for tithes. Except, however, where made under parliamentary authority, no composition for tithes, although made between the landowner and the parson or vicar with the consent of the patron and ordinary, bound a succeeding incumbent, the statute 13 Eliz. c. 10 prohibiting any parson or vicar from making any conveyance of (*inter alia*) tithes, being parcel of the possessions of their churches, to any persons, except leases for twenty-one years or three lives.

After the Commutation Acts.

2. The principle of the Tithe Commutation Acts (1836–1860) is to make permanent and general the system which had been only partial or temporary (in most cases), and to "substitute a corn rent (known as a tithe rent charge), permanent in quantity and payable in money, but fluctuating in value, for all tithes, whether payable under a *modus* or composition or not, which may have heretofore belonged either to ecclesiastical or lay persons" (Phillimore, *Eccles. Law*, ii. 1161).

Commissioners (now the board of agriculture) are appointed to execute the acts; a rent charge on all lands liable to tithes at the time of the passing of the first act is substituted for those tithes, of which the gross amount is ascertained either by voluntary parochial agreement, or, failing that, by compulsory award confirmed by the commissioners; and the value of the tithes is fixed in the latter case by their average value in the particular parish during the seven years preceding Christmas 1835, without deduction for parochial or county and other rates, charges and assessments falling on tithes, the rent charge being liable to all the charges to which tithes were liable. The rent charge is apportioned on all the lands liable in the parish, and such apportionment may be altered or a new one made: and the value of the rent charge is fixed at the value (at the time of confirmation of the apportionment) of the number of imperial bushels and decimal parts of bushels of wheat, barley and oats as the same would have purchased at the prices so ascertained by the advertisement (of prices of corn) to be published immediately after the passing of the act 6 & 7 Will. IV. c. 71, in case one-third part of such rent charge had been invested in the purchase of wheat, one-third part in the purchase of barley, and the remaining third part in the purchase of oats; and the respective quantities of wheat, barley and oats so ascertained shall be stated in the draft of every apportionment. The price at which the conversion from money into corn is to be made at the time of confirmation of such apportionment, according to the provisions of the said act, are 7s. 0¼d. for a bushel of wheat, 3s. 11½d. for a bushel of barley and 2s. 9d. for a bushel of oats (7 Will. IV. and 1 Vict. c. 69); the average price of the bushel of each grain is now computed by substituting for the "advertisement" above the statement of the septennial average price of the imperial bushel of British corn made under the Corn Returns Act 1882; and thus the value of the statutory amount of corn is now fixed for each year at the beginning thereof at the average price of the three components of corn for the previous seven years. The extent of the depreciation in value of tithe may be gathered from the fact that for 1902 the price of the wheat bushel is thus fixed at 3s. 5¼d., that of the barley bushel at 3s. 0½d. and that of the oats bushel at 2s. 1d.

As already indicated above, certain lands are exempt from payment of tithes while in the occupation of their owners, either by reason of their having been parcel of the possessions of any privileged order, or by reason of their being of the tenure of ancient demesne and exempt whilst in the tenure, occupation or manurance of the Crown, its tenants, farmers and lessees or under-tenants, although they are subject to tithes when aliened or occupied by subjects not being such; and in these and in all such cases, with the consent of such owners, a fixed rent charge may be substituted for any contingent rent charge imposed on them (2 & 3 Vict. c. 62; 3 & 4 Vict. c. 15, now repealed except as to tithes not commuted). In certain cases where commutation of tithes for rent charge in the ordinary way was impracticable, *e.g.* in the case of Lammas lands or in the case of common lands, power was given to charge a fixed sum or rate per head of the cattle there pasturing, with an exception in the case of Lammas lands which for seven years before Christmas 1835 had paid no tithe; and also to fix a rent charge in respect of tithes of common appurtenant on the allotment made in respect of the lands to which such right of common attached (2 & 3 Vict. c. 62; 3 & 4 Vict. c. 15; 9 & 10 Vict. c. 73). By an act of 1860 (23 & 24 Vict. c. 93) a gross rent charge can be substituted for a commutation of tithes on common rights at a fixed sum per head; a gross rent charge made payable in respect of the tithes of a gated or stinted pasture rated to the relief of the poor may be apportioned thereupon and enforced in the method prescribed by the other Tithe Acts; a rent charge on commons may be commuted for part of the land or redeemed, if the landowners and persons liable for tithe so agree; and upon enclosure, a rate per head may be converted into a rent charge on the lands allotted. These rent charges are not subject to the Tithe Act of 1891. This act of 1860 also gave power to convert the corn rents established under local acts into rent charges.

In the case of hop-grounds, orchards, fruit-plantations and gardens power was given to the commissioners to value them separately, according to the average rate of composition for the seven years preceding Christmas 1835, and to fix an ordinary and an extraordinary charge for tithes thereof, the former for such lands going out of cultivation, the latter for such as were thereafter newly cultivated: lands subject to the latter were exempted during their first years of cultivation; and such lands were only subject to it if situated in a parish in which an extraordinary charge had been distinguished at the time of commutation (6 & 7 Will. IV. c. 71; 2 & 3 Vict. c. 62; 3 & 4 Vict. c. 15; 23 & 24 Vict. c. 93; 36 & 37 Vict. c. 42). In 1886, however, it was enacted that no such extraordinary charge shall be levied on any such grounds so newly cultivated in future; the capital value of the existing charges was assessed, and the payment of interest thereon was made a rent charge on the land payable in priority to all other charges until its redemption, and recoverable in the same way as ordinary rent charge and exempt from all rates, charges and assessments: the charge was redeemable at the capital value, and, saving existing contracts, it was as between landlord and tenant payable by the landlord, any agreement to the contrary notwithstanding; and it is not subject to the Tithe Act of 1891. Under the act of 1840 (3 & 4 Vict. c. 15) gardens and lawns and the like, of small size, could be exempted from tithes.

Besides the tithes dealt with by local acts as already mentioned, certain other kinds of tithes are outside the scope of the Commutation Acts, namely, tithes of fish and fishing, personal tithes other than tithes of mills, and mineral tithes, unless the landowners and tithe-owners consent to make a parochial agreement for commutation before the confirmation of an apportionment after a compulsory award in such parish. As already seen, fish being *ferae naturae* are only tithable by custom; but fish taken in the sea by the custom of the realm are tithable as a personal tithe, *i.e.* in some small sum for the net profits of the fishing, and customs for payment in kind have been upheld by the courts. Personal tithes, if not commuted or otherwise still payable, are regulated by a statute of Edward VI., which (except in the case of fishing and tithes for houses in cities and towns, which may be due by custom) restricted them to such persons exercising merchandises, bargaining and selling clothing, handicraft or other art or faculty in such places as had for forty years previously so used to do. Personal tithes are now rare, except of fish caught at sea, when they are payable to the church where the taker hears divine service and receives the sacraments. Tithes on houses or customary payments in lieu of tithes have, by local acts, in some cases been turned into church rates. Statutory provision is also made for allowing tithes and tithe rent charge to be exchanged for land, and for the redemption of rent charges made under the acts, and also of corn rents under the local acts. Tithe rent charge may also be merged in the land tithable, with the consent of the tithe commissioners and the landowner, by the legal and equitable owners of tithes in fee simple or fee tail, or persons having power to appoint the fee simple in tithes, or owners of glebes, or owners of lands and tithes settled to the same uses.

Tithe rent charge under these acts is subject to the same liabilities and incidents as tithes, such as parliamentary, parochial, county and other rates, especially the poor rate and highway rate; but the owner of tithe rent charge attached to a benefice has been exempted by an act of 1899 from payment of half the amount of any rate which he would be liable to pay under the Agricultural Rates Act 1896, the other half being borne by the Inland Revenue Commissioners. The limitation of time for recovery of tithes or estates in tithes, whether between rival claimants to tithes or tithe-owners or tithe-payers, if belonging to lay individuals or lay or spiritual corporations aggregate, is a period of twelve years, as in the case of other real property (37 & 38 Vict. c. 57); and in the case of spiritual corporations sole the period of limitation of actions, if any, is governed by the Limitation Act 1833, s. 29, already quoted, the act 2 & 3 Will. IV. c. 100 being held only to apply to demands of tithe in kind.

The method of recovering rent charge under the Commutation Acts was distraint where the rent charge is in arrear for twenty-one days after the half-yearly days of payment, and entry and possession with power of letting if it is in arrear for forty days, and arrears for two years are so recoverable: this power of distress and entry extends to all lands occupied by the occupier of the land whose tithe is in arrear as owner or under the same landlord; but no action lies against the owner or occupier of the land personally. If a tenant quits leaving tithe unpaid, the landlord may pay it and recover it from him. The tithe-owner cannot recover damages from the tithe-payer for not cultivating the land. Special provision is made for the recovery of the rent charge in railway lands.

The act of 1891, has, however, altered this method of recovering tithes, and substituted another intended to shift the burden of responsibility from the occupier to the landowner, by making the latter directly and solely responsible, but giving the remedy against the land. The landowner is made liable to pay the rent charge in spite of any contract to the contrary between him and the occupier; the rent charge if in arrear for three months is recoverable by an order of the county court, whatever its amount may be: if the land is occupied by the owner, the order is executed by the same means as those prescribed in the Tithe Acts; but if it is not, then by a receiver being appointed for the rents and profits of the land: neither landlord nor occupier is personally liable for payment; and appeal lies to the High Court on points of law; and a remission of rent charge may be claimed when its amount exceeds two-thirds of the annual value of the land. The act does not apply to the particular kinds of rent charges mentioned above.

The Tithe Acts do not apply to the city of London, which has always had its own peculiar customary payment regulated by episcopal constitutions of 13 Hen. III. and 13 Ric. II. and statutes of Henry VIII., confirming a decree of the privy council, under which the rate of tithes was fixed at 16½d. for every 10s. rent, and at 2s. 9d. for every 20s. rent of houses, shops and the like by the year. Provision was made by statute after the fire of London for certain annual tithes to be paid in parishes whose churches had been destroyed, and there have been local acts from time to time with regard to particular parishes therein.

AUTHORITIES.—Phillimore, *Ecclesiastical Law* (2nd ed., London, 1895); Cripps, *Law of Church and Clergy* (6th ed., London, 1886); Eagle, *Tithes* (London, 1836); Leach, *Tithe Acts* (6th ed., 1896).

(G. G. P.*)

TITHING (for tithe, tenth; Lat. *decuma*), formerly a unit of local administration in England. In some districts the men who were bound to be in frankpledge (*q.v.*) were grouped in associations of ten, twelve or more individuals called tithings. When a person who was accused of any crime was not forthcoming, inquiry was made whether he was in frankpledge; if he were not, and had no right of exemption, the township was amerced, but if he were in a tithing, then it was upon the tithing that the amercement fell. South of the Thames the tithings were districts normally identical with the township which discharged the duties of the frankpledge. Some townships, however, contained more than one tithing. There are also indications that in the ancient kingdom of Mercia the tithing was originally a district and not a mere association of persons; but in Northumbria it is doubtful whether the system of frankpledge and tithing, either personal or territorial, was ever established. If, as seems likely, the territorial tithing is older than the personal, each territorial hundred (*q.v.*) was probably divided into ten tithings.

TITHONUS, in Greek legend, according to Homer son of Laomedon, king of Troy and husband of Eos (the morning). In the Homeric *Hymn to Aphrodite*, Eos is said to have carried him off because of his great beauty. She entreated Zeus that he might live for ever; this was granted, but she forgot to ask for immortal youth for him. He became a hideous old man; Eos then shut him up in a chamber; his voice "flowed on unceasingly," but his limbs were helpless. A later development is the change of Tithonus into a grasshopper, after Eos had been obliged to wrap him like a child in swaddling-clothes and to put him to sleep in a kind of cradle. He was probably associated with the Trojan royal house, since the inhabitants of the original home of the legend (probably central or northern Greece) looked upon the East, the land of the morning, as the home of Eos. In some versions she is said to have carried him away still farther East, to the land of Ethiopia near the ocean streams; this is euhemeristically referred by Diodorus Siculus to an expedition undertaken against Ethiopia by Tithonus, son of Laomedon.

It is probable that Tithonus was originally a sun-god; the scholiast on *Iliad*, xi. 5, who calls him Titan, identifies him with Apollo, and there are many points of resemblance between him and the sun-god Helios. The story is generally regarded as an allegorical representation of the fresh morning sun dried up by the heat of the advancing day. Possibly it is merely intended as a warning to mortals not to unite with immortals, lest they incur the jealousy and wrath of the gods.

See Homer, *Iliad*, xi. 1, xix. 237; *Hymn in Venerem*, 219 sqq., with Allen and Sikes's notes; Apollodorus iii. 12, 4; Diod. Siculus iv. 75; Horace, *Odes*, ii. 16, 30; Propertius iii. 10 (18); O. Gruppe, *Griechische Mythologie*, i. 313, n. 16, who attributes a Milesian origin to the story; articles "Eos" by Rapp in Roscher's *Lexikon der Mythologie* and by Escher in Pauly-Wissowa's *Realencyclopädie*.

TITIAN (*c.* 1477–1576). Tiziano Vecellio, or Vecelli, one of the greatest painters of the world, and in especial the typical representative of the Venetian school, was commonly called during his lifetime "Da Cadore," from the place of his birth, and has also been designated "Il Divino." The country of Cadore, in the Friuli, barren and poor, is watered by the Piave torrent poured forth from the Carnic Alps, and is at no great distance from Tirol. Titian, therefore, was not in any sense a Venetian of the lagoons and Adriatic, but was native to a country, and a range of association, perception and observation, of a directly different kind. Venice conquered Friuli at a date not very remote from the birth of Titian; and Cadore, having to choose between Venetian and imperial allegiance, declared for the former. Approaching the castle of Cadore from the village Sotto Castello, one passes on the right a cottage of humble pretensions, inscribed as Titian's birthplace; the precise locality is named Arsenale. The near mountain—all this range of hills being of dolomite formation—is called Marmarolo. At the neighbouring village of Valle was fought in Titian's lifetime the battle of Cadore, a Venetian victory which he recorded in a painting. In the 12th century the count of Camino became count also of Cadore. He was called Guecello; and this name descended in 1321 to the podestà (or mayor) of Cadore, of the same stock to which the painter belonged. Titian, one of a family of four, and son of Gregorio Vecelli, a distinguished councillor and soldier, and of his wife Lucia, was born in 1477. So it has very generally been stated; but of late years a subsequent date, 1489–1490, has been suggested, so as to make Titian, at the time of his death, not so singularly long-lived a man. As to this interesting point one should remember that Vasari in one passage (at variance with some others) says that Titian was born in 1480; while Titian himself, writing to Philip II. in 1571, professed to be ninety-five years old.

It used to be said that Titian, when a child, painted upon the wall of the Casa Sampieri, with flower-juice, a Madonna and Infant with a boy-angel; but modern connoisseurs say that the picture is a common work, of a date later than Titian's decease. He was still a child when sent by his parents to Venice, to an uncle's house. There he was placed under an art teacher, who may perhaps have been Sebastiano Zuccato, a mosaicist and painter now forgotten. He next became a pupil of Gentile Bellini, whom he left after a while, because the master considered him too offhand in work. Here he had the opportunity of studying many fine antiques. His last instructor was Giovanni Bellini; but Titian was not altogether satisfied with his tutoring. The youth was a contemporary of Giorgione and Palma Vecchio; when his period of pupilage expired, he is surmised to have entered into a sort of partnership with Giorgione. A fresco of "Hercules" on the Morosini Palace is said to have been one of his earliest works; others were the "Virgin and Child," in the Vienna Belvedere, and the "Visitation of Mary and Elizabeth" (from the convent of S. Andrea), now in the Venetian Academy. In 1507–1508 Giorgione was commissioned by the state to execute frescoes on the re-erected Fondaco de' Tedeschi. Titian and Morto da Feltre worked along with him, and some fragments of Titian's paintings, which are reputed to have surpassed Giorgione's, are still discernible. According to one account, Giorgione was nettled at this superiority, and denied Titian admittance to his house thenceforth. Stories of jealousies between painters are rife in all regions, and in none more than in the Venetian—various statements of this kind applying to Titian himself. One should neither accept nor reject them uninquiringly; counter-evidence of some weight can be cited for Vecelli's vindication in relation to Moroni, Correggio, Lotto and Coello. Towards 1511, after the cessation of the League of Cambrai—which had endeavoured to shatter the power of the Venetian republic, and had at any rate succeeded in clipping the wings of the lion of St Mark—Vecelli went to Padua, and painted in the Scuola di S. Antonio a series of frescoes, which continue to be an object of high curiosity to the students of his genius, although they cannot be matched against his finest achievements in oil painting. Another fresco, dated 1523, is "St Christopher carrying the Infant Christ," at the foot of the doge's steps in the ducal palace of Venice. From Padua Titian in 1512 returned to Venice; and in 1513 he obtained a broker's patent in the Fondaco de' Tedeschi (state-warehouse for the German merchants), termed "La Sanseria" or "Senseria" (a privilege much coveted by rising or risen artists), and became superintendent of the government works, being especially charged to complete the paintings left unfinished by Giovanni Bellini in the hall of the great council in the ducal palace. He set up an atelier on the Grand Canal, at S. Samuele—the precise site being now unknown. It was not until 1516, upon the death of Bellini, that he came into actual enjoyment of his patent, at the same date an arrangement for painting was entered into with Titian alone, to the exclusion of other artists who had heretofore been associated with him. The patent yielded him a good annuity—120 crowns—and exempted him from certain taxes—he being bound in return to paint likenesses of the successive doges of his time at the fixed price of eight crowns each. The actual number which he executed was five. Titian, it may be well to note as a landmark in this all but centenarian life of incessant artistic labour and productiveness, was now (if we adopt 1477 as the birth-date) in the fortieth year of his age. The same year, 1516, witnessed his first journey to Ferrara. Two years later was produced, for the high altar of the church of the Frari, one of his most world-renowned masterpieces, the "Assumption of the Madonna," now in the Venetian Academy. It excited a vast sensation, being indeed the most extraordinary piece of colourist execution on a great scale which Italy had yet seen. The signoria took note of the facts and did not fail to observe that Titian was neglecting his work in the hall of the great council.

Vecelli was now at the height of his fame; and towards 1521, following the production of a figure of "St Sebastian" for the papal legate in Brescia (a work of which there are numerous replicas), purchasers became extremely urgent for his productions. In 1525, after some irregular living and a consequent fever, he married a lady of whom only the Christian name, Cecilia, has come down to us; he hereby legitimized their first child, Pomponio, and two (or perhaps three) others followed. Towards 1526 he became acquainted, and soon exceedingly intimate, with Pietro Aretino, the literary bravo, of influence and audacity hitherto unexampled, who figures so strangely in the chronicles of the time. Titian sent a portrait of him to Gonzaga, duke of Mantua. A great affliction befell him in August 1530 in the death of his wife. He then, with his three children—one of them being the infant Lavinia, whose birth had been fatal to the mother—removed to a new home and got his sister Orsa to come from Cadore and take charge of the household. The mansion, difficult now to find, is in the Biri Grande, then a fashionable suburb, being in the extreme end of Venice, on the sea, with beautiful gardens and a look-out towards Murano. In 1532 he painted in Bologna a portrait of the emperor Charles V., and was created a count palatine and knight of the Golden Spur, his children also being made nobles of the empire—for a painter, honours of an unexampled kind.

The Venetian government, dissatisfied at Titian's neglect of the work for the ducal palace, ordered him in 1538 to refund the money which he had received for time unemployed; and Pordenone, his formidable rival of recent years, was installed in his place. At the end of a year, however, Pordenone died; and Titian, who had meanwhile applied himself diligently to painting in the hall the battle of Cadore, was reinstated. This great picture, which was burned with several others in 1577, represented in life-size the moment at which the Venetian captain, D'Alviano, fronted the enemy, with horses and men crashing down into the stream. Fontana's engraving, and a sketch by Titian himself in the gallery of the Uffizi in Florence, record the energetic composition. As a matter of professional and worldly success, his position from about this time may be regarded as higher than that of any other painter known to history, except Raphael, Michelangelo, and at a later date Rubens. In 1540 he received a pension from D'Avalos, marquis del Vasto, and an annuity of 200 crowns (which was afterwards doubled) from Charles V. on the treasury of Milan. Another source of profit—for he was always sufficiently keen after money—was a contract, obtained in 1542, for supplying grain to Cadore, which he visited with regularity almost every year, and where he was both generous and influential. This reminds us of Shakespeare and his relations to his birthplace, Stratford-on-Avon; and indeed the great Venetian and the still greater Englishman had something akin in the essentially *natural* tone of their inspiration and performance, and in the personal tendency of each to look after practical success and "the main chance" rather than to work out aspirations and pursue ideals. Titian had a favourite villa on the neighbouring Manza Hill, from which (it may be inferred) he made his chief observations of landscape form and effect. The so-called "Titian's mill," constantly discernible in his studies, is at Collontola, near Belluno (see R. F. Heath's *Life of Titian*, p. 5). A visit was paid to Rome in 1546, when he obtained the freedom of the city, his immediate predecessor in that honour having been Michelangelo in 1537. He could at the same time have succeeded the painter Fra Sebastiano in his lucrative office of the piombo, and he made no scruple of becoming a friar for the purpose; but this project lapsed through his being summoned away from Venice in 1547 to paint Charles V. and others, in Augsburg. He was there again in 1550, and executed the portrait of Philip II., which was sent to England and proved a potent auxiliary in the suit of the prince for the hand of Queen Mary. In the preceding year Vecelli had affianced his daughter Lavinia, the beautiful girl whom he loved deeply and painted various times, to Cornelio Sarcinelli of Serravalle; she had succeeded her aunt Orsa, now deceased, as the manager of the household, which, with the lordly income that Titian made by this time, was placed on a corresponding footing. The marriage took place in 1554. She died in childbirth in 1560. The years 1551 and 1552 were among those in which Titian worked least assiduously—a circumstance which need excite no surprise in the case of a man aged about seventy-five. He was at the Council of Trent towards 1555, of which his admirable picture or finished sketch in the Louvre bears record. He was never in Spain, notwithstanding the many statements which have been made in the affirmative. Titian's friend Aretino died suddenly in 1556, and another close intimate, the sculptor and architect Jacopo Sansovino, in 1570. With his European fame, and many sources of wealth, Vecelli is the last man one would suppose to have been under the necessity of writing querulous and dunning letters for payment, especially when the defaulter addressed was lord of Spain and of the American Indies; yet he had constantly to complain that his pictures remained unpaid for and his pensions in arrear, and in the very year of his death (February) he recites the many pictures which he had sent within the preceding twenty years without receiving their price. In fact, there is ground for thinking that all his pensions and privileges, large as they were nominally, brought in but precarious returns. It has been pointed out that in the summer of 1566 (when he was elected into the Florentine Academy) he made an official declaration of his income, and put down the various items apparently below their value, not naming at all his salary or pensions. Possibly there was but too much reason for the omission.

In September 1565 Titian went to Cadore and designed the decorations for the church at Pieve, partly executed by his pupils. One of these is a Transfiguration, another an Annunciation (now in S. Salvatore, Venice), inscribed "Titianus fecit," by way of protest (it is said) against the disparagement of some persons who cavilled at the veteran's failing handicraft. He continued to accept commissions to the last. He had selected as the place for his burial the chapel of the Crucifix in the church of the Frari; and, in return for a grave, he offered the Franciscans a picture of the "Pietà," representing himself and his son Orazio before the Saviour, another figure in the composition being a sibyl. This work he nearly finished; but some differences arose regarding it, and he then settled to be interred in his native Pieve. Titian was ninety-nine years of age (more or less) when the plague,[1] which was then raging in Venice, seized him, and carried him off on the 27th of August 1576. He was buried in the church of the Frari, as at first intended, and his "Pietà" was finished by Palma Giovane. He lies near his own famous painting, the "Madonna di Casa Pesaro." No memorial marked his grave, until by Austrian command Canova executed the monument so well known to sightseers. Immediately after Titian's own death, his son and pictorial assistant Orazio died of the same epidemic. His sumptuous mansion was plundered during the plague by thieves, who prowled about, scarce controlled.

Titian was a man of correct features and handsome person, with an uncommon air of penetrating observation and self-possessed composure—a Venetian presence worthy to pair with any of those "most potent, grave and reverend signors" whom his pencil has transmitted to posterity. He was highly distinguished, courteous and winning in society, personally unassuming, and a fine speaker, enjoying (as is said by Vasari, who saw him in the spring of 1566) health and prosperity unequalled. The numerous heads currently named Titian's Mistress might dispose us to regard the painter as a man of more than usually relaxed morals; the fact is, however, that these titles are mere fancy-names, and no inference one way or the other can be drawn from them. He gave splendid entertainments at times; and it is related that, when Henry III. of France passed through Venice on his way from Poland to take the French throne, he called on Titian with a train of nobles, and the painter presented him as a gift with all the pictures of which he inquired the price. He was not a man of universal genius or varied faculty and accomplishment, like Leonardo da Vinci and Michelangelo; his one great and supreme endowment was that of painting.

Ever since Titian rose into celebrity the general verdict has been that he is the greatest of painters, considered technically. In the first place neither the method of fresco painting nor work of the colossal scale to which fresco painting ministers is here in question. Titian's province is that of oil painting, and of painting on a scale which, though often large and grand, is not colossal either in dimension or in inspiration. Titian may properly be regarded as the greatest manipulator of paint in relation to colour, tone, luminosity, richness, texture, surface and harmony, and with a view to the production of a pictorial whole conveying to the eye a true, dignified and beautiful impression of its general subject-matter and of the objects of sense which form its constituent parts. In this sense Titian has never been deposed from his sovereignty in painting, nor can one forecast the time in which he will be deposed. For the complex of qualities which we sum up in the words colour, handling and general force and harmony of effect, he stands unmatched, although in particular items of forcible or impressive execution—not to speak of creative invention—some painters, one in one respect and another in another, may indisputably be preferred to him. He carried to its acme that great colourist conception of the Venetian school of which the first masterpieces are due to the two Bellini, to Carpaccio; and, with more fully developed suavity of manner, to Giorgione. Pre-eminent inventive power or sublimity

[1] Out of a total population of 190,000 there perished at this time 50,000.

of intellect he never evinced. Even in energy of action and more especially in majesty or affluence of composition the palm is not his; it is (so far as concerns the Venetian school) assignable to Tintoretto. Titian is a painter who by wondrous magic of genius and of art satisfies the eye, and through the eye the feelings—sometimes the mind.

Titian's pictures abound with memories of his home-country and of the region which led from the hill-summits of Cadore to the queen-city of the Adriatic. He was almost the first painter to exhibit an appreciation of mountains, mainly those of a turreted type, exemplified in the Dolomites. Indeed he gave to landscape generally a new and original vitality, expressing the quality of the objects of nature and their control over the sentiments and imagination with a force that had never before been approached. The earliest Italian picture expressly designated as "landscape" was one which Vecelli sent in 1552 to Philip II. His productive faculty was immense, even when we allow for the abnormal length of his professional career. In Italy, England and elsewhere more than a thousand pictures figure as Titian's; of these about 250 may be regarded as dubious or spurious. There are, for instance, 6 pictures in the National Gallery, London, 18 in the Louvre, 16 in the Pitti, 18 in the Uffizi, 7 in the Naples Museum, 8 in the Venetian Academy (besides the series in the private meeting-hall) and 41 in the Madrid Museum. In the National Gallery 3 other works used to be assigned to Titian, but are now regarded rather as examples of his school.

Naturally a good deal of attention has been given by artists, connoisseurs and experts to probing the secret of how Titian managed to obtain such astonishing results in colour and surface. The upshot of this research is but meagre; the secret seems to be not so much one of workmanship as of faculty. His figures were put in with the brush dipped in a brown solution, and then altered and worked up as his intention developed. The later pictures were touched off rapidly, telling well from a distant view. He himself averred that after his visit to Rome in 1546 he had greatly improved in art; and in his very last days he said—certainly with the modesty of genius, perhaps also with some of the tenacity of old age—that he was then beginning to understand what painting meant. In his earlier pictures the gamut of colour rests mainly upon red and green, in the later ones upon deep yellow and blue. The pigments which he used were nothing unusual; indeed they were both few and common. Palma Giovane records that Vecelli would set pictures aside for months, and afterwards, examining them with a stern countenance, as if they were his mortal enemies, would set to work upon them like a man possessed; also that he kept many pictures in progress at the same time, turning from one to the other, and that in his final operations he worked far more with finger than with brush. It has been said, and probably with truth, that he tried to emulate Palma Vecchio in softness as well as Giorgione in richness. Michelangelo's verdict after inspecting the picture of "Danae in the Rain of Gold," executed in 1546, has often been quoted. He said, "That man would have had no equal if art had done as much for him as nature." He was thinking principally of severity and majesty of draughtsmanship, for he added, "Pity that in Venice they don't learn how to draw well." As a draughtsman of the human figure Titian was not only competent but good and fine, and he is reported to have studied anatomy deeply; but one can easily understand that he fell not a little short of the standard of Michelangelo, and even of other leading Florentines. He was wont to paint in a nude figure with Venetian red, supplemented by a little lake in the contour and towards the extremities. He observed that a colourist ought to manipulate white, black and red, and that the carnations cannot be done in a first painting, but by replicating various tints and mingling the colours. He distanced all predecessors in the study of colour as applied to draperies—working on the principle (in which Giorgione may perhaps have forestalled him) that red comes forward to the eye, yellow retains the rays of light, and blue assimilates to shadow. In his subject-pictures the figures are not very numerous, and the attitudes are mostly reserved; even in bacchanals or battles the athletic display has more of facility than of furor. His architectural scenes were sometimes executed by other persons, especially the Rosas of Brescia. The glow of late afternoon, or the passionate ardour of early sundown, was much affected by Titian in the lighting of his pictures. Generally it may be said that he took great pains in completing his works, and pains also in concealing the traces of labour. He appears to have had little liking for teaching, partly from distaste of the trouble, and partly (if we are to believe biographers) from jealousy. He was quite willing, however, to turn to some account the work of his scholars: it is related that on going out of doors he would leave his studio open, so that the pupils had a clandestine opportunity of copying his works, and if the copies proved of saleable quality he would buy them cheap, touch them up, and resell them.

Titian's family relations appear to have been happy, except as regards his eldest son, Pomponio. This youth, at the age of six, was launched upon the ecclesiastical career; but he proved wasteful and worthless, and Titian at last got so disgusted with him that he obtained the transfer to a nephew of a benefice destined for Pomponio. The fortune which he left was, after his decease, squandered by the tonsured prodigal. The other son, Orazio, born towards 1528, who (as we have seen) assisted Titian professionally, became a portrait-painter of mark—some of his likenesses, almost comparable with Titian's own, being often confounded with his by owners and connoisseurs. He executed an important picture in the hall of the great council, destroyed by fire. He gave to alchemy some of the time which might have been bestowed upon painting. Several other artists of the Vecelli family followed, in the wake of Titian. Francesco Vecelli, his elder brother, was introduced to painting by Titian (it is said at the age of twelve, but chronology will hardly admit of this), and painted in the church of S. Vito in Cadore a picture of the titular saint armed. This was a noteworthy performance, of which Titian (the usual story) became jealous; so Francesco was diverted from painting to soldiering, and afterwards to mercantile life. Marco Vecelli, called Marco di Tiziano, Titian's nephew, born in 1545, was constantly with the master in his old age, and learned his methods of work. He has left some able productions—in the ducal palace, the "Meeting of Charles V. and Clement VII. in 1529"; in S. Giacomo di Rialto, an "Annunciation"; in SS. Giovani e Paolo, "Christ Fulminant." A son of Marco, named Tiziano (or Tizianello), painted early in the 17th century. From a different branch of the family came Fabrizio di Ettore, a painter who died in 1580. His brother Cesare, who also left some pictures, is well known by his book of engraved costumes, *Abiti antichi e moderni.* Tommaso Vecelli, also a painter, died in 1620. There was another relative, Girolamo Dante, who, being a scholar and assistant of Titian, was called Girolamo di Tiziano. Various pictures of his were touched up by the master, and are difficult to distinguish from originals. Apart from members of his family, the scholars of Titian were not numerous; Paris Bordone and Bonifazio were the two of superior excellence. El Greco (or Domenico Theotocopuli) was employed by the master to engrave from his works. It is said that Titian himself engraved on copper and on wood, but this may well be questioned.

We must now briefly advert to Titian's individual works, taking them in approximate order of time, and merely dividing portraits from other pictures. Details already given indicate that he did not exhibit any extreme precocity; the earliest works which we proceed to mention may date towards 1505. In the chapel of S. Rocco, Venice, is his "Christ Carrying the Cross," now greatly dilapidated; it was an object of so much popular devotion as to produce offerings which formed the first funds for building the Scuola di S. Rocco: in the scuolo itself is his "Man of Sorrows." The nobly beautiful picture in the Villa Borghese in Rome, commonly named "Divine and Human Love" (by some, "Artless and Sated Love"), bears some obvious relation to the style of Palma Vecchio. The story goes that Titian was enamoured of Palma's daughter; but nothing distinct on this point is forthcoming. The "Tribute Money" ("Christ and the Pharisee"), now in the Dresden Gallery, dated towards 1508; Titian is said to have painted this highly finished yet not "niggling" picture in order to prove to some Germans that the effect of detail could be produced without those extreme minutiae which mark the style of Albert Dürer. The St Mark in the church of the Salute—the evangelist enthroned, along with SS. Sebastian, Roch, Cosmo and Damian—a picture much in the style of Giorgione, belongs to 1512. Towards 1518 was painted, also in the same class of style, the "Three Ages," now in Bridgewater House—a woman guiding the fingers of a shepherd on a reed-pipe, two sleeping children, a cupid, an old man with two skulls, and a second shepherd in the distance—one of the most poetically impressive among all Titian's works. Another work of approximate date was the "Worship of Venus," in the Madrid Museum, showing a statue of Venus, two nymphs, numerous cupids hunting a hare, and other figures. Two of the pictures in the National Gallery, London—the "Holy Family and St Catherine" and the "Noli me tangere"—were going on at much the same time as the great "Assumption of the Madonna." In 1521 Vecelli finished a painting which had long been due to Duke Alphonso of Ferrara, probably the "Bacchanal," with Ariadne dozing over her wine-cup, which is now in Madrid. The famous "Bacchus and Ariadne" in the National Gallery was produced for the same patron in 1523. The "Flora" of the Uffizi, the "Venus" of Darmstadt, and the lovely "Venus Anadyomene" of the Bridgewater Gallery may date a year or so earlier. Another work of 1523 is the stupendous "Entombment of Christ" in the Louvre, whose depth of colour and of shadow stands as the pictorial equivalent of individual facial expression; the same composition, a less admirable work, appears in the Manfrini Gallery. The Louvre picture comes from the Gonzaga collection and from the gallery of Charles I. in Whitehall. In 1530 Titian completed the "St Peter Martyr" for the church of SS. Giovanni e Paolo; for this work he bore off the prize in competition with Palma Vecchio and Pordenone. Of all his pictures this was the most daring in design of action, while it yielded to none in general power of workmanship and of feeling. It showed the influence of Michelangelo, who was in Venice while Vecelli was engaged upon it. A calamitous fire destroyed it in 1867; the copy of it which has taken its place is the handiwork of Cardi da Cigoli. To 1530 belongs also the "Madonna del Coniglio" (Louvre), painted for Gonzaga; to 1536 the "Venus of Florence"; to 1538 the portraits of the "Twelve Caesars," for Gonzaga; and to 1539 the "Presentation of the Virgin in the Temple"—one of the conspicuous examples in the Venetian Academy, yet not of the first interest or importance. About 1540 were done the forcible but rather uninspired paintings for S. Spirito, Venice, now in the church of the Salute—"Cain Killing Abel," the "Sacrifice of Abraham" and "David and Goliath"; in 1543 the "Ecce Homo" of the Vienna Gallery, where Aretino figures as Pilate. The "Venus and Cupid" of Florence, the "Venus" of Madrid and the "Supper of Emmaus" in the Louvre were still in hand, or just completed, when Titian was summoned to Augsburg in 1547. In 1554 he sent to Philip II. in England a second "Danae" and a "Venus and Adonis." About the same time he sent to Charles V. a "Trinity" (or, as Titian himself termed it, "Last Judgment"), which represented the emperor, with his family and others, all in shrouds, praying to the Godhead; Moses and various other personages are also portrayed. This was the object upon which Charles continued to keep his eyes fixed until the film of death closed on them. Later pictures, from 1558 onwards, are the "Martyrdom of St Lawrence," "Christ Crowned with Thorns" (Louvre), "Diana and Actaeon," "Diana and Callisto," "Jupiter and Antiope," the "Magdalene," "Christ in the Garden," and "Europa"—the last six for Philip II.; of the two Diana subjects there are duplicates in London and in Vienna. Philip, it will be observed, was equally *au fait* with nudities and with sanctities. The "Jupiter and Antiope," now much restored, is commonly called "La Vénus del Pardo," having at first been in the Pardo Palace. The "Magdalene" here spoken of (1561) seems to be the picture now in the Uffizi of Florence; Titian, in one of his letters, said that it was the most popular picture he had ever painted. In 1563 Vecelli offered to Philip II. his "Last Supper," which had been in hand for six years; it was cut down in the Escorial to suit a particular space, and offers now little noticeable beyond the fine grouping. The "St Jerome" of the Brera Gallery in Milan, a work of wonderful energy, spirit and force, especially for a more than octogenarian hand, was probably rather earlier than this; there is a replica of it in the Escorial. One of the master's latest pictures (1574–1575) is in Madrid, and commemorates the "Battle of Lepanto"; it is a work of failing power—but still the power of a Titian. Two of the mosaics in St Mark's church, Venice—the Mark in pontificals and the sword-sheathing angel on the right of the high altar—are after Vecelli's designs; but they are contrary to the true spirit of mosaic work, and the Mark in especial is a decided eyesore.

We now turn to the portraits—works so great in style, so stately, and in the best sense so simple in perception and feeling that, after allowing everything which can be said on behalf of some other masters of the craft, such as Raphael, Velazquez, Rubens and Rembrandt, one is still compelled to say that Titian stands on the whole supreme. Among the highest examples are—Alphonso, duke of Ferrara (Madrid), the same duke and his second wife Laura Dianti (Louvre), commonly called "Titian and his Mistress"; Francis I. (Louvre), painted towards 1536, but not from direct sittings, for Titian never saw the French king; various likenesses of himself, one of about 1542, and another of 1562; Paul III., also the same pope with his grandsons Cardinal Alessandro and duke Ottavio (Naples)—the former, done in about four weeks, was presented to the pontiff in May 1543 and cost two gold ducats; Pietro Aretino (Pitti); Titian's daughter Lavinia (with a fan in the Dresden Gallery, with a jewelled casket in Lord Cowper's collection); the Cornaro Family (Alnwick Castle); "L'Homme au Gant" (Louvre), an unknown personage, youthful and handsome, the *ne plus ultra* of portraiture; Sansovino Eleonora duchess of Urbino, Francesco duke of Urbino, Caterina Cornaro queen of Cyprus (these four are in the Uffizi); Charles V. on horseback (Madrid); Cardinal Bembo (Naples), discovered in an uncared-for condition in 1878, very unlike the portrait in the Barberini Gallery. The female portraits done by Titian are few, and are almost invariably of women of exalted rank. Of Ariosto, with whom Titian was intimate in Ferrara, though there may probably have been nothing approaching to a romantic friendship between them, the painter is said to have done three portraits. Much uncertainty, however, besets this matter. One of the three appears as a woodcut in an edition of the *Orlando furioso*. A second, formerly at Cobham Hall, corresponds with the woodcut likeness, and is signed "Titianus F."—a work of admirable beauty; it is now in the National Gallery of London. It is difficult, however, to reconcile the features here with those which appear in some other portraits of Ariosto. There is also in the gallery another and singularly beautiful portrait which used to be called "Ariosto" by Titian, then was assumed to be an "Unknown Poet" by Palma Vecchio; it is now again attributed to Titian, but not as representing Ariosto.

Authorities.—For English readers, the *Life and Times of Titian* by Crowe and Cavalcaselle (1877) superseded all previous works, such as those of Sir Abraham Hume (1829) and Northcote (1830). There is now also the translation (1904) of the monumental German work (1900) by George Gronau, which may be regarded as taking the first place of all. Claude Phillips has brought out two valuable books (1897 and 1898) on the earlier and the later work of Titian, which should be consulted on controversial details. Josiah Gilbert's book, *Cadore, or Titian's Country* (1869), supplies many interesting side-lights on the subject. R. F. Heath's monograph (1885) is founded mainly on Crowe and Cavalcaselle and on Gilbert, and forms a very convenient compendium. (W. M. R.)

TITLE (O. Fr. *title*, mod. *titre*, from Lat. *titulus*), an inscription prefixed to a book or other writing, designating the name by which it is to be known, and in many cases indicating the scope of the book or some idea of the nature of its contents. Further, the term is extended to the descriptive heading or caption to a document, such as a deed or other instrument, or to a bill or act of parliament. Another general meaning is that of an appellation of rank (see Titles of Honour, and the articles Emperor, King, Prince, Majesty, Highness, Duke, &c.). In law "title" is equivalent to right of ownership. The instruments in writing forming the evidences of the title to land are the title-deeds (see Conveyancing; Land Registration). In ecclesiastical usage, the word "title" (*titulus*) are used of certain churches in Rome to which districts were attached, their history being of importance in the evolution of the Roman cardinalate (see Cardinal). It was also used, as now, for a condition precedent to ordination; in the early Roman Church an appointment to officiate in a particular church; this was extended gradually from the idea of locality to that of evidence of means of support. In the Church of England the candidate must have "some certain place where he can exercise his function"; for deacon's orders he must have a nomination to a curacy, and for priest's orders either that or a presentation to a living. A fellowship or chaplaincy at the university of Oxford or Cambridge is also a sufficient "title."

TITLE GUARANTEE COMPANIES, the name given to companies which apply the principle of corporate indemnity to the protection of those interested in real estate titles, either as owners or lenders. They are of the class of indemnity companies in which technical skill and experience in investigation of risks are relied upon to protect the guarantor from loss. They are peculiar to countries where the title to real estate is a matter of public record, and where the complexity of the record and the variety of possible liens and encumbrances have made it difficult and expensive to determine whether the title is good. The only country where they have reached large proportions or achieved success as independent business enterprises is the United States. In Australia no investigation of a title to real estate is necessary, because before the land passed into individual ownership the government adopted a system of state registration and guarantee of title, so that its certificate of registered title was universally accepted. In certain other countries there is neither registration of title nor recording of deeds; the title-deeds are preserved and passed from owner to owner, and are accepted on the authority of the records and opinions of family solicitors. In the United States, however, there have been from the beginning acts providing that all deeds and mortgages be recorded, and the records, when properly made, constitute legal notice to all the world of their contents and claims. At the same time, there are other records of wills, suits, judgments, taxes and mechanics' claims which may encumber the title. In the great cities these various records became in course of time so voluminous that the proper investigation of them, and the determination of the validity of the title in view of them, required the best skill of an experienced lawyer and involved very heavy expenses. On a re-sale of the property the new buyer did not rely upon the lawyer who had made the examination for the seller, but felt called upon to employ and pay his own lawyer, who had to go over the same work again, and more, for with each new transaction the history was getting longer. The delay and expense involved were great, and yet the owner had little or no protection, for a lawyer is not held to guarantee the correctness of his opinion.

The first legislative grant of corporate authority to guarantee titles to real estate was included in the charter of the New York Guaranty and Indemnity Company, a trust company incorporated in New York by act of the legislature in 1864; but the power to guarantee titles was never exercised. In 1869 the Real Estate Assurance Company of the City of New York was chartered with the sole object of insuring the validity of titles, but was never organized. In 1871 a pamphlet was issued by a member of the New York bar, calling attention to the business carried on by the Prussian Mortgage Insurance Company of Berlin, and outlining plans very similar to those now followed by the principal title guarantee companies of the United States; but the pamphlet seems to have been forgotten. The first company actually to undertake the guarantee of real estate titles was formed in Philadelphia, Pennsylvania, in 1876. It differed from the Prussian Mortgage Insurance Company (which guaranteed titles merely as an incident in its business as a dealer in, and custodian and guarantor of, mortgages) in that its main business was the issue of a policy of guarantee on a transfer of title to land. The advantages of its method were immediately recognized. Corporations to carry on the business were organized in Washington, Baltimore, Boston and New York, in the order named, and subsequently in nearly every considerable city in the United States.

In order to be independent of the inaccurate and clumsy methods of the public record offices, title guarantee companies generally compile in their own office a copy or digest of all the real estate records of the locality in which they are established, maintaining for this purpose a staff of skilled clerks. To make the necessary examination of a title prior to the issuing of a guarantee, they require continually a body of experienced real estate lawyers. By these means a title can be examined and guaranteed in a week, whereas thirty or forty days was formerly required. This has done much to make real estate available capital, for individual and corporate lenders on mortgage accept the guarantee of the companies as the best evidence of title, and loans can be had without the delay that once prevailed.

The expense of maintaining the staff of clerks and lawyers is great, amounting to half of the gross charges on titles guaranteed. Strictly speaking, the risks outstanding are also large, running up to $100,000,000 a year for a single company in New York City; but in well-managed companies the losses are very small, not exceeding 2 % of the gross charges on titles guaranteed, so that the outstanding obligations should scarcely be called risks. In spite of the office expenses, the charges for first bringing a piece of land under the guarantee are no more than owners were in the habit of paying each time for examination and opinion by counsel, amounting to about one-half of 1 % on the value of the property or on the amount of the mortgage; and when once the guarantee has been issued, it is re-issued on a subsequent sale or mortgage on short notice and for a small fee. (C. H. K.)

TITLES OF HONOUR, "those various names of greatness or eminency, which are the most distinguishing titles of civil dignity" (John Selden, *Titles of Honor*, 3rd ed., 1672). This definition covers, if we understand "civil" in its proper and widest sense, all titles, whether official or honorary, civil or military, temporal or ecclesiastical. In general, however, we now understand by titles of honour what Selden calls "honorary titles," *i.e.* distinctive designations implying rank and dignity, not office or vocation. The broader definition would cover all titles, including those of military and ecclesiastical rank, of municipal office and of university degrees. The narrower definition, which it is proposed to adopt for the purposes of this article, would cover only what in the United Kingdom are known as the "titled classes," which embrace only those whose titles are meaningless save as a mark of rank. In this category it is, however, necessary to include, somewhat illogically, the highest titles of all—those of sovereigns; for, though they have not been divorced from the functions of sovereignty, they are the fount and source of all the rest. In the present work a large number of titles are dealt with under their several headings (EMPEROR, KING, DUKE, &c.); in this article it is proposed therefore to discuss them only in their general aspect and to attempt some classification of them according to their meanings and origins.

The philosophy of titles is as tempting a subject as Carlyle found the philosophy of clothes. The democrat and the superior man affect to despise them. They point out that the world's greatest men need no such hall-mark to prove they are not base metal; in England they point to such examples as those of Pitt and Gladstone, who, dispensers of titles themselves, lived and died untitled; and they argue that to accept a title is not a sign of "greatness or eminency," but at best of a quality which falls short of this standard. This attitude has some justification in the limitless abuse at all times in the bestowal of titles as a means of bribing those whose ambition looks no higher than to be a "figure among cyphers." But the desire to be taken notice of is an instinct too deeply rooted in human nature for all the satirists that ever lived, or shall live, to eradicate; and of this instinct titles are the most ancient expression, more ancient—it may be hazarded—even than clothes.[1] The French Revolutionists in their zeal for primeval equality essayed to abolish them; at best they succeeded in making them universal, the *citoyens* of the first generation of republican France becoming the *monsieurs* of the next—just as every Englishman is now a "gentleman" or an "esquire," every Castilian a *caballero*, and every German a *Herr*. Similarly, in the democratic countries of the English-speaking world the common style of Mr (master), also once a prerogative of gentle birth, is apt to become too commonplace, and the official prefix of "honourable" is assumed on very slender pretexts. For where titles are not planted, they tend to sow themselves.

Titles are also elaborated under cultivation; for they are apt to degenerate if too widely scattered, and need to be crossed with other varieties to produce a more marketable type. Thus James I. of England produced the baronet (*q.v.*), and the titles of minister plenipotentiary, and envoy extraordinary were combined in the evolution of that fine flower of diplomacy the "envoy extraordinary and minister plenipotentiary," so styled *honoris causa*, since technically he is neither "extraordinary" nor, as such, armed with plenary powers (see DIPLOMACY). These are but two familiar examples of a process which was at one time carried on with a singular earnestness and in a spirit of the keenest competition. Rival sovereigns, by the mouths of heralds and ambassadors, recited the long roll of their styles and titles at each other, in the spirit of Homeric heroes endeavouring to shout down the enemy before coming to blows. The ambassador of Queen Elizabeth to the tsar of Muscovy boggled at the length and complexity of the barbaric emperor's style, and endeavoured to address him by six of his principal titles only, but in the end was forced to repeat the whole (Fletcher, *Russian Commonwealth*, cap. 6). As for the Ottoman sultans, the Oriental imagination of their secretaries was exhausted in adding "exorbitant and swelling attributes" to their styles, which were usually intended to be insulting to those whom they addressed. Thus Ahmed I., writing to Henry IV. of France, describes himself, with very much besides, as "emperor of victorious emperors, distributor of crowns to the greatest princes of the earth, . . . lord of Europe, Asia and Africa."

So far as medieval Europe was concerned, the court of Constantinople, where East and West met, was the forcing-bed of the more extravagant varieties of titles and attributes. Old Rome had granted to its deserving citizens titles of honour, such as *felix*, *pius*, *pater patriae*, besides those which, like *patricius*, denoted hereditary rank. The first emperors were, in theory, merely citizens who alone and in a supreme degree were entitled to be the recipients of these honours. But the *majestas reipublicae Romanae* was soon identified with the person of the emperor. Himself become the fountain of honour, he showered his titular attributes upon those whom it was his whim or his policy to distinguish, while ever fresh styles were invented to illustrate his own unique dignity. For this purpose all the abstract terms in the vocabulary of flattery were put under contribution, not even excepting the lofty attributes of God (*nostra eternitas*, *nostra perennitas*, "most high," "most mighty," "most sacred majesty"). This tendency ran riot when the East Roman Empire had become byzantinized, until by the middle ages there was—to quote Selden— "such innovation of titles as made the dignities of the empire almost ridiculous in those strange and affected compounds."[2]

From the Byzantine court that of the Frankish emperors of the West largely borrowed its forms, and this again set the fashion for the courts of lesser potentates. To this source, then, are due the honorary attributes, if not in all cases the titles, of the sovereigns of modern Europe. Throughout the middle ages, indeed, there was no rigid classification of the abstract attributes (highness, eminence, excellency, honour and the like) addressed in the second and third persons to sovereigns or other dignitaries. These depended very much on the fancy of secretaries eager to display their Latinity—or even a smattering of Greek—by

[1] Many proper names are but primitive titles in disguise: *e.g.* Henry (*q.v.*) = "ruler of the home," or Walter = "lord of power."

[2] *E.g. Sebastocrator*, compounded of σεβαστὸς (augustus) and κρατεῖν (to rule), or *panhypersebastos*.

devising new forms.[1] It was not until the 17th century that they became fixed, under the influence mainly of the newly organized international diplomatic service (see DIPLOMACY). But meanwhile they had developed from the simplicity of the early feudal age[2] into a Byzantine pomposity, the exuberance of which bored even the ceremonious court of Spain into a free use of the pruning knife.[3] Honorary styles are, for the rest, now mere stereotyped formulae; the words that compose them have become—to use Emerson's phrase— "polarized" and deprived of meaning. Not otherwise could a German journalist, late in the 19th century, have recorded, without exciting surprise, that "to-day their All-highest majesties went to church to give thanks to the Highest."[4] The same is more or less true of all titles. They are traditional, and are mainly valued for this reason. An imaginative person might devise a dozen styles in themselves better fitted to express the peculiar eminency of a successful money-lender or a wealthy brewer than the feudal title of baron, or than that of knight to indicate the qualities of a Radical apostle of the gospel of "peace at any price." But the instinct in these matters is to put new wine into old bottles; and, on the whole, the bottles bear the strain. The process is, indeed, very old. William Harrison, in his inimitable style, has left a description of it in the 16th century (see GENTLEMAN), and it was older far than his day. In all ages the new nobility has been looked down upon by the old; but the ancient titles have always in the end adapted themselves to their new users. Long before the *bourgeois* age was dreamed of, dukes as such had ceased to "lead" (*ducere*), marquesses to guard the "marches," *Ritters* to "ride," and no one marked the incongruity of their styles. The process is but continued if, for instance, in the 20th century the title of baron often suggests, not the feudal power of the sword, but the international power of the purse.

Titles have therefore in themselves a world of historical significance. In some the significance is obvious, the history comparatively recent. In others the significance is veiled under obscure etymologies, which carry us back to the very beginnings of social life. We find in these words, too, most singular contrasts of fortune. Caesar, a nickname (*caesaries*) given to some long-haired Roman, grows into a surname which the founder of the empire chanced to bear, and so remains to this day the title of German kaisers and Slavonic tsars, of the king of England as Kaisar-i-Hind and of the sultan of Turkey as Kaisar-i-Rum. The first of the German Caesars bore the name of Karl,[5] which in itself means no more than "man" and in English speech has sunk to the base meaning of "churl" (see CHARLES); for the barbarians beyond the eastern borders of his empire, the Slavs and Magyars who felt the weight of his arm, his name became identified with his office, and remains to this day in the sense of "king" (Mag. *Király*, Slav. *Kral*, Russ. *Korol*).[6] On the other hand, we have the contrary process. The proud title of "count of the stable," once borne by the highest official of the Byzantine court, is now associated in the public mind mainly with humble police officials, in the United States with the humblest of all, the village constable only (see CONSTABLE). Less impressive perhaps is the fate of the title "valet," which, once that of a gentleman, has sunk to be that of a "gentleman's gentleman" (see VALET). The same word, too, develops differently in different languages. The German *Knecht* remains a servant; in England the *cniht* has developed into the knight, just as the *serviens* (servant) survives in the very various modern uses of the title serjeant (*q.v.*). In one exalted case at least we even have a title based on a mistaken etymological deduction. The title "Augustus," *i.e.* sublime or sacred, used originally of persons or places consecrated by the auguries, is derived ultimately, in a passive sense, from *augere*, to increase. This led to the rendering of the Latin title "semper Augustus," borne by the Holy Roman emperors until 1806, in German as "at all times augmenter of the empire" (*zu allen Zeiten Mehrer des Reichs*), a style as ill-grounded in etymology as it was lamentably untrue in fact.[7]

The fortunes of individual titles are outlined in the separate articles devoted to them. Here it only remains to discuss them generally from the point of view of their classification according to origin and general character. Of the styles that are mere attributes—like serene, honourable, reverend—enough has been said; they are but stereotyped courtesies. Most titles proper, on the other hand, have in their origins a deeper significance. The title king, for instance, recalls a remote time when it was borne by right of kinship, as head of a tribe (see KING). Other titles recall that forgotten stage of society in which it was the rule for age to command and youth to obey: such as the French *seigneur*, *sieur*, *sire*, *monsieur*, *monseigneur*; the Italian *signor*, *monsignore*; the Spanish *señor*, and the English "sir," all derived from *senior*, "older" (see MONSIEUR and SIR), itself a Latin translation of a type of title which in the Teutonic languages appears to survive only in the English alderman (*q.v.*). *Seigneur*, *sire* and the rest developed, of course, into the equivalents, not of *senior*, but of *dominus* (lord). But the idea of the title originally must have been the same as that of "elder," like the Arab *sheikh* (*q.v.*) or the *starostas* and *starshinas* of the Russian village communities; the *seniores*, in early feudal times, were the full grown fighting men as opposed to the *pueri* (boys), the unfledged squires and valets. Other titles are derived from the idea of command or rule: such are those of emperor (*q.v.*); the Latin *rex* (*regere*, to rule, guide)—whence the French *roi*, Italian *rè* and the English attributive style "royal"—and from the same common Indo-European root the Indian titles of *raja* and *maharaja*; the title of duke (*q.v.*); the Latin *dominus*, *domina* (originally, a master or mistress in the house, *domus*), whence the modern *dame*, *madame*, *mademoiselle*, *don* and *dom*; the German *Herr* (cf. *herrschen*, to rule); or, to take an Oriental instance, that of *sultan* (Arabic *salat*, to rule). Some titles again are derived from mere ideas of precedence, like that of "prince" (*q.v.*), which may be described as the generic sovereign title; the Spanish title of "grandee" (*q.v.*); or that of "master" (*q.v.*), which as a title of honour survives in Scotland. Very rare are the titles of honour that have their origin in the idea of gentle birth, which indeed, in earlier times, was predicated of all wearers of titles in Europe. The only modern equivalent of the Anglo-Saxon *ætheling* (*q.v.*) in Europe would appear to be the Austrian title of *Edler*, which means, strictly speaking, no more than "noble," though it implies a rank higher than that of the untitled *Adeliger*. The English title "earl" (*q.v.*) has a similar origin, but passed through the stage of an official style as the equivalent of "count." The word "gentleman" (*q.v.*) is not a title, any more than the French *gentilhomme*; it is, in so far as it is used in any definite sense at all, an attribute, like the German *hochwolgeboren* or the Russian *barin*—the equivalent of the Latin *generosus*, "well-born." In the Mahommedan East its equivalent, in the sense of well-born, is the Arabic title *sherīf*,

[1] The papal chancery, however, seems early to have established definite rules. Those sovereigns who had special titles, bestowed or recognized by the pope, such as "Most Catholic King" (Spain) or "Most Christian King" (France), were so addressed. The rest were "Illustrious" (*illustres*).

[2] The only title of mere honour would, *e.g.* in the 12th century, seem to have been *dominus* (*Sire*, *Lord*), which in the Anglo-Norman poem of *Guillaume le Maréschal* is applied to any one of birth, from the king's son of France down to the humblest noble (see SIR).

[3] By the *Pragmatico de los titulos y cortesias* of the 8th of October 1636 King Philip III. decreed that he was to be addressed in letters only as *Señor*, while at the end was to appear no more than "God guard the Catholic person of your Majesty." (Selden p. 103.)

[4] Die Allerhöchsten Herrschaften sind heute in die Kirche gegangen dem Höchsten ihren Dank u.s.w. The sentence is fixed in the writer's memory, but the exact reference is forgotten.

[5] Known traditionally as Charlemagne (*Carolus Magnus*, Karl the Great), the unique instance of a posthumous title of honour being absorbed into a name. Modern English historians have tended to dissolve this immemorial union in the interest of historic accuracy. But "Charles" is only a degree less conventional than Charlemagne.

[6] A parallel case, but more obscure, of a proper name developing into a title is that of the curious title of "Dauphin," ultimately borne only by the heir-apparent to the French throne (see DAUPHIN).

[7] So Rigord, the monk of St Denis, says in his *Gesta* of Philip Augustus, king of France, that he was so styled after the Caesars, who bore the name of Augustus because they augmented the empire. *Unde iste merito dictus est Augustus ab aucta republica.*

now applied only to the descendants of the Prophet. The most characteristic and familiar of English titles, again, that of "lord," carries us back to a very primitive state, when the lord was *par excellence* the "loaf-warden" (*hlaf-ord*, *hlaf-weard*). Here it may be noted that the title "lord" has no foreign European equivalent: the German *Herr* (though *Herrenhaus* is strictly House of Lords), the Italian *signor*, the Spanish *señor*, the Slavonic *pan* and the Greek *κύριος* are all equivocal, being used most commonly in the sense of Mr (Master). Even the French do not translate "lord" by *monseigneur* (though *seigneur* is strictly speaking its equivalent), and still less by *monsieur*, though the ancient custom has survived of using the latter colloquially in place of all titles,[1] but by *milord*. Lastly there are two important European titles derived from personal relations with the sovereign, though they have long ceased to have any such connotation. Of these the oldest is that of "count," which goes back to the *comites* (companions) of the early Roman emperors (see COUNT); the second is "baron," originally meaning no more than "man" and so, under the feudal system, the king's "men" *par excellence*, the great tenants-in-chief of the crown (see BARON). In England the barons formed and form the body of the peerage, "peer" not being a title of honour, but the description of a status and function bestowed by their creation upon all barons, viscounts, earls, marquesses and dukes (see PEERAGE). In France, on the other hand, "peer" (*pair*) was under the old monarchy a title of honour; for not even all dukes were peers of France, and the style of such as were, therefore, ran *duc et pair*.

From the above it will already have become apparent that titles of honour, as they now survive in Europe, are picturesque relics of the feudal system (see FEUDALISM). In theory they are still territorial, and it is the shadowy suggestion of landed estate that gives, in France and Germany, to the nobiliary particles *de* and *von* their mystic virtue.[2] In Great Britain there has been of late years a tendency in the case of some newly made peers to drop the affectation of territorial power. In the case of some titles, *e.g.* Earl Carrington—this merely follows a very ancient English tradition; even under the feudal system after the Norman Conquest it was not unusual for the great nobles to use their titles with their family names or those of their fiefs indifferently; for instance, the Norman earls of Derby described themselves, as often as not, as Earls Ferrers (see DERBY, EARLS OF). Convention, however, dictates that barons and viscounts should, on creation, adopt a territorial style. In the case of such titles as Lord James of Hereford and Lord Morley of Blackburn, this style is adopted from the place of birth; for which a certain precedent might perhaps be pleaded in the medieval custom exemplified in such names for royal princes as "John of Gaunt" or "Henry of Woodstock." On the other hand, there has been also a somewhat absurd tendency to exaggerate the territorial styles by piling one on the top of the other. It would be invidious to mention actual instances; but the process may be illustrated by the imaginary title of Baron Coneyhurst of Ockley.

From the fact that, as feudalism developed, fiefs became hereditary, it comes that most European titles of honour are hereditary. Knighthood alone formed, in general, an exception to this rule. Yet, in their origin, no one of the titles familiar to us were descendible from father to son, and the only hereditary quality was that of abstract nobility. Yet, by a curious inversion of the whole idea of titles of honour, an inherited title has come to be far more valued than one bestowed;[3] it has the peculiarly aristocratic virtue ascribed by Lord Palmerston to the most Noble Order of the Garter: "There is no damned merit about it;" it has the crowning quality that it must needs be the monopoly of the few. Hereditary titles sink in value, indeed, just in proportion as they become common. In the United Kingdom their value has been kept up by the rule of primogeniture: there can be only one bearer of such a title in a single generation. In France custom distributes the various titles of a family among all the sons, the eldest son, for instance, of a duke inheriting his dukedom, the second son his marquisate, the third his countship, and so on. In Germany and Austria titles pass to all the sons in each successive generation, though in Prussia the rule of primogeniture has been introduced in the case of certain new creations (*e.g. Fürst*, prince). The result is that equivalent titles vary enormously in social significance in different countries. An attempt has been made to estimate the extent of this variation in the case of individual titles in articles devoted to them. Here we need only illustrate the argument by one striking example. The Russian title of "prince" (*knyaz*) implies undoubted descent from the great reigning houses of Russia, Poland and Lithuania; but the title descends to all male children, none of whom is entitled to represent it *par excellence*. There may be three or four hundred princes bearing the same distinguished name; of these some may be great nobles, but others are not seldom found in quite humble capacities—waiters or droshky-drivers. The title in itself has little social value.

In the countries east of the marches of the old Empire, *i.e.* Hungary and the Slav lands, existing titles are partly developed from the native tradition (feudal in Hungary, Bohemia and Poland; autocratic and Oriental in Russia and the lands of the Balkan peninsula), partly borrowed from the West, like that of *gróf* (count) in Hungary and *graf* in Russia. Just as in autocratic Russia the sole indigenous title of honour (*knyaz*) is associated with royal descent,[4] so in the Mahommedan East there are, outside the reigning families, no hereditary titles, except that of *sherīf*, already mentioned. In India the hereditary styles of certain great Mahommedan nobles are exceptions that prove the rule; they represent reigning families whose *raj* has been absorbed in the imperial government, and they are still reigning princes in the sense in which the heads of German mediatized houses are so described (see MEDIATIZATION). For the rest, the titles of Oriental princes follow much the same gradation as those of the West. As caliph (*q.v.*), or vicar of the Prophet, the Ottoman sultan is in Islam the equivalent of the pope in Roman Catholic Christendom; his imperial dignity is signified by the Persian title of *padishah* (lord king), his function as leader of a militant religion by the style of "commander of the faithful" (see AMIR). *Shah* is in Persia the equivalent of king; the style of *shah-in-shah*, king of kings, recalls the days of the Persian "great king" familiar in the Old Testament. *Khan* (prince) and *amir* (commander, lord) are other Eastern sovereign titles. Pasha and bey, originally exclusively military titles, are now used also as civilian titles of honour, but they are not hereditary. When the pashalik of Egypt was made hereditary the situation was ultimately regularized by bestowing on the pasha the Persian title of khedive (*q.v.*). In the Far East, Japan has adopted a system of titles, based on her ancient feudal hierarchy, which closely corresponds to that of Europe (see JAPAN). China, on the other hand, stands apart in the curious custom of bestowing titles on the ancestors of persons to be honoured, and in making them hereditary only for a limited number of generations (see CHINA: *Social Customs*). In Europe such posthumous honours are rendered only in the case of saints (see CANONIZATION).

Of ecclesiastical titles of honour it can only be said that they tend to an even greater exaggeration than those bestowed on secular dignities. The swelling styles of the Eastern patriarchs are relics of the days when Rome, Constantinople, Antioch, Alexandria and Jerusalem were vying with each other for precedence (see CHURCH HISTORY and PATRIARCH). The style

[1] *E.g.* Monsieur de la Rochefoucauld, for M. le duc de la R. In the United Kingdom the parallel custom stops short of dukes. All other peers, from marquesses to barons, are commonly spoken of and addressed by the title of lord.

[2] In Germany a distinction is drawn between those titles derived from estates still held by the head of the family and those that are landless. The latter are simply "of" (*von*), the former are "of and at" (*von und zu*).

[3] Thus in the *Instructions* annexed to the commission for the selection of the new order of baronets, King James I. gives these precedence over knights, "because this is a *Dignity*, which shall be *Hereditary*, wherein divers circumstances are more considerable, than such a Mark as is but *Temporary*." (Selden, *op. cit.* p. 685.)

[4] The designation *barin* (boyarin, boyar) is not, properly speaking, a title, but the equivalent of "gentleman."

of the bishop of Rome, who alone in the Western Church retains the name of pope, includes the old Roman titles of *pontifex maximus* and *pater patriae*, and always in his signatures the proudly humble phrase "slave of the slaves of God" (*servus servorum Dei*), based on Matt. xx. 27 (see POPE). Of ecclesiastical titles those expressing orders and no more—priest, deacon, sub-deacon and the rest—are never honorary (Prester John, *q.v.*, is a shadowy medieval exception). Those expressing office, whether in the Church at large (patriarch, archbishop, &c.), or in the papal court (*e.g.* protonotary), are often merely honorary. That of bishop even became for a time, after the Reformation, a title borne by certain secular princes (see BISHOP). "Cardinal," which with the predicate Eminence (*q.v.*) is now reserved for the princes of the Roman Church, was at one time the honorary style of the chief clergy of great cathedrals generally (see CARDINAL). "Abbot," the official title of the head of the monastery, has also in several languages (*e.g.* the French *abbé*) come to be used as a purely honorary title (see ABBOT). For the honorary styles of the clergy in the English-speaking countries, see the articles REVEREND, VICAR, RECTOR, CANON, DEAN. As for the archdeacon, it is only in the Church of England that he can be still defined as "one who performs archidiaconal functions"; elsewhere, if he exists at all, he is purely titular (see ARCHDEACON).

Among titles of honour, finally, may be reckoned honorary degrees bestowed by universities, the pope, and in England by the archbishop of Canterbury. Any degree may be bestowed *honoris causa*. The universities of Oxford and Cambridge thus regularly bestow the degree of D.D. (doctor of divinity) on those of their *alumni* who become bishops. It is also the custom to bestow honorary degrees at the yearly "Commemoration" (generally D.C.L., doctor of civil law, at Oxford; LL.D., doctor of laws, at Cambridge) on a selected list of eminent personages. The right of the archbishop of Canterbury to confer degrees *honoris causa*, known as "Lambeth degrees," is supposed to be derived from one of his powers as *legatus natus* of the pope, which survived the Reformation. An attempt was made by some of the Swiss reformers of the 16th century to abolish degrees. They were certainly "popish" in their origin, and others besides Herbert Spencer have objected to them as misleading, since they are by no means necessarily a hall-mark of learning. They tend, however, to multiply rather than to decrease in number, and in England some criticism has been aroused by the growing custom in certain quarters of assuming degrees (notably that of D.D.) granted corruptly, or for wholly insufficient reasons, by certain so-called "universities," notably in the United States. For a list of the degrees of the principal universities and their hoods, see UNIVERSITIES, *ad fin.*

The history of many peerage and other titles is outlined in the articles on historic families in this work. For British peerage titles the standard work is G. E. C. (okayne)'s *Complete Peerage* (1st ed., 8 vols., 1887; new ed., vol. i., 1910). For baronets and others see the manuals of Burke and Debrett. The standard authority for the royal houses and "high nobility" of Europe is the *Almanach de Gotha*, published yearly. See also the article NOBILITY, and for further references the authorities attached to those on individual titles, *e.g.* COUNT. (W. A. P.)

TITMOUSE (O. Eng. *mase* and *tylmase*, Ger. *Meise*, Swed. *mes*, Du. *mees*, Fr. *mésange*), the name[1] long in use for several species of small English birds, which are further distinguished from one another by some characteristic appellation. These go to make up the genus *Parus* of Linnaeus, and with a large number of other genera form the Passerine family Paridae. Titmice are usually non-migratory, and the genus *Parus* occupies most of the globe except South America and the Australian region east of Lombok and Flores.

[1] The prefix "tit" by heedless writers often used alone, though equally proper to the titlark (see PIPIT), is perhaps cognate with the Greek τιτίς, which originally meant a small chirping bird (*Ann. Nat. Hist.*, 4th series, vol. x. p. 227), and has a diminutive form in the Icelandic *Titlingur*—the English or at least Scottish *titling*. It is by false analogy that the plural of titmouse is made titmice; it should be titmouses. A nickname is very often added, as with many other familiar English birds, and in this case it is "tom."

Among the more common European and English forms the first to be mentioned is that called, from its comparatively large size, the great titmouse, *P. major*, but known also in many parts as the oxeye,[2] conspicuous by its black head, white cheeks and yellow breast, down which runs a black line, while in spring the cock makes himself heard by a loud love-note that resembles the noise made in sharpening a saw. It is widely distributed throughout the British Islands and over nearly the whole of Europe and northern Asia. The next is the blue titmouse, bluecap or nun, *P. coeruleus*, smaller than the last and more common. Its names are so characteristic as to make any description needless. A third common species, but not so numerous as either of the foregoing, is the coal-titmouse, *P. ater*, distinguished by its black cap, white cheeks and white nape. Some interest attaches to this species because of the difference observable between the race inhabiting the scanty remnants of the ancient Scottish forests and that which occurs throughout the rest of Britain. The former is more brightly tinted than the latter, having a clear bluish-grey mantle and the lower part of the back greenish, hardly either of which colours are to be seen in the same parts of more southern examples, which last have been described as forming a distinct species, *P. britannicus*. But it is to be observed that the denizens of the old Scotch fir-woods are nearly midway in coloration between the dingy southern birds and those which prevail over the greater part of the continent of Europe. It would therefore seem unreasonable to speak of two species only: there should be either three or one, and the latter alternative is to be preferred, provided the existence of the local races be duly recognized. Much the same thing is to be noticed in the next species to be mentioned, the marsh-titmouse, *P. palustris*, which, sombre as is its plumage, is subject to considerable local variation in its very extensive range, and has been called *P. borealis* in Scandinavia, *P. alpestris* in the Alps, and *P. lugubris* in south-eastern Europe, to say nothing of forms like *P. baicalensis*, *P. camchatkensis* and others, whose names denote its local variations in northern Asia, while no great violence is exercised if to these be tacked on *P. atricapilla*, with several geographical races which inhabit North America. A fifth British species is the rare crested titmouse, *P. cristatus*, only found in limited districts in Scotland, though common enough, especially in pine-woods, in many parts of Europe.

In addition to species of *Parus*, North America possesses two peculiar genera of tits—*Psaltriparus* and *Auriparus*. During the greater part of the year the various species of the genus *Parus* associate in family parties and only break up into pairs at the beginning of the breeding season. The nests are nearly always placed in a hollow stump, and consist of a mass of moss, feathers and hair, the last being worked almost into a kind of felt. Thereon the eggs, often to the number of eight or nine, are laid, and these have a translucent white shell, freckled or spotted with rust colour. The first plumage of the young closely resembles that of the parents; but, so far as is known, it has always a yellower tinge, very apparent on the parts, if there be such, which in the adult are white. Few birds are more restless in disposition. Most of the European species and some of the North American become familiar, haunting the neighbourhood of houses, especially in winter, and readily availing themselves of such scraps of food, about the nature of which they are not particular, as they can get.[3] By gardeners every titmouse is generally regarded as an enemy, for it is supposed to do infinite damage to the buds of fruit-trees and bushes; but the accusation is wholly false, for the buds destroyed are always found to be those to which a grub—the bird's real object—has got access, so that there can be little doubt that the titmouse is a great benefactor to the horticulturist.

Akin to the genus *Parus*, but in many respects differing from it, is *Acredula*, containing that curious-looking bird the long-tailed or bottle titmouse, with many local races or species. The bird itself, having its tail longer than its body, is unlike any other found in the northern hemisphere, while its nest is a perfect marvel of construction, being in shape nearly oval, with a small hole in one side. The exterior is studded with pieces of lichen, worked into a firm texture of moss, wool and spiders' nests, and the inside is profusely lined with soft feathers—2379 having been, says Macgillivray, counted in one example. Not inferior in beauty or ingenuity is the nest built by the penduline titmouse, *Aegithalus pendulinus*, of the south of Europe, which differs, however, not merely in composition, but in being suspended to a bough, while the former is nearly always placed between two or more branches.

The so-called bearded titmouse, *Panurus biarmicus*, has habits wholly unlike those of any of the foregoing, and is now placed in

[2] The signification of this name is obscure. It may perhaps be correlated with a Swedish name for the bird—*Talgoxe*.

[3] Persons fond of watching the habits of birds may with little trouble provide a pleasing spectacle by adopting the plan, practised by the late A. E. Knox, of hanging a lump of suet or tallow by a short string to the end of a flexible rod stuck aslant into the ground close to the window of a sitting-room. It is seldom long before a titmouse of some kind finds the dainty, and once found visits are made to it until every morsel is picked off. The attitudes of the birds as they cling to the swinging lure are very diverting, and none but a titmouse can succeed in keeping a foothold upon it.

a separate Passerine family—Panuridae. It was formerly found in many parts of England, especially in the eastern counties, where it bore the name of reed-pheasant;[1] but through the draining of meres, the destruction of reed-beds, and the rapacity of collectors it now exists in few localities. It is a beautiful little bird, of a bright tawny colour, variegated with black and white, while the cock is further distinguished by a bluish grey head and a black tuft of feathers on each side of the chin. Its chief food seems to be reed-seeds and the smaller kinds of fresh-water molluscs, which it finds among the reed-beds it seldom quits.

The general affinities of the Paridae seem to lie rather with the Sittidae (see NUTHATCH) and the tree-creepers. (A. N.)

TITUS, one of the companions of St Paul, was of Greek origin (Gal. ii. 3), and was perhaps a native of Asia Minor. He appears to have been among the apostle's earliest converts, being first mentioned (Gal. ii. 1) as having accompanied Paul and Barnabas to Jerusalem (cf. Acts xv. 2) "to represent the success of the Pauline gospel outside Judaism." Here the conservative section demanded that he should be circumcised; but Paul successfully opposed this (see PAUL). Subsequently he came into close connexion with the Achaean churches and especially with Corinth, bearing letters from Paul and being charged with promoting the proposed collection for poor Christians in Judaea. In these matters he proved himself a trusty lieutenant, winning the esteem of the Corinthians by his zeal and disinterestedness. The liberality which a generation later was recognized by Clement of Rome as a traditional virtue of the Corinthian Church owed its inception to Titus. In the epistle with which his name is associated he is represented (Titus i. 5) as having been left by Paul in Crete to "set in order the things that are wanting, and ordain elders in every city." He is expected afterwards to join Paul at Nicopolis (iii. 12). In 2 Tim. iv. 10 he is spoken of as having gone (perhaps on a mission) to Dalmatia. Tradition, obviously resting on the Epistle to Titus, has it that he died in Crete as bishop at an advanced age; another line connects him with Venice. Attempts to make him the author of the "We" sections in Acts and to include him in the seventy disciples are futile. There is more to be said for the suggestion that he was the brother of St Luke.

See A. Souter and E. P. Boys-Smith in *The Expository Times*, xviii. 285, 335, 380.

TITUS, THE EPISTLE TO, in the New Testament, an epistle which purports to have been written by Paul to Titus (i. 1–4), who is in charge of the local churches at Crete (i. 5). The younger man is reminded of the qualifications which he is to insist upon in officials (i. 5–16), in view of current errors,[2] doctrinal and moral. The genuine teaching, or "sound doctrine," which he is to propound (ii. 1, seq.), is then outlined, with regard to aged men and women, younger men and slaves especially.[3] After a postscript (iii. 8–11), reiterating the counsels of the letter, with particular reference to the outside public, some personal notices are briefly added (iii. 12–13), and, with some final exhortations, the epistle ends.

The origin of Christian missions in Crete is obscure. A strong Jewish element existed among the population (cf. i. 13 seq., iii. 9), which explains the particular hue of the local heresies as well as, perhaps, the initial efforts of a Christian propaganda (cf. Acts ii. 11). The geographical situation of the island also favoured an early introduction of the new faith. "Crete was a great wintering place" for vessels (cf. Acts xxvii. 12 seq.) working their slow way to Rome along the southern coast of the Mediterranean,[4] so that the possibility of Jewish Christian evangelists having reached it before long is to be granted freely.

[1] The common names given to this bird are so very inapplicable that it is a pity that "silerella" (from *siler*, an osier) bestowed upon it by Sir T. Browne, its original discoverer, cannot be restored.

[2] On the somewhat harsh estimate of the Cretans in i. 12 see Dr J. Rendel Harris in *Expositor* (7th series, vol. ii. p. 305 seq.). The other features noted in the epistle, their turbulence, drunkenness and greed, all happen to be verified in the pages of ancient writers like Polybius.

[3] On the sub-Pauline tone of iii. 5 cf. Sokolowski's *Geist und Leben bei Paulus* (1903), p. 108 seq.

[4] Cf. W. M. Ramsay: *Pauline and other Studies* (1907), p. 76, Hoennicke's *Das Judenchristentum* (1908), p. 156 seq., and Harnack's *Mission and Expansion of Christianity*, ii. 229–230 (2nd ed., 1908).

It is more difficult to determine when Paul can have visited the island and left Titus behind him. Attempts have been made to find a setting for the epistle within the apostle's life previous to his Roman imprisonment (as recorded in Acts), but by common consent[5] it is now held that the epistle (if written by the apostle) must fall later, during the period of missionary enterprise which is supposed to have followed his release from the first captivity. Like the epistles to Timothy, the Epistle to Titus thus belongs to a phase of the apostle's life for which we possess no other contemporary evidence. The second imprisonment of Paul, after a period of freedom following his acquittal, is an historical hypothesis (cf. the statement in Steinmetz's *Die zweite röm. Gefangenschaft des Paulus*, p. 46 seq.), which is absolutely essential to the Pauline authorship of the pastorals. It is indeed supported by several critics who reject the latter, just as it is occasionally rejected by advocates of their authenticity. But, upon the whole, such evidence from early tradition as can be adduced from the 2nd century seems no more than an expansion of Paul's language in Rom. xv. 24, 28. The pastorals themselves never mention any mission in Spain. Spanish tradition is silent on the fact, and the allusion to the "west" (in Clem. Rom. v.) can be interpreted at least as fairly of Rome as of Spain. The entire problem is not without its difficulties still, after all the research lavished upon it, but the probabilities seem to converge upon the conclusion that Paul was never released from his imprisonment, and consequently that he never revisited the East.

The internal criticism of the epistle starts from i. 7–9, which is plainly an interpolation, perhaps from the margin, upon the qualifications of *episcopoi*. On the other hand a passage like iii. 12–13 is indubitably a Pauline fragment, and the problem for the critic is to determine whether in the epistle as a whole we have a redacted and interpolated edition of what was originally a note from the hand of Paul, or whether the epistle drew upon some Pauline tradition (connecting Titus with Crete) and material, and was afterwards interpolated at i. 7–9. The latter hypothesis seems more probable, upon the whole, although there is little to choose between the two. The substantially Pauline character of the epistle, for all practical purposes, is to be granted upon either hypothesis, for the author or the editor strove not unsuccessfully, upon the whole, to reproduce the Pauline spirit and tradition.[6] The older notion that the personal data in Titus, or in the rest of the pastorals, were invented to lend verisimilitude to the writing must be given up. They are too circumstantial and artless to be the work of a writer idealizing or creating a situation. Thus, in the present epistle, a passage like iii. 12–13 is palpably genuine. But it is another question whether other passages can be added to it (*e.g.* i. 1 seq., 5–6, 12–13*a*, 16, iii. 1–7, 15, by Hesse; i. 1, 4, iii. 15, by von Soden; i. 1–6?, iii. 1–7, by McGiffert), in order to reconstruct a more or less independent note from Paul's own pen.

It seems improbable that Titus or any of the pastorals is directed against any one phase of contemporary heresy.[7] The prohibition of marriage (1 Tim. iv. 3) was common to Marcion and Apelles, while the injunction of fasting[8] is attributed to the Encratites (Iren. *Adv. Haer.* i. 28, 1) and to Saturninus of Antioch in Syria (ibid. 1. 24, 3), the latter being also credited with having been the first to introduce a dualism into humanity, which made God send his Saviour to destroy the evil and redeem the good, both classes having been formed by the angels (cf. Titus ii. 11; 1 Tim. iv. 10). The exhaustive discussions on this point (cf. Bourquin, pp. 55 seq.) have led most scholars to the conclusion that no one system of 2nd-century gnosticism is before the writer's mind. He is maintaining Paul's rôle. He makes the apostle prophesy, vaguely of course, the evil tendencies which were to come upon the church; but the internal evidence,

[5] W. E. Bowen, Professor Bartlet (*Apostolic Age*, pp. 178 seq.; cf. also article on PAUL), Lisco (*Vincula sanctorum*, 1900) and Laughlin are the only recent exceptions, and their conjectural schemes are mutually destructive. The common style of the epistles forbids any dispersion of them over a term of years. They stand or fall together, as critics of all schools are practically agreed. The impossibility of placing them within the period of Acts is best known by Hatch, Bourquin (pp. 10–25), Bertrand (23–47) and von Soden.

[6] The historical site for iii. 12–13, as well as for the tradition which forms the setting of the epistle, is probably to be sought in the neighbourhood of Acts xx. 3 (so Krenkel). Clemen dates iii. 12–13 from Macedonia after 2 Cor. x.–xiii., i.–ix., previous to Romans (in A.D. 59).

[7] Essenism, blended with Ebionitism, is the plausible conjecture of Schleiermacher, Neander and Mangold, but the Essenes do not seem to have prohibited marriage so dogmatically.

[8] Asceticism was bound up with the gnostic depreciation of the body. By a natural recoil it produced licentiousness of conduct which the pastorals hotly denounce.

together with the impossibility of placing the epistles later than the first ten or twenty years of the 2nd century, render it impracticable to detect anything except incipient phases of syncretistic gnosticism behind the polemical allusions. It was a gnosticism fluctuating not only in its relation to the Church but in its emphasis upon certain ethical and theosophical ideas. One definite trait is its Jewish character (Titus i. 10; 2 Tim. iii. 16; 1 Tim. i. 7, &c.). The errorists developed speculations and practical theories on the basis of the Old Testament law, which proved extremely seductive to many Christians. But it is difficult to find any homogeneity in the repeated descriptions of this semi-gnostic phase, although now and then (*e.g.* in 1 Tim. i. 7 seq.; Titus i. 14, iii. 9) there are suggestions of the legalism which Cerinthus advocated. The Ophites are said to have not only used myths but forbidden marriage and held that the resurrection was purely spiritual (Lightfoot); this, however, is probably no more than an interesting coincidence, and all attempts to identify the errorists definitely must be abandoned.[1] The early Fathers often indeed identify them with later types of gnosticism, but this cannot be taken as any sure clue to the author's meaning. They naturally found in his prophetic words the anticipation of heresies current in their own age.

Sometimes, as in the cases of the resurrection being allegorized[2] and marriage repudiated,[3] it is feasible to detect distortions or exaggerations of Paul's own teaching, against which the Paulinist of the pastorals puts in a caveat and a corrective. But these somewhat "indiscriminate denunciations are certainly not what we expect from a man like Paul, who was an uncommonly clear-headed dialectician" (McGiffert). They partake of the nature of a pastoral manifesto, which does not trouble to draw any fine distinctions between the principles or motives of its opponents. The method resembles that of the First Epistle of John, for although the errorists attacked in the latter manifesto are not those of the pastorals, and although the one writer eschews entirely the inner authority of the Spirit which the other posits, the same anti-gnostic emphasis on practical religion and stereotyped doctrine is felt in both.

LITERATURE.—Special monographs on Titus have been written by Jerome, Casper Cruciger (*Expositio brevis et familiaris*, 1542), Mosheim (*Erklärung des Briefs an Tit.*, 1779), and Kuinoel (*Explicatio epist. Pauli ad Titum*, 1812). Commonly, however, the epistle has been edited and criticized along with the epistles of Timothy. The ablest recent editions are by B. Weiss (in Meyer's *Commentar*, 7th ed., 1902; full and exact), Wohlenberg (in Zahn's *Commentar*, 1906), and J. E. Belser, the Roman Catholic savant (1907), with which may be ranked Wace's (*Speaker's Commentary*, 1886) and J. H. Bernard's (*Cambridge Greek Testament*, 1899) editions. All these present the conservative position. On the other side, Von Soden's *Hand-Commentar* (2nd ed., 1893) and Franz Koehler's popular commentaries *Die Schriften des N. T.* (1906) are most notable. Brief English notes are furnished by Horton (*Century Bible*, 1901, from Zahn's standpoint) and J. P. Lilley (Edinburgh, 1901). Of the older editions, the most valuable are Heydenreich's (*Die Pastoralbriefe*, 1826–1828), Alford's (3rd ed., 1862), Huther's (3rd ed., Göttingen, 1866), Bisping's (1866), P. Fairbairn's (Edinburgh, 1874), Ellicott's (5th ed., 1883, strong in exegesis) and Knoke's (in Lange's *Bibel-Werk*, 4th ed., 1894), with Riggenbach's (in the Strack-Zöckler *Commentar*, 1897). Editions in English have recently been undertaken in the *International Critical Commentary* (by W. Lock), in the *Expositor's Greek Testament* (by N. J. D. White), and by Sir W. M. Ramsay. For the patristic literature see Wohlenberg (*op. cit.* p. 76).

For the view that a Paulinist was the author, see Schleiermacher, *Über den sogen. ersten Brief des Paulus an den Tim.* (1807), which really opened the modern phase of criticism on all three epistles; Baur, *Die sogenannten Pastoralbriefe des Apostels Paulus* (1835); H. J. Holtzmann, *Die Pastoralbriefe kritisch u. exegetisch behandelt* (1880), an exhaustive treatment; Hilgenfeld, *Zeitschrift für die wiss. Theologie* (1897), 49 seq., 61 seq., 79 seq.; E. Y. Hincks, *Journal of Bibl. Literature* (1897), 94–117; and Renan, *S. Paul* xxiii.–liii., *L'Église chrétienne*, ch. v. The conservative position is maintained with varying confidence by C. W. Otto, *Die geschichtlichen Verhältnisse der Pastoralbriefe* (1860); Bertrand, *Essai critique sur l'authenticité des ép. pastorales* (1888); G. G. Findlay, appendix to Eng. trans. of Sabatier's *L'Apôtre Paul*, pp. 341 seq.; W. E. Bowen, *Dates of Pastoral Letters* (1900); T. C. Laughlin, *The Pastoral Epp. in the Light of one Roman Imprisonment* (California, 1905); and J. D. James, *The Genuineness and Authorship of the Pastoral Epistles* (1906). For general studies, see Schenkel's *Bibel-Lexicon*, iv. 393–402; Sabatier's article in *Ency. des sciences religieuses*, x. 250–259; J. R. Boise, *The Epp. of Paul written after he became a Prisoner* (New York, 1887); Plummer, *Expositor's Bible* (1888); Bourquin, *Étude critique sur les past. épîtres* (1890); Harnack, *Die Chronologie*, 480 seq., 710–711; Moffatt, *Ency. Bib.*, 5079–5096, and W. Lock (Hastings's *Dict. Bible*, vol. iv.). (J. MT.)

[1] Clemen (*Paulus* i. 148) distinguishes broadly between the errorists of 2 Tim. and those controverted in the other two epistles. The former, he argues, are in the last resort libertinists and antinomians; the latter must be regarded as ascetic Judaists.

[2] 2 Tim. ii. 18. Paul's teaching about the believer being already risen with Christ gave a welcome handle to the later Gnostics. The passage in John v. 28–29 seems a correction of the possible inferences which might be drawn from such teaching in Paul and in the Fourth Gospel itself.

[3] Cf. Von Dobschütz, *Christian Life in the Primitive Church* (pp. 261 seq.).

TITUS, FLAVIUS SABINUS VESPASIANUS, Roman emperor from A.D. 79–81, son of the emperor Vespasian, was born on the 30th of December A.D. 40 (or 41). He was educated in the imperial court, and thoroughly accomplished: he could speak Greek fluently and compose verses; he was a proficient in music; he could write shorthand, and imitate handwriting so skilfully that he used to say that he might have been a most successful forger. He was handsome and commanding, and had a vigorous frame, well trained in all the exercises of a soldier. As a young man he served with credit in Germany and in Britain. Soon he had the command of a legion, and joined his father in Syria, where he took an active part in the Jewish War. In 68 he was sent by his father to congratulate the newly proclaimed emperor, Galba; but, hearing of Galba's death and of the general confusion in the Roman world, he returned to Palestine, having in the meantime consulted the oracle of the Paphian Venus and received a favourable answer. In the following year Vespasian, having been proclaimed emperor, returned to Italy, and left Titus to carry on the siege of Jerusalem, which was captured on the 8th of September 70. On his return to Rome, Titus and his father celebrated a magnificent triumph, which has been immortalized by the so-called Arch of Titus. He was now formally associated with his father in the government, with the title of Caesar, and during the nine remaining years of Vespasian's reign he was in fact emperor. He was anything but popular; he had the character of being profligate and cruel. His connexion with Berenice, the sister of the Agrippa of the *Acts of the Apostles*, also created a scandal; both brother and sister followed Titus to Rome, and were allowed to reside in the imperial palace. Public opinion was outraged, and Titus, though he had promised Berenice marriage, felt obliged to send her back to the East. Vespasian died in 79, leaving his son a safe throne and a well-filled treasury. The forebodings of the people were agreeably disappointed, for Titus put an end to prosecutions for high treason, and the *delatores* (informers) were scourged and expelled from the city. He assumed the office of pontifex maximus, in order that he might keep his hands free from blood. He forgave his brother Domitian, who more than once plotted against his life, and having let a day pass without bestowing a present, he exclaimed, "I have lost a day."

Titus, like his father, spent money in adding to the magnificence of Rome. The Flavian amphitheatre (later called the Colosseum) was completed and dedicated in his reign, with combats of gladiators, shows of wild beasts, and representations of some of the great Greek naval battles. He gave the city splendid baths, which surpassed those of Agrippa and of Nero, and supplied the mob with every kind of luxury.

During his reign, in 79, occurred the eruption of Vesuvius which destroyed Herculaneum and Pompeii. The emperor visited the scenes and contributed liberally to the relief of the distressed inhabitants. During his absence a fire raged for three days at Rome, in which the new temple of Jupiter Capitolinus, the library of Augustus, and other public buildings were burnt; then followed a pestilence, and Titus again assisted freely with his purse. Italy and the Roman world were peaceful during his reign. The only fighting was in Britain under Agricola, who in the year 80 carried the Roman arms as far as the Tay. Titus died on the 13th of September 81. The verdict of history is favourable to him, but the general feeling throughout the Roman world was that he had been fortunate in the briefness of his reign.

See Suetonius, *Titus*: Dio Cassius lxvi. 18–26; C. Beulé, *Titus et sa dynastie* (1870); L. Double, *L'Empereur Titus* (1877); Merivale, *Hist. of the Romans under the Empire* (ch. 60); H. Schiller, *Geschichte der römischen Kaiserzeit*, i. pt. 2.

TITUS TATIUS, in Roman legend, the Sabine king of Cures, who waged war upon the Romans to avenge the rape of the Sabine women (see ROMULUS). After various indecisive conflicts the latter, who had become Roman matrons, intervened and prevailed upon the combatants to cease fighting. A formal treaty was then arranged between the Romans and Sabines, whereby Romulus and Tatius were to be joint and equal rulers of the Roman people. Rome was to retain its name and each citizen was to be called a Roman, but as a community they were to be called Quirites (*q.v.*); the Sabines were to be incorporated in the state and admitted into the tribes and curies. After this arrangement had lasted for five years it came to an end by the death of Tatius, who was killed out of revenge by the inhabitants of Lavinium. According to Mommsen, the story of his death, (for which see Plutarch) looks like an historical version of the abolition of blood-revenge. Tatius, who in some respects resembles Remus, is not an historical personage, but the eponymous hero of the religious college called Sodales Titii. As to this body Tacitus expresses two different opinions, representing two different traditions: that it was introduced either by Tatius himself to preserve the Sabine cult in Rome; or by Romulus in honour of Tatius, at whose grave its members were bound to offer a yearly sacrifice. The *sodales* fell into abeyance at the end of the republic, but were revived by Augustus and existed to the end of the 2nd century A.D. Augustus himself and the emperor Claudius belonged to the college, and all its members were of senatorial rank. Varro derives the name from the *Titiae aves* which were used by the priests in certain auguries.

See Livy i. 10–14; Tacitus, *Annals*, i. 54, *Hist.* ii. 95; Dion. Halic. ii. 36–52; Plutarch, *Romulus*, 19–24; Marquardt, *Römische Staatsverwaltung* (1885) iii. 446; Schwegler, *Römische Geschichte*, bk. ix. 3, 14; x. 5.

TITUSVILLE, a city of Crawford county, Pennsylvania, U.S.A., on Oil Creek, about 42 m. S. by E. of Erie. Pop. (1900), 8244, of whom 1573 were foreign-born; (1910 census) 8533. Titusville is served by the Dunkirk, Allegheny Valley & Pittsburg, and the Pennsylvania railways. It has the Benson Memorial library (1904), and in Woodlawn Cemetery there is a monument (erected by Henry H. Rogers in 1902) to Colonel Edwin L. Drake (1819–1880), who here sank the first oil well (69½ ft. deep) in America in August 1859 and who is buried here. Titusville was the principal centre in Pennsylvania of the opposition to the Standard Oil Company; but after 1875, when John D. Archbold (b. 1848), a leader of the independents, became a director of the Standard, few of the Titusville operators remained independent. It was in the Titusville district that the natural gas industry of Pennsylvania was first established about 1872.

There are various manufactures, and in 1905 the value of the factory products was $3,249,890. The first settlement was made here in 1796 by Samuel Kerr and Jonathan Titus (in whose honour the place was named). Titusville was incorporated as a borough in 1847 and was chartered as a city in 1866. On the 5th of June 1892 Oil Creek rose suddenly, overflowed its banks and wrecked many oil tanks along the bottom-lands. A large part of the water was covered with oil, which soon caught fire. About 60 persons were drowned or burned to death, and about a quarter of the city was destroyed.

TIVERTON, a market town and municipal borough in the Tiverton parliamentary division of Devonshire, England, situated amid beautiful scenery at the confluence of the Loman and Exe, 187¾ m. W. by S. of London by the Great Western railway. Pop. (1901), 10,382. The upper town is built on high ground along the left bank of the Exe, and a bridge leads to the lower town, named West Exe. St Peter's church, originally consecrated as a chapel by Leofric, bishop of Exeter, in 1073, is a beautiful Perpendicular building. Its high tower has four stages, each adorned with grotesques; and Greenway's chapel, built in 1517 by John Greenway, a wool merchant of Tiverton, is ornamented with figures minutely carved in stone. Of the original Norman fabric only a doorway remains. Within are some fine carvings, brasses and monuments. Of the castle, founded about 1105 by Richard de Redvers, the banqueting-hall, a tower, the chapel and a 14th-century gateway remain. After serving as the home of the Redvers and Courtenay families, earls of Devon, until the 16th century, the castle was dismantled by Fairfax. Partly rebuilt, it is used as a dwelling-house; while in its gardens an annual race-meeting is held in August. Blundell's grammar school, founded under the will of Peter Blundell, a rich cloth merchant, in 1604, has modern buildings outside the town in Tudor style; and, among others, scholarships at Balliol College, Oxford, and Sidney Sussex College, Cambridge. The number of boys is about 230. The Chilcott Free School was established in 1611, and the Bluecoat Charity School, dating from 1714, was reorganized in 1876 to give secondary education to boys and girls. After the decline of its woollen trade Tiverton became noted for the lace manufacture introduced by John Heathcoat (1783–1861), inventor of the bobbin net frame. There are also breweries, flour-mills, and a large trade in farm produce and livestock. Amicia, countess of Devon, brought a stream of water from Norwood, 5 m. distant. This system was improved in the 19th century. Hannah Cowley, the dramatist (1743–1809), Richard Cosway, the miniature painter (b. 1742) and John Cross, an artist of some celebrity (b. 1819), were natives of Tiverton. The town is governed by a mayor, 6 aldermen and 18 councillors. Area, 17,680 acres.

Tiverton (*Tuyverton*, *Tovretona*) exhibits traces of very early settlement, and is mentioned under the name of Tuyford in the will of King Alfred. In the Domesday survey it appears as a royal manor containing two mills, but it was bestowed by Henry I. on Richard de Redvers, and in 1245 appears as a mesne borough under Baldwin de Redvers, who in that year obtained a grant of a Monday market and a three days' fair at the feast of St James. In 1275 Amicia, countess of Devon, claimed to hold fairs at Tiverton at the feasts of St Andrew and St Giles, and at the translation of St Thomas the Martyr. In 1618 the borough received its first charter of incorporation from James I., instituting a governing body of a mayor, 12 chief burgesses, and 12 assistant burgesses, with a recorder, deputy-recorder, town-clerk and two serjeants-at-mace; a court of record every fortnight on Tuesday; and fairs at Michaelmas and on the second Tuesday after Trinity Sunday, which were kept up until within the last fifty years. The borough also sent two representatives to parliament until disfranchised by the Reform Act of 1885. Cromwell in 1655 changed the market day from Monday to Tuesday. Fresh charters of incorporation from James II. in 1689 and from George I. in 1724 left the style and constitution of the governing body unchanged. Tiverton was an important centre of the woollen trade in the 16th century, and Risdon, writing in 1608, describes it as thronged with rich clothiers, and the Monday market famous for its kersies, known as "Tiverton kersies," while as late as the reign of George II. the town had 56 fulling-mills; but about this time the industry began to decay, and is now extinct.

See *Victoria County History: Devonshire*; M. Dunsfold, *Historical Memoirs of the Town and Parish of Tiverton* (Exeter, 1790); W. Harding, *History of Tiverton* (1845–1847).

TIVOLI (anc. *Tibur*, *q.v.*), a town and episcopal see of the province of Rome, Italy, 18 m. E.N.E. of Rome by road and tramway, 24½ m. by rail, 760 ft. above sea-level. Pop. (1901), 11,610 (town), 12,881 (commune). Tivoli lies on the west of the Sabine Mountains, where the river Anio issues from them, upon a limestone rock above the river. The town on one side overlooks the Campagna di Roma and Rome itself, on the other the deep gorge of the Anio, with its lofty falls, and the environs are very beautiful. The Roman remains are described under the heading of TIBUR. The Villa d'Este, begun in 1549 by Pirro Ligorio for Cardinal Ippolito d'Este the younger (the cardinal of Ferrara), has the finest example of a Renaissance garden in Italy; it was erected on a steep slope, with many terraces, and embellished with numerous fountains, fantastically decorated in stucco, which once formed the background to the splendid collection of ancient statuary formed by the cardinal, but now dispersed (see F. S. Seni, *La Villa d'Este in Tivoli*, Rome, 1902; T. Ashby, in *Archaeologia*, vol. lxi.). The villa contains damaged frescoes by the brothers Zuccari. The register of the see of

Tivoli has documents dating from the 10th century relating to the landed property of the see (L. Bruzza, *Regesto della chiesa di Tivoli*, Rome, 1883), and the municipal archives date from 1450. The castle was erected in 1460 by Pius II. on the site of the amphitheatre; it is now a prison. In November 1826 a flood of the Anio led to a change in its course, and threatened to carry away the town. A new channel, consisting of two parallel tunnels (the Traforo Gregoriano) 290 and 330 yds. long, was therefore made to the north-east in 1826–1835 by Folchi, and on emerging from these the river has a fall of 354 ft. Farther north-west are smaller falls (the *cascatelle*) of that portion of the river which is carried through the town and serves for industrial purposes. Five miles west are the sulphur baths of Acque Albule, which were known to the ancients, and are now frequented by over 40,000 persons annually. The temperature of the water is 75·2° F. The falls in the river afford electric power for lighting Rome and driving its trams, as well as for driving several factories in Tivoli itself. Tivoli is also the centre of an agricultural district, and its olive trees are especially fine.

TLAXCALA, an inland state of Mexico, bounded N.E. and S. by Puebla, and W. by the state of Mexico. Area 1505 sq. m. Pop. (1900), 172,315. Tlaxcala lies on the great central plateau of Mexico and has a mean altitude of about 7000 ft. Several mountains rise in the west and south, culminating in the volcanic peak of Malinche, or Malintzin (14,636 ft.). The state has three railway lines crossing its territory. The capital is Tlaxcala and the principal towns are Chiautempan (about 5000), Calpulalpan, San Antonio, Tlaxco, Huamantla and Barron-Escandon (Apizaco). The state nearly coincides with the ancient Indian republic founded in the 13th century by a branch of the Nahuatlan race, who migrated from the western shores of Lake Texcoco. Though surrounded on all sides by the great Aztec Empire, the tiny republic maintained its independence until the arrival of the Spaniards. The Tlaxcaltecs, or Tlascalans, after a fierce resistance to Cortés in 1519, became efficient allies of the Spaniards and contributed largely to their final success. The present inhabitants are chiefly of this original stock, and retain their language and many ancient customs.

TLAXCALA, a town of Mexico, capital of a state of the same name, on the Atoyac river, 58 m. E. of Mexico city by rail. Pop. (1900), 2715. It is of historic interest in connexion with the conquest of Mexico by Cortés. The state-house is its only fine edifice of a political character, and the old bishop's palace its finest building of a religious character. Of most historic interest, perhaps, is the church of San Francisco, the first erected on the American continent, which still contains the vestments, pulpit, font and cedar ceiling brought from Spain in 1521. The handsome sanctuary over the holy well of Ocotlan, on a hill outside the town, is one of the landmarks of the surrounding country.

TLEMÇEN, a town of Algeria, the capital of an arrondissement in the department of Oran, near the frontier of Morocco, 68 m. by road and 102 by rail S.W. of Oran. It stands 2500 ft. above the sea, on the north slope of the Lella Setta hills, which rise to a height of over 4000 ft. It is the chief town of a wide district exporting olive oil, esparto, corn and flour, wools and Algerian onyx; and has a population of (1906) 24,060. From Tlemçen the railway is continued westward to the Moroccan frontier at Lalla Maghnia, a distance of 44 m.

Among the cities famous in the annals of Arab-Berber, or Moorish, art and civilization, Tlemçen takes high rank. In architectural merits its monuments, though not so extensive, are worthy of comparison with those of Granada. The older walls and towers—there were three ancient lines of fortifications—are in great part destroyed, but a wall built by the French encircles the town.

The various quarters are grouped around the principal mosque—the Jewish to the south-west, the Moorish to the south-east, that of the merchants to the north-east, while the new town with the civic buildings lies to the north-west. Of the sixty-four mosques which existed at the period of the French conquest, several have disappeared. The great mosque (Jamaa-el-Kebir) has a brick minaret 112 ft. high, adorned with marble columns, and cased with mosaic of the most varied designs; a fountain of alabaster—of the kind known as Algerian onyx—stands in the alabaster-paved inner court; and 72 columns support the arches of the interior. This mosque was built A.D. 1136 to replace a much older building. The *mihrab* is finely ornamented with arabesques. The mosque of Sidi Ahmed bel Hassan, usually called Abul Hassan, built A.D. 1298, now transformed into a museum of antiquities, has two series of arches, which rest on alabaster pillars. The courts are ornamented by sculptures of great beauty and richness; the delicately-carved cedar ceiling bears traces of polychromatic painting. The exterior has been altered in French taste. Among the antiquities preserved in the museum are the epitaph of Boabdil, the last king of Granada, who died at Tlemçen in 1494, and the standard cubit measure—in marble—used in the *Kissaria*, bearing date A.H. 728 (1328). The mosque of El-Halawi (the Sweetmeat Maker), dating from 1353, is outside the walls of the town. It has eight magnificent columns of Algerian onyx, with richly sculptured capitals. The ceiling of cedar is richly carved, and there is a fine colonnade on each side of the court. The minaret is decorated with mosaics. The military authorities occupy the Meshuar or citadel, built in 1145, which separates the Jewish and Moorish quarters and was formerly the palace of the rulers of Tlemçen. Only the minaret of the mosque, dating from the 14th century, and the battlemented wall, flanked by two towers, remain of its former magnificence. The vast basin (*sahrij*) under the old walls, now dry (720 ft. in length, 490 in width and 10 in depth), was apparently made for naval exhibitions. At one period barracks of the spahis occupied all that remains of the *Kissaria*, the place of residence of European merchants from Pisa, Genoa, Catalonia and Provence. The barracks have been cleared away and a covered market made in the upper part of the *Kissaria*. The ancient college (medressa) where many learned Arabs taught—of whom Ibn Khaldūn, author of a *History of the Berbers*, may be mentioned—has entirely disappeared. The church erected by the French is a fine building in the Byzantine style. Besides the large trade carried on there are native manufactories of cloth, carpets and leathern articles. A special manufacture is that of red shawls, used throughout the department of Oran by Jewish women when in mourning.

Sidi Bu Medin.

In the immediate neighbourhood of the modern Tlemçen are numerous remains of the fortifications of Agadīr (*vide infra*), and the minaret of the mosque, a beautiful tower dating from the 13th century, the lower part of which is built of large hewn stones from the Roman Pomaria. More noteworthy, however, are the ruins of Sidi Bu Medin and of Mansura. Sidi Bu Medin (more properly El Eubbad) is a little over a mile south-east of Tlemçen. It was founded A.D. 1337 by Ali V., the first of the Beni-Marīn (Marinide) sultans who ruled Tlemçen, and commonly called the Black Sultan. The ruins of a small building, conjectured to be a palace of Sultan Ali, which commands a beautiful view, were excavated in 1881. The *kubba* or tomb of Sidi Bu Medin, near the palace, is held in great veneration by the Arabs. The roof and walls are covered with arabesques, and the legend *El-Mulk Lillah*, "the kingdom is God's," is repeated again and again. The saint himself was born at Seville A.D. 1126, and died near Tlemçen in his 75th year; his disciple Sidi Abd-es-Selam of Tunis lies near him. The adjacent mosque is a beautiful specimen of Moorish art. The large double doors of cedar wood, covered with bronze showing a geometric interlaced pattern, have been compared with those of Ghiberti at the Baptistery of Florence. The mosque is divided by columns into five aisles. Delicate lacework extends from the spring of the arches to the roof. The tile mosaics are believed to have come from Morocco. The medressa is a building resembling the mosque.

Mansura.

Mansura, which is about 1½ m. west of Tlemçen, owes its foundation to the attempts of the Beni-Marīn rulers of Morocco to extend their sovereignty. The Amir Abu Yakub Yusef besieged Tlemçen in the early years of the 14th century. The siege lasted eight years, and Yusef turned his camp into a walled city. The siege being raised, El Mansura (the victorious), as the new city was called, was abandoned. It was reoccupied when (1335) Ali V. renewed the siege, which this time proved successful. On the expulsion of the Marinides in 1359 Mansura was finally deserted. Besides the walls and towers, and the minaret of the mosque, little remains of Mansura, of which Ibn Khaldūn has left a contemporary and graphic sketch. The minaret, notwithstanding that one side and parts of two other sides have perished, is one of the finest mosque towers in existence. It is 125 ft. high, and is built of hewn stone. The arches are circular or pointed. The upper part of the tower is ornamented with green and blue tiles and the entrance arch is beautifully carved. An inscription records that the tower was built by order of Abu Yakub Yusef. Of the rest of the mosque only the outer walls remain. It is about 320 ft. long by 200 wide and was divided by magnificent marble columns into thirteen aisles. Excavations made by the French brought to light some of these columns, which are now in the museums of Tlemçen and Algiers.

History.—A Roman town, Pomaria, occupied a site east of the present town. It derived its name from the abundance and luxuriance of the apple, pear and other fruit trees in the neighbourhood. The Roman town was ruined in the period following the Vandal invasion, and at the time of the Arab conquest appears to have been deserted. Many inscriptions of the Christian era have been found, some as late even as the 7th century. The site was purchased from the Zenata Berbers, in the 8th century, by Idris-bin-Abdallah, who began the building of a new city named Agadir (Berber, the fortress). Idris, founder of the Idrisite dynasty of Fez, left his brother Suleiman in possession of Agadir, and the city was ruled by the Beni-Suleiman until 931, when it fell into the hands of the Fatimites. From the Fatimites it passed into the possession of the Beni-Yala, of the Beni-Ifren branch of the Zenata Berbers, who held it as vassals of the Omayyad rulers of Spain. In 1080 the Almoravide sovereign Yusef ibn Tashfin, after besieging and sacking Agadir, built a new town on the site of his camp. The new town, called Tagrart, became the commercial quarter, whilst Agadir remained the royal residence. The two towns when united received the name of Tlemçen. The Almoravides reigned sixty-five years, when, after holding Agadir four years against the enemy, they were overcome by the Almohades, who massacred the inhabitants, rebuilt, enlarged and repeopled the ruined town, and built a wall (1161) surrounding the double town. In 1248 Tlemçen was captured by Abu Yahia Yarmorasen (Ghamarasan) who was chief of the Zenata tribe of Berbers and claimed descent from the Caliph Ali. Yarmorasen, who died in 1282, founded the dynasty of the Abd-el-Wahid, who ruled the greater part of what now constitutes Algeria. Under their sway Tlemçen flourished exceedingly. The presence of Jews and Christians was encouraged and the Christians possessed a church. The bazaar of the Franks (*kissaria*) was a large walled enclosure, the gates of which were closed at sunset. As many as 5000 Christians lived peaceably in Tlemçen, and the Sultan included in his army a Christian bodyguard. In 1337 the power of the Abd-el-Wahid was temporarily extinguished by the Marinide sultans of Morocco. They left some fine monuments of the period of their ascendancy, which lasted twenty-two years. Once more, under the Abd-el-Wahid, now known as the Beni-Zeiyan, from 1359 to 1553, Tlemçen enjoyed prosperity. It had a population reputed to number 125,000, an extensive trade, a brilliant court and a powerful army. The Spanish occupation of Oran (1509) struck a fatal blow at the European commerce of the town. The Beni-Zeiyan, after the capture of Algiers in 1516 by the corsair Barbarossa (*q.v.*) gradually lost their territory to the Turks, while Tlemçen itself for forty years became tributary to the Spanish governor of Oran. In 1518 the town was held for a short time by Arouj Barbarossa, but Arouj was killed in a fight with the Spaniards. It is said that, while master of the town, Arouj caused twenty-two of the Zeiyan princes to be drowned in the *sahrij*. In 1553 the Turks under Salah Rais, pasha of Algiers, captured Tlemçen and the Sultanate of Tagrart, as it was still frequently called, came to an end. Under the Turks the town ceased to be of any importance. When the French entered Algeria the sultans of Morocco were disputing the possession of Tlemçen with the Kuluglis, who fought first for themselves and afterwards for France. In 1835 Abd-el-Kader, on whose appearance the Moors retired, sought to re-establish the ancient empire of Tlemçen, but he retreated before General Clausel in 1836. The treaty of the Tafna (1837) gave Tlemçen to Abd-el-Kader, but, war being renewed in 1842, Tlemçen was definitely occupied by the French, under whom it has prospered.

The Sultanate of Tlemçen.

The commune of Tlemçen, which includes a number of villages near the city, had a population (1906) of 39,757, and the arrondissement, which includes nine communes, 149,467.

See *Les Monuments arabes de Tlemçen*, by William Marçais and Georges Marçais (Paris, 1903). This accurate and finely-illustrated work, one of the publications of the *Service des monuments historiques de l'Algérie*, cites the principal works dealing with Tlemçen, and gives a critical estimate of their value. (F. R. C.)

TOAD, a name commonly applied, in contradistinction to "frog," to tailless batrachians of stout build, with more or less warty skin. Thus, of the two closely related discoglossid genera *Bombinator* and *Discoglossus*, the former is called a toad and the latter a frog. But the true toads are the Bufonidae, arciferous batrachians with dilated processes to the sacral vertebra and without any teeth in the jaws. The type of the family is our common toad, *Bufo vulgaris*, and round it cluster a large number of species of the same genus, and the smaller genera *Eupemphix*, *Pseudophryne*, *Nectophryne*, *Nectes*, *Notaden*, *Myobatrachus*, *Rhinophrynus* and *Cophophryne*. That the shape of the body is not a safe guide in judging of the batrachians is shown by certain species, such as *Bufo jerboa*, which in its slender form and extremely long limbs surpasses the typical frogs, whilst on the other hand, some true frogs (*Rana*), adapted to burrowing habits, are absolutely toad-like. The Bufonidae include terrestrial, burrowing, thoroughly aquatic and arboreal types; *Rhinophrynus*, of Mexico, may be described as an ant-eater.

The genus *Bufo* embraces about 100 species, and is represented in nearly every part of the world except the Australian region and Madagascar. Two species are found in the British Isles: the common toad, *Bufo vulgaris*, and the natterjack, *Bufo calamita*. The former is found almost everywhere; the second, which differs in its shorter limbs with nearly free toes (which are so short that the toad never hops but proceeds in a running gait) and in usually possessing a pale yellow line along the middle of the back, is local in England, the south-west of Scotland, and the west of Ireland; it is further remarkable for the very loud croak of the males, produced by a large vocal bladder on the throat which, when inflated, is larger than the head. Toads lay their eggs in long strings, forming double files in straight, jelly-like tubes.

A small toad, *Pseudophryne vivipara*, recently discovered in German East Africa, has proved to be viviparous, this being the only such instance known among tailless bactrachians.

TOADSTOOL, the popular name for fungi which more or less resemble mushrooms, but are either poisonous or worthless as food.

TOAST, a slice of bread scorched brown on the two surfaces by the heat of a fire. The word was borrowed from the O. Fr. *toste*, Lat. *torrere*, *tostum*, to scorch, burn. It was formerly the custom to have pieces of toast floating in many kinds of liquor, especially when drunk hot. It is said to be from this custom that the word is used of the calling upon a company to drink the health of some person, institution or cause (see Health).

TOBACCO, the name (see below) for the leaves of several species of *Nicotiana* (nat. ord. Solanaceae), variously prepared for use as a narcotic. While it is principally manufactured for smoking, a large amount is also prepared for chewing, and, to a more limited extent, it is taken in the form of snuff. Under one or other of these forms the use of tobacco is more widely spread than is that of any other narcotic or stimulant.

History.—Although the fact has been controverted, there cannot be a doubt that the knowledge of tobacco and its uses came to the rest of the world from America. In November 1492 a party sent out by Columbus from the vessels of his first expedition to explore the island of Cuba brought back information that they had seen people who carried a lighted firebrand to kindle fire, and perfumed themselves with certain herbs which they carried along with them. The habit of snuff-taking was observed and described by Ramon Pane, a Franciscan who accompanied Columbus on his second voyage (1494–1496), and the practice of tobacco-chewing was first seen by the Spaniards on the coast of South America in 1502. As the continent of America was opened up and explored, it became evident that the consumption of tobacco, especially by smoking, was a universal and immemorial usage, in many cases bound up with the most significant and solemn tribal ceremonies.

The term tobacco appears not to have been a commonly used original name for the plant, and it has come to us from a peculiar instrument used for inhaling its smoke by the inhabitants of

Hispaniola (San Domingo). The instrument, described by Oviedo (*Historia de las Indias Occidentales*, Salamanca, 1535), consisted of a small hollow wooden tube, shaped like a Y, the two points of which being inserted in the nose of the smoker, the other end was held into the smoke of burning tobacco, and thus the fumes were inhaled. This apparatus the natives called "tabaco"; but it must be said that the smoking pipe of the continental tribes was entirely different from the imperfect tabaco of the Caribees. Benzoni, on the other hand, whose *Travels in America* (1542–1556) were published in 1565, says that the Mexican name of the herb was "tabacco."

The tobacco plant itself was first brought to Europe in 1558 by Francisco Fernandes, a physician who had been sent by Philip II. of Spain to investigate the products of Mexico. By the French ambassador to Portugal, Jean Nicot, seeds were sent from the Peninsula to the queen, Catherine de' Medici. The services rendered by Nicot in spreading a knowledge of the plant have been commemorated in the scientific name of the genus *Nicotiana*. At first the plant was supposed to possess almost miraculous healing powers, and was designated "herba panacea," "herba santa," "sana sancta Indorum"; "divine tobacco" it is called by Spenser, and "our holy herb nicotian" by William Lilly. While the plant came to Europe through Spain, the habit of smoking was initiated and spread through English example. Ralph Lane, the first governor of Virginia, and Sir Francis Drake brought with them in 1586, from that first American possession of the English crown, the implements and materials of tobacco smoking, which they handed over to Sir Walter Raleigh. Lane is credited with having been the first English smoker, and through the influence and example of the illustrious Raleigh, who "tooke a pipe of tobacco a little before he went to the scaffolde," the habit became rooted among Elizabethan courtiers. During the 17th century the indulgence in tobacco spread with marvellous rapidity throughout all nations, and that in the face of the most resolute opposition of statesmen and priests, the "counterblaste" of a great monarch, penal enactments of the most severe description, the knout, excommunication and capital punishment.

Botany.—There are about fifty species of *Nicotiana*, nearly all of which are natives of America. Few, however, are of economic importance. The great bulk of the tobacco supply is derived from

FIG. 1.—Flowering Top of *N. Tabacum.*

N. tabacum, the Virginian tobacco, a native of some part of Central or South America and now cultivated in almost all temperate and warmer countries. It is a coarse rank-growing annual, with a simple, unbranched, cylindrical stem which attains a height of 6 ft. and upwards, terminating in a panicle of pink or rose-coloured flowers and an elongated corolla tube (fig. 1). The plant has alternate, simple, oblong-lanceolate leaves, those at the lower part of the stem being slightly stalked, and of large size, reaching to 2 ft. in length, while the upper are semi-amplexicaul and of variable outline. The seeds are brown in colour, with a rough surface, of minute size, and exceedingly numerous; as many as 1,000,000 may be produced by a single plant. The whole of the green parts of the plant are covered with long soft hairs which exude a viscid juice, giving the surface a moist glutinous feeling. The hairs are multicellular, and of two kinds, one branching and ending in a fine point, while the other, unbranched, terminates in a clump of small cells. Stomata occur on both surfaces of the leaves, and, with the peculiar hair structure render the microscopic appearance of the plant highly characteristic.

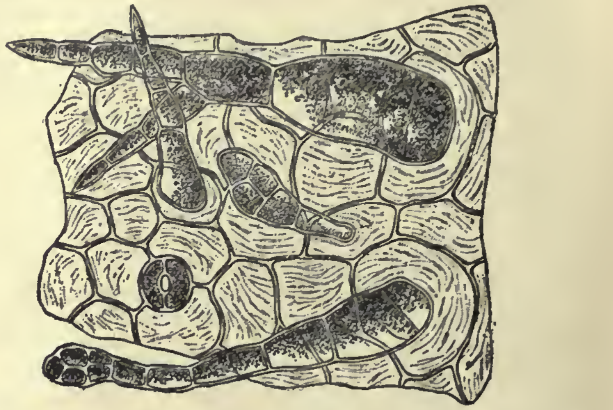

FIG. 2.—Microscopic Structure of Tobacco Leaf.

From this species the tobaccos of Cuba, the United States, the Philippine Islands and the Latakia of Turkey are derived, and it is also largely cultivated in India; the variety *macrophylla* is the source of the Maryland tobaccos. *N. persica*, Persian tobacco, the source of the famous Shiraz tobacco, is regarded as only a variety of *N. tabacum*, and an introduction from America. East Indian, or Green, tobacco is the product of another species, *N. rustica*, a smaller plant with a much-branched stem and greenish-yellow flowers with a short, broad tube. It is a native of Mexico, and now widely cultivated in southern Germany, Hungary and the East Indies.

Cultivation.—Tobacco is cultivated in localities scattered over almost the whole world, ranging as far north as Quebec, Stockholm and the southern shores of Lake Baikal in one hemisphere, and as far south as Chile, the Cape of Good Hope and Victoria in the other. Whilst, however, the plant adapts itself to a great variety of climatic conditions and will grow on almost all kinds of soil, the flavour and quality of the produce are profoundly affected by variations in these two factors. Very slight differences in climate appear to cause very great differences in the quality of the tobacco, and ordinary meteorological records are of little use in determining the suitability or not of a region for a particular kind of leaf; this essential point must be determined by experiment. In general, tropical and semi-tropical conditions as to temperature, with a comparatively dry climate, give the best results.

Given suitable climatic conditions, the type of tobacco produced is determined mainly by the soil, and particularly by its mechanical or physical condition. Speaking generally, clay soils retentive of moisture produce heavy-cropping tobaccos which cure to a dark brown or red colour. Sandy soils produce tobaccos with a thin leaf, curing to a yellow or bright red colour. In the same locality, *i.e.* under the same climatic conditions, quite different kinds of tobacco may be produced in direct relation to the character of the soil. Thus the bright yellow tobacco used for cigarettes, &c., is largely produced in Virginia and N. Carolina on a loose porous sand, which must be at least a foot deep, and contains usually about 8% of clay; this sand is underlaid by a clay subsoil, and, as Mr Milton Whitney points out in *Tobacco Soils* (U.S.A. Dept. of Agriculture, Farmers' Bulletin, No. 83), this clay is the same as that on which the heavy manufacturing and export tobacco is grown. Where the clay is exposed on the surface the heavy type of tobacco is produced, and bright tobacco where the clay is covered by from 12 to 20 in. of sand. Tobacco soils should be well drained and contain a large percentage of humus.

Tobacco being cultivated over such a large area of the world, under very varying climatic conditions, and by many different races of mankind, the methods employed in its production naturally differ very considerably. As the United States of America produce more tobacco than any other country it will be best to deal generally with conditions there and to refer to marked differences in dealing with production in other countries.

The seed is sown in nursery beds, and the plants set out in the field later. Tobacco seeds are very small, and it is estimated that about 300,000 to 400,000 seeds go to the ounce. Allowing for those which fail to germinate (perhaps 25%), loss in transplanting, weak and backward plants, &c., one ounce of seed should yield about 40,000 plants.

The greatest possible care is bestowed on the preparation of the seed bed—it must have good, very rich soil in fine tilth, be protected from winds, and yet well exposed to sunlight; the southern or south-eastern slope of an open place in a forest is often selected. Hot beds are made when necessary. A bed with an area of about 50 sq. yds. is adequate for 1 oz. of seed. To destroy the seeds, &c., of weeds, and the larvae of insect pests, a fire is often lighted, kept from the ground itself by intervening wood logs, or the seed-bed is thoroughly steamed. After this treatment the upper 2 or 3 in. of soil are well pulverized, and fertilizers added, usually, to prevent reintroduction of seeds of weeds, in the form of guano or chemical manures. The seed is now set; usually it is thoroughly mixed with a relatively large quantity of fine ashes, sand or meal, to facilitate thin and even sowing, and the surface of the bed is afterwards lightly brushed over with a broom; it is very important to avoid burying the seed at all deeply; a light covering of cloth or muslin, raised on short sticks, is often stretched over the bed. Great care is necessary in attending to the watering of the young and delicate seedlings, which are ready for transplanting in from fifty to sixty days after sowing. They must be well hardened off before being set out in the open.

The land for their reception must be thoroughly well tilled and manured. If moist, ridges are formed about 3 to 4 ft. apart; the distance apart in the rows varies greatly with various types of tobacco: 3 ft. is the normal for ordinary manufacturing and smoking tobaccos, 1 to 1½ ft. for Cuba and Sumatra types. Cigar tobaccos become coarse if planted too widely. An acre of tobacco planted 3 ft. by 15 in. will contain 11,600 plants and 3 ft. 6 in. by 15 in., 10,000 plants. During the transplanting, preferably done on cloudy days or during light rains, the plants must be handled very carefully; machines are now available which can set out and water plants over from two to six acres in a working day.

After transplanting the crop takes about another sixty days to mature, *i.e.* about 120 days in all from the date the seed was sown. During this period, until the plants begin to ripen, the tilth is maintained and weeds checked first by horse cultivators or horse-hoes, and, as the plants increase in size, by hand labour. When the plants show signs of flowering they are "topped" to prevent seed formation, the terminal buds being removed, and only a certain number of leaves left on each plant to ripen. This operation requires experienced judgment to decide when it should be done; the number of leaves to be left varies with the variety and vigour of the plant, the nature of the soil, climate, seasons and particular use for which the crop is intended. The product from plants which have not been topped is of little value. In the U.S.A., in the cigar tobacco district, fifteen to twenty leaves are often left on each plant, and of manufacturing tobaccos only ten to twelve leaves. As one result of the topping, suckers are usually formed; these also must be removed, although, *e.g.* in Florida, vigorous suckers are sometimes allowed to remain when the plant is cut, and produce a "sucker crop" inferior in character to the first or principal crop, but still serviceable.

The leaves now ripen, indicated by a change from a dark to lighter green, and by the appearance of yellow spots. Ripening is complete in about 35 days after topping or about 155 days after sowing. A ripe leaf easily cracks or shows a crease when folded between the fingers. The leaves on a plant decrease in age from below upwards, and all are not ripe at exactly the same time. In high quality tobaccos the leaves are "primed" or picked singly as they ripen, but in the great bulk of American tobaccos the whole plant is cut close to the ground when the middle leaves are about ripe. In either case leaves should not be gathered when wet with dew or rain, or in very hot sunshine; the afternoon is usually the best time. The next step is to remove the harvested crop to the drying-shed; primed leaves are placed at once in shallow baskets or boxes, and when under cover are strung on string or on wire and hung up on laths in the barn. Cut plants are allowed to wilt, or become flaccid, before removal from the field, to prevent injury to the turgid leaves. These cut plants may be laid in rows on the ground to wilt, or spitted on long rods or laths supported on trestles, or placed on special drying racks. When sufficiently wilted they are hauled to the barn and hung up there on the same laths on which they were placed in the field.

Cultivation under Shade.

A very interesting development of quite recent years is that of growing some valuable cigar tobaccos under artificial shade. Sumatra produced the best cigar wrappers of the world, and efforts to cultivate Sumatra tobacco in Florida under apparently suitable conditions of climate and soil were not successful. It was noticed, however, that if the tobacco was grown under the shade of trees the character of the leaf was improved. Artificial shading, first by laths, and later by cheese-cloth, both supported on posts, was then resorted to with eminently satisfactory results. The U.S.A. Department of Agriculture, in co-operation with local growers, devoted a great deal of attention and money to the problem, and Sumatra tobacco of very high quality is now produced in Florida and Connecticut. The yield of leaf is often much increased, the plants are protected from the weather, and the enhanced value of the crop much more than repays the very considerable expense involved in artificially shading whole fields. So successful have the results been that American-grown tobacco of the Sumatra type is now exported even to Cuba.

Important changes take place in the tobacco leaf from the time it is cut until the finished product is ready for consumption. These may be all placed under curing, but it is usual to recognize three stages: (1) curing proper; (2) fermentation; and (3) ageing.

Curing.

Sun curing, now but little practised in the United States, is the simplest method. The wilted tobacco is suspended on racks in the sun. Great care is necessary to protect it from rain, and it must if necessary be placed in a barn in which fires may be required during wet weather. This method is employed in a portion of Virginia and results in a very sweet chewing tobacco.

Air curing is essentially similar to sun curing. The tobacco is hung in a barn in which there is a free circulation of air during dry weather. Artificial heat may be resorted to in bad weather; in the States, cigar tobaccos and "White Burley" are usually cured in this way. The process takes about six weeks.

In fire curing the tobacco is hung in the barn, and, after it has become of a rich yellow colour, slow fires, producing a gradual increase in temperature up to about 150° F., are lighted on the floor and maintained for four or five days. The firing must be repeated at intervals as the leaves become soft again. A considerable portion of the tobacco exported to England and Africa is fire-cured.

In flue curing, also known as the Virginian cure, fires are set outside the barn, and the heat led in iron pipes or flues, into the building are under the suspended tobacco, which is placed there quite fresh from the field. The temperature is raised, during three to five days, from about 90° F. to 140° F. for primed leaves, or 160° to 175° F. for tobacco on the stalk. The process, which requires great judgment and care, results in the bright yellow leaf so largely used for pipe tobacco, cigarettes and chewing tobacco. In a modification of this method, known as the Kentucky cure, large barns are used, the temperature is not raised above 100° F., and the process occupies from four to six weeks. By whichever way treated, the tobacco-leaf after curing is brittle and cannot be handled without crumbling to powder. The contents of the barn are therefore left till moist weather occurs, and then by the admission of atmospheric air the leaf blades absorb moisture and become soft and pliant. In this condition the leaves are stripped from the stems and sorted into qualities, such as "lugs," or lower leaves, "firsts" and "seconds." These are made up into "hands," or small bundles of from six to twelve leaves. Each bundle is tied round with a separate leaf, and in this condition the tobacco is ready for bulking for fermentation.

Fermentation.

The tobacco, whether in bundles, hands or separate leaves, is piled up or bulked on the floor in a barn into a solid stack to the height of 5 or 6 ft. Within this stack a process of fermentation is quickly set up, and the temperature of the mass rises steadily till it reaches about 130° F. Great care is now taken to prevent overheating and to secure the uniform fermentation of all the tobacco. The pile is from time to time taken down and rebuilt, the tobacco from the top going to the bottom and that exposed at the edges being turned in to the centre. In from three to five weeks the fermentation should be sufficiently carried out, and the leaves then have a nice uniform brown colour. Dark-coloured leaves are produced when the temperature is allowed to mount higher than when light leaves are required. Fermentation is essentially a chemical process due apparently to the presence of enzymes, developed in the leaf during the earlier curing stages. The view has been put forward that fermentation is due to the activity of bacteria, distinct types occurring in various tobaccos, but the balance of evidence is against it. On the bacterial theory it was thought possible to inoculate a poor tobacco with, say, the special bacteria present in Cuban tobacco, and so give the product the aroma and other good qualities of the more valuable tobacco. When fermentation is completed the tobacco is graded, an operation carried out very carefully in the case of the better cigar tobaccos, and packed for export, cigar tobaccos in bales, and other kinds in hogsheads. It is then kept at a moderate and fairly uniform temperature in a warehouse, when, although there is no marked outward change, the tobacco becomes more mellow. Two years are usually required for ageing, but some tobaccos are kept for four or five years before being manufactured.

An artificial aroma is sometimes given to tobaccos, especially for the "fillers" of cigars, by saucing or treating the leaves with a solution containing an infusion of fine quality tobacco stems, rum, sour wine and various flavouring materials such as oil of aniseed, tincture of valerian, powdered cloves, cinnamon and liquorice.

Pests and Diseases.—Tobacco, like other cultivated plants, is subject to attack by various pests and diseases, but fortunately these are less destructive than with many crops. On the other hand, comparatively trivial incidents do more harm to a relatively delicate plant like the tobacco than to more robust plants.

The "tobacco flea-beetle" (*Epitrix parvula*, Fabr.) is a small active beetle, the larvae of which attack the roots, while the adult beetles eat holes in the leaves. The latter is the more serious, as in addition to the actual damage done by the beetle the holes afford entrance to fungus spores, &c. Under the name "horn worms" are included the larvae or caterpillars of species of *Protoparce*. These comparatively large and voracious animals, when abundant, do great damage by eating the leaves. Other caterpillars, "budworms" (*Heliothis*, spp.), attack the buds or burrow into the seed-pods. Seedling plants of tobacco, like many other crops, are liable to attack by "cut worms," the caterpillars of species of *Peridromia* and *Agrotis*. "Plant bugs," which suck the juice of the leaves, have been recorded as serious enemies in some parts of the world. Recently, shade-grown tobacco in some localities has suffered considerably from the attacks of small sucking insects known as thrips, which produce "white veins" in the leaf. White vein may also be induced by other causes besides the attacks of thrips.

Stored tobacco is liable to be attacked and ruined by the "cigarette beetle," a cosmopolitan insect of very varied tastes, feeding not only on dried tobacco of all kinds, including snuff, but also on rhubarb, cayenne pepper, tumeric, ginger, figs and herbarium specimens. Other beetles, such as the rice weevil (*Calandra oryza*), also attack dried tobacco.

The fungoid diseases of tobacco are comparatively unimportant; there are, however, some diseases of obscure origin which at times cause considerable damage. "Mosaic disease" is the name given to a condition in which the leaves are more or less sharply differentiated into light and dark green patches. The matter has been fully investigated by Mr A. F. Woods (Bulletin No. 18, Bureau of Plant Industry, U.S. Department of Agriculture), who attributes it not to any specific parasite but to a disturbance of the normal physiological activity of the cells.

"Frog's eye," or "leaf spot," denotes the occurrence of small white specks on the leaf. This disease is probably bacterial in origin. Wind and hail may break plants or damage leaves, especially if required for wrapper purposes. The provision of wind breaks is the only effective remedy.

Diseases which occur in curing are important. Excessive humidity causes small dark spots to appear; these become confluent and the whole leaf may become dark and decay. Various names are given, such as "pole burn," "pole sweat," "house burn." The disease is checked by raising the temperature above 110° F., and reducing the humidity of the barn. Stem rot, due to a mould (*Botrytis* sp.), occurs in wet weather. Too rapid drying of the outer tissue of the leaf leads to the formation of "white veins," which injure leaves required for wrapper purposes, otherwise it is not important. Another defect arising during curing and fermentation is the efflorescence of salts on the surface, a phenomenon known as "saltpetre"; light brushing and spraying with a weak solution of acetic acid are effective remedies.

Improvement by Selection.—Careful examination of a large number of individuals of one variety growing under similar conditions reveals differences in such characters as number of leaves per plant, the size and shape of the leaves, tendency to form suckers, time of maturing and resistance to disease. Other tests show variability in burning quality, elasticity of leaf, texture, taste, &c. The United States Department of Agriculture has closely investigated this important question and the results attained are brought together by Messrs H. D. Shamel and W. W. Cobey in *Tobacco Breeding* (Bulletin 96, Bureau of Plant Industry, 1907). No crop, it is pointed out, responds so readily to breeding as tobacco, or deteriorates more rapidly, as regards both yield and quality, if neglected. The variations are classified as: (1) Variation in type due to crossing, change of soil and climate, especially, for example, when seed from the tropics is introduced to temperate regions. (2) Variations within the type, due to natural tendency to vary, local conditions and maturity of seed. When Cuban tobaccos were first introduced into Florida, the type broke up, but by carefully selecting the best plants and using them only as sources of seed for later crops, a good type was obtained. The tobacco flower is fortunately perfectly self-fertile, and by enclosing the flowers of selected plants in paper bags, so as to exclude all possibility of hybridization, progeny true to the type of the mother plant can be obtained.

No attempt should ever be made to raise large crops of tobacco from imported seed, but only a small crop, and the seed of the selected plants should be used for future propagation. In selection work the grower must keep definitely in view the special market requirements for the kinds of tobacco he is producing. Thus for wrapper tobaccos, amongst other points a broad, rounded leaf, which will yield perhaps eight wrappers, is much more valuable than a narrow pointed leaf which yields perhaps only four. Plants may be found growing side by side, the one with broad leaves, the other with narrow, but by selection the broad type can be perpetuated and gradually improved.

Hybridization can also be readily controlled in the case of tobaccos, and in this connexion it is useful to note that, if pollen is desired of some variety growing at a distance, it will retain its vitality for several weeks if kept perfectly dry, and so can readily be sent by post from one place to another. Another favourable feature is the fact that a single capsule contains from 4000 to 8000 seeds, and one tobacco plant may easily produce from 500,000 to 1,000,000 seeds.

Production.

United States.—Tobacco cultivation dates in the States from the very early years of the 17th century, when it was taken up in Virginia. A general description has already been given of the methods of cultivation and preparation. In 1906 the total area under tobacco in twenty-five states was 796,099 acres, and the production 682,428,530 lb, valued at about £13,500,000. The principal tobacco-producing states, with the approximate value of their crops, were: Kentucky, £3,885,400; Ohio, £1,706,600; North Carolina, £1,396,153; Wisconsin, £1,342,600; Virginia, £1,206,309, Pennsylvania, £979,550; Connecticut, £883,184; Tennessee, £511,035; Florida, £330,750; New York, £244,053, and Maryland, £241,046. The average yield per acre in the States as a whole in 1906 was 857·2 lb. New Hampshire had the highest average, 1785 lb per acre, and Mississippi the lowest, 440 lb.

The successful production of cigar tobaccos from Cuban and Sumatran seed was a development of the late 19th century.

Perique tobacco is worthy of special notice. This famous tobacco is produced only at Grand Points in Louisiana. Great care is given to the cultivation, and damp atmospheric conditions are desirable during the ripening stages. The leaves, when stripped from the stalks, are made into rolls and subjected to great pressure, which is released daily to allow the leaves to absorb their expressed juice. To the chemical changes, mainly oxidation, which go on in this juice while it is exposed to the air, the characteristic aroma and flavour of Perique tobacco are mainly due.

Cuba.—Tobacco is the second industry of the country, the value of the crop being surpassed only by that of sugar. The cultivation was formerly a monopoly of the Spanish crown, but from 1817 payment of a tax, usually heavy, has been the only restriction. The superiority of Cuban tobaccos in flavour and aroma, especially for cigar fillers, has long been recognized, but exactly to what conditions these qualities are due is not fully known. The leaf known as "Vuelta Abajo," produced in the province of Pinar del Rio, is perhaps the best cigar leaf of the world. The other tobacco-producing provinces in order of importance are Havana, Santa Clara and Santiago de Cuba. The crop is mostly grown in the open, air-cured and carefully fermented. Cuban tobacco is grown as a "winter" crop, the summer months being those of high rainfall. Cultivation under shade was recently tried with satisfactory results; "166·65 acres cultivated under cheesecloth produced in 1903 10 bales of wrappers and 1·5 bales of fillers of tobacco per acre, the output under the old system having been 4·5 bales of tobacco per acre of which only 10% represented wrappers of good colour" (Diplomatic and Consular Report on Cuba, 1904, No. 3522).

Mexico is an important tobacco-producing country, and Mexican leaf is largely used in Europe for cigar wrappers and other purposes. Mexican tobacco approximates more or less closely to that of Cuba, and is cultivated and prepared in very similar ways.

France.—Tobacco cultivation is an important industry, and the home production is carried out under government supervision. In 1905, 53,750 planters cultivated 39,439 acres, and the total crop amounted to 61,614,900 lb, of the approximate value of £2,000,000. The variety grown is usually of the Virginia type, and the leaf is coarse, dark and heavy, and suited to the manufacture of plug and snuff.

Germany.—The chief tobacco-producing divisions are Baden and Alsace. The leaf is of medium size, heavy, and is mainly used in the manufacture of cigars.

Hungary produces tobacco of a rich, dark brown colour, useful for cigars, and also a small, bright yellow leaf, of value as a cigarette and pipe tobacco.

Russia.—In northern Russia the produce is mainly a large, coarse, heavy, dark leaf, of use only for the manufacture of plug and snuff. In southern and Asiatic Russia good tobacco of the Turkish type is produced.

Italy produces two principal types, a dark, heavy Virginian tobacco on the heavy soils of northern Italy, and a Turkish type tobacco on the sandy soils of the southern part of the country.

Syria.—The distinctive Latakia tobacco is produced in the province of Saida in northern Syria. The leaf is subjected to the smoke produced by burning in the green condition leafy branches of species of evergreen oaks (*Quercus* spp.). The process of fumigation lasts from seven to nine months, and during it the tobacco acquires its black colour and peculiar flavour.

Greece.—Grecian tobacco is grown from Turkish seed and closely resembles Turkish tobacco in character and uses. Egyptian cigarettes are to a great extent made from Grecian tobacco. Paper is a monopoly in Greece, and Grecian cigarette manufacturers, to escape the monopoly, have transferred their business to Egypt, where they make cigarettes from Grecian tobaccos by the aid of Greek workmen.

Turkey.—Tobacco is an important crop in Turkey, where its cultivation and manufacture are monopolies. The ordinary tobacco and cigarette trade is controlled by the Regie Compagnie intéressée des tabacs de l'empire Ottoman, and Narquileh tobacco (called "tumbeki" and used in "hubble-bubbles") is in the hands of a similar organization. The small Turkish leaf is famous throughout the world. Some of the finest flavoured tobaccos are produced in the regions around Cavalla in Macedonia and ancient Ephesus in Asia Minor. The cultivation of Turkish tobaccos has been taken up in various parts of the world, *e.g.* South Africa, and to maintain the standard of the produce fresh supplies of seed were obtained annually from Turkey. To guard against this competition, the export of tobacco seed from Turkey was prohibited in 1907. The method of cultivation in Turkey is simple, and the plants are set out close together. For the best qualities the leaves are primed, air-cured, and then subjected to a lengthy treatment corresponding to mild fermentation. High prices are obtained for the best Turkish tobaccos. Thus in 1906 from Cavalla and Xanthi 11,000 tons were exported of a value of about £1,101,000, the range of the various qualities per kilo (2⅕ lb) being:—

Ghienbek.	10s. 5d. to 16s. 0d.
Kir	4s. 10d. „ 6s. 0d.
Pursuccian	2s. 11d. „ 3s. 9d.
Drama	2s. 0d. „ 2s. 10d.
Inferior brands	0s. 7d. „ 2s. 0d.

The exports go mainly to Austria-Hungary, Rumania, Italy, Egypt, the United Kingdom and the United States.

Japan.—Tobacco cultivation is a government monopoly, and in 1905 the crop amounted to about 106,572,000 lb, yielding a profit to the government of some £3,500,000. The produce is usually leaf of considerable size, of medium colour and suited only for cigarette and pipe smoking.

China.—The cultivation is widespread throughout Southern China. The picked leaves are usually either prepared for market by simple exposure to the sun for a few days, or in addition are sprinkled with groundnut oil and sometimes other materials also, which result in an increase of strength.

Sumatra.—The tobaccos of Sumatra are especially valued for outside wrappers of cigars, being very uniform, of fine texture, light brown colour, thin and elastic. They do not, however, possess the aroma essential to cigar-fillers. The industry is of quite recent growth, dating only from 1862. The famous tobacco region, about 15,000 sq. m. in area, is on the east coast of the island, almost directly on the equator, and has a very uniform and high temperature and a very high rainfall. The soil is mainly of volcanic origin. Deli is the principal district and produces the best tobaccos. The estates are usually very large, and are divided up into fields which are cultivated in rotation, each field being given several years' rest after producing one crop. The tobacco is air-cured, fires being only employed during continuous wet weather, and the process of curing occupies four or five weeks. The fermentation is very carefully controlled, and to obtain the desired light colour the temperature is kept comparatively low. The leaves are graded with the most scrupulous care and finally packed in bales of about 176 lb each. The high quality of Sumatra tobacco is due in part to the local conditions of soil and climate, and perhaps to an even greater degree to the care taken at every stage in its cultivation and preparation. The work is done by Chinese coolies under European—chiefly Dutch—supervision. The commercial success of some of the companies has been very striking, dividends as high as 111 % having been paid.

Java and Borneo tobacco is very similar to that of Sumatra.

The Philippines.—Tobacco is extensively cultivated in the plains and on the rich alluvial deposits along the sides of rivers. During recent years the average value of the product has fallen, due apparently to deterioration in quality. The exports of manufactured tobacco, such as Manila cheroots, find their principal market in China, British India, Australasia and the United Kingdom, whilst of the leaf tobacco fully three-quarters goes to Spain.

British Empire.—Tobacco is grown for local use in many parts of India, but the principal centres of its cultivation on a commercial scale are Bombay, Madras and the Punjab. American experts are frequently employed to superintend the estates and factories. In Ceylon tobacco is grown in the northern portion of the island; the produce is but little suited to the European market and is mainly exported to southern India and Cochin China.

British North Borneo competes with Sumatra as the source of the best cigar wrappers. The cultivation was begun in the island in 1883 by planters seeking new lands free from the heavy taxation to which they were subjected in Sumatra. The industry is now in the hands of three large companies, the survivors of some twenty or more which have started at various times. The greater portion of the most suitable land appears to be already under cultivation and there is little immediate prospect for much expansion of the industry. The annual value of tobacco exported is over £300,000.

In Australia tobacco is produced on a small scale in Queensland, New South Wales and Victoria. Efforts are being made to develop the industry. New Zealand has attempted to produce tobacco as a commercial crop, but the effort was abandoned several years ago.

In the West Indies tobacco is grown on a small scale in many of the British colonies, but only in Jamaica is there a definite industry. An expert, Mr F. V. Chambers, recently reported on Jamaica tobacco as of good quality and flavour but often of a heavy nature. The shade-grown tobacco was, however, hardly likely for making wrappers to be excelled by any tobacco in the world.

In the British African possessions the outlook for tobacco cultivation is in several instances favourable. Rhodesian-grown Turkish tobacco is already on the English market, as also various brands of tobacco from the Transvaal. Natal and Cape Colony have also industries of considerable local importance. Tobacco cultivation has made considerable progress in Nyasaland (British Central Africa). In 1900 there were 69 acres under this crop, the yield being 4480 lb of the value of £113. In 1907 the acreage had increased to 2330, the yield to 413,316 lb, and the value to £6889. Flue-cured bright tobacco is principally produced, but sun-cured is also exported; and in 1906–1907 experiments with Turkish tobacco gave encouraging results.

Canada produces in Ontario and Quebec coarse Virginian type tobacco.

Chemistry.

The constituents of tobacco, as of all other vegetable matter, can be grouped under three heads: water, mineral acids and bases (which pass into the ash on combustion) and organic substances. The following analyses of upper leaves made at the Connecticut state station, and recorded in Report No. 63, Office of Experiment Stations, U.S. Department of Agriculture, indicate the more important constituents and also the changes which take place during fermentation.

	Unfermented.	Fermented.
	%	%
Water	23·50	23·40
Ash	14·89	15·27
Nicótine	2·50	1·79
Nitric acid (N_2O_5) . .	1·89	1·97
Ammonia (NH_3) . . .	0·67	0·71
Other nitrogenous matters	12·19	13·31
Fibre	7·90	8·78
Starch	3·20	3·36
Nitrogen free extract .	29·39	27·99
Ether extract. . . .	3·87	3·42

Nicotine (*q.v.*) ($C_{10}H_{14}N_2$) is a volatile alkaloid which appears to be present only in plants of the genus *Nicotiana* (see NICOTINE).

Manufacture.

In the manufacture of tobacco for smoking, we have to do with the numerous forms of tobacco used for smoking in pipes, embracing cut smoking mixtures, cake or plug, and roll or spun tobacco. Under this heading come also the cigar and cigarette manufacture.

The raw material in the warehouses is of various qualities: some is strong, rough and harsh, and so is unfit for ordinary smoking; other samples are mild and fine, with aromatic and pleasant flavour, but devoid of strength. By a proper mixing and blending the manufacturer is enabled to prepare the smoking mixture which is desirable for his purpose; but certain of the rough, bitter qualities cannot be manufactured without a preliminary treatment by which their intense disagreeable taste is modified. The storing of such tobacco for a lengthened period matures and deprives it of harshness, and the same result may be artificially hastened by macerating the leaves in water acidulated with hydrochloric acid, and washing them out with pure water. The most efficient means, however, of improving strong, ill-tasting tobacco is by renewed fermentation artificially induced by moisture and heat.

Smoking Mixtures.

The manufacturer having prepared his mixture of leaves, proceeds to damp them, pure water alone being used in the United Kingdom, whereas on the Continent and in America certain "sauces" are employed, which consist of mixtures of aromatic substances, sugar, liquorice, common salt and saltpetre, &c., dissolved in water. The primary object is to render the leaves soft and pliant; the use of the sauces is to improve the flavour and burning qualities of the leaves used. When uniformly damped, the leaves are separately opened out and smoothed, the midrib, if not already removed, is torn out, except when "bird's-eye" cut is to be made, in which mixture the midrib gives the peculiar "bird's-eye" appearance. The prepared tobacco, while still moist and pliant, is pressed between cylinders into a light cake, and cut into fine uniform shreds by a machine analogous to the chaff-cutter. The cut tobacco is now roasted, partly with the view of driving off moisture and bringing the material into a condition for keeping, but also partly to improve its smoking quality. The roasting is most simply effected by spreading it on heated slabs, on which it is constantly turned, or a roasting machine is used, consisting of a revolving drum in which the tobacco is rotated, gradually passing from one end to the other, and all the time under the influence of a current of heated air. The increase in favour of packet tobaccos has brought about the invention of elaborate packing machines.

Roll Tobacco.

For roll, twist or pigtail tobacco the raw material is damped or sauced as in the case of cut tobacco. The interior of the roll consists of small and broken leaf of various kinds, called "fillers"; and this is enclosed within an external covering of large whole leaf of bright quality, such leaves being called "covers." The material is supplied to the twisting machinery by an attendant, and formed into a cord of uniform thickness, twisted and wound on a drum by mechanism analogous to that used in rope-spinning. From the drum of the twisting machine the spun tobacco is rolled into cylinders of various sizes. These are enclosed in canvas, and around the surface of each stout hempen cord is tightly and closely coiled. In this form a large number, after being cooked or stoved in moist heat for about twenty-four hours, are piled between plates in an hydraulic press, and subjected to great pressure for a month or six weeks, during which time a slow fermentation takes place, and a considerable exudation of juice results from the severe pressure. The juice is collected for use as a sheep-dip.

Cake Tobacco.

Cake or plug tobacco is made by enveloping the desired amount of fillers within covering leaves of a fine bright colour. The packages are placed in moulds, and submitted to powerful pressure in an hydraulic press, by which they are moulded into solid cakes. Both cake and roll tobacco are equally used for smoking and chewing; for the latter purpose the cake is frequently sweetened with liquorice, and sold as honey-dew or sweet cavendish.

Cigars.

For cigar-making the finest and most delicately flavoured qualities of tobacco are generally selected. A cigar consists of a core or central mass of fillers enveloped in an inner and an outer cover, the former the binder and the latter the wrapper. The fillers or inner contents of the cigar must be of uniform quality, and so packed and distributed in a longitudinal direction that the tobacco may burn uniformly and the smoke can be freely drawn from end to end. For the binder whole leaf of the same quality as the fillers is used, but for the wrapper only selected leaves of the finest quality and colour, free from all injury, are employed. The covers are carefully cut to the proper size and shape with a sharp knife, and, after being damped and smoothed out are placed together in a pile. In making cigars by the hand, the operator rolls together a sufficient quantity of material to form the filling of one cigar, and experience enables him or her to select very uniform quantities. This quantity is wrapped in the inner cover, an oblong piece of leaf the length of the cigar to be made, and of width sufficient to enclose the whole material. The cigar is then rolled in the hand to consolidate the tobacco and bring it into proper shape, after which it is wrapped in the outer cover, a shaped piece made to enclose the whole in a spiral manner, beginning at the thick end of the cigar and working down to the pointed end, where it is dexterously finished by twisting to a fine point between the fingers. The finished cigars are either spread out in the sunlight to be dried, or exposed to a gentle heat. They are then sorted into qualities according to their colour, packed in boxes, in which they are stored for sale. Machinery is now employed for forming and moulding the fillings of the cheaper grades of cigars.

Havana cigars are, as regards form, classification, method of putting up and nomenclature, the models followed by manufacturers of all classes of the goods. Genuine ("legitimas") Havana cigars are such only as are made in the island; and the cigars made in Europe and elsewhere from genuine Cuban tobacco are classed as "Havanas." Other brands of home manufacture contain some proportion of Cuban tobacco; and very good cigars may be made in which the name only of that highly-prized leaf is employed. When we come to the inferior classes of cigars, it can only be said that they may be made from any kind of leaf, the more ambitious imitations being treated with various sauces designed to give them a Havana flavour. The highest class of Cuban-made cigars, called "vegueras," are prepared from the very finest Vuelta Abajo leaf, rolled when it is just half dry, and consequently never damped with water at all. Next come the "regalias," similarly made of the best Vuelta Abajo tobacco; and it is only the lower qualities, "ordinary regalias," which are commonly found in commerce, the finer, and the "vegueras," being exceedingly high-priced. The cigars, when dry, are carefully sorted according to strength, which is estimated by their colour, and classed in a scale of increasing strength as *claro*, *colorado claro*, *maduro* and *oscuro*. They are pressed into the cigar boxes for sale, and branded with the name or trade mark of their makers. Cheroots differ from ordinary cigars only in shape, being either in the form of a truncated cone, or of uniform thickness throughout, but always having both ends open and sharply cut across. Cheroots come principally from Manila, but there are now large quantities imported into the United Kingdom from the East Indies and Burma.

Cigarettes.

Cigarettes consist of small rolls of fine cut tobacco wrapped in a covering of thin tough paper specially made for such use. Originally cigarettes were entirely prepared by the smoker himself; but now they are very largely made by automatic machinery. The machines cut the paper, gum its edge, measure out the proper quantity of tobacco, wrap it up, make the gummed edge adhere, and cut the ends. In other machines a roll of narrow paper, in width equal to the circumference of the cigarette, is converted into a long tube, filled with tobacco, and automatically cut off into proper lengths. Such machines can make several hundred cigarettes per hour. The best cigarettes, however, are made by hand; the tobacco leaves are selected and hand-cut, and the paper tubes are filled by hand.

Snuff.

The manufacture of snuff is the most complex, tedious and difficult undertaking of the tobacco manufacture, but it is now of but little importance. The tobacco best suited for snuff-making is thick fleshy leaf of a dark colour, but scraps and waste pieces resulting from the preparation of smoking mixtures and cigars, and the midribs of leaves are largely used. The material is moistened with a solution of common salt and placed in very large heaps to ferment for some weeks. Various flavouring materials, such as liquorice, tonka beans (*Dipteryx odorata*) and other ingredients are added, the natures of which are often trade secrets.

The mass is dried, ground, and allowed to ferment again, the process being repeated if necessary. The peculiar properties of snuff are dependent on the presence of free nicotine, free ammonia and the aromatic principles developed during fermentation.

Fiscal Restrictions.

In nearly all civilized countries the cultivation of tobacco and its manufacture are conducted under state supervision and form an important source of public revenue. In some, for instance, France, Austria-Hungary and Italy, the cultivation is a state monopoly, and in other countries the crop is subject to heavy excise duties. Since the time of Charles II. the growth of tobacco in Great Britain has been practically prohibited, the original enactment to that effect having been passed to encourage trade with the young colony of Virginia. In 1886 experiments were conducted, under certain restrictions, and the plant was grown in Norfolk, Kent and other counties with sufficient success to prove the entire practicability of raising tobacco as a commercial crop in England. In more recent years tobacco has been grown in Ireland, but up to 1910 it had been found impracticable to obtain from the government sufficient relaxation from fiscal restrictions to encourage the home cultivation, though in 1907 the prospect of licences being issued was held out.

Statistics.

The following table, taken from the *Year Book of the U.S. Department of Agriculture, 1906*, indicates the crops of tobacco in 1905 in the regions mentioned, so far as figures are available.

	1905.
North America	721,492,000 ℔.
South America	108,575,000 ,,
Europe	630,133,000 ,,
Asia	690,161,000 ,,
Africa	23,346,000 ,,
Australia and Fiji	1,486,000 ,,
Total	2,175,193,000 ℔.

The estimated value of the world's annual crop is approximately £40,000,000.

Consumption of Tobacco.—The comparative consumption of tobacco in various countries is best appreciated by expressing it in pounds per head, and the following figures are taken from Bartholomew's *Atlas of the World's Commerce*: Belgium 6·21 ℔, United States 5·40 ℔, Germany 3·44 ℔, Austria 3·02 ℔, Australasia 2·20 ℔, Canada 2·54 ℔, Hungary 2·42 ℔, France 2·16 ℔, United Kingdom 1·95 ℔, Russia 1·10 ℔.

The literature of tobacco is very extensive. William Bragge of Birmingham published in 1880 a revised bibliography of the subject, *Bibliotheca nicotiana*, extending to 248 quarto pages. From such a mass of authorities it would be vain here to make selections, but mention may be made of Fairholt's capital gossiping work, *Tobacco, its History and Associations* (2nd ed., 1876). As modern standard works there may also be quoted Tiedemann's *Geschichte des Tabaks* (1856) and Wagner's *Tabakcultur, Tabak- und Cigarren-Fabrication* (1884). In the foregoing account various passages from the article by J. Paton and W. Dittmar, in the 9th ed. of the *Ency. Brit.*, have been utilized. (W. G. F.)

TOBAGO, an island in the British West Indies, 20 m. N.E. of Trinidad, in 11° 15′ N. and 60° 40′ W. Pop. 18,751. It is 26 m. long and 7½ m. broad, and has an area of 114 sq. m. or 73,313 acres, of which about 10,000 are under cultivation. It consists of a single mountain mass (volcanic in origin), 18 m. in length, and rising in the centre to a height of 1800 ft. A great part of the island is clothed with dense forest, in which many valuable hardwood trees are found. The higher lands form part of what is known as the "Rain Preserve," where, in order to attract and preserve the rainfall, the trees are never allowed to be felled. The average temperature is 81° F. and the yearly rainfall is 66 in. The rainy season lasts from June to December, with a short interval in September. The valleys are particularly adapted to horse- and sheep-farming, which are growing industries. The soil is fertile and produces rubber, cotton, sugar, coffee, cocoa, tobacco and nutmegs, all of which are exported; *pimento* (allspice) grows wild in the greatest profusion. The schools are conducted by various denominations, assisted by government grants. The island is divided into seven parishes. Scarborough (pop. 769), the capital, is on the south coast, 8 m. from its south-western point. It stands at the foot of a hill 425 ft. high, on which is situated Fort King George, now without a garrison. There is a lighthouse at Baedlet Point. Tobago, properly Tobaco, was discovered in 1498 by Columbus, who named it Assumption, and the British flag was first planted in 1580. It afterwards passed into the hands of the Dutch and then of the French, and was finally ceded to the British in 1814. Until 1889 it formed part of the colony of the Windward Islands, but in that year it was joined to Trinidad, its legal and fiscal arrangements, however, being kept distinct. Ten years later it became one of the wards of Trinidad, under a warden and magistrate; its revenue, expenditure and debt were merged into those of the united colony, and Trinidadian law, with very few exceptions, was made binding in Tobago.

TOBIN, JOHN (1770–1804), English dramatist, was born at Salisbury on the 28th of January 1770, the son of a merchant. He was educated at Bristol Grammar School, and practised in London as a solicitor. From 1789 he devoted all his spare time to writing for the stage. He submitted no fewer than thirteen plays before, in 1803, he got an unimportant farce staged. In 1804, having just submitted his fourteenth play, a romantic blank verse drama entitled *The Honey Moon*, to the Drury Lane management, he came to the conclusion that it was useless to continue playwriting and left London to recruit his health. The news that his play had been accepted came too late. He had long had a tendency to consumption, and was ordered to winter in the West Indies. He left England on the 7th of December 1804, but died on the first day of the voyage. In the following year *The Honey Moon* was produced at Drury Lane, and proved a great success. Several of Tobin's earlier plays were subsequently produced, of which *The School for Authors*, a comedy, was probably the best.

See also *The Memoirs of John Tobin*, with a selection from his unpublished writings, by Miss Benger (London, 1820).

TOBIT, THE BOOK OF, one of the books of the Old Testament Apocrypha. It is a good specimen of the religious novel, a form of literature invented by the Jews. The romance may be read in a beautiful dress in the Revised Version of the English Apocrypha. It was never admitted into the Jewish canon, but it was admitted into the Christian Canon at the Council of Carthage (A.D. 397). In the Roman Church it still forms a part of the Bible, but by the Church of England it is relegated to the position of those other books which "the Church doth read for example of life and instruction of manners, but yet doth it not apply them to establish any doctrine" (art. vi.). Some verses (Tob. iv. 7–9), however, are read in the offertory; and Tobias and Sarah once occupied the position now held by Abraham and Sarah in the marriage service.

The Book of Tobit has reached us in Greek, Latin, Syriac, Aramaic and Hebrew versions; of these the Hebrew are the latest, and need not be considered. Of the Greek there are three forms. One is in the Vatican and Alexandrian MSS.; another is in the Sinaitic. Both these texts are to be found in Swete's Septuagint, the former denoted by B, and the latter by ℵ. B is the common text, which is followed in the English Apocrypha. Nevertheless ℵ is fuller, except in ch. iv., and more intelligible; it is also more Semitic than B. The two must have behind them a common original, for they throw light upon one another, and the full meaning of a passage is sometimes only to be got from a combination of both. The fullness of ℵ often runs into superfluities, which are retrenched in B. The third Greek text is only a partial one (vi. 9–xiii. 8). It may be derived from a study of Codices 44, 106, 107 in Holmes and Parsons, which diverge from the Vatican text throughout the part indicated. Of the Latin there are two chief forms, the old translation, sometimes called the *Itala*, and that of Jerome in the Vulgate. The *Itala* was published by Pierre Sabatier at Paris in 1751, and is reproduced in the Book of Tobit by Neubauer (Clarendon Press, 1878). It agrees very fairly with ℵ, except in the matter of proper names. Jerome's version is from the Aramaic, or, as it used to be called, the Chaldee. It cost the saint one day's work. He describes in his preface the method of its production. He procured the services of a man who was familiar with Chaldee and Hebrew. This man translated to him out of Chaldee into Hebrew, while Jerome dictated to a shorthand writer his own translation into Latin. The work was done at the request of two Christian bishops, Chromatius and Heliodorus. Jerome does not mention the *Itala*, but it is plain that he was indebted to it. The Syriac text is said to be based on a Greek version. It was only in 1878 that the Aramaic version was brought to light, being published by Adolph Neubauer from a unique MS. in the Bodleian Library. It agrees with ℵ and the *Itala*, but resembles the Vulgate in having nothing in the first person. According to Neubauer, it is the very text which was used by Jerome, after allowance has been made for the arbitrary methods of the Rabbis and of Jerome himself. But the Aramaic version has Greek birthmarks (see especially p. 7, line 18), which other scholars than its editor have thought decisive against its originality. It was held by Robertson Smith (after Nöldeke) to be "in the highest degree probable that the Greek text is original." But the Greek text appears to be itself a translation from some Semitic source. Was this source Hebrew or Aramaic? The forms Ἀθήρ and Ἀθουρείας in xiv. 4, 15 of ℵ show that, at least, that chapter is drawn from Aramaic, not from Hebrew. But that chapter does not appear in all the versions, and so may be later than the rest.

With regard to the date of composition there is the widest difference of opinion. Ewald refers it to the end of the Persian period, about 350 B.C. (an opinion which Westcott declared to be "almost certainly correct"); Kohut thinks that the book was composed in Persia under the Sassanid Dynasty, about A.D. 250. But Tobit is already quoted as "scripture" by Clement of Alexandria (*Strom.* ii. 139, p. 503 Pott). The words of Tobit (xii. 8, 9) seem almost to have been present to the writer of ii. Clement (xvi. 4). The date of this document is uncertain; but in Irenaeus (i. 28, § 5) in his refutation of the Kabbalistic heresy of the Ophites, we find Tobias figuring as a prophet, on the same level as Haggai. Earlier still the Book of Tobit is quoted, though not by name, in the Epistle of Polycarp to the Philippians (x. 2; Tob. iv. 10. Cf. Prov. xii. 2; Ecclus. xxix. 12). Now the martyrdom of Polycarp is assigned by C. H. Turner to the year A.D. 156. We seem to have even a quotation by St Paul from the Book of Tobit (1 Tim. vi. 19; Tob. iv. 9), in which the identity amid difference seems to show that the Apostle is drawing, not from the Greek, but from the Semitic original. Josephus displays no knowledge of the work, but he may have been animated by the same prejudice as the Pharisees of St Jerome's day, whose displeasure, that father tells us, he had to face in giving to Latin readers a book which was against their canon. (Preface to Tobit.) Internal evidence shows that the writer of the 14th chapter lived after the building of the Second Temple, which was "not as the first." In *vv.* 5 and 6 of that chapter Tobit is made to predict a glorious building of Jerusalem and the Temple, which was to be followed by the conversion of all the Gentiles. Such a passage might well have been penned when the idea of Herod's Temple was already in the air. If so, this chapter may be supposed to have been written a little before 19 B.C., while the bulk of the work may have been indefinitely earlier.

As to the place of composition Persia, Egypt and Palestine have each had advocates. One thing only appears fairly certain, namely, that the Greek versions were composed in Egypt. This conclusion could, we think, be established by an examination of the language, especially of some technical terms of administration. But the tale itself carries us back to Persia. It has what Moulton called an "Iranian background." The evil demon Asmodeus (*q.v.*) is the Persian Aēshma Daēva. Raphael, "one of the seven holy angels, which present the prayers of the saints, and go in before the glory of the Holy One," resembles the protecting spirit Sraosha. And the dog, the companion of Sraosha, is there too. For Tobit differs from all other books of the Bible in containing the only polite reference to the dog. Tobias's dog indeed does nothing but accompany his young master on his journey to Ecbatana and back. But he is there as the companion and friend of man, which is Aryan and not Semitic. So alien indeed is this from the Semitic mind that in the Aramaic and Hebrew versions the dog does not appear.

Even in א, the more Semitic of the two Greek versions, the dog has evidently been found an offence. Mention of him is suppressed in v. 17, while in xi. 4, ὁ Κύριος is made to go behind Tobias, instead of ὁ κύων!

The motive of the story has been variously regarded as a desire to insist upon the duty of tithe-paying, upon that of almsgiving, and upon that of burying the dead. The Midrash given by Neubauer has no doubts on this point, as the story is immediately followed by the remark—"Behold we learn how great is the power of alms and tithes!" But the third motive is equally apparent. Accordingly some have insisted that the story must have been composed at some period when Jewish dead were left unburied, either in the time of Antiochus Epiphanes (2 Macc. v. 10), or in that of Hadrian, after the revolt of Bar-Cochebas. If our choice were limited to these two periods, we should certainly prefer the former. For the book carries within itself signs of early date. It contains no Messianic expectation nor any reference to a future life. The last fact is obscured by the Vulgate. Even in the *Itala* the word *aeterna* is added in xii. 9 after *saturabuntur vita*.

A new interest has been added recently to the study of Tobit by the publication of the *Wisdom of Aḥikar* (*Aḥiqar*). In the Book of Tobit Aḥikar is represented as the prime minister of Sennacherib and his son Esar-Haddon, and is claimed by Tobit as his nephew. There is a desire manifested to bring in Aḥikar wherever possible (i. 21, 22; ii. 10; xi. 18; xiv. 10). The intention evidently is to bestow authority upon the fiction by connecting it with a story already known.

See K. D. Ilgen, *Die Geschichte Tobias nach drei verschiedenen Originalen* (Jena, 1800); Fritzsche, *Handbuch zu den Apocryphen* (Leipzig, 1853); F. H. Reusch, *Das Buch Tobias* (Freiburg, 1857); Schürer, *Geschichte*, 3rd edition; Ad. Neubauer, *The Book of Tobit* (Oxford, 1878); Fuller in *Speaker's Commentary* (1888); E. J. Dillon, *Contemporary Review* (March 1898); *The Story of Aḥikar*, by Conybeare, Harris and Lewis (Cambridge, 1898); J. Rendel Harris, "The Double Text of Tobit," *American Journal of Theology* (July 1899), pp. 541–554; Moulton, "The Iranian Background of Tobit," *Expository Times* (March 1900), pp. 257–260; B. F. Westcott in Smith's *Dict. Bible*; I. T. Marshall in Hastings's *Dict. Bible*; W. Erbt in *Ency. Bib.*; Toy in *Jewish Encyclopedia*; Johannes Müller, *Beiträge zur Erklärung und Kritik des Buches Tobit*; and in the same volume *Alter und Herkunft des Achicar-Romans und sein Verhältniss zu Aesop*, by Rudolf Smend. (St G. S.)

TOBOGGANING (Micmac Indian, *tobaakan*, sledge), the sport of sliding down snow-covered hills and artificial ice-shutes on the toboggan, a sled from 3 ft. to 8 ft. long and 2 ft. to 3 ft. wide, formed of strips of wood from ¼ in. to ½ in. in width, fitted together and curved up at the front. The toboggan is not so well fitted for use on roads that are not steep or very smooth as is the sled provided with runners, but is generally used on open hills, or upon artificial courses (chutes), which are very popular in Canada. For "Tobogganing," as known in the Engadine winter resorts, see Coasting.

TOBOLSK, a government of western Siberia, having the Arctic Ocean on the N., the governments of Archangel, Vologda, Perm and Orenburg on the W., the provinces of Akmolinsk and Semipalatinsk on the S., and the governments of Tomsk and Yeniseisk on the E. It is one of the largest provinces of the Russian Empire, occupying 530,820 sq. m. The northern coast is formed by the Yalmal or Yanmal peninsula, separating the Bay of Kara (on the west) from the double bays of the Ob and Taz (on the east). The Pai-ho coast-ridge touches Tobolsk only at its south-eastern extremity. The Urals proper, which run south-west from the Kara Sea as far as the Töll-pos (5445 ft.), and thence take a southerly direction, form the boundary between Tobolsk and Vologda as far as 62° N., but further south their eastern slopes are included in the government of Perm, and only their lowest spurs, 200 m. from the main chain, belong to Tobolsk.

The remainder of the government is lowland, but varies greatly in its different parts. In the south it assumes the character of grassy steppes or prairies, in the north of immense marshes sparsely overgrown with forest, and of treeless tundras as the shores of the Arctic Ocean are approached. The south steppes, in their turn, may be subdivided into two distinct portions, the Tobol and Ishim steppe in the west and the Baraba in the east. The former, nearly 43,000 sq. m. in area, is one of the most fertile parts of the empire. One-third is under forest, and the remainder has a soil of very productive black earth, which enjoys the further advantage of being sufficiently drained. The climate is very severe, the mean annual temperature (30° to 34° F.) being that of the north of Sweden and of Archangel; but the warm summer (65° to 68° in July) and the amount of light received from a bright sky combine to make vegetation develop with a rapidity unknown to west Europe. The Baraba steppe extends to about 55,000 sq. m. and is covered with recent deposits; but, as there is no definite slope, the surface waters accumulate in a large number of lakes and marshes. The climate is moister and the summer shorter and less hot than in the Tobol and Ishim steppe. Forests, consisting chiefly of birch, occur sporadically over its surface. The soil of this region also is very productive, but the fertile patches are separated by marshy ground, and the dense clouds of mosquitoes in summer are a plague to both man and beast. To the north of the regions just indicated lie the administrative districts of Tura, Tobolsk and Tara, with an area of about 110,000 sq. m.; this may be described as the *taiga* region. It consists throughout of impenetrable forests and quaking quagmires—the dreadful *urmans*, which are altogether impenetrable 50 m. from the scattered settlements. Gigantic cedar-trees, larches, firs, pines, birches and maples grow very close together, and the underwood is so dense that a passage can be forced only with the hatchet, the difficulties being further increased by the abundance of decayed wood and by the marshy foothold. To cross these *urmans*, which are treacherously concealed under a swaying carpet of grassy vegetation, a kind of snow-shoe has to be used even in summer, and many can be crossed only in winter. Indeed vast areas have never been visited by man. The south-western parts of this region are traversed by the Siberian highway, and to this circumstance alone is it indebted for its population of nearly half a million.

The government is drained by the Ob, which traverses it for more than 1300 m., and is navigable throughout. It receives many tributaries, some of which are 200 to 350 m. long, but flow through quite uninhabited regions. The Irtysh, a left-hand tributary, spreads a network of affluents all over the south of the government and is navigable for the whole of its length of 760 m.; it receives the Tobol, about 420 m. long, also navigable, the Ishim, and a number of less important streams; while the Tura, a tributary of the Tobol, is also navigable. Navigation lasts for nearly six months in the south. The first steamer on the Ob system was launched in 1845 and the second in 1860; since the latter date steam navigation has steadily developed.

The estimated population in 1906 was 1,656,700, and is practically all Russian, except for some 42,000 Tatars in the south, 18,000 Ostyaks, 4500 Samoyedes, and 4800 Voguls. There are, moreover, about 5000 Germans and Finns, some Jews in the towns, and about 1500 gipsies. The government is divided into ten districts, the chief towns of which are Tobolsk, Berezov, Ishim, Kurgan, Sugut, Tara, Turinsk, Tyukalinsk, Tyumen and Yalutorovsk. The standard of education is very low. The Ostyaks are in a very miserable condition, having come under heavy obligations to the Russian merchants and being compelled to hand over to them nearly all the produce of their hunting and fishing. The Tatar settlements are prosperous in the south, but not in the Tobolsk district, where their lands have been appropriated for the Russian settlers. Many of the Samoyedes, Ostyaks and Voguls are nominally Christians. The Russians and the Tatars live mostly by agriculture. Of the total area of land regarded as suitable for cultivation (28,400,000 acres), 15,600,000 or 55 % are owned by the peasant communities.

Agriculture is generally the chief occupation, and Tobolsk is fast becoming a granary from which corn is exported to the northern governments of European Russia. The total area under cereal crops in 1900 was 3,334,600 acres, and the principal crops are rye, wheat, oats, barley and potatoes. Flax, hemp and tobacco are cultivated in the south. Livestock breeding is carried on on a large scale. Dairy-farming has made remarkable progress since the trans-Siberian railway was built.

The industries are insignificant (chiefly tanning, distilling and tallow-melting); ironworks and cloth mills are still in their infancy. The export of cattle, hides, tallow, corn, flour, fish and furs to Russia, both from Tobolsk and from the Kirghiz steppe, is of some importance. Spirits are sent farther east to Tomsk; while all kinds of manufactured wares are imported from Russia. The fairs of Irbit and Ishim are the chief centres for trade. (P. A. K.; J. T. Be.)

TOBOLSK, a town of Asiatic Russia, capital of the government of the same name, on the right bank of the Irtysh, near its confluence with the Tobol. Pop. (1900), 21,401. It is 305 m. E.N.E. from Ekaterinburg, and is no longer the capital of West

Siberia nor even an administrative centre for exiles. The kreml, or citadel, built in the reign of Peter the Great, by Swedish prisoners, in imitation of the kreml of Moscow, contains the cathedral, erected towards the end of the 17th century. Some 12 m. south-east are the ruins of the "fort of Kuchum," the site of the capital of Siberia, Isker, before the Russian conquest. Tobolsk was founded in 1587 by Cossacks, and forms the see of the bishop of Tobolsk and Siberia.

TOBRUK (anc. *Antipyrgos*), a settlement with small Turkish garrison on a fine natural harbour situated on the N. coast of Africa at the intersection of 32° N. Lat., with 24° E. Long. The harbour, which is small but deep, and sheltered by high ground, opens to the east. It is about 2½ m. long by ¾ m. wide; the depth in the centre is over 40 ft. and soundings of over 30 ft. extend to within a very short distance of the shores. It is the only safe port easily accessible to large vessels for over 1000 m., between Sfax in Tunisia and Alexandria, for, although there is safe and deep anchorage in the recess of the Gulf of Bomba, the entrance is rocky and difficult. Tobruk has long been the outlet for the trade of the oases which extend from Jarabub to Siwah, and are a stronghold of the Senussi order (see CYRENAICA); and it is also the headquarters of the Libyan sponge fishery, prosecuted by Greeks. In the spring it is visited by a great number of boats, to protect which a small Hellenic warship has sometimes been despatched. But it is as a future man-of-war harbour that Tobruk is likely to be important. It has been visited both by British and Italian squadrons and has become an object of considerable solicitude to the government of Italy. By running into Tobruk and the neighbouring Gulf of Bomba the French fleet eluded British vigilance on its way to Egypt in 1798. (D. G. H.)

TOCHI VALLEY, or DAWAR, one of the chief routes into Afghanistan in the North-West Frontier Province of India. It leads from the Bannu through tribal country, and is inhabited by the Dawari (*q.v.*). The valley is divided into two parts, known as Upper and Lower Dawar, by a narrow pass called the Taghrai Tangi, some three m. long. Between Dawar and British territory is the low range of uninhabited hills, which skirt the Bannu district. It was by this route that Mahmud of Ghazni effected several of his raids into India and the remains of a road flanking the valley and of defensive positions are still to be traced. After the Waziristan Expedition of 1894 the Tochi was garrisoned by British troops; but when Lord Curzon reorganized the frontier in 1901, the British troops were withdrawn, and their place supplied by tribal militia. The chief posts are Saidgi, Idak, Miranshah, Datta Khel and Sheranni. The valley was the scene of action for the Tochi or Dawari Expedition under Brigadier-General Keyes in 1872, and the Tochi Expedition under General Corrie Bird in 1897.

TOCQUEVILLE, ALEXIS HENRI CHARLES MAURICE CLEREL, COMTE DE (1805–1859), was born at Verneuil on the 29th of July 1805. His family on the father's side were of good descent, and distinguished both in the law and in arms, while his mother was the granddaughter of Malesherbes. Alexis de Tocqueville was brought up for the bar, or rather for the bench, and became an assistant magistrate in 1830. A year later he obtained from the government of July a mission to examine prisons and penitentiaries in America, and proceeded thither with his life-long friend Gustave de Beaumont. He returned in less than two years, and published a report, but the real result of his tour was the famous *De la Démocratie en Amérique*, which appeared in 1835, and very soon made his reputation (3rd ed. 1868). It was at once caught up by influential members of the Liberal party in England, which country Tocqueville soon after visited, and where he married an Englishwoman. Returning to France, he was elected a member of the *Académie des sciences morales et politiques* (Jan. 6, 1838), and beginning life as a country gentleman at Tocqueville, he thought to carry out the English ideal completely by standing for the chamber of deputies. But, with a scruple which illustrated his character, he refused government nomination from Molé, and was defeated. Later he was successful, and sat for several years both before and after the revolution of February, becoming in 1849 vice-president of the assembly, and for a few months minister of foreign affairs. He was a warm supporter of the Roman expedition, but an equally warm opponent of Louis Napoleon, and after being one of the deputies who were arrested at the *coup d'état* he retired from public life. Twenty years after his first, he produced another book, *De l'Ancien régime*, which almost, if not quite, equalled its success. His health was never very strong, and in 1858 he broke a blood-vessel. He was ordered to the south, and, taking up his residence at Cannes, died there on the 16th of April 1859. He had published some minor pieces during his lifetime, and his complete works, including much unpublished correspondence, were produced after his death in uniform shape by H. G. de Beaumont (*Œuvres complètes de Tocqueville*, 9 vols., 1860–1865).

During the last twenty years of his life, and for perhaps half that time after his death, Tocqueville had an increasing European fame. His manner, which is partly imitated from Montesquieu, has considerable charm; and he was the first and has remained the chief writer to put the orthodox liberal ideas which governed European politics during the first half or two-thirds of the 19th century into an orderly and attractive shape. He was, moreover, as has been said, much taken up by influential persons in England—N. W. Senior, John Stuart Mill and others—and he had the great advantage of writing absolutely the first book of reasoned politics on democratic government in America. Besides, he was, if not an entirely impartial writer, neither a devotee nor an opponent of democracy. All this gave him a very great advantage which he has not yet wholly lost. At the same time he had defects which were certain to make themselves felt as time went on, even without the alteration of the centre of liberal opinion which has taken place of late years. The chief of these was a certain weakness which can hardly be described by any word more dignified than "priggishness." His correspondence with Molé, above alluded to, is an instance of this, and it was also reflected on in various epigrams by countrymen and contemporaries; one of these accuses him of having "begun to think before he had begun to learn," while another declares that he *avait l'air de savoir de toute éternité ce qu'il venait d'apprendre*. He appears both in reading history and in conducting actual political business to have been constantly surprised and disgusted that men and nations did not behave as he expected them to behave. This excess of the deductive spirit explains at once both the merits and the defects of his two great works, which will probably remain political classics, though they are less and less likely to be used as practical guides.

See Heinrich Jacques, *Alexis de Tocqueville; ein Lebens- und Geistesbild* (Vienna, 1876); James Bryce, *The Predictions of Tocqueville* (Baltimore, 1887); Count de Puymaigre, *Les Souvenirs d'Alexis de Tocqueville* (1893); and *Correspondance entre Alexis de Tocqueville et Arthur de Gobineau* (1908).

TOCSIN, a signal of alarm given by the ringing of a bell, hence any warning or danger signal. The earliest form in English is *tocksaine*, which was borrowed from the O. Fr. *toquesin* (*toquer*, to strike, cf. *toucher* and *sin*, mod. *signe*, a signal, Lat. *signum*). The use of "touch" and its cognate forms with the idea of giving a sound is seen in "tucket," Ital. *toccata*, which probably originally meant a signal given by tap of drum, but is always applied to a flourish or fanfare on a trumpet.

TOD, JAMES (1782–1835), British officer and Oriental scholar, was born on the 20th of March 1782, and went to India as a cadet in the Bengal army in 1799. He commanded the escort attached to the resident with Sindia from 1812 to 1817. In the latter year he was in charge of the Intelligence Department which largely contributed to break up the confederacy of Maratha chiefs in the Pindari War, and was of great assistance in the campaign in Rajputana. In 1818 he was appointed political agent for the states of western Rajputana, where he conciliated the chieftains, settled their mutual feuds and collected materials for his *Annals and Antiquities of Rajasthan* (2 vols., 1829–1832). Another book of value, *Travels in Western India* (1839), was published posthumously. He returned from India in 1823, was promoted lieutenant-colonel in 1826, and died in London on the 17th of November 1835.

TODAS, a small pastoral tribe of Southern India, found only on the Nilgiri hills. They are distinguished by their tall, well-proportioned figures, aquiline noses, long, black, wavy hair and full beards. Their colour is a light brown. Their dress consists of a single cloth, which they wear like the plaid of a Scotch highlander. The women cover the whole body with this mantle. Their sole occupation is cattle-herding and dairy-work. They practise polyandry, a woman marrying all the brothers of a family. The proportion of females to males is about three to five. Their language is a mixture of Tamil and Kanarese, and is classified by Bishop Caldwell as a separate language of the Dravidian family. The Todas worship their dairy-buffaloes, but they have a whole pantheon of other gods. The only purely religious ceremony they have is Kona Shastra, the annual sacrifice of a male buffalo calf. Toda villages, called *mands*, usually consist of five buildings or huts, three of which are used as dwellings, one as a dairy and the other for sheltering the calves at night. These huts are of an oval, pent-shaped construction usually 10 ft. high, 18 ft. long and 9 ft. broad. They are built of bamboo fastened with rattan and thatched. Each hut is enclosed within a wall of loose stones. The inhabitants of a *mand* are generally related and consider themselves one family. The Todas numbered 807 in 1901.

See W. H. R. Rivers, *The Todas* (1906).

TODHUNTER, ISAAC (1820–1884), English mathematician, son of George Todhunter, a Nonconformist minister, was born at Rye on the 23rd of November 1820. He was educated at Hastings, at which town his mother had opened a school after the death of his father in 1826. He became an assistant master at a school at Peckham, attending at the same time evening classes at the University College, London. In 1842 he obtained a mathematical scholarship and graduated as B.A. at London University, and was awarded the gold medal on the M.A. examination. About this time he became mathematical master at a school at Wimbledon. In 1844 he entered St John's College, Cambridge, where he was senior wrangler in 1848, and gained the first Smith's prize and the Burney prize; and in 1849 he was elected to a fellowship, and began his life of college lecturer and private tutor. In 1862 he was made a fellow of the Royal Society, and in 1865 a member of the Mathematical Society of London. In 1871 he gained the Adams prize and was elected to the council of the Royal Society. He was elected honorary fellow of St John's in 1874, having resigned his fellowship on his marriage in 1864. In 1880 his eyesight began to fail, and shortly afterwards he was attacked with paralysis. He died at Cambridge on the 1st of March 1884.

Works.—*Treatise on the Differential Calculus and the Elements of the Integral Calculus* (1852, 6th ed., 1873), *Treatise on Analytical Statics* (1853, 4th ed., 1874); *Treatise on the Integral Calculus* (1857, 4th ed., 1874); *Treatise on Algebra* (1858, 6th ed., 1871); *Treatise on Plane Coordinate Geometry* (1858, 3rd ed., 1861); *Plane Trigonometry* (1859, 4th ed., 1869); *Spherical Trigonometry* (1859); *History of the Calculus of Variations* (1861); *Theory of Equations* (1861, 2nd ed. 1875); *Examples of Analytical Geometry of Three Dimensions* (1858, 3rd ed., 1873); *Mechanics* (1867), *History of the Mathematical Theory of Probability from the Time of Pascal to that of Lagrange* (1865); *Researches in the Calculus of Variations* (1871); *History of the Mathematical Theories of Attraction and Figure of the Earth from Newton to Laplace* (1873); *Elementary Treatise on Laplace's, Lamé's and Bessel's Functions* (1875); *Natural Philosophy for Beginners* (1877). An unfinished work, *The History of the Theory of Elasticity*, was edited and published posthumously in 1886 by Karl Pearson. Todhunter also published keys to the problems in his textbooks on algebra and trigonometry; and a biographical work, *William Whewell, account of his writings and correspondence* (1876), in addition to many original papers in scientific journals.

See obituary notices in the *Proc. Lond. Math. Soc.* (1884), and *Proc. Roy. Soc.* (1884).

TODI (anc. *Tuder*), a town and episcopal see of the province of Perugia, Italy, 28 m. S. of Perugia by road, on a steep hill above the east bank of the Tiber, 1348 ft. above sea-level, and 866 ft. above the river. Pop. (1901), 3599 (town), 16,528 (commune). Some portions of the ancient town walls—of two enceintes, an inner and an outer, the former attributed to the original Umbrian inhabitants, the latter to the Romans—are preserved, and also remains of baths, amphitheatre, theatre, and a substruction wall of massive masonry, with four niches. Here was found the bronze statue of Mars, now in the Vatican, so that the building is sometimes erroneously called the temple of Mars. Beneath the cathedral square, at the highest point of the town, is a large reservoir. The Romanesque cathedral has a simple façade (partly of the 11th, partly of the 14th and 15th centuries), with a fine portal and rose window. In the same square is the massive Romanesque Gothic Palazzo Comunale of 1267, the Palazzo dei Priori and the Palazzo della Podesta. The Gothic church of S. Fortunato, with its nave and aisles of the same height, has a splendid portal; the upper part of the façade is unfinished. Both this church and the cathedral have good choir-stalls.

Just outside the town on the west is the pilgrimage church of S. Maria della Consolazione, one of the finest buildings of the Renaissance, and often wrongly attributed to Bramante. Contemporary documents prove that the interior was begun in 1508 by Cola Matteuccio da Caprarola, and the exterior completed in 1516–1524 by Ambrogio da Milano and Francesco di Vito Lombardo; the slender dome was not added till 1606; its plan is a Greek cross. S. Fillippo in the town, a church of the early 16th century, betrays the influence of the Consolazione in details.

During the period of its independence, the town struck coins with the legend *Tutere*. It is hardly mentioned in history until it received Roman citizenship in the Social War. Crassus took it in 83 B.C.; and a colony was founded there by Octavian, including some soldiers of the 41st legion, which only existed in his time, after which it bore the name *Colonia Iulia fida Tuder*. It was a station on the road between America and Perusia, but otherwise is hardly mentioned. Narses won a victory over the Goths near Todi in 552, and Totila lost his life. In the middle ages it had frequent struggles with Perugia, and its obedience to the church until the 16th century was somewhat fitful. The village of Vicus Martis Tudertium lay 9 m. to the east on the Via Flaminia. Several inscriptions mention it (*Corpus inscript. lat.* xi. 694).

TODLEBEN (or Totleben), **FRANZ EDUARD IVANOVICH,** Count (1818–1884), Russian engineer general, was born at Mittau in Courland, on the 20th of May 1818. His parents were of German descent, and of the mercantile class, and he himself was intended for commerce, but a strong instinct led him to seek the career of a military engineer. He entered the school of engineers at St Petersburg, and passed into the army in 1836. In 1848 and the two following years he was employed, as captain of engineers, in the campaigns against Schamyl in the Caucasus. On the outbreak of war between Russia and Turkey in 1853, he served in the siege of Silistria, and after the siege was raised was transferred to the Crimea (see Crimean War). Sevastopol, while strongly fortified toward the sea, was almost unprotected on the land side. Todleben, though still a junior field officer, became the animating genius of the defence. By his advice the fleet was sunk, in order to blockade the mouth of the harbour, and the deficiency of fortifications on the land side was made good before the allies could take advantage of it. The construction of earthworks and redoubts was carried on with extreme rapidity, and to these was transferred, in great part, the artillery that had belonged to the fleet. It was in the ceaseless improvisation of defensive works and offensive counterworks to meet every changing phase of the enemy's attack that Todleben's peculiar power and originality showed itself. He never commanded a large army in the open field, nor was he the creator of a great permanent system of defence like Vauban. But he may justly be called the originator of the idea that a fortress is to be considered, not as a walled town but as an entrenched position, intimately connected with the offensive and defensive capacities of an army and as susceptible of alteration as the formation of troops in battle or manœuvre. Until the 20th of June 1855 he conducted the operations of defence at Sevastopol in person; he was then wounded in the foot, and at the operations which immediately preceded the fall of the fortress he was not present. In the course of the siege he had risen from the rank of lieutenant-colonel to that of lieutenant-general, and had also been made aide-de-camp to the tsar. When he recovered he was employed in strengthening the fortifications at the mouth of the Dnieper, and also those of Cronstadt. In 1856 he visited England, where his merits were well understood. In 1860 he was appointed assistant to the grand-duke Nicholas, and he became subsequently chief of the department of engineers with the full rank of general. He was given no command when war with Turkey began in 1877. It was not until after the early reverses before Plevna (*q.v.*) that the soldier of Sevastopol was called to the front. Todleben saw that it would be necessary to draw works round Osman Pasha, and cut him off from communication with the other Turkish commanders. In due time Plevna fell. Todleben then undertook the siege of the Bulgarian fortresses. After the conclusion of preliminaries of peace, he was placed in command of the whole Russian army. When the war was over he became governor of Odessa and hereditary count. But his health was broken, though for some time after 1880 he held the post of governor of Vilna, and after much suffering he died at Bad Soden near Frankfort-on-Main, on the 1st of July 1884.

His great work on the defence of Sevastopol appeared in Russian, French and German (5 vols. 1864–1872). Besides this, he wrote a letter to General Brialmont on the operations around Plevna; this was printed in the Russian engineer journal, and in German in the *Archiv für preussische Artillerie-offiziere* (1878).

See Brialmont, *Le Général comte Todleben* (Brussels, 1884); Rieger, "Todleben u. seines Wirkens Bedeutung für die Kriegskunst der Zukunft" (in *Mittheilungen über Gegenstände des Artillerie- und Geniewesens*, Vienna, 1885); Witzleben, in *Internationale Revue über die gesammten Armeen und Flotten* (1879); Schröder, in *Archiv für Artillerie- und Ingenieur-Offiziere* (Berlin, 1888); *Life* by Schilder (in Russian, St Petersburg, 1885–1887); Krahmer, *General-Adjutant Graf Todleben* (Berlin, 1888).

TODMORDEN, a market town and municipal borough in the Sowerby parliamentary division of the West Riding of Yorkshire, England, extending into the Middleton parliamentary division of Lancashire; 19 m. N.N.E. of Manchester, on the Lancashire & Yorkshire railway. Pop. (1901), 25,418. It lies on both sides of the river Calder, and the scenery of the valley is beautiful in spite of the numerous factories. Todmorden Hall, a picturesque old mansion of various dates, was the seat of the Radcliffes, but they sold the manorial rights about the close of the 17th century. The town hall is a handsome classical building erected in 1875; it bridges the county boundary, the Calder, enabling the magistrates to exercise jurisdiction in both counties. There is a bronze statue to John Fielden (1784–1849), to whose energy in developing the cotton manufacture the town owes much of its prosperity. The staple industry is the spinning and weaving of cotton, and there are also foundries and machine-works. The municipal borough, incorporated in 1896, is under a mayor, 6 aldermen and 18 councillors. Area, 12,773 acres.

TODY, T. Pennant's rendering (*Gen. Birds*, pp. 15, 61) through the French *Todier* of M. J. Brisson (*Ornithologie*, iv. 528) of the somewhat obscure Latin word *Todus*,[1] not unhappily applied in 1756 by Patrick Browne (*Civ. and Nat. Hist. Jamaica*, p. 476) to a little bird remarkable for its slender legs and small feet, the "green sparrow" or "green humming-bird" of Sir H. Sloane (*Voyage*, ii. 306). The name, having been taken up by Brisson (*loc. cit.*) in 1760, was adopted by Linnaeus, and has since been recognized by ornithologists as that of a valid genus, though many species have been referred to it which are now known to have no affinity to the type, the *Todus viridis* of Jamaica, and accordingly have since been removed from it. The genus *Todus* was at one time placed among the *Muscicapidae* (cf. FLYCATCHER); but J. Murie's investigations (*Proc. Zool. Society*, 1872, pp. 664–680, pl. lv.) have conclusively proved that it is not passerine, and is nearly allied to the *Momotidae* (cf. MOTMOT) and *Alcedinidae* (cf. KINGFISHER), it being regarded as forming a distinct sub-family *Todinae* of the Momotidae peculiar to the Greater Antilles, each of which islands has its own species, all of small size, the largest not exceeding four inches and a half in length.

Of the species already named, *T. viridis*, P. H. Gosse (*B. Jamaica*, pp. 72–80) gives an interesting account. "Always conspicuous from its bright grass-green coat and crimson-velvet gorget, it is

(After Gosse.)

Tody (*Todus viridis*).

still a very tame bird; yet this seems rather the tameness of indifference than of confidence; it will allow a person to approach very near, and, if disturbed, alight on another twig a few yards distant . . . commonly it is seen sitting patiently on a twig, with the head drawn in, the beak pointing upwards, the loose plumage puffed out, when it appears much larger than it is. It certainly has an air of stupidity when thus seen. But this abstraction is more apparent than real; if we watch it, we shall see that the odd-looking grey eyes are glancing hither and thither, and that ever and anon the bird sallies out upon a short feeble flight, snaps at something in the air, and returns to his twig to swallow it." The birds of the family also show their affinity to the kingfishers, motmots and bee-eaters by burrowing holes in the ground in which to make their nest, and therein laying eggs with a white translucent shell. The sexes differ little in plumage.

All the four species of *Todus*, as now restricted, present a general similarity of appearance, and possess very similar habits; and even these, by some ornithologists, might be regarded as geographical races. The Cuban form is *T. multicolor*; that of Haiti is *T. subulatus* or *dominicensis*; and that of Porto Rico, originally named in error *T. mexicanus*, has since been called *hypochondriacus*.

(A. N.)

TOGGENBURG, THE, a special name given to the upper valley of the river Thur, in the Swiss Canton of St Gall. It descends in a N.W. direction from the watershed between the Rhine and the Thur, and is enclosed N.E. by the chain of the Säntis (8216 ft.) and S.W. by that of the Kurfürsten (7576 ft.) and of the Speer (6411 ft.). It is a fertile valley of about 30 m. in length from the source of the river to Wil on the railway line between Winterthur and St Gall. The upper half is traversed by an excellent carriage road, while from Kappel there is a railway to Wil (15½ m.). Its industrious population numbered 34,594 in 1900, nearly equally divided between Romanists and Protestants, mostly German-speaking. Those of the upper half are devoted to pastoral pursuits while those of the lower half are engaged in the manufacture of muslin and cotton. This valley is as yet frequented only by Swiss visitors, and retains many characteristics of sub-alpine Switzerland before the arrival

[1] In Forcellini's *Lexicon* (ed. De Vit, 1875) we find "Todus genus parvissimae avis tibias habens perexiguas." Ducange in his *Glossarium* quotes from Festus, an ancient grammarian, "Toda est avis quae non habet ossa in tibiis; quare semper est in motu, unde Todiu (al. Todinus) dicitur ille qui velociter todet et movetur ad modum todae, et todere, moveri et tremere ad modum todae." The evidence that such a substantive as *Todus* or *Toda* existed seems to rest on the adjectival derivative found in a fragment of a lost play (*Syrus*) by Plautus, cited by this same Festus. It stands "cum extritis [*extortis*] talis, cum todillis [*todinis*] crusculis"; but the passage is held by scholars to be corrupt. Among naturalists Gesner in 1555 gave currency (*Hist. animalium*, iii. 719) to the word as a substantive, and it is found in Levins's *Manipulus vocabulorum* of 1570 (ed. Wheatley, 1867, col. 225) as the equivalent of the English "titmouse." Ducange allows the existence of the adjective *todinus*. Stephanus suggests that *todi* comes from *τυτθοί*, but his view is not accepted. The verb *todere* may perhaps be Englished to "toddle"!

of the horde of tourists. At Wildhaus, the highest village (3632 ft.), the house wherein Huldreich Zwingli, the Swiss Reformer, was born in 1484, is still shown. The chief village is Lichtensteig (1387 inhab.), but those of Kirchberg (5025 inhab.) and of Wattwil (4971 inhab.) are the most populous. On the extinction of the main line of the local counts (1436), this portion of their dominions passed to the lord of Raron (in the Valais), who sold it in 1468 to the abbot of St Gall. (W.A.B.C.)

TOGO, HEIHACHIRO, Count (1847–), Japanese admiral, was born in Kagoshima. He studied naval science and navigation in England from 1871 to 1878, and first became a prominent figure when, in 1894, as captain of the cruiser "Naniwa," he sunk the Chinese troopship "Kowshing" *en route* for Korea, thus precipitating war with China. When the Russo-Japanese conflict broke out in 1904, he was appointed to the command-in-chief of the Japanese fleet, and under his direction various brilliant operations took place, culminating in the battle of the Sea of Japan when the Russian fleet was annihilated. For these services he received (1907) the title of count. In 1906 he was made a member of the British Order of Merit.

TOGOLAND, a German colony on the Gulf of Guinea, West Africa. It forms part of the territory formerly distinguished as the Slave Coast and was annexed by Germany in 1884. It is bounded S. by the Atlantic, W. by the British possessions on the Gold Coast, N. by the French colony of Upper Senegal and Niger, E. by Dahomey, also a French colony. (For map see French West Africa and Gold Coast). The coastline is only 32 m. in length (1° 14′ E. to 1° 38′ E.) but inland Togoland widens to three or four times that breadth. It contracts again at its northern boundary to about 30 m. From the coast northward the extreme length is 350 m. The area of the colony is some 33,700 sq. m. Pop. about 1,000,000. The white inhabitants numbered (1909) 330 of whom 300 were German. The boundary between Togo and Dahomey, by Franco-German agreement of 1897, follows the coast lagoon from Little Popo to the Mono river, ascends the middle of that river as far as 7° N., thence goes in a direct line to 9° N. and from that point in a north-westerly direction to 11° N. The western boundary was settled by Anglo-German agreements of 1890 and 1899; it leaves the coast west of the town of Lome and proceeds in a zigzag line to where the Deine river joins the Volta; thence follows the Volta to its junction with the Daka and then the Daka up to the point where 9° N. cuts the river. From this point the frontier follows a north-easterly course to 11° 8′ N., leaving the town of Yendi and the Chakosi territory on the German side of the boundary line. The agreement of 1899 defined the western boundary from 8° N. northward, and partitioned between the two powers a large block of territory, which by an agreement of 1888 had been declared a neutral zone. The northern frontier is a line drawn between the northernmost points of the eastern and western frontiers.

Physical Features.—The coast is low and sandy and is formed by the detritus deposited by the sea current called Calema. It is perfectly straight, without harbours, and approached only through a dangerous bar. This coast strip is nowhere more than 2 m. broad. It masks a series of lagoons, of which the largest, occupying a central position, is called the Togo, Avon or Haho lagoon. It is connected by a channel running eastward parallel with the sea, with the Wo and Little Popo lagoons, and with the Mono river. Behind the lagoons an undulating plain stretches some 50 m. The Sio and Haho, the two largest rivers of the coast region, both flow into the Togo lagoon. These rivers rise on the eastern versant of a chain of mountains which traverse the country in a south-westerly to north-easterly direction. Beginning in the south-east corner of the Gold Coast colony this range, composed of quartzites and schists, extends beyond the borders of Togoland into upper Dahomey. It has no general name, but in the south is called Agome. On the eastern side it presents a fairly continuous escarpment. It is most elevated in its southern portion, Mt Dabo having a height of 3133 ft. and Mt Atilakuse (in 7° 20′ N. 0° 43′ E.) 3248 ft. Its general elevation is between 2000 and 2500 ft.; on the north-west side of the range the country is table-land some 600 to 1000 ft. high. Baumann Spitze (3215 ft.) is an isolated peak in 6° 50′ N., 0° 46′ E., east of the main range. South and east of the range the country, apart from that watered by the coast streams, drains to the Mono river. The greater part of the colony lies west and north of the chain and belongs to the basin of the Volta. The chief river traversing it is the Oti, which rises in about 12° N., enters Togoland at its north-east corner, and runs with a very sinuous course south-south-west to its junction with the Volta in 7° 37′ N. For a considerable distance the left bank of the Volta itself is in German territory, but its lower course is wholly in the Gold Coast colony.

Climate.—The climate on the coast is hot, humid and unhealthy. There are two wet seasons, the first lasting from March till June, the second from September to November. Apart from the coast region, seasons of drought are not uncommon. The dry wind from the Sahara called harmattan, which carries great quantities of fine red sand, causes a fall of temperature in the (European) summer.

Flora and Fauna.—Coco-nut palms, introduced about the beginning of the 19th century by the Portuguese, grow along the coast and for 80 m. or so inland. The lagoons are surrounded by dense belts of reeds, and the coast-land is covered with low, impenetrable bush. There are considerable forests of oil palms, rubber trees and vines, and timber and dyewood trees. Many of the river valleys are densely wooded. On the hills the baobab and hyphaene palm are characteristic; on the plateau are stretches of open savanna, and park-like country with clumps of silk cotton and shea-butter trees. The fauna resembles that of other parts of West Africa; it is poor on the coast. Elephants and lions are found in the interior.

Inhabitants.—The inhabitants are negroes and negroids. In the north the people are mostly Hausa, in the west they belong to the Tshi-speaking clans, while on the coast they are members of the Ewe (Dahomey) tribes. Among the coast people there is a distinct infusion of Portuguese blood, and in all the ports are descendants of Brazilian negroes who returned to Africa during the 19th century. Pidgin English is the common language along the coast. The Adeli and Akposso hill tribes have a dialect of their own. In the north the tribes form small, well-organized states. In the coast lands the inhabitants are traders and agriculturists, in the interior they are largely pastoralists. The Hausa are often traders, traversing the country in large caravans. The inhabitants are partly Mahommedans, partly believers in fetish; comparatively few profess Christianity. As a rule the tribes are peaceful. Slave raiding has ceased, but domestic slavery in a mild form continues.

Towns.—The capital and chief port is Lome (pop. about 5000), near the western frontier. It is a creation of the Germans, the site, in 1884, being occupied by a small fishing village. It is provided with a jetty, is the sea terminus of the railway systems, the residence of the governor, and has churches, schools, hospitals and large business houses. The chief African traders are Hausa immigrants. Togo, which has given its name to the country, is a town on the south-eastern shores of the Togo lagoon. On the narrow spit of land between the lagoons and the sea are Bagida and Porto Seguro—the last named one of the oldest towns on the Slave Coast and the port of Togo town—and, close to the eastern frontier, Little Popo, called by the Germans Anecho. Anejo or Anecho means the houses or quarter of the Anes. The Anes are reported to have come from the Gold Coast by sea and to have been wrecked at this place. Little Popo dates from the 17th century or earlier. At the time of the German annexation Anecho was one of three distinct quarters into which the town was divided. In the hill country are the government stations of Misahöhe and Bismarckburg. On the Volta, a short distance above the Oti confluence, are the adjacent towns of Kete-Krachi; on an affluent of the Mono in 7° N. is Sagada. In the north are the large native towns of Yendi and Sansane Mangu, both on caravan routes between Ashanti and the Niger countries.

Agriculture and Trade.—The country is rich in natural products, and its resources have been largely developed by the Germans. It was the first German colony to dispense (1903–1904) with an imperial subsidy towards its upkeep. Several firms have acquired plantations in which coffee, cocoa, cotton, kola and other tropical products are cultivated. Coco-nut palms thrive; maize, yams, bananas, tapioca and ginger are cultivated by the natives. The chief trade is in, and the principal exports are, palm oil and kernels, rubber, cotton, maize, groundnuts (*Arachis*), shea-butter from the *Bassia parkii* (Sapotaceae), fibres of the *Raphia vinifera*, and the *Sansevieria guineensis*, indigo, and kola nuts, ebony and other valuable wood. In the interior cattle and sheep are plentiful, on the plateau horses and donkeys. The natives have several industries, including pottery, straw plaiting, smithwork and woodcarving. Some of their carving is very fine. They collect and spin the indigenous cotton, which is of good quality, and dye it with indigo or other pigments; they also manufacture very handsome shawls. Cotton growing under European direction began about 1900, with the result that in 1901–1902 over 100,000 lb of cotton grown from native, American and Egyptian seed were shipped to Bremen. In subsequent years the industry attained considerable proportions.

The imports are chiefly textiles, metals and hardware, and gin. Imports are mainly from Germany, exports to Germany and to other West African colonies. In 1908 the value of the imports was £425,000, of the exports £389,000.

Communications.—Good roads have been built connecting the coast towns with the principal places in the interior. A railway about 20 m. long connects Lome with Little Popo. From Lome another railway 76 m. long runs north-west to Agome-Palime near Misahöhe. There are telegraph and telephone lines between Lome and Little Popo, and both places are in telegraphic communication with the Gold Coast and Dahomey, and thus with the international cable system. There is direct steamship communication between Togoland and Hamburg, and the steamers of three French and two English lines call at Togoland ports.

Government, &c.—The colony is administered by a governor who is advised by a nominated council of unofficial members. Revenue is derived principally from customs duties, direct taxation being light. In 1907–1908 revenue and expenditure balanced at £103,000. A judicial system has been instituted to which natives as well as Europeans are amenable. The government maintains schools at all the coast towns. Various missionary societies have also established schools. In 1909 some 10,000 native children were receiving instruction.

History.—Before its annexation by Germany the lagoons were a favourite resort of slavers, and stations were established there by Portuguese, British, French and German traders. The coast natives were dependent on the rulers of Dahomey or Porto Novo. Little Popo and Togo were capitals of small independent kingdoms. Little Popo is said to have been founded in the 17th century by refugees from Accra, who were driven out by the Akwamu. At the time that "the scramble for Africa" began, the narrow strip of coast over which the king of Togo ruled was the sole district between the Gambia and the Niger to which Great Britain, France or some other civilized power had not a claim. At Togo Bremen merchants had trading stations, and taking advantage of this fact Dr Gustav Nachtigal, German imperial commissioner, induced the king of Togo (July 5, 1884) to place his country under German suzerainty. The claims made by Germany to large areas of the hinterland gave rise to considerable negotiation with France and Great Britain, and it was not until 1899 that the frontiers were fixed on all sides (see Africa, § 5). Meantime the development of the coast region had been taken in hand. On the whole the history of the colony has been one of peaceful progress, interrupted now and again, as in 1903, by severe droughts. At stated intervals the native chiefs are summoned to Lome to discuss administrative matters with the government.

See H. Klose, *Togo unter deutscher Flagge* (Berlin, 1899), a comprehensive survey, with bibliography; N. Seidel, *Die Küste und das Vorland der Togocolonie* (Berlin, 1897), and *Die Ewhesprache in Togo* (Heidelberg, 1906); Schönhärt, *Volkstümliches aus Togo* (Dresden, 1909); R. Büttner, *Die Forschungsstation Bismarckburg und Adeli* (1894); *Das deutsche Schutzgebiet Togo* (Bremen, 1891); L. Von Ammon, "Zur Geologie von Togo und vom Nigerlande" in *Mitteil. der geog. Gesell. in München* (1905); Klose, "Religiöse Anschauungen und Menschenopfer in Togo" in *Globus* 1902; P. Sprigade, *Karte von Togo*, scale 1:200,000, 12 sheets, also in 2 sheets on the scale 1:500,000 (Berlin, 1902–1907).

TOILET, the process or operation of dressing, also dress and its appurtenances, also applied, especially in the French form "toilette," to a particular costume worn by a lady. The word is adapted from French *toilette*, a diminutive of *toile*, cloth, Latin *tela*, web, woven cloth, from root of *texere*, to weave; this word survives in the English "toils," net, snare.[1] The earliest use of "toilet" and *toilette* is for a cloth, usually of linen or other fine material spread over a table when used to hold the looking-glass and all the other articles used in dressing, or for a small sheet or cloth thrown over the shoulders of a person while being shaved or having his or her hair dressed. It was thus applied especially to the various articles collectively which form the apparatus of a toilet-table or dressing-table. Dressing-tables or *toilettes* were articles of domestic furniture on which the 18th century cabinet makers and *ébenistes* of France lavished their decorative art. The escritoire and toilette combined which belonged to Marie Antoinette is in the Victoria and Albert Museum, South Kensington (see Furniture, Plate IV., fig. 4).

[1] "Toil," labour, fatigue, weariness, must of course be distinguished. The M. Eng. *toilen* appears to mean to pull, struggle, and is probably related to Scots *toilyie*, broil, and to Fr. *touiller*, to entangle, shuffle together, smear. It is, however, usually referred to "till," to cultivate, O. Eng. *tiolian*, from *til*, profitable, cf. Ger. *Ziel*, goal.

TOKAJ (or Tokay), a town of Hungary, in the county of Zemplén, 148 m. E.N.E. of Budapest by rail. Pop. (1900), 5104. It is situated at the confluence of the Bodrog with the Theiss, and gives its name to the famous Tokay wine. Tokaj lies at the foot of the Hegyalja Mountains, which stretch to the north and north-west of the town, between the rivers Hernad and Bodrog, for a distance of about 60 m. as far north as Eperjes. The northern part of the range is also called Sóvar Mountains. These mountains, which have in the northern part an altitude of 2700 ft., slope down towards the south-east near Tokaj in a hilly plateau of about 1500 ft. altitude, where the vineyard region is situated. This vineyard region covers an area of about 135 sq. m., and belongs to 21 adjoining communities. The soil is of volcanic origin (trachyte). The principal places where the wine is produced are Tarczal, Tálya, Mád, Liszka, Tokaj, Tolcsva, Sarόspatak, Keresztur, and Zsadaný. The yearly production averages 5,000,000 gallons. It is believed that the vine was introduced into this region by colonists from Italy and Morea in 1241.

TOKAT (Armenian *Evtoghia*, anc. *Dazimon*) the chief town of a sanjak of the same name in the Sivas vilayet of Asia Minor. It is situated in the Sivas-Samsun *chausée*, altitude 2280 ft., at the mouth of a rocky glen which opens out to the broad valley of the Tozanli Su, a tributary of the Yeshil Irmak. It rose to importance under the Seljuks. Pop. about 30,000, two-thirds Mussulman. The industries are the manufacture of copper utensils and yellow leather, and the stamping of colours on white Manchester cotton. Near Tokat copper pyrites, with iron and manganese, kaolin and coal are found; but most of the copper worked here comes from the mines of Keban Maden and Arghana Maden, on the upper Euphrates and Tigris. (D. G. H.)

TOKELAU (or Union Islands), a group of three atolls in the Pacific Ocean, about 350 m. N.E. of Samoa, belonging to Britain. Atafu consists of 63 islets, Nukunau of 93 and Fakaafo of 62. They produce little but copra. The natives are all Christians, and in type and speech are akin to the Samoans. They number about 500.

TOKEN MONEY, the term employed originally to describe the counters or "tokens" issued by traders to meet the lack of small change. It has now been appropriated by economists and officials to denote the smaller currency that circulates at a nominal value higher than its cost. It is contrasted with "standard" money, and is limited in its amount by state authority. Its power of discharging debts is also limited: in England, *e.g.*, silver is legal tender only up to 40s., copper to 12 pence. Various substances have been utilized for the manufacture of token coinage—silver at a lower degree of fineness, copper in different alloys, and nickel. The French term *monnaie divisionnaire* has much the same meaning; so has the German *Scheidemünze*. A currency, restricted in amount, but with full legal tender power—such as the Indian rupees and the French 5-franc pieces—is midway between token and standard money. Representative money also bears some analogy to token coinage. (See Money and Seigniorage.) (C. F. B.)

TOKUGAWA, the name of a Japanese family which provided the ruling dynasty of shōguns from 1603 until the revolution which restored the power of the mikado in 1867. The founder of this dynasty was Iyéyasu Tokugawa (1542–1616), a great general and consummate politician, who was connected by descent with the Minamoto clan. The most famous of the subsequent shōguns was his grandson Iyemitsu (from 1623 to 1650. (See Japan: *History*.)

TŌKYŌ (or Tōkiō, formerly called *Yedo*), the capital of the empire of Japan, situated in 35° 41′ N. and 139° 45′ E., at the head of the bay of the same name on the south-east coast of the main island. The city stands on the banks of the river Sumida, which, although pretty wide, is unnavigable by vessels of large tonnage owing to its shallowness. Yokohama, with which Tōkyō is connected by 18 m. of railway, is practically the port of the capital. Tōkyō is the centre from which several railways radiate. The trains of the Tokai-do line, starting from the Shimbashi station, run westwards to Kobe, thence to Shimonoseki, at the western end of the main island, a distance of 700 m. The Uyeno station is the starting-point for trains to Aomori, a town 460 m. away, at the northern extremity of the island. In 1907 a central station was designed to be built south of the imperial palace.

The climate is mild and healthy, and for the greater part of the year very pleasant, the seasons of spring and autumn being more especially delightful.

The area of Tōkyō is about 30 sq. m. Topographically it may be divided into two parts, upland and lowland (Yamanote and Shitamachi). There are hills varying in height from 50 to 130 ft. in the upland district; that is to say, the outskirts of the city from north to west. Lowland Tōkyō, that part of the city covering the flats on both sides of the river Sumida, is intersected by a system of canals. The bridges over the Sumida, and those which span the canals, have always been distinctive features of Tōkyō. The Nihon-bashi (Bridge of Japan), in the district of the same name, is by far the most famous. It is the point from which all distances in Japan are measured. The largest bridges are those named Azuma, Umaya, Ryogoku, Shin-o and Eitai over the Sumida.

The streets were formerly narrow and irregular, but the principal thoroughfares have been widened under the Street Improvement Act of 1888. Electric tramcars run throughout the city carrying passengers at a uniform rate of 4 sen, which means that it is possible to travel some 10 m. for one penny. The jinrikisha, drawn by one man or sometimes two men, which were formerly the chief means of passenger conveyance, have notably decreased in number since the introduction of the trams. Tōkyō has often experienced earthquakes, and more than once has suffered from severe shocks, which have hitherto prevented the erection of very large buildings. The numerous residences of the daimyos were the chief characteristics of the old town, especially in the Kojimachi-ku. Many of these have been demolished and government offices erected on their sites; others have given place to new streets and houses. Nearly in the centre of Kojimachi-ku, on an eminence, surrounded by moats, stood the castle of Yedo, formerly the residence of the shōguns, which was burnt down in 1873. The imperial palace was subsequently erected on this site. The palace is half European and half Japanese in its style of architecture. The Nijū-bashi is the main entrance. To the east and south of the palace the neighbourhood has undergone great changes in modern times. It was here, at the Sakurada Gate, that Ii Kamon-no-Kami, prime minister of the shōgun's government, was assassinated by the anti-foreign party in 1860. On the site of his residence a little higher up to the right of the gate now stand the war office and the offices of the general staff. In another street, leading from the gate, are the foreign office, the supreme court, the local court and the departments of justice and the navy. The temporary buildings of the Imperial Diet, which first met in 1890, are also in this part of the capital. Adjoining the above-named buildings is the Hibiya Park, modelled on the European style, while retaining the special features of the Japanese gardeners' art. The parks have always afforded to the people their chief means of recreation. The largest and most beautiful are those in Shiba and Uyeno, formerly the mausolea of the shōguns. In Uyeno, too, are the Imperial Museum, the Imperial Library and the Zoological Gardens. The famous temple of Kwannon, the goddess of mercy, is in the Asakusa Park, in which a permanent fair is held; it is a great holiday resort of the citizens. In Kudanzaka Park is the Yasukuni Temple, popularly known by the name of Shokonsha, and consecrated to the spirits of departed heroes who fell in war. In the same ground is a museum of arms, containing trophies of the wars with China and Russia.

Administration.—For administrative purposes Tōkyō is divided into fifteen districts or *Ku*, of which Kojimachi, Hongo, Koishikawa, Ushigome, Yotsuya, Akasaka, Azabu and Shiba are situated in the upland portion, while Kanda, Kiobashi, Nihonbashi, Shitaya, Asakusa, Honjo and Fukagawa are in the lowland. Suburban Tōkyō is divided into eight districts or *Gun*, which, with the city proper, collectively form the Tōkyō-Fu (prefecture), under the general control of one governor called Fu-Chiji. Questions affecting the interests of the whole Fu come before the *Fu-kwai*, or prefectural assembly, made up of representatives from both *Ku* and *Gun*, and a prefectural council, of which the governor is president; while matters concerning the city alone are discussed by a *Shi-kwai*, or municipal assembly, and administered by a municipal council, of which the Shicho or mayor is president. There is a regular water supply worked by the municipality. The reservoir at Yodobashi is capable of supplying water (from the river Tama) to all parts at a pressure varying from 80 to 100 ft. Hydrants are fixed in all the streets for the use of the fire brigade, which has a well disciplined and efficient personnel, and does not lack opportunities for the exhibition of its skill in a town built largely of wood. The police force is another well-trained and successful service. Both police and fire brigade are under the command of a single *Keishi-sokan* (inspector-general). The postal arrangements are very satisfactory, frequent deliveries being made with the utmost despatch. The telephone system is extensive, including long-distance wires to Yokohama, Osaka and other large towns. A complete and successful system of education exists. There are many schools for advanced students devoted to the various branches of science, mechanics and art. The imperial university of Tōkyō, which consists of the colleges of law, medicine, literature, science, engineering and agriculture, is the principal institution of learning in the empire. There are several daily newspapers as well as weekly and monthly publications of all kinds. In the lowland part of the city and in the suburbs there are many factories, their number having so much increased in recent years that Tōkyō may now be described as an industrial town.

Population.—There are no reliable data as to the population of Yedo during the shōgunate. Owing to the influx caused by the periodical visits of the daimyōs (feudal lords) with their numerous attendants, it probably exceeded $1\frac{1}{2}$ million during the early part of the 19th century. The population was 857,780 in 1880; 1,207,341 in 1890; 1,339,726 in 1895; 1,497,565 in 1900, and 1,969,833 in 1905.

History.—No mention is made of Tōkyō in Japanese history before the end of the 12th century. It appears to have assumed no importance till about 1457, when Ota Dokwan, a general in the service of Uyesugi Sadamasa, governor of Kamakura, built a castle here. About thirty years later the town fell into the hands of Hōjō of Odawara, and on his overthrow by Hideyoshi and Iyeyasu, the castle was granted to the latter, who was the founder of the shōgun house of Tokugawa. In 1590 Iyeyasu made his formal entry into the castle of Yedo, the extent of which he greatly enlarged. From this date the real importance of Yedo began. The family of the Tokugawas furnished the shōguns (or tycoons) of Japan for nearly three hundred years, and these resided during that period at Yedo. At the restoration in 1868 the shōgunate was abolished, and the population of Yedo speedily decreased. A fresh vitality was imparted by the transfer of the court from Kiōto, and the town then received its present name Tōkyō (eastern capital). (G. U.)

TOLAND, JOHN [christened JANUS JUNIUS] (1670–1722), English deist, was born on the 30th of November 1670, near Londonderry, Ireland. Brought up a Roman Catholic, in his sixteenth year he became a zealous Protestant. In 1687 he entered Glasgow University, and in 1690 was created M.A. by the university of Edinburgh. He then spent a short time in some Protestant families in England, and with their assistance went to Leiden University, to qualify for the dissenting ministry. He spent about two years studying ecclesiastical history, chiefly under the famous scholar Friedrich Spanheim. He then went to Oxford (1694), where he acquired a reputation for great learning and "little religion," although at the time he professed to be a decided Christian. While at Oxford he began the book which made him famous—his *Christianity not Mysterious* (1696, anonymous; 2nd ed. in the same year, with his name; 3rd ed., 1702, including an *Apology for Mr. Toland*). It gave great offence, and several replies were immediately published. The author was prosecuted by the grand jury of Middlesex; and, when he attempted to settle in Dublin at the beginning of 1697, he was denounced from the pulpit and elsewhere. His book having been condemned by the Irish parliament (Sept. 9, 1697) and an order issued for his arrest, Toland fled to England. The resemblance, both in title and in principles, of his book to Locke's *Reasonableness of Christianity*, led to a prompt disavowal on Locke's part of the supposed identity of opinions, and subsequently to the famous controversy between Stillingfleet and the philosopher. Toland's next work of importance was his *Life of Milton* (1698), in which a reference to "the numerous supposititious pieces under the name of Christ and His apostles and other great persons," provoked the charge that he had called in question the genuineness of the New Testament writings. Toland replied in his *Amyntor, or a Defence of Milton's Life* (1699), to which he added a remarkable list of what are now called apocryphal New Testament writings. In his remarks he really opened up the great question of the history of the canon. The next year his *Amyntor* and *Christianity not Mysterious* were under discussion in both houses of Convocation, and the Upper House declined to proceed against the author. In 1701 Toland spent a few weeks at Hanover as secretary to the embassy of the earl of Macclesfield, and was received with favour by the electress Sophia in acknowledgment of his book *Anglia Libera*, a defence of the Hanoverian succession. On his return from the Continent he published *Vindicius Liberius* (1702), a defence of himself and of the bishops for not prosecuting him. In this he apologized for *Christianity not Mysterious*, as a youthful indiscretion, and declared his conformity to the doctrines of the established Church. The next year he visited Hanover and Berlin, and was again graciously received by the electress and her daughter Sophia Charlotte, queen of Prussia, the "Serena" of the *Letters* published on his return to England (1704). In two of these (*A Letter to a Gentleman in Holland*, and *Motion essential to Matter*), ostensibly an attack on Spinoza, he anticipated some of the speculations of modern materialism. The *Account of the Courts of Prussia and Hanover* (1705) was used by Carlyle in his *Life of Frederick the Great*. From 1707 to 1710 Toland lived in varying circumstances on the Continent. In 1709 he published (at the Hague) *Adeisidaemon* and *Origines Judaicae*, in which, amongst other things, he maintained that the Jews were originally Egyptians, and that the true Mosaic institutions perished with Moses. After his return to England, he lived chiefly in London and latterly in Putney, subsisting precariously upon the earnings of his pen and the benevolence of his patrons. His literary projects were numerous (see Mosheim's *Vita*); his warm Irish nature appears in his projected history of the ancient Celtic religion and his chivalrous advocacy of the naturalization of the Jews. The last of his theological works were *Nazarenus, or Jewish, Gentile and Mahometan Christianity* (1718), and *Tetradymus* (1720), a collection of essays on various subjects, in the first of which (*Hodegus*) he set the example, subsequently followed by Reimarus and the rationalistic school in Germany, of interpreting the Old Testament miracles by the naturalistic method, maintaining, for instance, that the pillar of cloud and the fire of *Exodus* was a transported signal-fire. His last and most offensive book was his *Pantheisticon* (1720). He died on the 11th of March, 1721–1722, as he had lived, in great poverty, in the midst of his books, with his pen in his hand. Just before his death he composed an epitaph on himself, in which he claimed to have been "Veritatis propugnator, libertatis assertor." The words "Ipse vero aeternum est resurrecturus, at idem futurus Tolandus nunquam" seem to indicate his adherence to the pantheistic creed expounded in the *Pantheisticon*.

Toland is generally classed with the deists, but at the time when he wrote *Christianity not Mysterious* he was decidedly opposed to deism. The design of the work was to show, by an appeal mainly to the tribunal of Scripture, that there are no facts or doctrines of the "Gospel," or the "Scriptures," or "Christian revelation," which, when revealed, are not perfectly plain, intelligible and reasonable, being neither contrary to reason nor incomprehensible to it. It was intended to be the first of three discourses, in the second of which he was to attempt a particular and rational explanation of the reputed mysteries of the gospel, and in the third a demonstration of the verity of Divine revelation against atheists and all enemies of revealed religion. After his *Christianity not Mysterious* and his *Amyntor*, Toland's *Nazarenus* was of chief importance, as calling attention to the right of the Ebionites to a place in the early church, though it altogether failed to establish his main argument or to put the question in the true light. His *Pantheisticon, sive formula celebrandae sodalitatis socraticae*, of which he printed a few copies for private circulation only, gave great offence as a sort of liturgic service made up of passages from heathen authors, in imitation of the Church of England liturgy. The title also was in those days alarming, and still more so the mystery which the author threw round the question how far such societies of pantheists actually existed.

See Mosheim's *Vindiciae antiquae christianorum disciplinae* (1722), containing the most exhaustive account of Toland's life and writings; a *Life of Toland* (1722), by "one of his most intimate friends"; "Memoirs of the Life and Writings of Mr John Toland," by Des Maizeaux, prefixed to *The Miscellaneous Works of Mr John Toland* (London, 1747); John Leland's *View of the Principal Deistical Writers* (last ed. 1837); G. V. Lechler's *Geschichte des englischen Deismus* (1841); Isaac Disraeli's *Calamities of Authors* (new ed., 1881); article on "The English Freethinkers" in *Theological Review*, No. 5 (November, 1864); J. Hunt, in *Contemporary Review*, No. 6, June 1868, and his *Religious Thought in England* (1870–1873); Leslie Stephen's *History of English Thought in the Eighteenth Century*, vol. i. (1881), and article in *Dictionary of National Biography*; J. Cairns's *Unbelief in the Eighteenth Century* (1881). On Toland's relation to the subsequent Tübingen school, as presented in his *Nazarenus*, see D. Patrick in *Theological Review*, No. 59 (October, 1877); and on his relation to materialism, F. A. Lange's *Geschichte des Materialismus* (Eng. trans. by E. C. Thomas, 1877), and also G. Berthold, *John Toland und der Monismus der Gegenwart* (1876).

TOLEDO, a province of central Spain, formed in 1833 from part of New Castile; bounded on the N. by Ávila and Madrid, E. by Cuenca, S. by Ciudad Real and W. by Cáceres. Pop. (1900), 376,814; area 5919 sq. m. The surface is throughout lofty, and in a great part of its extent mountainous. Towards the centre there are extensive plains or tablelands, but the whole of the south and east is occupied by the Montes de Toledo, and the hills which separate the waters of the Tagus on the north from those of the Guadiana on the south. These mountains are of no great height; until late in the 19th century they were densely covered with forests. Toledo is well watered by the Tagus (*q.v.*) and its numerous affluents, including the Guadarrama and Alberche on the north and the Algodor, Torcon, Pusa and Sangrera on the south. The Giguela waters the eastern districts. Gold, silver, lead, iron, quicksilver, copper, tin and other minerals have been discovered, but the mining industry does not prosper and there is little export trade in agricultural products. The number of sheep, goats, asses and mules is large; dairy-farming and the breeding of draught oxen and fighting bulls are also practised. Bees and silkworms are kept in considerable number. Manufactures once flourished, but now silk and woollen cloth, earthenware, soap, oil, chocolates, wine, rough spirit (*aguardiente*), guitar strings and arms are almost the only articles made. There is also a small trade in charcoal and timber. The province is traversed by three lines of railway—that of Madrid-Seville-Cadiz in the east, Madrid-Toledo-Ciudad Real through the centre, and Madrid-Cáceres-Lisbon in the north.

TOLEDO, the capital of the Spanish province of Toledo and formerly of the whole kingdom, 47 m. by rail S.S.W. of Madrid, on the river Tagus, 2400 ft. above sea-level. Pop (1900), 23,317. Toledo occupies a rugged promontory of granite, washed on all sides except the north by the Tagus, which here flows swiftly through a deep and precipitous gorge. Towards the north the city overlooks the desolate Castilian plateau; beyond the river it is confronted by an ampitheatre of bare mountains, the Montes de Toledo. From a distance it has the aspect of a vast fortress, built of granite, defended by the river and by a double wall on the north, and dominated by the towers of its cathedral and alcázar. The absence of traffic in its maze of dark and winding alleys creates a silence uncommon in so large a city. There are few *plazas*, the principal open spaces being the arcaded Zocodover, described by Cervantes in the *Novelas ejemplares*; and some of the finest monuments of antiquity are hemmed in by meaner structures. The houses, tall, massive and sombre, are entered by huge iron-studded doors, and, owing to the extremes of heat and cold characteristic of the Castilian plateau, most of their windows open on a sheltered inner court (*patio*), the walls facing the street being often blank, though their monotony is sometimes relieved by carved Gothic or Moorish stonework. Nowhere, even in Spain, have the appearance and atmosphere of a Gothic city been preserved with so little change. Though the Moslems have left their imprint upon its architecture, and though many ancient buildings were destroyed after the Christian reconquest to make room for churches, convents and seminaries, Toledo as a whole remains as distinctively Gothic and medieval as Granada is Moorish, Madrid Castilian or Barcelona modern. It has also been from the earliest times the centre of Spanish Christianity, and its archbishop is styled *ex officio* "primate of all the Spains."

Principal Buildings.—The Tagus is spanned by two fortified Moorish bridges, the Puente de Alcántara, on the north-east, which was rebuilt in the 13th and 17th centuries, and the Puente de San Martin, on the north-west, founded in 1212 and rebuilt in 1390. The inner wall of the city is said to have been founded in the 7th century by the Visigothic King Wamba; much of its masonry is Moorish. Alphonso VI. of Castile added the outer wall in 1109. To the same period belongs the Mudéjar Puerta del Sol, the finest of several ancient gateways, among which the Puerta Visagra (1550, restored 1575), and the Puerta del Cambron (1102, restored 1576) are also interesting. The Puerta Visagra Antigua, a Moorish gateway of the 9th century, has been walled up, but its original form is preserved. The Alcázar, a huge square building with a tower at each corner and a fine arcaded *patio*, stands on the highest ground in Toledo, originally the site of a Roman fort. Built as a citadel by King Wamba and used as such by the Moors, it was converted into a palace by St Ferdinand (1200–1252) and was enlarged in the 15th and 16th centuries by Ferdinand and Isabella, Charles V. and Philip II. During the war of the Spanish Succession it was burned down (1710), but Cardinal Lorenzana restored it in 1775. After the French had burned it a second time in 1810, it was again rebuilt and in 1882 became a military academy. In 1887 a third fire was followed by a third restoration. Despite these successive disasters, part of the 15th and 16th century palace has been preserved, including a fine façade designed by Juan de Herrera, a gateway by Alonso de Covarrúbias and a staircase by Herrera and Francisco de Villalpando. The Ayuntamiento, or City Hall, is a 15th-century building with 17th-century alterations by Doménico Theotocópuli (el Greco). Some fine Moorish work is preserved in the Salón de Mesa (*c.* 1450); in the Taller del Moro, which dates in part from the 14th century and was long the workshop (*taller*) of masons employed in repairing the cathedral; and in the palace of the counts of Fuensalida.

More important architecturally than any of these secular buildings are the churches of Toledo, and especially its magnificent Gothic cathedral (for illustration see ARCHITECTURE). The cathedral occupies the site of a Visigothic church, which an inscription preserved in the cloister shows to have been dedicated to the Virgin by King Reccared, on the 12th of April 589. If the event thus commemorated were a reconsecration—and it was in 589 that Reccared was converted from Arianism to orthodoxy—the church may well have been the cathedral of Eugenius, Eladius, Ildefonso and Julian, the four Toledan bishops who were canonized, and the first of whom is said to have been a disciple of St Paul. From 712 until 1227 the Visigothic church was used by the Moors as their principal mosque. It was then razed by St Ferdinand, who founded the present cathedral in August 1227. The completion of the main fabric was delayed until 1493, while many of the chapels and other subordinate buildings were added even later; thus Renaissance and baroque features have been introduced into a design which was originally Gothic of the 13th century. Though sacked by the Comuneros in 1521 and by the French in 1808, the cathedral is still one of the richest and most splendid foundations in the Peninsula. The exterior is masked by adjacent buildings, its most impressive part being the western façade, flanked by two towers, of which one is unfinished while the other rises to a height of 295 ft. The interior is somewhat dwarfed in appearance by its immense width. It is 395 ft. long by 178 ft. broad, and is divided by 84 pillars into five naves, with central lantern and choir, and a complete series of side chapels. Most of the chapels date from the 15th and 16th centuries, and are very magnificent in detail. The superb stained-glass windows, chiefly of Flemish work, belong to the same period and number 750. The choir-stalls, placed in alabaster recesses divided by columns of red jasper and white marble, are among the finest extant examples of late medieval and Renaissance wood-carving, though rivalled by the *retablo*, which rises behind the high altar to the roof. The treasury, reliquaries and library, notwithstanding their repeated despoilings, contain many priceless MSS. and works of art, including the custodia executed by Enrique de Arfe in 1524, which is nearly 10 ft. high and is adorned with 260 silver-gilt statuettes. In it is a monstrance, said to have been wrought from the first gold brought home by Columbus. There are paintings by many masters, including Goya, El Greco, Titian and Rubens. In the Mozarabic chapel mass and other offices are still performed daily according to the Mozarabic liturgy, which was also used in six of the parish churches until the middle of the 19th century. (See MOZARAB.) Within the precincts of the cathedral are interred the archbishops and cardinals Tenorio, Fonseca, Mendoza, Ximenez, the great constable Alvaro de Luna and a long array of kings and heroes. In the principal tower is hung the *campana gorda*, a bell weighing nearly two tons and said to be audible as far as Madrid. A huge wooden rattle (*matraca*) is used to summon worshippers between Maundy Thursday and the Saturday before Easter.

Apart from the cathedral, many of the other churches are of great interest and beauty. The Franciscan convent and church of San Juan de los Reyes (florid Gothic) were founded in 1476 by Ferdinand and Isabella, who intended the church to be their own burial-place; but after the erection of a royal mausoleum in Granada the fabric remained incomplete until the 17th century. El Cristo de la Luz was originally a mosque, built in 922 and incorporating some pillars from an older Visigothic church. Santo Tomé, also a mosque, was reconstructed in the Gothic style during the 14th century. El Cristo de la Vega, formerly known as the Basilica de Santa Leocadia, occupies the site of a Visigothic church built in the 4th century to mark the burial-place of the saint, whose reputed remains, like those of St Eugenius, are enshrined in the cathedral—here several church councils were held, but the original church was destroyed by the Moors and the present building dates principally from 1816. The Mudéjar Santa Maria la Blanca became successively a synagogue, in the 13th and 14th centuries, a church (1405), an asylum for women (1550), barracks (1791–1798) and again a church. El Tránsito, a Mudéjar synagogue (*c* 1365) was occupied by the knights of Calatrava in 1492, and was afterwards dedicated to the Passing (*Tránsito*) of the Virgin. Its inner walls are adorned with Moorish arabesques. It was restored after the ceiling, of cedar inlaid with ivory, had fallen in 1903. Santiago del Arrabal dates from the 11th century and has a Moorish tower. Some admirable Renaissance sculpture is preserved in the court and staircase of the former hospital of Santa Cruz (1494–1514), which was restored in 1906, to be used as a provincial library and museum. The Hospital de San Juan Bautista, outside the walls, was founded in 1541.

Toledo was the seat of a university from 1498 to 1845, and is still an important educational centre, having numerous elementary schools, a military academy and a provincial institute; it also contains the provincial court of justice and several modern hospitals. Its characteristic industry is the manufacture of swords, carried on by private firms and especially in the royal factory (1788), which, like the railway station, is about 1 m. from the city. Toledan blades have been famous for 2000 years, the *culter toletanus* being mentioned in the *Cynegetica* of Grattius (Faliscus), during the 1st century B.C. The industry throve under the Moors and especially during the 16th century; it is now practised on a smaller scale, but the blades produced are still remarkable for flexibility and strength.

History.—Toledo is of immemorial antiquity; Spanish legend variously ascribes its foundation to Hercules, to Tubal, the grandson of Noah, to "Iberia, daughter of Hispanus," and to Jews who, having been exiled by Nebuchadrezzar, settled here, naming their city *Toledoth*, the "city of generation." It was a stronghold of the Carpetani and may have been a Carthaginian trading-station. Livy (xxv. 7) mentions *Toletum* as *urbs parva, sed loco munita*, which was captured by the Romans in 193 B.C. Under Roman rule it became a *colonia* and the capital of Carpetania. Various fragmentary remains have been preserved, including parts of an aqueduct, of a circus, which seems never to have been completed, and of a temple (the so-called Cave of Hercules). Toletum was never captured by the Vandals. Its ecclesiastical importance is coeval with the introduction of Christianity into Spain; numerous church councils (see below) were held here, notably in 396, 400 and 589, and here was the chief battle-ground in the long political and religious struggle which ended (589) in the triumph of Spanish Catholicism over Arianism. From the reign of Athanagild (534–547) until the Moorish conquest in 712, Toletum was generally regarded as the capital of Visigothic Spain. The Moorish chroniclers grow eloquent over the treasures captured by Musa and his army in 712; these are said to have included the "Table of Solomon," carved from a single flawless emerald, and a copy of the *Psalms*, written upon gold with ink made from melted rubies. *Tolaitola*, as the city was now called, prospered under the Moors, first as a provincial capital in the caliphate of Cordova, governed by an emir (712–1035), afterwards as an independent state (1035–1085). Its rulers protected the large Jewish colony, founded extensive silk and woollen industries, and made their city an important centre of Arab and Hebrew culture, one of the great names associated with it being that of Rabbi ben Ezra (1119–1174). The Spanish and Jewish inhabitants adopted the language and many customs of their conquerors, becoming "Mozarabs," but retaining their own creeds. In 1085 Alphonso VI. of Leon and Castile captured Toledo, aided by the Cid, and in 1087 made it his capital. For a time the Castilians emulated the tolerance of the Moors, but the Jews were expelled in 1492 and the Arabic language was forbidden (except in church services) in 1580. Before this the archbishops of Toledo had become almost independent of any secular power; they possessed enormous wealth and some of them, such as the Cardinal Jimenez de Cisneros, directed the policy and even led the armies of all Spain. In 1521 Toledo was the centre of the revolt of the Comuneros (see SPAIN: *History*); its commercial and political decline dates from 1560, when Philip II. chose Madrid as his capital. The city was the home of Lope de Vega (1562–1635) and forms the scene of several of his dramas. It suffered severely during the Peninsular War, being several times occupied by the French in 1808–1812.

See J. Ibañez Marin, *Recuerdos de Toledo* (Madrid, 1893); H. Lynch, *Toledo* (London, 1898); A. F. Calvert, *Toledo* (London, 1907).

TOLEDO, a city and port of entry, the county-seat of Lucas county, Ohio, U.S.A., on both banks of the Maumee river, about 4 m. from Maumee Bay, Lake Erie, and about 95 m. W. of Cleveland. Pop. (1900), 131,822, of whom 1710 were negroes, and 27,822 were foreign-born, including 12,373 Germans, 2449 English Canadians, and 1636 English; (1910 census) 168,497. Area, 28·57 sq. m. Toledo is served by the Ann Arbor, the Cincinnati, Hamilton & Dayton, the Cleveland, Cincinnati, Chicago & St Louis, the Detroit, Toledo & Milwaukee, the Detroit & Toledo Shore Line, the Hocking Valley, the Lake Shore & Michigan Southern, the Michigan Central, the Pennsylvania, the Père Marquette, the Toledo, St Louis & Western, the Wabash, and the Wheeling & Lake Erie railways, by a "belt line" (30 m. long), the Toledo Railway & Terminal Company, by ten interurban electric railways (about 585 m.), and by the Wabash & Erie and the Miami & Erie canals. A channel 400 ft. wide and 21 ft. deep admits the largest vessels from Lake Erie to the city. Six passenger and freight steamship lines communicate with Cleveland, Buffalo, Sandusky, Detroit, Port Huron, Alpena, Mackinac, Georgian Bay and other points on the Great Lakes, and the city has 25 m. of docks. The city park system includes Ottawa Park (280 acres), Bay View Park (202 acres), Riverside Park (118 acres), Central Grove Park (100 acres), Collins Park (90 acres), Walbridge Park (67 acres), with a zoological collection, Navarre Park (53 acres), several smaller parks and triangles, and a boulevard, 18 m. long (incomplete in 1910), connecting the parks. Noteworthy public buildings are the County Court-house, the Public Library (about 85,000 volumes in 1910), the Soldiers' Memorial Building, the Toledo Club and the Toledo Museum of Art (1901). The city is the seat of Toledo University, including Toledo Medical College (1880), which is affiliated, for clinical purposes, with the Toledo Hospital (1876). There are numerous hospitals and charities.

Toledo is the port of entry for the Miami customs district and is an important shipping point for the iron and copper ores and lumber from the Lake Superior and Michigan regions, for petroleum, coal, fruit, and grain and clover-seed. In 1909 the imports of the port were valued at $642,286 and the exports at $600,794. The capital invested in manufacturing under the factory system in 1905 was $38,643,390 (62·4 % more than that of 1900). The value of the factory products in 1905 was $44,823,004 (40·2 % more than in 1900). Foundry and machine-shop products ($4,087,497) were the most valuable manufactures in 1905. In flour and grist mill products (value in 1905, $3,676,290) Toledo is the most important city of the state. Other important manufactures in 1905 were petroleum products ($2,006,484); lumber and planing mill products ($1,604,274); women's clothing ($1,477,648); children's carriages and sleds ($1,465,599); car-shop construction and repairs, by steam railway companies ($1,366,506); carriages and wagons ($1,225,387); structural iron work ($1,102,035); agricultural implements, bicycles, automobiles (a recent and growing industry), plate and cut-glass (made largely from a fine quality of sand found near the city), tobacco, spices and malted liquors. The building of boats, and of large vessels is also an important industry. At Rossford (pop. about 400), a suburb, is the large plant of the Ford plate-glass works. The water supply is derived from the Maumee river and is filtered by a municipal filtration plant.

The administration of the city became famous after 1897 when Samuel Milton Jones (1846–1904), a manufacturer of oil machinery, was elected mayor by the Republican party; he was re-elected on a non-partisan ticket in 1899, 1901 and 1903, and introduced business methods into the city government. His honesty and sincerity in business and politics gained him the nickname "Golden Rule" Jones. The independent movement which he started was carried on under Brand Whitlock (b. 1869), a lawyer and writer who was mayor of Toledo in 1906–1911. The city council has 16 members, three elected at large and the others by wards, and there are boards of public service, public safety, public health and education.

The site of Toledo lies within an immense tract of land, constituting sixteen reservations, acquired by the United States government from several Indian tribes in 1795, and a stockade fort, called Fort Industry, was built here about 1800. In 1817 two companies bought from the government a portion of the tract, at the mouth of Swan Creek, including most of the land now occupied by Toledo. Upon the tract farthest up-stream the town of Port Lawrence was laid out (in 1817). In 1832 a rival company laid out the town of Vistula on the tract immediately below Port Lawrence, in the following year these towns were united and were named Toledo, and in 1837 the city was incorporated. The "Toledo War" was a dispute over the boundary between Ohio and Michigan. When Ohio Territory was organized in 1800 its northern boundary was described as a line drawn from the southern extremity of Lake Michigan due east to the Pennsylvania line, and the official map of the time placed the southern end of Lake Michigan at 42° 20′ N. lat. The state constitution adopted in 1802 followed the enabling act in accepting this line, but made the proviso that if it should not intersect Lake Erie east of the mouth of the Miami river, then the northern boundary should be a line from the southern end of Lake Michigan to the most northern cape of Maumee Bay and thence to the Territorial line, and to the Pennsylvania line. In 1805 the Territory of Michigan was organized with a southern boundary in accordance with the line extending due east from the southern end of Lake Michigan; and therefore there was in dispute a strip of land, about 5 m. wide at its western end and about 8 m. wide at its eastern end, a rich agricultural region, stretching across portions of what are now Lucas, Fulton and Williams counties, and including all of what are now Ashtabula and Lake counties, and portions of Geauga and Cuyahoga counties, in Ohio. Within the belt lay what is now Toledo, and its great importance as a lake port was even then clearly recognized. On the 29th of January 1818 the Ohio legislature accepted the "Harris line" (surveyed in 1817 in accordance with the proviso of the state constitution) as the northern boundary of the state. Acting on the recommendation of Governor Robert Lucas (1781–1853), on the 23rd of February 1835 the Ohio legislature passed an Act extending the northern boundaries of what were then Wood, Henry and Williams counties (lying partly within the disputed strip) north to the Harris line, and providing for the organization of new townships within this added territory, and for the appointment of three commissioners to re-mark the line. Upon the appointment (March 9, 1835) by Governor Lucas of the three commissioners to re-mark the Harris line, Governor Stevens T. Mason of Michigan ordered out a division of Michigan militia, which near the end of March entered and took possession of Toledo. A division of Ohio militia marched to Perrysburg, on the Maumee river, about 10 m. south of Toledo; but both militias disbanded when Richard Rush, of Philadelphia, and Benjamin C. Howard, of Baltimore, appeared at Toledo as peace emissaries, appointed by President Jackson. In April several members of the party accompanying the Ohio commissioners were arrested by Michigan militia. In June the Ohio legislature created Lucas county, mostly from the disputed territory, and made Toledo its county-seat. President Jackson now urged Michigan to discontinue interfering with the re-marking of the Harris line, and requested Ohio to postpone putting into effect the Act of February 1835; but as petty outbreaks continued throughout the summer and an Ohio judge and court officers at Toledo were arrested in September, he peremptorily removed Governor Mason from office. In June 1836 Congress decided the dispute in favour of Ohio, and in 1837 Michigan was admitted to the Union as a state upon condition of relinquishing all claim to the disputed territory, but received what is now known as the Upper Peninsula (the land between Lakes Superior, Huron and Michigan).

TOLEDO, COUNCILS OF (*Concilia toletana*). From the 5th to the 16th century about thirty synods, variously counted, were held at Toledo in Spain. The earliest, directed against Priscillianism, assembled in 400. The "third" synod of 589 marked the epoch-making conversion of King Reccared from Arianism to Roman Catholicism. The "fourth," in 633, probably under the presidency of the noted Isidore of Seville, regulated many matters of discipline, decreed uniformity of liturgy throughout the kingdom and took stringent measures against baptized Jews who had relapsed into their former faith. The "twelfth" council in 681 assured to the archbishop of Toledo the primacy of Spain. As nearly one hundred early canons of Toledo found a place in the *Decretum Gratiani*, they exerted an important influence on the development of ecclesiastical law. The synod of 1565 and 1566 concerned itself with the execution of the decrees of Trent; and the last council of Toledo, that of 1582 and 1583, was so guided in detail by Philip II. that the pope ordered the name of the royal commissioner to be expunged from the acts.

See *Canones apostolorum et conciliorum saeculorum, iv., v., vi., vii., rec.* H. T. Bruns, *pars prior* (Berlin, 1839), critical text of seventeen councils of Toledo (A.D. 400–694); P. B. Gams, *Die Kirchengeschichte von Spanien* (Regensburg, 1862–1879); E. H. Landon, *A Manual of the Councils of the Holy Catholic Church*, revised ed. (London, 1893), 151–169. These two summarize the chief canons. Neher, in Wetzer and Welte's *Kirchenlexicon* (1855–1857), vol. xi. (2nd ed. Freiburg, 1899), gives a list of 29 synods. (W. W. R.*)

TOLENTINO (anc. *Tolentinum Picenum*), a town of the Marches, Italy, in the province of Macerata, 11 m. by rail W. by S. of that town. Pop. (1901), 5111 (town), 13,197 (commune). It is situated on the Chienti, 735 ft. above sea-level, and was once a fortified town of great strength. The cathedral has a fine portal by the Florentine Giovanni Rosso (1435), and contains the remains of S Nicholas of Tolentino (d. 1309), whose Renaissance tomb and frescoes illustrating the life of the saint by Lorenzo and Jacopo da San Severino are preserved in a room adjoining the chapel north of the high altar. The church of San Catervo contains the early Christian sarcophagus of that saint, which is embellished with curious reliefs. The Museo Civico contains antiquities discovered during excavations near the town (in 1880–1884) in the Picene necropolis, dating from the 8th–4th centuries B.C. The town is the birthplace of the condottiere Niccolo Mauruzzi, and of the learned Francis Philelphus, one of the first disseminators of classical literature, who was born in 1398. At Tolentino the treaty was made between Bonaparte and the pope in 1797, by which the pope ceded Avignon; and here in 1815 a battle was fought in which the French under Murat were defeated by the Austrians.

TOLERATION (from Lat. *tolerare*, to endure), the allowance of freedom of action or judgment to other people, the patient and unprejudiced endurance of dissent from one's own or the generally received course or view.

TOLFA, a town of the province of Rome, Italy, 10 m. E.N.E. of Civitavecchia by road, 1558 ft. above sea-level. Pop. (1901), 3956. It is the chief place in the Tolfa Mountains, an extinct volcanic group between Civitavecchia and the Lake of Bracciano. Vapours are emitted which deposit sulphur and alum, and some mining is carried on. The output of alum averages 4000 to 5000 tons a year, and is mostly exported from Civitavecchia.

TOLL, JOHAN KRISTOFFER, COUNT (1743–1817), Swedish statesman and soldier, was born at Mölleröd in Scania. Toll came of a very ancient family, of Dutch origin, which can be traced back to the 13th, but migrated to the Baltic provinces in the 16th century. Toll's father was one of Charles XII.'s warriors, his mother a descendant of the aristocratic Gyellenstjernas. In his youth Johan Kristoffer served in the Seven Years' War, and then, exchanging the military for the civil service, became head ranger of the county of Kristianstad. During the riksdag of 1771–1772 the dominant "Caps" deprived him of his post, and Toll, shrewdly guessing that the king was preparing a revolution, almost forced his services on the conspirators, Göran Magnus Sprengtporten (*q.v.*) declaring that a man who knew so much of their most secret plans must either "be killed or squared." To Toll was assigned by far the most difficult part of the enterprise. It was his business to secure the important southern fortress of Kristianstad. Two days after the coronation, on the 31st of May 1772, he set forth from Stockholm with twenty-two pounds wherewith to corrupt a garrison and revolt a province. He had no sort of credentials, and the little that was known about him locally from the official point of view was not to his credit. Finally, in the fortress itself there was but one man known to be a safe royalist, namely, Captain Abraham Hellichius. On the 21st of June Toll reached Kristianstad. By sheer bluff Toll first won over Hellichius, and, six weeks later (August 12), the whole garrison of Kristianstad, arresting the few officers who proved recalcitrant; taking possession of the records and military chest, and closing the gates in the face of the "Cap" high commissioner who had been warned by the English minister, John Gooderich, that something was afoot in the south. Seven days later Gustavus III.'s *coup d'état* at Stockholm completed the revolution. Toll was liberally rewarded and more and more frequently employed as his genius as an administrator and his blameless integrity came to light. His reforms in the commissariat department were epoch-making, and the superior mobility of the Swedish forces under Gustavus III. was due entirely to his initiative. But it was upon Toll's boundless audacity that Gustavus chiefly relied. Thus as Gustavus, under the pressure of circumstances, inclined more and more towards absolutism, it was upon Toll that he principally leant. In 1783 Toll was placed at the head of the secret "Commission of National Defence" which ruled Sweden during the king's absence abroad without the privity of the senate. It was he who persuaded the king to summon the riksdag of 1786, which, however, he failed to control, and in all Gustavus's plans for forcing on a war with Russia Toll was initiated from the first. In 1786 he had already risen to the rank of major-general and was Gustavus's principal adjutant. It was against Toll's advice, however, that Gustavus, in 1788, began the war with Russia. Toll had always insisted that, in such a contingency, Sweden should be militarily as well as diplomatically prepared, but this was far from being the case. Nevertheless, when the inevitable first disasters happened, Toll was, most unjustly, made a scapegoat, but the later successes of the war were largely due to his care and diligence as commissary-general. After the death of Gustavus III. Toll was for a short time war minister and commander-in-chief in Scania and, subsequently, was sent as ambassador to Warsaw. Unjustly involved in the so-called "Armfelt conspiracy," he was condemned to two years' imprisonment; but was fully reinstated when in 1796 Gustavus IV. attained his majority. At the riksdag of Norrköping, 1800, he was elected marshal of the Diet, and led the royalist party with consummate ability. On this occasion he forced the mutinous *riddarhus* to accept the detested "Act of Union and Security" by threatening to reveal the names of all the persons suspected of complicity in the murder of the late king. Subsequently he displayed great diplomatic adroitness in his negotiations with the powers concerning Sweden's participation in the war against Napoleon. In the Pomeranian campaign of 1807 Toll assisted in the defence of Stralsund. The fortress was compelled to surrender on the 20th of August by Marshal Brune, whereupon the Swedish army of 13,000 men, which had retired to Rügen, seemed irretrievably lost. It was saved by Toll, who cajoled the French marshal into a convention whereby the Swedish army, with all its munitions of war, was permitted to return unmolested to Sweden (September 7). For this exploit Toll received his marshal's bâton. It was in the camp of Toll, then acting commander-in-chief in Scania, that Gustavus IV. was about to take refuge when the western army rebelled against him, but he was arrested in the capital before he could do so. Toll retained his high position under Bernadotte, who, in 1814, created him a count. He died unmarried.

See R. Nisbet Bain, *Gustavus III. and his Contemporaries* (London, 1895); K. N. Liliekrona, *Fältmarskalken Grefve J. K. Toll* (Stockholm, 1849–1850). (R. N. B.)

TOLL (etymologically, that which is numbered or counted; from a common Teutonic form, cf. "tale," "tell"), a sum of money paid for the use and enjoyment of a privilege or advantage. In England it is now usually a sum of money; but formerly tolls in kind were frequent. Among the sins of the Miller in Chaucer's Prologue is that he could "tollen thryes," in that he was clever enough and rogue enough to subtract thrice the legal allowance from the corn he ground. In a note to the *Heart of Midlothian*, Scott asserts that the name of Lockman given in Old Scots to the hangman was because he was entitled to take a *lock* or fixed toll out of every boll of meal exposed in the market for sale. An act of 1796 for the regulation of mills, substituting a money payment for tolls of corn in kind taken by millers, makes an exception for tolls taken by custom in soke mills. The Weights and Measures Act 1878 enacts that all tolls are to be charged and collected according to imperial weights and measures.

The word "toll" in early times had various meanings, thus it is defined by Glanville as the liberty of buying and selling in one's own land: "*tol, quod nos vocamus theloneum, scilicet libertatem emendi et vendendi in terra sua.* It also signified the right to be free of toll, but this implies a more general signification of the term, the right to take and the thing so taken. It formed the most obvious source of revenue in the early English boroughs; goods coming to market or passing through the borough paid toll, to this extent the practice still exists in various European countries under the name of *octroi* (*q.v.*). Private lords also levied tolls, but these in no case were levied theoretically at pleasure, all ultimately depending upon some real or feigned grant from the Crown. Imposts by the Crown are more properly taxes, though the name was frequently used, as in *maletote*, an arbitrary and vexatious impost levied till Edward III.'s time, usually on wool. Such payments might bring freedom from other exactions. We learn from Domesday Book that the men of Dover who paid the king's dues there were quit of toll throughout all England. Many subsequent charters granted the like, or even greater immunities from toll to favoured folk. In modern English law toll is either an incident of a franchise, as of a market or fair, or is independent of franchise. In the latter case it is claimed by prescription, as toll traverse or toll thorough, or is created by act of parliament, as in the case of turnpikes, railways, harbours, navigable rivers and canals. Toll traverse is paid for passing over a private way, bridge or ferry. No consideration need be proved. Toll thorough is paid for the use of a highway. In this case, if charged by a private person, some consideration, such as repair of the highway, must be shown, as such a toll is against common right. At common law a toll must be reasonable. The same principle appears in various acts of parliament. The Statute of Westminster the First inflicts a penalty for taking excessive toll. The Railway Clauses Act 1845 provides for the equality of tolls, that is, that all persons and classes of goods shall in like circumstances be treated alike as to charges. A right of distress is incident to the right to toll, but the distress cannot be sold unless an act of parliament expressly authorizes the sale. Tolls are not rateable, unless they are appurtenant to land. Exemption from tolls may be claimed by the prerogative, by grant or prescription, or by act of parliament. The king and queen consort pay no toll, and the Crown may grant to another exemption from toll. Turnpike tolls, bridge money and causeway mail were abolished in Scotland by the Roads and Bridges Act 1878 as from the 1st of June 1883. In England tolls on roads and bridges are now only payable in a few places.

In the United States tolls are a subject for state legislation, unless they affect the whole commonwealth, when they are dealt with by acts of congress. A city may levy reasonable tolls in a market established by itself. A *shunpike*, or road constructed to facilitate evasion of tolls on a turnpike road, may be closed by injunction.

The question of tolls was at one time an important one in international law. Tolls were exacted on certain straits and tidal rivers by virtue of the sovereignty of a particular state. Notable instances were the Scheldt tolls and the Sound dues levied by Denmark. These last were justified as a return for the lights maintained on the coast and the terror to pirates inspired by the castle of Elsinore. In 1659, owing to the united efforts of England, France and Holland, an unvarying rate was arranged.

See Pollock and Maitland, *History of English Law* (1895); Pease and Chitty, *Markets and Fairs* (1899); Cunningham, *Growth of English Industry and Commerce* (1903).

TOLLEMACHE (or TALMASH), **THOMAS** (*c.* 1651–1694), British soldier, was the second son of Sir Lionel Tollemache, Bart. (d. 1668), of Helmingham, Suffolk, although an idle report of the time made his mother, Elizabeth Murray (d. 1698), afterwards countess of Dysart and duchess of Lauderdale, the mistress of Oliver Cromwell. In 1678 he became captain in the Guards, with which he served in Tangier, and in 1685 he was made lieutenant-colonel of a regiment of fusiliers, but almost at once he gave up his commission because he disliked the proceedings of James II., and became colonel of an Anglo-Dutch regiment, usually stationed in Holland. At the head of his men he landed in England with William of Orange in 1688 and was made governor of Portsmouth and colonel of the Coldstream Guards, while in 1689 he was chosen an English member of parliament. With the Coldstreams he served William III. at the battle of Walcourt, and then as a major-general in Ireland, where in 1691 he gained fame at the battle of Aughrim and at the sieges of Athlone, Galway and Limerick. He then went to the Netherlands and added to his high reputation by his conduct at the battles of Steenkirk and Neerwinden. In 1694 Talmash, as he was generally called, proposed an expedition against Brest, the leadership of which was given to him. The fortifications, however, were too strong, and although he led on the English troops with great gallantry they were beaten off with heavy loss. Talmash himself was wounded, and returning to Plymouth he died there on the 12th of June 1694. He was buried in Helmingham church, where a long inscription summarizes his life.

TOLSTOY, LEO (1828–1910), Russian novelist and social reformer, was born on the 9th of September (August 28) 1828, in the home of his fathers—Yasnaya Polyana, near Toula—a large country house (not the present one) built in a severely formal style, with Doric pillars and architraves, standing solitarily in a typical Russian landscape. The Tolstoy family, to whom it had belonged for several generations, was originally of German extraction, and had settled in Russia in the days of Peter the Great. The first ancestor of distinction was Petr Andreevich Tolstoy (*q.v.*). His descendant Nicholas (the father of the great author) was born in 1797. After serving for a short time in the army he retired in 1824, and led the life of a Russian boyar. By his marriage with the princess Maria Volkonsky, Count Nicholas in a great measure rebuilt the family fortunes, which had fallen into decay during the two previous decades. Count Leo Tolstoy was the youngest but one of the five children of this marriage, and lost his mother when he was barely three years old. Six years later his father died also, at the age of forty-one. As a child, Tolstoy, though observant and thoughtful, showed no marked talent. He was plain and very sensitive on the point, suffering keenly for want of notice and affection. This sensitiveness led him as he grew older to hide himself away from his playmates and spend hours in lonely brooding. He describes in *Childhood* how, one day, it dawned suddenly upon his mind that Death was ever lying in wait, and that to be happy one must enjoy the present, unconcerned with the future. Whereupon the youthful Epicurean flung aside his books and pencils, and, stretched on his bed, fell to munching sweetmeats and reading romances. But Tolstoy's childhood was not without its share of wholesome pleasure. Hunting and shooting, the delight of the Russian noble, occupied much of his father's leisure, and from his earliest years the boy was wont to accompany his parent. At other times he was quite happy sitting beside his father's coachman on an expedition to one of the neighbouring towns, or with his brothers running in and out of the stables and coach-houses. The tedium of the schoolroom and the reproofs of his tutor made a reverse side to the picture, but did not prevent this fund of early memories from being, as he writes, "ever to be treasured, and fondled again and again, serving as a well-spring from which to draw my choicest treasures." After his father's death at Moscow, in 1837, Tolstoy and his brothers were placed under the guardianship of his aunt, the countess Osten-Sacken, and in the care of Mme Ergolskaya, a distant relative. The former died, however, in 1840, and the charge devolved on another aunt, Mme Jushkov, who lived in Kazan. Mme Jushkov was a typical Russian lady of her class. Keeping open house, fond of gaiety and society, her ideas on moral questions were liberal in the extreme. Tolstoy was eleven years old when he became subject to her influence—an influence which he subsequently regarded as having been the reverse of beneficial. A French tutor was engaged for him and his brothers, prior

Childhood.

to their entrance into the university of Kazan. Outside the hours of study Tolstoy spent his days either in solitary rambles, during which he reflected on the problems of life, or in violent exercise at the gymnasium (the only form of athletics enjoyed by boys of his position in Russia). Thus the physical and philosophical impulses of his nature were developed in equal measure, and these two conflicting forces began their lifelong duel. Only in later years has the philosopher sometimes seemed to outweigh the man of action in Tolstoy's vigorous personality.

At College.

In 1843, at the age of fifteen, he entered the university of Kazan, and gained with his college cap and uniform what he prized most, his independence. The lax rule of the university—which was of no high scholastic repute, giving ready admittance to the sons of the rich and noble—enabled him at the same time to enter the world of society and study its complex problems at leisure. Kazan was in those days a real paradise for such as sought happiness in social excitement, dining and dancing. No city in Russia was so given up to the pursuit of pleasure. Among these scenes of luxury and licence the students played a prominent part. Amid such influences the boy soon ripened into the man. The constant succession of balls, picnics and parties wearied and disgusted him. The pages of *Youth* are eloquent of deadly ennui. He is for ever seeking "Her," engaged in an undefined "pursuit of the Well-beloved," with a half spiritual, half physical longing. At intervals in this quest of the unknown he devoured the novelists of his day, chiefly Dumas and Eugène Sue. He already thought deeply on the object of existence; forming new ideals, aspiring to noble deeds, seeing himself in imagination now a passionate lover, now a leader of men. He was always trying to be original, and to tread unbeaten tracks. Partly in consequence of this feeling, he determined to enter the school of Eastern languages. His first attempt was unsuccessful, but finally passing in through the medium of a supplemental examination, he took up Arabic and Turkish. These studies, however, proved uncongenial to his versatile nature, and failing to distinguish himself in them, he turned his attention in 1845 to the school of law. Here he met with equal discouragement. The professors—all Germans, and many of them not knowing enough Russian to make themselves understood—were favourite butts for the students' wit. There was practically no serious teaching, nor any personal interest shown in the pupils. Tolstoy's evil genius had once more cast him in stony places and left him to work out his own salvation. History, religion and law now claimed his attention in his final efforts to gain the university diploma. In religion his opinions had undergone a great change. From the child's unthinking acquiescence in a hereditary faith had sprung absolute unbelief. History he held a useless form of knowledge. "Of what avail," he said, "to know what happened a thousand years ago?" Hence he neglected the lectures on these subjects, absented himself from the examinations, was confined in the university gaol for irregular attendance, and ended by coming out but moderately well in the yearly examination. The conviction that he was wasting his time forced itself upon him. An idle, dissipated life had told upon his health, and early in 1847 Tolstoy asked permission to go down, "on account of ill health and private reasons." Thus ended his college life, which from an educational point of view he had treated as a jest. Somewhat of an enigma as he was to his companions, with his alternate fits of feverish gaiety and melancholy abstraction, aristocratic hauteur and liberal views, there was yet found a little band of students to accompany him on the first stage of his journey homewards. While probably admiring the original bent of his mind, they little dreamed their late comrade would one day be acclaimed as Russia's greatest thinker and novelist.

The Youthful Reformer.

Tolstoy went back to his estates with fresh hope and energy, determined to ameliorate the condition of his peasantry and fulfil the duties of a landlord. Rumours had reached him at Kazan from time to time of the recurring famines, revolts and miseries of the serfs. In 1847, as often before, the crops failed to suffice for the needs of the starving people, and whole districts set forth to petition the tsar for food. Here was a vital problem requiring prompt solution. In the course of desultory reading at the university he had studied the writings of Jean Jacques Rousseau, and the Frenchman's plea for Nature, honest work and simplicity of life, had impressed him greatly. Fired with enthusiasm, he now entered heart and soul on the task of realizing this ideal. Unfortunately, he was as yet without sufficient moral stamina to withstand recurring disappointments and to combat the suspicions of the serfs. The youthful reformer lacked the patience necessary to deal with the deep-rooted mistrust engendered by years of oppression and neglect. After six months of struggle with this discouraging state of things he temporarily gave up the attempt, and we find him in St Petersburg taking up for a time the broken threads of his education. But with the restlessness of transition strong upon him he soon returned to country life, and in company with his brother Sergius gave himself up to hunting, gambling, carousing with Zigani dancers, and throwing all serious thoughts to the winds. *The Landlord's Morning* may be taken as a picture of this stage of Tolstoy's life. The inevitable reaction soon came. Oppressed by debts and difficulties, in the spring of 1851 he betook himself to the Caucasus, where his eldest brother Nicholas was stationed with his regiment. At Pyatigorsk, at the foot of the mountains, he rented a cottage for about twelve shillings a month, and lived there with the utmost frugality.

Enters the Army.

Finally his brother's persuasions, aided by the influence of relations in high places, led him to enter the army. He passed the necessary examination at Tiflis, and joined the artillery in the autumn of the year. At that time Russia was much disturbed by the lawlessness of the Caucasian races. Bands of Circassians were constantly on the move, plundering and looting. The punitive expeditions in which Tolstoy took part were his first taste of warfare. Neither his military duties nor his love of sport entirely absorbed him, however. The great power which had hitherto lain dormant now awoke. He began to write, and within the next few years produced some of his finest works. Nekrassov, the editor of the Russian *Contemporary*, accepted *Childhood*, the young author's maiden effort. In accordance with the common practice, he received nothing for the MSS. Publication of a first attempt was considered ample payment in those days. Tolstoy was now twenty-four years of age. *Childhood* was followed by *The Landlord's Morning*, *Boyhood* and *Youth*, in quick succession. His early aspirations were revived in these pages, which reflect the doctrines of Rousseau. "You neither know what happiness is nor what life is," he writes to expostulating friends. "Once taste life in all its natural beauty, happiness will consist in being with Nature, seeing her, communing with her." His philosophy notwithstanding, Tolstoy felt a pardonable desire for promotion, which was slow in coming to him. Some verses ascribed to him (an authorship never denied) making fun of the general during the siege of Sebastopol, which appeared in print, may possibly have had something to answer for. Be that as it may, the spirit of unrest and dissatisfaction was moving Tolstoy to return home, when rumours of hostilities arose, and the Crimean War burst into flame. He promptly volunteered for active service, and asked to be allowed to join the army on the Danube, under the command of Prince Gortchakov.

The Crimea.

In the early part of 1854 we find him encamped before the walls of Silistria, a town of Bulgaria, which Gortchakov had invested. At the very height of the bombardment, however, Austrian intervention prevailed, and the siege was raised. The din of battle was hushed and revelry took its place. At the ball which promptly celebrated the event Tolstoy felt ill at ease. The joyous music and babel of tongues jarred on his sensitive ear, fresh from the moans of the wounded and dying. He went up to the prince and asked leave to start for Sebastopol. Permission being granted, he hastened from the ballroom, and left Silistria without delay.

He now exchanged the offensive for the defensive. Shot and shell fell like hailstones on the bastions of Sebastopol. Courage, fortitude, presence of mind were at every moment demanded, while assault followed assault, until at last the overwhelming strength of the allies compelled the Russians to retreat. Throughout that trying time Tolstoy cheered his companions, whiling away many a weary hour with jest and story. Amid this "wrackful siege of battering days" he wrote those *Tales from Sebastopol* which earned him instant literary celebrity, and caused the emperor Nicholas to issue special orders that he should be removed from a post of danger. An official despatch recounting the events of the siege was next written by Tolstoy at the command of his superior officer, and with the charge of this document he was shortly afterwards sent to St Petersburg. He was never again on the field of battle.

At St Petersburg.

Tolstoy returned home with new impressions. Sad at heart and sick of the horrors of war, he came back with a feeling of brotherly love for the common soldiers, whom he had seen day by day doing quiet deeds of courage and devotion, fighting for their country without hope of reward, without fear of death. He contrasted them with the more self-seeking nobles, and felt their superiority. The stirring scenes through which he had passed, the simple faith of his men, all had helped to renew his belief in God. Preceded by the fame of his descriptions of Sebastopol and the Caucasus, he arrived in St Petersburg to find himself the object of a general ovation. The *Sovremennik* (*Contemporary*), in which Tolstoy's first work, *Childhood*, had appeared, numbered among its contributors the foremost writers of the day. To be admitted to their ranks was considered by them an honour equivalent to the award of a *fauteuil* in the French Academy. They welcomed Tolstoy with open arms, the veteran novelist, Turgeniev, in particular hastening to greet him on his arrival, and begging him to make his house his home. Society was equally eager to open its doors to the young soldier-author. His vivid and dramatic pictures of the war had been widely read and had created a profound sensation. The great official world of St Petersburg proceeded to offer him a brilliant series of entertainments in which he found himself the central figure. It is not surprising that this combined adulation from literary men and society overcame for a time the growing asceticism of his character. Yet it also in a measure hastened its development. Even while borne swiftly on the current of pleasure, his strenuous nature gradually reasserted itself. In the pages of *My Confession* Tolstoy describes the phases of this mental unrest. The narrowness of a literary clique soon became irksome to his dominant character. His passionate desire for truth brought him into frequent conflict with those who paid more regard to convention. With Turgeniev especially he found himself constantly at variance. A friendship between natures so diametrically opposite, between two men who might be described as leaders respectively of the old and the new school of thought, could not long subsist. Mutual admiration does not imply sympathy. Turgeniev presently wrote to a friend, "I regret I cannot draw nearer to Tolstoy, our views are so opposed, the one to the other." And these differences of opinion gradually led to a complete estrangement. On the other hand, in Fet, the poet, he found a lifelong friend. Others of his intimates were Nekrassov, the editor of the *Contemporary*, already mentioned; Katkov, the celebrated journalist; Droushinine, Grigorovitch, Fet, and Ostrovski, the dramatist.

Russian Popular Movement.

While Tolstoy was thus waking to a sense of distaste for his environment, a great event was pending. With the accession of Alexander II. in 1855 a wave of progressive policy—set in motion by the tsar himself—stirred the bureaucratic circles of Russia, and while fiercely resisted by some of the nobility, met generally with cordial encouragement. The emancipation of the serfs became the burning question. "The People!" and "Progress!" were the cries quickly caught up by the press of Russia and of Germany also. It was in Germany, indeed, that the novel of humble life sprang into being, Gotthelf leading the way with his tales, *Uli the Serf* and *Uli the Tenant*. Auerbach followed with his village stories, which opened a new world of thought; Stifter and a host of others brought up the rear. This new impulse in literature soon spread to Russia. Turgeniev in his *Sportsman's Tales*, Grigorovitch in *The Village* and *Anton Goremika*, showed their sympathy with the moujik. But above all others, Tolstoy was most deeply and lastingly affected. Awakened by this echo from without of his own inmost yearnings, he realized at last the true bent of his mind. "The People" became his watchword. One increasing purpose henceforth ruled his life, and gradually brought into harmony the inequalities and contradictions of his character. Roused from the inertia which had been caused by nerves and hypochondria, he wrote *Polikoushka*, a painful story dealing with the ills of serfdom. His active brain then turned to considering the meaning and scope of the catchword "Progress," and fully to do this he determined to go abroad and study the educational and municipal systems of other countries. He finally started for Germany in January 1857.

Foreign Travel.

Tolstoy only three times crossed the Russian frontier, and these journeys were all between 1857 and 1861. On his first trip, Germany and Italy were hurriedly visited. He also made a short stay in Paris, which had attractions for him in the society of several Russian friends, among whom were Nekrassov and Turgeniev. With the latter he had not yet come to open rupture. From Paris he went to Lucerne. An incident which occurred there, and is reproduced in his semi-autobiographical *Lucerne*, shows the workings of his spirit. He tells how a wandering musician stood one day in the hotel courtyard, and after his performance asked in vain for alms from the convivial crowd assembled. Tolstoy, in the person of the hero, then indignantly came to the rescue, brought the poor minstrel into the hotel, and, moved to wrath with the churlish waiters who were unwilling to serve him, ordered a private room where he himself supplied his guest's wants, and sent him away happy with a double lining to his pockets. Of his successive journeys westwards, the third alone was of long duration and of corresponding importance in its results. Prior to this last visit to foreign parts, his time was spent between Yasnaya Polyana and Moscow, often in the company of his friend Fet. On a bear-hunt together, Tolstoy narrowly escaped death, an incident which he graphically describes in his *Fourth Reading-book for Children* (20th ed., 1900, &c.). Fet also mentions it in his *Reminiscences*. His departure was finally hastened by the serious illness of his brother Nicholas, who had gone to France to recruit his failing health. Tolstoy, after halting in Berlin and Dresden, joined him, but only to endure the grief of witnessing his end. Nicholas died on the 20th of September 1860, and Tolstoy's letters of that period show how deeply he was affected by the death of his brother. It gave a yet more serious turn to his thoughts. In a letter to Fet he reverts to his old trouble, the enigma of life. "In truth," he writes, "the position in which we stand is terrible." This mental gloom probably still hung over him during his wanderings through Italy. There is no record of his impressions of Rome, Naples, Florence. Turning his footsteps northwards, however, he began to take renewed interest in social conditions, elementary and monastic education, and the general subject of his quest. From Paris (where his friend spoke of him as "singular indeed, but subdued and kindly") he went to London in 1861, no noteworthy incident marking his brief visit.

Educational Experiments.

The spring of 1861 found him once more at Yasnaya Polyana, where some little time before he had forestalled the Emancipation Act by freeing all the serfs on that estate. He now began digesting the mass of information he had acquired abroad, eager to put his ideas into practice. The feelings with which he reviewed his experiences were largely those of disappointment. Of the educational systems of Italy, France and Germany, that of the last-named country alone earned his partial approval. While there he visited the universities, prisons and working-men's clubs. He made the acquaintance of Auerbach, and was greatly influenced by his ideas on village schools. He was also much impressed by the novel institution of the kindergarten, to which Fröbel, the great educationist, was devoting all his energies. Determined to follow these lines, he sought and obtained permission to open a school. In his zeal he also started an educational journal called *Yasnaya Polyana*. This journal now only exists as a literary curiosity, but the essays published in it have all been reprinted in his collected works. The time for opening the school was well chosen. The liberal spirits of Russia had gained the day and won a great victory. Just two months previously the decree of emancipation (February 1861) had been sent forth. The air was rife with schemes for the betterment of the peasantry. A new era seemed to have begun. Tolstoy's school was essentially "free." "Everything that savours of compulsion is harmful," he said, "and proves either that the method is indifferent or the teaching bad." So that not only were no fees paid, but the children came and went as they pleased, learned what they pleased, and were subjected to no sort of punishment. It was the duty of the teacher to fix the pupils' attention, and his the blame if they failed to learn. "The student," said Tolstoy "must have the right to refuse those forms of education which do not satisfy his instincts. Freedom is the only criterion. We of the older generation do not and cannot know what is necessary for the younger." On these principles the Yasnaya Polyana school was started in a house near that of Tolstoy. He himself taught drawing, singing and Bible history. The Old Testament was his handbook; he held it as indispensable in any course of instruction, a model for all books. Doubts and fears sometimes assailed him, still for a year all went well. Other schools were opened on the same lines in the district, and success seemed assured. But the eyes of the government inspectors had long been suspiciously fixed on them, and a correspondence on the subject presently ensued between the ministry of education and the home department. The verdict passed by the former was free from overt animus. "The activity of Count Tolstoy deserves respect and should win co-operation from the educational department, although it cannot agree with all his ideas; ideas which he will in all probability abandon on due consideration" (October 1862). Yet there was a subtle threat conveyed in these last words which was probably not without effect. Signs of discouragement grew visible. We find the enthusiast complaining that his masters desert him, his pupils fall away. The plague of inquisitive visitors annoys him. At the end of the second year the schools were closed, the journal discontinued, and Tolstoy, disheartened and sick, "more," as he writes, "in mind than body," betook himself to the healthful quiet of the steppes, to breathe fresh air, to drink *koumiss* and to vegetate. This was the end of his educational experiment, the aim of which was rather to develop the character than to educate in the ordinary sense of the term. When later he asked leave from the authorities to reopen the schools, it was peremptorily refused.

His socialistic theories were now fully unfolded. In his view the people were everything, the higher classes nothing. The latter had misinterpreted the meaning of "progress," imagining it to be synonymous with education; and hence compulsory teaching had been resorted to, with harmful results. Reading and writing played but a small part in forming a man's mind and fitting him for life. They merely rendered him more articulate. These questions should be left to the people themselves. Their demands were very clearly expressed. They knew what they wanted, and were thoroughly convinced that "in the great question of their spiritual development they would neither take a wrong step nor accept that which was false." Such was in substance Tolstoy's doctrine. "The people," he affirms, "are stronger, more independent, more just, more human, and, above all, more necessary than the upper class. It is not they who should come to our schools; we should learn of them." This desire to subvert society is akin to the philosophy of Rousseau, as expressed in *Émile* (livre iv.):—

"C'est le peuple qui compose le genre humain; ce qui n'est pas peuple est si peu de chose, que ce n'est pas la peine de le compter. L'homme est le même dans tous les états; si cela est, les états les plus nombreux méritent le plus de respect. Devant celui qui pense, toutes les distinctions civiles disparaissent: il voit les mêmes passions, les mêmes sentiments dans le goujat et dans l'homme illustre; il n'y discerne que leur langage, qu'un coloris plus ou moins apprêté. . . . Étudiez les gens de cet ordre, vous verrez que, sous un autre langage, ils ont autant d'esprit et plus de bon sens que vous. Respectez donc votre espèce; songez qu'elle est composée essentiellement de la collection des peuples; que quand tous les rois et tous les philosophes en seraient ôtés, il n'y paraîtrait guère, et que les choses n'en iraient pas plus mal."

While Tolstoy's theories were thus in course of practical solution, his literary powers suffered eclipse. Turgeniev, who lived near him in the country, writes in disgust that he "has grown a long beard, leaves his hair to fall in curls over his ears, holds newspapers in detestation, and has no soul for anything but his property." Indeed, his time was fully taken up, for while still occupied in supporting the school, he had allowed himself to be nominated to the position of "Arbitrator," which he held for a year and some months (1861–1862). This was an arduous post. The arbitrators were appointed under the Law of Emancipation to supervise the distribution of land, to adjust the taxes, define the conditions of purchase, and decide all matters in this connexion. These duties were after his own heart, and he went to work with a will. Every day he had difficult points to deal with, deputations of peasants coming to see him, the new law and the rights it bestowed on them having to be explained. The hardest of all Tolstoy's tasks was to remove the suspicion and mistrust felt by the serf towards the landlord. On the other hand, he had to contend with the nobility of the district, who were well aware of the side on which his sympathies placed him. For a year and a half he tried energetically to do his duty, but this experience led him eventually to regard the Emancipation Law as a not unmixed blessing. It had come too soon, and been granted unasked. The condition of the peasantry was worse than before. A noble impulse, inspired by love of the people, impelled Tolstoy to become their champion and interpreter.

Relations with the Peasantry.

A tragic incident occurring about this period (1866) forcibly illustrates Tolstoy's character as a defender of the helpless. A regiment had recently been stationed near Yasnaya Polyana, in consequence of some five hundred convicts being at work upon the railway. In this regiment was a certain Captain N., a strict disciplinarian, who led a solitary life and was much disliked by his brother officers and his men. For trifling faults he would condemn his soldiers to unheard-of punishments. One of his orderlies in particular, a young man of some education —who had voluntarily taken the place of a comrade to free him from military service—was constantly getting into trouble, until, for some slight clerical error in a report, Captain N. ordered him to be degraded and flogged. This was too much for the poor volunteer. He followed the officer as he was leaving the orderly-room, and struck him a blow on the face. He was immediately placed under arrest, and the details of the occurrence quickly spread through the neighbouring villages. Two officers of the regiment brought the story to Tolstoy and begged him to undertake the soldier's defence. He consented readily, and no opposition being made by the military authorities, at once prepared for the court-martial. A few days afterwards the court assembled. Warned by the president of the severity of military law, Tolstoy made answer that he was come to defend not a criminal but a man compelled to crime by force of circumstances outside his will. The plea he set up was that the prisoner was not in full possession of his senses; but this defence was not allowed to stand. The soldier was condemned to be shot, in spite of the utmost intercession Tolstoy could make. The emotion of the crowded assembly stirred by his appeal, the mute quiescence of the soldier (persuaded that death was better than the living agony of exile), the closing tragedy—all this, added to the many scenes of war and bloodshed which he had previously witnessed, made a lasting impression and caused him to raise his voice yet louder in the cause of universal love and peace. During the preceding period of ethical experiment he published only two books, but these stand high among his works. They were *Three Deaths* (1859) and *The Cossacks* (1863)—the latter written ten years before, its leading idea being that culture is the enemy of happiness. At the conclusion of his arbitratorship, seeing his efforts partially nullified, and feeling himself overstrained and overworked, he determined to exile himself for a time to Samara, a south-eastern province. He halted on his way in Moscow, and here one night's high play cost him the MSS. of *The Cossacks*, which he sold to the editor of the *Russian Messenger* for £100 to pay his debts of honour. A pleasanter feature of this visit to Moscow lay in the renewal of his intimacy with the Behrs family, Sophia, the younger daughter of the house, being his special attraction. He finally reached Samara in the spring of 1862, and went through a "koumiss cure," revelling in what he called "the life of a beast of the field."

By the month of July he felt completely restored to health, and returned to Yasnaya Polyana, where his sister Maria and his aunt, Mme Ergolskaya, were looking after the property. The house in which he now lived was comparatively new. The one in which he was born was sold to pay some earlier gambling debts, and had been removed bodily to the Dolgoe estate some 30 m. distant. He now felt a sense of something wanting in his home—a feeling of incompleteness took possession of him. He wanted to see Sophia Behrs, and accordingly left almost immediately for Moscow. Sophia's father was a fashionable Russian doctor, born and bred in Moscow, and a graduate of that university. He had three daughters, of whom Sophia was the second. The friendship between the Behrs and the Tolstoy families was of old standing, Countess Maria Tolstoy having been a school companion of Mrs Behrs. It was now the height of summer, and every one of consequence was leaving the city for their country seats. The Behrs family were going on a visit to their grandfather, whose estate lay not more than 40 m. from Yasnaya Polyana. Here they accordingly broke their journey, and during the pleasant days that followed Tolstoy's attachment deepened. Not long after their departure his impulse took shape, and mounting his horse, he set out for Twicy, where they were staying. His errand was a definite one; and he lost no time in fulfilling it. At first

Marriage.

Dr Behrs demurred, unwilling to allow his second daughter to marry before her elder sister, but his objections were presently overruled. On the 23rd of September 1862 the marriage took place, and Tolstoy installed his bride at Yasnaya Polyana with the conviction that calm and contentment were his at last. Two weeks later he wrote to his friend Fet, saying that he was now happy and felt quite a new man. In his *Confession* some years later he writes: "The new conditions of a happy family circle led me away from my researches into the meaning of life. My whole mind became concentrated on the family—on the mother, the children, and the anxiety to provide due means of subsistence. The effort after perfection resolved itself into the effort to ensure the happiness of my offspring." Tolstoy thereupon settled down to country life, and though to the young countess this exile from her town friends and relations must have been somewhat of a trial, they remained on their estates for the following eighteen years, with very short intervals of absence. They had thirteen children, of whom the eldest was born in June 1863. In the bringing up and instruction of his family Tolstoy conformed in essentials to the requirements of his position. No experiments were attempted. English and German governesses were engaged, and their educational methods followed the usual routine. Both father and mother devoted a considerable amount of time to their children. Punishment was rare. It consisted in a strict "boycott" of the offender, which was not relaxed until a frank confession of fault was made—no light penalty to a sensitive child. The theory of free option in study was dropped by Tolstoy in the case of his children, but he was for ever joining in their games, taking them on his shooting expeditions and sharing in their gymnastic exercises. Manual labour was always congenial to the great writer, and formed a natural concomitant to his pastoral existence. It was a common thing for him to mow the lawns, hoe and rake the garden beds, or when out walking to take the scythe from a labourer and wield it lustily.

Literary Work.

War and Peace and *Anna Karenina*, Tolstoy's two most widely known and finest novels, date their commencement from this period. These two novels were received with scant favour by both the Liberals and Conservatives in Russia. Katkov, the editor who was publishing *Anna Karenina* in his periodical, introduced so many changes into the MSS. that the publication was not continued. It was due to N. Strachov, the literary critic, that public opinion was brought to recognize the merits of these novels. Every day Tolstoy retired to his room for a certain number of hours, and whether in the humour or not, sat at his table and wrote. "Inspiration comes with writing," he used to say. Authorship he avowedly despised, yet confessed the temptation of public applause and heavy gains was too great to resist. The reading world has reason to be glad of this touch of inconsistency. Despite his genius for characterization, the task of novel-writing cost him a severe and determined effort. The technique of literary composition irked him exceedingly. "You cannot conceive," he writes in 1864 to his friend Fet, "how hard is this preliminary labour of ploughing the field in which I am compelled to sow. To consider and reconsider all that may happen to all the characters beforehand, and to think over the million of possible combinations, and to choose one out of a hundred thousand, is very difficult."

In the course of this correspondence interesting sidelights are thrown on Tolstoy as landowner and farmer. Not long after his marriage he wrote, "I have made an important discovery, of which I hasten to tell you. Agents, stewards and overseers are only so many hindrances to farming! Dismiss them all and lie abed till 10 o'clock, and you will see things will certainly go none the worse. I have made the experiment, and am quite satisfied. Now to business. When you are in Orel buy me 20 poods of various kinds of string, &c., and send them to me if it does not cost more than two roubles thirty kopecks a pood with the carriage"; and in this vein he enters into manifold rural matters, the progress of crops, the illness of a favourite horse or the calving of a valuable cow. Again the philosopher rises to the surface, and he questions Fet as to the workings of his mind.

"I don't mean in the Zemstvo nor in agriculture; these are occupations for active men, with which we employ ourselves in a perfunctory fashion, much like ants engaged in hollowing out a clod of earth—work of which the result is neither good nor bad. But what are you doing with your thoughts; how is the inner mechanism working? Is the secret spring trying to show itself, making its presence felt? Has it forgotten how to work? that is the all-important question."

At another time he pays a well-earned tribute to his wife's helpful sympathy. "She is by no means a trifler," he writes, "but is an earnest helpmeet to me." In literary matters he valued above everything the opinions of Fet and of Turgeniev (notwithstanding his saying of the latter, "the older I grow the less I love him"). Fet, indeed, was an intimate and devoted friend, constantly interchanging visits with the Tolstoy family. To him the scenes of *War and Peace* were first unfolded as Tolstoy read them aloud in the quiet evenings.

Quarrel with Turgeniev.

It was at Fet's house (in 1864) that the violent quarrel took place between Turgeniev and Tolstoy which nearly culminated in a duel. Many inaccurate accounts of it have been given, but the history of the rupture as recorded by Fet may be looked on as trustworthy. It seems that Turgeniev in rather a boasting spirit was praising his daughter's English governess—how she had desired him to name the precise sum his daughter might spend in charity, and how, at her instigation, the young lady made a practice of mending the clothes of some of the poorest peasants. Tolstoy, who was always against the artificial "philanthropy" of the wealthy, said brusquely that he thought it was theatrical and *poseuse* for a daintily-dressed girl to sit sewing at filthy, evil-smelling garments in the name of charity. Turgeniev thereupon rose, furious, from the table. "Stop saying such things!" he cried, "or I will force you to silence, with insults if need be." Peace was with difficulty restored by M and Mme Fet. The letters which subsequently passed between them only served to fan the flame, so that even the amiable Fet was involved in the dispute and for a short time estranged from Tolstoy. Finally, after a lengthy and acrimonious correspondence, the threatened resort to arms was averted through the interposition of friends; but fourteen years were allowed to pass before a reconciliation took place. In 1878 Tolstoy, believing himself to be in a dying state, at length made overtures of peace to his brother author; overtures which Turgeniev met cordially in the following terms:—

"Dear Leo Nikolaevitch,—I received your letter to-day which you sent to me *poste restante*. I was delighted and much moved by it. With the greatest pleasure I am ready to renew our former friendship and to press your proffered hand. You are quite right in thinking I harbour no feelings of enmity towards you. If they ever did exist they have long since disappeared, and no remembrance of you now remains save that of a man to whom I am sincerely devoted, and of a writer whose first step it was my great privilege to be one of the earliest to welcome; whose every new work has always aroused in me the greatest interest. I rejoice from my heart that our misunderstanding has come to an end. I hope to be in the province of Orel this summer, and then we shall meet. I send you my best wishes, and once more grasp your hand in friendship."

Meanwhile Tolstoy had pursued literary labours with relentless ardour and with ever-increasing fame. Prince André (the hero of *War and Peace*) and *Anna Karenina* in turn occupied all his thoughts. Several years were given to the perfecting of these remarkable character-paintings. When the publication (1864–1869) of *War and Peace* had been succeeded by that of *Anna Karenina*, he set himself to write yet another great novel, dealing with the times of Peter the Great, but after working at it for some months he suddenly abandoned the scheme. One of the few excursions made during these years of tranquillity was undertaken in 1866 to the battlefield of Borodino, the scene of the famous fight in 1812. For two days Tolstoy wandered over the plain, investigating and taking notes, and there he drew a plan of the battle, which was afterwards published as a frontispiece to *War and Peace*. But the continued pressure of severe nervous and mental strain was bound to affect a man of his calibre; health and spirits gradually sank, so that in 1870 Countess Tolstoy induced him once more to seek the healthful air of Samara, and subject himself to the "koumiss cure" in practice there. A strange feature of this "treatment" lay in the avoidance of meal and vegetables, the diet being strictly confined to meat. Tolstoy pitched his tent in the village of Karalieck, where the primitive life among the Bashkir nomads exactly suited his habits and disposition. He had a faculty for making himself at home with peasant folk, and was a great favourite among them. In this district there was a large community of Molochans, a sect whose tenets differ considerably from those of the Orthodox religion of Russia. They acknowledge no guide save the Bible, and reject all the rites and ceremonies of the Greek Church. Their honesty, industry and temperance made them an example to all the country round, and caused Tolstoy to study them with special interest. So delighted was the count with this visit to Samara, that he shortly afterwards purchased an estate of over 2000 acres in the district. But his pleasure was short-lived, for not long afterwards (1872–1873) the crops failed and a serious famine broke out. He thereupon opened a subscription fund for the starving population, and went from village to village taking a quantity of grain with him, and making what provision was possible in the circumstances.

At Samara.

Tolstoy was now making up for lost time, learning what he had failed to learn at the university. Greek was his great attraction. "Without Greek," he exclaims, "there is no culture." He also became enamoured of the writings of Schopenhauer, and for the greater part of a year (1869) devoted himself to the study of that philosopher. "Never," he says, "have I experienced such spiritual joys." Enthusiastic in everything he takes up, he assures his friends that Schopenhauer is the greatest genius he has met with. He sets himself to translate his works, and tries to enrol Fet as a co-translator. Philosophy at this stage of his life went hand in hand with sport and agricultural interests. He contemplated buying an estate in the province of Penza, but on the 21st of October 1869 he writes:—

Studies in Philosophy.

"The purchase of the estate in Penza has not come to anything. I have now finished the sixth volume (*War and Peace*), and I hope it will be published on the 1st of November. There are a lot of snipe. I have shot four brace, and to-day found two brace and killed one bird."

After a period of comparative rest and ease, the shadows of war and death once more encompassed Tolstoy. Two of his children died in 1873, and their loss was followed by that of his much-loved aunt, Mme Ergolskaya. A mental restlessness and uneasiness came over Tolstoy, and also a desire for the exercise of a wider philanthropy. The Russo-Turkish War put the crowning touch to these feelings. God and death, war and the intricacies of life were now the constant subjects of his letters. "You will not believe what joy your last letter has given me," he writes in 1877 to his dear friend Fet. "When you speak of the existence of the Deity, I agree with everything you say, and I would wish to write much, but time fails me and it is difficult in a letter. For the first time you write to me on the Divinity of God. I have been thinking about it for a long time. Don't say that we must not think about it. Not only we must, but we ought. In all ages the best people, the true people, have thought about it." Tolstoy now resumed the study of the Bible, and took special delight in the books of Ecclesiastes and Proverbs. He treats them as a new discovery, and recommends them to his friends as having much in common with the teaching of Schopenhauer! This revived interest in religious questions was accompanied and perhaps deepened by a state of extreme depression. It was then he reconciled himself with Turgeniev, and in December 1878 we find the latter staying with him on a visit of three days' duration. Turgeniev writes that he finds him "very silent, but much developed." The count on his side feels the same want of mutual sympathy as of old, and confesses that no real friendship seems possible between them.

Tolstoy now entered on the third phase of his life. He himself thus describes the stages of his mental growth. In the first phase he lived only for his own lusts and pleasures. This came to an end at the age of thirty-four. Then came the interest in the welfare of humanity, which married life cooled and obscured for a while. The striving for the welfare of mankind was mingled with the striving for personal well-being. But the third and highest phase was reached when the service of God became the motive power of his existence. All other aims grew subservient to this, and interest in the merely personal life had begun to disappear. He had passed through every imaginable grade of religious thought. As a child he had gone to church and confession unquestioningly. As a student and young man he had scorned and ridiculed religion. Later in life he became a pious and devoutly orthodox Greek Churchman, until one day during the Russo-Turkish War he was filled with a spirit of revolt at hearing the priests pray for the destruction of the enemy, beseeching the Almighty to help them to kill their hundreds and thousands. His whole being recoiled from the un-Christianity of these prayers, and he then and there renounced the orthodox faith. For three years he had exceeded the priests themselves in the regularity of his attendance. Now he felt there was something vitally amiss, and he flung it all to the winds. The novelist was rapidly being hidden in the philosopher's cloak, to the dismay of literary Europe. So early as 1859 Turgeniev had exclaimed, "If only Tolstoy would not philosophize, all might yet be well." His brilliant contemporaries, Gogol, Dostoievski and others, had all in different ways been seized in turn by what may be called the fever of religion. Tolstoy was to suffer from it too. Like the flickering of a dying lamp, his imagination again shone out in *The Death of Ivan Ilyitch* and *The Power of Darkness*. Subsequently, with rare exceptions, his writings were overloaded with ethical reasonings. He was now fifty. While leading a life outwardly calm and

Religious Development.

peaceful, he had passed through innumerable mental struggles and vicissitudes. Of these he speaks with simple candour in *My Confession*, an autobiographical sketch which appeared in print at intervals between the years 1879 and 1882. In the orthodoxy of the Greek Church, with fastings, prayers and rigid observances of her rites, he vainly sought an answer to his doubts; finally he broke away from a ceremonial which had become empty and lifeless to him, and built up a religion of his own. Impressed with the conviction that the peasant's mental ease was the result of his life of physical toil, Tolstoy tried to adopt the same habits, and for some ten years (dating from about 1880) he renounced the life of his own class as completely as it was possible for him to do. He rose early and went to work in the fields, ploughing, cutting the corn, working for the widow and orphan, and helping them to gather in the crops. He also learnt boot and shoe making, and enjoyed being praised for his skill. Thus he laboured late and early, and in these simple physical acts found the best cure for his attacks of despondency. "Simplicity! Simplicity! Simplicity!" His food and drink, his pleasures and personal indulgences, were curtailed. Meat was given up and replaced by a vegetarian diet. Field sports—equivalents for cruelty and lust of blood—were abandoned, and his gun hidden away to rot and rust. Even tobacco was renounced as luxurious and unhealthy.

But with all his straining towards simplicity, it was in the nature of things impossible for Tolstoy absolutely to lead the life of a peasant. Labour though he might throughout the day, there was his well-appointed house to return to. He could not cut himself off from his wife and children. Friends and acquaintances could not be wholly ignored by the would-be Diogenes. Circumstances in this respect were too strong for his views and wishes. The renunciation was still only a partial one. But as the strain of a great surrender is greatest while it is still incomplete, so Tolstoy felt more and more impelled to emancipate himself from worldly concerns. The break in the long spell of country life which presently occurred only served to deepen this desire. In 1881 his eldest son went to the university, and the two next in seniority soon followed him. It became necessary for the family to be in Moscow a great deal, for the sake of the children's education. The eldest daughter had come out into society, and friends were continually calling, obliging Tolstoy to sit and talk with them. All the elements of town life were distasteful to him. Money was an evil thing in his sight, and he gave up carrying it about with him, or even making use of it. "What makes a man good is having but few wants," he said, and he accordingly set himself to limit his wishes rigidly, and to detach his heart from all treasured objects. The year 1880 was the census year in Russia. The government, as usual, called for volunteers to help to carry it out. Tolstoy became one of the enumerators, whose duties afforded an excellent opportunity for seeing the conditions under which the poor lived. The misery of it made him often wish to surrender all his property and have nothing more to do with lands and money, but the government and family circumstances prevented him. In the pamphlet, *What are we to do?* he graphically narrates his census experiences. Again and again he attempted to carry his theories into effect. At last, calling his wife into his room, he explained to her that property and many possessions had become irksome to him. Wealth he now regarded as a sin. He wished to be rid of all personal ownership. In 1888 Tolstoy renounced all claim to his estates; everything was made over to his wife and children, the countess acting as trustee. True, this renunciation made little difference in his manner of life. He lived under the same roof as before, ate at the same table, wrote and read in the same study. The change was mental rather than material. He cared no longer for the growth or improvement of his estates, but gave himself up to ethical questions, and endeavoured day by day to bind himself more closely to the people. He now began to write specially for their benefit a number of simple tales which have been widely read, tales directed mostly against crying evils—the peasant's love of *vodka*, and like themes. He found willing fellow workers in the firm of Russian publishers known under the name of Posrednik (V. Tchertkoff, and a group of friends). *John the Fool*, which was published in 1886 in the "Posrednik Series," is generally considered the best of these stories. *The Power of Darkness* (1885) also appeared in this series, and was written with the same object in view. Unfortunately, the popularity of these stories aroused the attention of the government, and led to many of them being forbidden on account of their Socialistic tendencies.

Renunciation of Property.

The terrible famine of 1891–1892 added fresh lustre to Tolstoy's name. He and his family worked unceasingly in soup-kitchens and barns, distributing food and clothes. No true leader lacks a following. Every oppressed sect or individual turned instinctively to Tolstoy for sympathy and support, the most important case in point being that of the sect of the Doukhobors. Early in 1891 rumours began to reach headquarters of social and religious excitement fermenting among the inhabitants of the Caucasus, and especially among the Doukhobors (*q.v.*). This people, numbering from fifteen to sixteen thousand, shared their goods and property in common, and made laws of conduct for themselves, based on a simple form of religion unobscured by ceremonies or ritual. In these matters, and especially in refusing to serve as soldiers, they defied the governors of the Caucasian provinces, so that, as their numbers and strength of opposition to authority grew formidable, severe measures were put in practice for their suppression. Several of their leaders were exiled, and in 1895 some hundred of them were condemned to be enrolled for three years in the so-called "disciplinary regiment." It was in that year that Tolstoy came in contact with them personally, and became deeply interested in them. He promptly identified himself with the agitation in their favour, and by his endeavours aroused sympathy for them in other countries, especially in England. After many rebuffs from the government, and many unavailing efforts to reach the kindly ear of the Tsar, the persecution of the Doukhobors at length ceased, and they were allowed to emigrate. It was in aid of these people that Tolstoy wrote and published *Resurrection*. The attack on the Orthodox Church in this novel was probably the chief cause which led to his formal excommunication by decree dated the 22nd of February 1901. In later years Tolstoy maintained all his interests, but old age gradually told on his strength. He died on the 20th of November 1910 at Astapovo, where he was stricken with pneumonia when carrying out a sudden decision to leave Yasnaya Polyana and end his days in retirement.

The Doukhobors.

Death.

No account of Tolstoy can pretend to any measure of completeness which does not refer to his views on religion. Tolstoy himself attributes so much importance to them that he has written several books with the sole object of telling the world what he considers truth. In *My Confession* he describes the various stages of religious experience through which he has passed. He begins with a graphic picture of the religious state of the society in which he was brought up. There, although people were nominally orthodox, actually they believed in nothing. Indeed so inconsistent were the ideals of that society with any real belief in the Orthodox Church that at sixteen Tolstoy practically renounced Christianity and became a sceptic. During the whole of this period he felt unhappy and dissatisfied, for he had no theory which enabled him to solve the riddle of life. He found no solution to the question he often put to himself—Why do I live? nor to the other which depended on the first—How ought I to live?

Tolstoy's Religion.

It seemed to him that the men he met dealt with these questions in four ways. Some ignored them and treated life as if it were a meaningless jumble of vanity and evil. Others, recognizing the difficulty of satisfactorily solving these questions, simply shut their eyes and made the best of life as they understood it without thinking of the future. A third group answered these questions by regarding life as an evil and foolish thing and by putting an end to it. Fourthly, there were those who considered it a stupid and ridiculous farce and yet continued to live on, making the best of it.

Tolstoy himself took up the last position, although it failed to meet his spiritual needs. He felt that the millions who accepted the religious theory of life had somehow a better answer to the problem, notwithstanding that their solution was based on an absurd hypothesis. Although faith was unreasonable it alone gave meaning to life, faith being understood as the theory which linked man's finite life with the infinite. Having arrived at this conclusion Tolstoy was ready to accept any faith which did not require a direct denial of reason, and for this purpose studied Buddhism, Mahommedanism and Christianity. The only persons he felt who were happy and found a meaning in life were the poor, and the only life that could be lived in accordance with reason was life under simple conditions such as animals lived. Only man must labour, not as the animals, each for itself, but for all. The search after God was not an act of reason but of feeling. To live after God's word we must renounce all the material pleasures of life and be humble and charitable to all men. This belief he found in the churches, but mixed up with other things which he could not understand and which repelled him, viz. sacraments, fasts, bowing before relics and images. The church festivals, as commemorating miracles or alleged facts of Christ's life, were repugnant to him. Communion he explained to himself as an action done in remembrance of Christ and as signifying a cleansing from sin and an acceptance of Christ's teaching. When asked by the priest to repeat before receiving the elements that he believed that what he was about to receive were the real Body and Blood, he repeated the formula but found that no wish to believe could make him believe it. The attitude of the various Christian churches towards one another also alienated his sympathy; it had no resemblance to a union of love. He thought that there should be mutual concessions where beliefs had so much in common, but was told that any compromise involved an admission that the clergy had altered the primitive faith and that it was their duty to hand on the faith inviolate. He was also very much repelled by the attitude of the Church towards war and capital punishment. Tracing the happiness of the peasantry to their faith, he became convinced that there were certain elements of truth in Christianity. The Christian churches and the Greek Orthodox Church in particular had in his view combined to obscure the basis of truth in Christ's teaching.

Tolstoy therefore set himself to endeavour to eliminate what he thought the false doctrines and superstitious elements which had grown up round Christianity, and to discover the verities contained in it. Tolstoy started with the premise that Christ's teaching was communicated to unlettered persons and only put down in writing long after his death. "It may be assumed," he says, "that the Church in accepting the three synoptic gospels had accepted much that was inaccurate." Tolstoy argues that it should be remembered that the gospels must have gone through many changes and that he is therefore at liberty to deal with them critically. He sees in Christianity not an exclusively divine revelation, nor a mere historical phenomenon, but a teaching which gives meaning to life. The churches, he considered, were substituting a teaching which was not Christ's, but was a strained and contorted version of what Jesus taught. The sectarianism of Christianity had its root in the idea that the gospels are to be understood not by taking them by themselves, but by interpreting them in such a manner as to make them agree not only with the other sacred writings but with the traditions of the Church, which were themselves obscure. Tolstoy maintained that it was the foreign elements foisted upon Christ's teaching which have alienated the best minds from Christianity. Anyone taking Christ's teaching alone will see that it has no admixture of elements that contradict common sense. It has no sympathy with superstitions, contains no "dregs," has no "darknesses," but is the strictest and fullest system of ethics.

The substance of Christianity seems to Tolstoy the inculcation of love, humility, self-denial and the duty of returning good for evil, and these essential principles attracted him throughout his life, even when he was a sceptic. The Greek Orthodox Church treated these principles rather as accessory to the teaching of Jesus than of its essence, and the Church considered dogma of more importance. The rule of the Orthodox Church concerning dogmas, sacraments, fasts, prayers, seemed not only unnecessary but were not based on anything in Christ's teaching. The Sermon on the Mount as reported in Saint Matthew contains, according to Tolstoy, the essence of Christ's teaching which Christians should carry out entirely. The key to the sermon is contained in the words "Resist not evil," this injunction meaning that not only should Christians never repay evil with evil but also that they should not oppose it with physical force. Any physical resistance of evil is contrary to the law of love. This command he regards as the central point of the doctrine of Jesus and as really easy to obey, for which view he quotes Christ's statement, "My yoke is easy." The whole teaching of the churches was contrary to Christ's teaching when they gave their sanction and approval to armies and the enforcement of the criminal law by the executive powers of a government. Christian society not only ignored Christ's injunction not to resist evil but was actually based on a denial of its truth. The words "Judge not that ye be not judged" Tolstoy treats as an expansion or rather as a logical result of the command "Resist not evil." Jesus denied the possibility of human justice, demonstrating in the case of the woman taken in adultery that man could not judge his fellow man, since he himself was also guilty. Jesus' declaration amounted to saying, "You believe that your laws reform criminals; as a matter of fact they only make more criminals. There is only one way to suppress evil, that is to return good for evil without respect of persons." The whole social fabric of modern so-called "Christian" society was founded upon principles disapproved of by Christ. Its prison cells, factories and houses of infamy, its state church, its culture, science, art and civilization were all based on coercion and violence. People pretended that Christ did not abolish the Mosaic law, but that the law of Christ and the law of Moses harmonized. But Christians acted on the principle of "an eye for an eye," discarding the law of Christ and following that of Moses.

Tolstoy goes through the gospel for the purpose of finding out what Christ's teaching really is. In doing so, he puts aside the miraculous events of Christ's birth and all other miracles as irrelevant to his inquiry, and also impossible of belief. The result is that he finds that Christ laid down five "entirely new" commandments, the first commandment being "Live in peace with all men," which was the interpretation put upon the words "Ye have heard it ever said by the men of old time that thou shalt not kill and that whosoever shall kill shall be in danger of the judgment, but I say unto you whosoever is angry with his brother shall be in danger of the judgment." The words "without cause," Tolstoy rejects, as does also the Revised Version. He considers these words open the door to the evasion of the commandment. Tolstoy interprets the next words, "and whoever shall say to his brother 'raca' shall be in danger of the council, but whosoever shall say 'thou fool' shall be in danger of hell fire" to mean that one must never look upon a human being as worthless and as a fool. Not only must Christians refrain from anger, but it is the duty of a follower of Jesus to live in peace with all men. They should not regard anger as justifiable in any circumstances. The second commandment of Jesus Tolstoy declares to be, "Thou shalt not be united physically to any woman except the one whom thou hast originally known sexually. You commit a sin if you ever abandon that woman. Marriage is marriage, whether there have or have not been any legal or ecclesiastical formalities, once there has been physical union." The third commandment as Tolstoy understands it is "Swear not at all." This commandment applies not merely to profane swearing but to all kinds of oaths, whether taken by witnesses in courts of law, by soldiers when being sworn in, by magistrates in pursuance of their office, oaths of fidelity and the like. All the oaths are imposed for an evil purpose and are entirely wrong. The fourth commandment is "Resist not evil." Christ's followers were never meant to act as judges, citizens, policemen or in any other capacity in which it would be their duty to resist evil. Christians should do good in the sense of living virtuously. To abolish evil they should avoid the commission of evil, and never under any circumstances resist wrongs by force. They should never return violence by violence. Christ taught "If any one strike you, suffer it; if any one would deprive you of anything, yield it up to him; if any one would force you to work for him, go and work for him; if any one would take away your property, abandon it to him." The fifth commandment is laid down in Matt. v. 43–48. After calling the attention of his readers to the fact that the words which introduce the injunction to "Love your enemies," &c., read, "Ye have heard it said of old that thou shalt love thy neighbour, and hate thine enemy," Tolstoy points out that these words must be understood as meaning "Thou shalt love thy fellow countryman and hate the foreigner." But when Christ taught in opposition to this maxim "Love your enemies, bless them that curse you," He meant "You have heard it laid down of old that you must love those of your own race and hate foreigners, but I say to you, love every one without distinction of nationality." It is difficult to love your personal enemy, but it is perfectly possible to love citizens of a foreign nation equally with your own. Tolstoy admits that it is difficult to conceive that everything that is considered essential and natural—what is thought noble and grand—love of country, defence of one's own country, its glory, fighting against one's country's enemies—is not only an infraction of the law of Christ but directly denounced by Him. People might here retort "If it is true that Jesus really meant this He would have said so plainly." To this objection he replies "We must not forget that Jesus did not foresee that men having faith in His doctrine of humility, love and fraternity could ever with calmness and premeditation organize themselves for the murder of their brethren. Christ not foreseeing this did not in so many words forbid Christians to participate in war." To make good this point Tolstoy shows by quotations from the Fathers that none of the early Christians ever contemplated fighting with any thing but spiritual weapons.

The doctrines of original sin, of the Atonement, of the Trinity, of the Resurrection, are, according to Tolstoy, all without foundation and contrary to Christ's teaching. Man is conscious, he writes, of a spiritual essence which exists in an imperfect form not only within himself but also in all other living creatures. The perfect spiritual essence is what we call God. It is the indwelling of this spiritual essence in man which creates the desire for communion with God and with those who possess the spirit imperfectly. The true life of man consists in fulfilling the needs of the spirit; and everything that helps to free it from the influence of the body which is antagonistic, tends to encourage the growth of that immortal part. When death comes the spirit is emancipated from the body and returns to God, where possibly, says Tolstoy, it ceases to have an individual existence. The spirit in man is not subject to the limitations of time and space. The life of the individual, however, is essentially bounded by time and space. With the destruction of the body this life ceases to exist, but the divine spiritual life remains. Death is therefore not annihilation but merely the emancipation of the spirit, its introduction to a new and unknown state of existence, to another form of manifestation of the divine spiritual essence. The more a man endeavours to live the life of the spirit the nearer his approach to the eternal and the less the significance of death. But it is impossible for the human intellect to conceive any form of existence outside space and time. So far therefore as immortality implies a resurrection of the body Tolstoy denies it; so far as it implies an individual consciousness of the soul he states we can predicate nothing of it. There are two doctrines of life. One of these doctrines, the source of all error, consists in believing that the personal life of man is one of his essential attributes. The other doctrine, that taught by Jesus, is that the whole purpose of our personal life lies in the fulfilment of the will of God.

Before attempting to define the powers and position of an author, it is best to pass in review the works which have led to his present reputation. Tolstoy the writer is a guide of unusual faithfulness to Tolstoy the man. The gradual evolution of the reformer and preacher out of the brilliant novelist is described in no pages so clearly as in his own. *Childhood* (1852), *Boyhood* (1854) and *Youth* (1855–1857)—Tolstoy's first literary efforts—may be regarded as semi-autobiographical studies; if not in detail, at least in the wider sense that all his books contain pictures, more or less accurate, of himself and his own experiences. No plot runs through them; they simply analyse and describe with extraordinary minuteness the feelings of a nervous and morbid boy, a male Marie Bashkirtseff. They are tales rather of the development of the thoughts than of the life of a child, with a pale background of men and events. The distinct charm lies in the sincerity with which this development is represented. We are introduced by the child, Nicholas Irtenyev, to a number of characters one after the other—father, mother, grandmother, tutor, servants and serfs; and are led by him from the father's study to the morning-room, and so on to the kitchen and the housekeeper's closet; and we catch, as in a magic crystal, the lifelike scenes on his waking—in the schoolroom—at his mother's side. But the apparently unconscious change of the child's mind into that of the youth—his budding thoughts, hopes, fears—form the true drama of the story. The *Cossacks* (1863), written round the theory that culture is an enemy to happiness, was followed by *War and Peace* (1864–1869), which has been justly called a Russian epic. Within its pages Tolstoy has marshalled a panoramic array of kings, princes and nobles as they lived and moved during the times of the great Napoleonic wars. There are so many figures in the picture, so much kaleidoscope colour and movement, that the spectator often finds it difficult to follow the thread of the narrative. The leading characters principally belong to the highest Russian society, whose circle—with its inflexible code of laws and customs, and a vitiated moral atmosphere affecting each member of it in a greater or less degree—links them together. The interest centres not so much in any single person as in the groups formed by four leading families of the "grand monde"—the Rostovs, Bezouchovs, Volkonskys and the Kouragines—all bound together by common aims and interests. The men are eager to make a name and enjoy life; the women seek pleasure in gossip and romance. Peter Bezouchov and Prince André, with natures essentially different but united by a love of truth, are the exceptions to this rule. Peter Bezouchov is one of Tolstoy's finest characterizations, drawn with a masterly hand. He is the embodiment of all that is good and bad in the Russian temperament. On the one side there is the striving after an ideal and a capacity for self-sacrifice, on the other an absence of firmness and balance. Like Tolstoy himself, he is always in doubt as to what is right and what is wrong, as to the meaning of life and death, and, like Tolstoy at that time, can as yet find no answer to these riddles. While Peter Bezouchov is a typical Russian, a very Tolstoy, Prince André if a less striking, is a more lovable personality. Upright and noble-minded, he yet is unable to cast off the chains of custom which have held him from childhood. He too is constantly seeking mental rest and finding none. The love-story of André and Natasha Rostov, which runs through the novel, is a poem in itself. Natasha is almost the only heroine Tolstoy has given us who wins our affections; but even she, after many transitions, sinks to the level of the *Hausfrau*, with no aim beyond the propagation and nurture of the race. It must be borne in mind that in *War and Peace* Tolstoy winged his shafts not at men generally but at that particular section of society to which he himself by birth and association belonged.

Tolstoy as a Writer.

"War and Peace."

A long period of silence followed the publication of this novel, during which the world heard little of him. At length in 1873 he issued the first parts of *Anna Karenina*. It is without doubt his greatest literary production. The area of time and space in it, as in the preceding book, is large, but it has more continuity of action, and the principal characters are kept well in the foreground. It is a study of modern Russian life, in which the normal passivity of unsympathetic conjugal relations is sharply contrasted with the transient omnipotence of passion and deep love. The hero and heroine are Count Wronsky, a young soldier in a crack regiment, and Anna Karenina, the wife of an important official in the political world of St Petersburg. The parts of secondary heroine and hero are filled by Kitty Cherbatzky and her lover and ultimate husband, Levine. The central figure is of course Anna herself, an elegant and fascinating "mondaine." She is honest, frank and well endowed by nature, and has an innate striving after truth and beauty in art and in life, but her early marriage with Karenina (who is double her age, reserved and taciturn), while socially advantageous, has dulled and stunted her ideals. Ignorant of the meaning of love, she despises it, and it is not till she meets Wronsky that she realizes to the full the emptiness of her existence. Wronsky, young, handsome, impassioned, recognizing no principle but his own desires, offers her the rich wine of life at a draught. She tastes it, after scant hesitation; and then, flinging away her worldly position, deserting her husband and child, she drains it to the dregs, only to find that poison lies in the cup. Anna and Wronsky have no true ideal to cling to. He, as their passion cools, finds the tie irksome and a hindrance to his career. She grieves for her lost and dearly-loved son, and frets as she sees that Wronsky's devotion is waning, recognizing too late that he loved her chiefly for vanity's sake, that they are slipping daily asunder, and growing displeasing to each other. Her past life is closed to her, the future opens like an abyss. The crisis has come, and swiftly obeying the impulse of her despair she seizes on death as her only weapon for wounding Wronsky and cutting the hopeless knot of her life. This pitiful end is led up to step by step with microscopic truth and insight into the springs of human action. In the married life of Kitty and Levine, on the other hand, Tolstoy describes a state of happiness of a material nature—disagreements easily bridged over, and mutual interest in their children and the pleasures of the country. Levine is the Tolstoy of fiction. The improvement and development of his estates, the life of a country squire, fail to satisfy him. The death of his brother, the birth of his child, awaken his mind to the problems of existence, and he is plunged in melancholy. Finally, relief comes to him with the words of a peasant who bids him "live for his soul and for his God." Thereupon Levine exclaims, "I have discovered nothing. I have simply opened my eyes to what I knew already; I have come to the recognition of that power which formerly gave me life and which renews life in me to-day. I am freed from error; I recognize my master." And the novel ends with the effacing of the intellect in a cloud of happy mysticism.

"Anna Karenina."

The *Kreutzer Sonata*, published in 1890, created a profound impression. Many who were previously unacquainted with Tolstoy's work read this story of love, jealousy and revenge, and were dumbfounded by its boldness. It is a startling advance upon *Family Happiness*, published thirty years earlier. Society generally, and Russian society in particular, is ruthlessly condemned for its views on marriage and its attitude towards the vexed question of the relations between man and woman. Marriage, Tolstoy says, can only be condoned if spiritual sympathy exists, and then only as the means to the continuance of the race; otherwise it is a breach of true morality. The "motive" of the *Sonata* is that the ideal we should strive after is a life where the spiritual penetrates and pervades everything, and where all that is carnal is eliminated. But in the "Sequel" to the *Sonata* Tolstoy adds that great ideals are always unattainable, and affirms that no man can know, whilst yet striving, how nearly he approaches them. He is only conscious of his deviations.

"Kreutzer Sonata."

The views of culture forming the basis of *The Cossacks* are yet further elaborated in *What is Art?* (1898), a sweeping criticism of the philosophy of aesthetics, to which he had devoted fifteen years of thought. He dismisses as inadequate the theories which define art as the pursuit of beauty, whether beauty be regarded with Shelley and Hegel as an approximation to archetypal perfection, and thus allied to God and goodness, or with Kant as that which gives disinterested pleasure. Tolstoy sets forth his own view that art is a human activity which aims at the transmission of emotion. He proceeds to demand that the emotion shall be actually felt and shall belong to the highest feelings to which men can rise. True art must appeal to the religious perception of the brotherhood of man, and it must find universal response. He asserts that exclusive art is bad art, and that such subjects as sexual love, patriotism and religious devotion should be avoided. (C. H. W.)

"What is Art?"

TOLSTOY, PETR ANDREEVICH, Count (1645–1729), Russian statesman, was the son of the *okolmnichy* Andrei Vasilevich Tolstoy. He served in 1682 as chamberlain at the court of Theodore III. Miscalculating the strength of the tsarevna Sophia (*q.v.*) he became one of her most energetic supporters, but contrived to join the other, and winning, side just before the final catastrophe. For a long time Peter kept his latest recruit at arm's length; but when, in 1697, Tolstoy volunteered to go to Venice to learn Italian and ship-building, Peter could not resist the subtle flattery implied in such a proposal from a middle-aged Muscovite noble. In November 1701 Tolstoy was appointed the first regularly accredited Russian ambassador to the Porte, and more than justified the confidence of the most exacting of masters; though his peculiar expedients (*e.g.* the procuring of the strangulation of a grand vizier and the removal by poison of an inconvenient private secretary) savoured more of the Italian than of the Russian Renaissance. Even before Poltava, Tolstoy had the greatest difficulty in preventing the Turks from aiding the Swedes, and when Charles XII. took refuge on Turkish soil he instantly demanded his extradition. This was a diplomatic blunder, as it only irritated the already alarmed Turks; and on the 10th of October 1710 Tolstoy was thrown into the Seven Towers, a proceeding tantamount to a declaration of war against Russia. On his release from "this Turkish hell," in 1714, he returned to Russia, was created a senator, and closely associated himself with the omnipotent favourite, Menshikov. In 1717 his position during Peter's reign was secured once for all by his successful mission to Naples to bring back the unfortunate tsarevich Alexius, whom he may be said to have literally hunted to death. For this he earned the undying hatred of the majority of the Russian people; but Peter naturally regarded it as an inestimable service and loaded Tolstoy with honours and riches, appointing him, moreover, the head of the secret chancellery, or official torture chamber, a post for which Tolstoy was by nature eminently fitted. He materially assisted Menshikov to raise the empress consort to the throne on the decease of Peter (1725), and the new sovereign made him a count and one of the six members of the newly instituted supreme privy council. Tolstoy was well aware that the elevation of the grand duke Peter, son of the tsarevich Alexius, would put an end to his own career and endanger his whole family, so that when Menshikov, during the last days of Catherine I., declared in favour of Peter II., Tolstoy endeavoured to form a party of his own whose object it was to promote the accession of Catherine's second daughter, the tsarevna Elizabeth. But Menshikov was too strong and too quick for his ancient colleague. On the very day of the empress's death (May 11, 1727), Tolstoy, now in his eighty-second year, was banished to the Solovetsk monastery in the White Sea, where he died two years later. He is the author of a sketch of the impressions made upon him by western Europe during his tour in the years 1697–1698 and also of a detailed description of the Black Sea.

See N. A. Popov, "Count P. A. Tolstoy" (Russ.) in *Old and New Russia* (Petersburg, 1875); and "From the Life of P. A. Tolstoy" (Russ.) in *Russian Reporter* (Petersburg, 1860); R. N. Bain, *Pupils of Peter the Great* (London, 1897); and *The First Romanovs* (London, 1905). (R. N. B.)

TOLTECS (Mexican *Tolteca*), or dwellers in Tollan (the place of reeds), the name of a people that if partly mythical is also partly historical. Traces of this people can unquestionably be detected in historic times; and many cities, particularly those which carried on traffic with the coast, claimed to be of Toltec origin. The conception of Toltecs, like that of Chichimecs, acquired in time so general and vague a significance that in vocabularies such a word as "toltecatl" is interpreted as meaning merely an expert artist. So that in some cases the name "Toltecs" denotes no more than some race of Nahua affinities possessed of a certain degree of culture. In others, however, there is a substantial reason for believing in the existence of a specific tribe or people called Toltecs, though the genuine historical background has been obscured by the legends which the priests embroidered upon it to glorify their hero and god Quetzalcoatl.

Our ignorance as to the distribution and movements of the native peoples before the time of the Spanish invasion forbids any positive statement as to the original home of the Toltecs. It is certain, however, that they, as well as their god and their ancient city of Tollan, were known to those who lived in the Maya countries far beyond the confines of Mexico proper. Their migration-myths point to the eastern districts known as the "tierras calientes," famous for such valuable products as feathers and cacao, with which the Mexicans from the earliest times carried on a vigorous commerce. It is possible that the legendary wanderings of Quetzalcoatl (Feathered Serpent), who was said to have committed himself to the flames in Tlillan-Tlapallan (the land of the black and red, *i.e.* the land of picture-writing), the region of Tabasco and Campeche, are mainly a mythological description of the moon's periodic course. But even in that case there can be no doubt that the nature-myth has been embellished with details derived from an actual race movement which took place in prehistoric times.

The *Historia de Colhuacan y de Mexico* is a most valuable manuscript written by an anonymous author in the Mexican language. In this work it is stated that Quetzalcoatl died in A.D. 895, and was followed by four kings in succession, after whom the wise Huemac ascended the throne in A.D. 994 under the name of Atecpanecatl. In the reign of this sovereign there broke out a great famine, which occasioned the institution of the custom of human sacrifice. From the same source we learn that it was in A.D. 1064 (a date which is assigned to the beginning of a half-mythical history by various other documents and MSS.) that the Toltecs left their homes and migrated eastward to Tabasco and Soconusco. At the same time Huemac killed himself in the cave of Cincalco. Tradition ascribes to him the authorship of an encyclopaedic picture-writing called "teoamoxtli" dealing with the history of his people, with astronomy, the calendar system, &c. According to the *Historia de Colhuacan y de Mexico*, which is confirmed in spite of some slight variations of detail by Ixtlilxochitl, the duration of the "Toltec Empire" was not more than 318 years.

Archaeologists are justified in claiming as indubitable monuments of the Toltecs the serpent-pillars which have been found *in situ* at Tula, close to the City of Mexico. The historian Sahagun states that Tula was an old centre of the Toltecs and explicitly mentions these pillars as their work. It is interesting therefore to note that the only other place where such pillars occur is Chichenitza in Yucatan (see CENTRAL AMERICA: *Archaeology*), a site which exhibits most strikingly Mexican features, so that archaeology fully confirms the assertion of the historians that Chichenitza, though in Mayan territory, was subject to the domination of some Nahua people. Chichenitza and Mayapan are the only sites in Mayan territory at which are found those round temples, which are attributable exclusively to Quetzalcoatl, the principal god and national hero of the Toltecs. (W. L.*)

TOLUCA, or TOLOCCAN, a city of Mexico and capital of the state of Mexico, on the S.W. border of the Anahuac plateau, at the foot of the Cerro San Miguel de Tutucuitlalpillo, about 8650 ft. above sea-level. Pop. (1900), 25,940. Toluca is on the Mexican National railway, 36 m. W.S.W. of the national capital. Its situation near the high cordillera gives it a cold, changeable climate. The government has a meteorological station here and a national college. Industries include the manufacture of cotton fabric, flour and wax candles. Swine-breeding is a profitable occupation in the vicinity. The Nevado de Toluca, an extinct volcano, rises to a height of 14,950 ft. on the south-west side of the town. Its summit is frequently draped with snow, and its broken-down crater contains a lake. Traditionally Toluca was one of the earliest Toltec settlements on the Anahuac tableland, but no remains of this occupation have been preserved.

TOLUENE, or METHYLBENZENE, C_7H_8 or $C_6H_5 \cdot CH_3$, an aromatic hydrocarbon; the first homologue of benzene. Discovered by Pelletier (*Ann. chim. phys.*, 1838, 67, p. 269) in the oil obtained in the manufacture of gas from the resin of *Pinus maritima*, and named retinnaphte, it was prepared from the same gas by Couerbe (ibid., 69, p. 184) and named heptacarbure quadrihydrique, C_7H_4 ($C = 6$); Sainte-Claire Deville (ibid. 1841 [3] 3, p. 168) obtained it by distilling Tolu balsam, naming it benzoène, and Glénard and Bouldault obtained a substance by the dry distillation of dragon's blood which they called dracyl. The complete identity of these substances was established by A. W. Hofmann and Muspratt, and they adopted the name toluol (anglicized to toluene), which was proposed by Berzelius. Its derivatives and its relation to benzene had been previously studied by the above and other experimenters, its relation to benzene being first proved experimentally by Cannizzaro and its constitution settled by Fittig and Tollens's synthesis from sodium and a mixture of methyl iodide and brombenzene.

The hydrocarbon occurs in wood-tar and in petroleum, and is prepared commercially by fractional distillation of the light oil fraction of the coal-tar distillate (see COAL TAR). It may be obtained synthetically by Fittig and Tollens's method (above); by Friedel and Craft's process, devised in 1877, of acting with aluminium chloride on a mixture of benzene and methyl chloride; this reaction leads to the production of higher homologues which may, however, break down under the continued action of the aluminium chloride; or by heating the toluene carboxylic acids obtained by oxidizing the higher homologues of benzene. It forms a colourless mobile liquid, boiling at 110·3° C. and having a specific gravity of 0·8708 (13·1/4°). It is insoluble in water, but dissolves readily in alcohol and ether. On reduction it yields hexahydrotoluene; oxidation with dilute nitric acid or chromic acid gives benzoic acid; whilst chromyl chloride and water give benzaldehyde. On nitration it gives ortho- and para-nitrotoluenes—which on reduction yield the valuable toluidines, $C_6H_4(CH_3)(NH_2)$—and on sulphonation the parasulphonic acid is formed with a little of the ortho acid. Chlorination in the cold gives ortho- and para-chlortoluenes, but at the boiling point the side chain is substituted (see BENZALDEHYDE).

TOMAHAWK (a native American word, probably from the Algonquian verb *otomahuk*, to knock down), the war-hatchet of the North American Indians. The earliest tomahawks were of chipped stone, usually sharpened to a point at each end something like a pickaxe, and passed through a hole bored in a stout wooden cudgel. In the more primitive types the stone head was simply tied to the handle by animal sinews, or a withe was doubled over the head and fastened below to form a handgrip. Sometimes deer antlers were used instead of stones. After the arrival of the white man the heads were usually of iron. Where the stone head was sharpened only at one end the blunt end was sometimes cut out into a pipe-bowl, the handle, hollowed, serving as the stem. The weapon was at once symbolical of war and peace, and was ceremoniously buried at the termination of hostilities, to be as formally exhumed when the feuds revived. Hence the colloquialism "to bury the hatchet."

TOMASZÓW, or TOMASZÓW FABRYCZNY, an industrial town of Russian Poland, in the government of Piotrków, 41 m. N.E. of the town of Piotrków. Pop. (1897), 21,041. It has woollen mills, steam flour-mills and ironworks.

TOMATO, *Lycopersicum esculentum* (Nat. Ord. Solanaceae), a tender annual, native of South America, probably Peru. The fruit is much esteemed in salads and as a vegetable. Efforts have been made to popularize it for dessert, with varying success.

Plants intended to fruit out of doors during the summer should be raised from seed sown at the end of February or early in March, under glass, in a temperature of about 60°. Pots, pans or shallow boxes are suitable for the purpose. The compost should be light and fresh, preferably of loam, sand and leaf mould in equal proportions. As soon as the young plants appear they should be fully exposed to sunlight, as near the glass as practicable. When the second pair of leaves appear they should be potted singly in pots of about 3 in. diameter, using slightly richer compost and less sand. This operation should on no account be deferred. The next shift should be into pots 7–8 in. diameter, the compost mostly loam, enriched with the ashes of plants, &c., from the refuse heap. The first flowers will appear towards the end of April or early in May. The pollen should be gathered and applied to the stigmas of the flowers by hand. The plants should be fit for planting out early in June, and should bear at least two clusters of rapidly growing fruits. They should be planted in the sunniest and warmest position available. It is customary to confine the plants to one shoot, pinching off all lateral shoots as they appear. Owing to the fickleness of the English climate it is of the utmost importance that the setting of fruit should be secured early. Manure should be applied sparingly to tomatoes until the crops become heavy.

Under glass, without artificial heat, tomatoes succeed well. In cold, sunless seasons, however, the crops are seldom remunerative. The culture is substantially as advised for out of doors. In heated structures tomatoes may be produced all the year round. They are always a small and precarious crop during winter, however. During summer the crops are usually heavier and of better flavour, even in favourable seasons, than from out of doors. It is necessary to provide a succession of plants to replace those that are being worn out by heavy cropping. Periodical sowings are therefore necessary. Some prefer to raise the plants intended for winter fruiting by cuttings inserted in August. Planting out is usually effected on shallow benches in small quantities of moderately rich soil, and the shoots trained on wires near the glass. As more nourishment is required, new soil is added. In this way excessive luxuriance, to which the tomato is so addicted, is avoided. The plants should never be allowed to become dry—they are large consumers of water.

The following varieties comprise some of the best in cultivation:

Large Smooth Red Fruited.—The Hastings, Conference, Ham Green Favourite Perfection.

Yellow Fruited.—Chiswick Peach, Golden Jubilee, Carter's Greengage.

Early Varieties for Outdoor Culture.—Chemin, Frogmore Selected.

TOMB (Gr. τύμβα, τύμβος, probably allied to Lat. *tumulus*, literally a swelling, *tumere*, to swell), a general term for a place of burial for the dead, including the excavation or cavity in which the body is laid and the superstructure which marks the place. (See BURIAL and FUNERAL RITES.)

The various forms which the tomb has taken throughout the ages are treated under such heads as BARROW; CAIRN; TUMULUS; CENOTAPH; SARCOPHAGUS; &c.

TOMPA, MIHÁLY [MICHAEL] (1817–1868), Hungarian lyric poet, was born in 1817 at Rima-Szombat, in the county of Gömör, his father being village bootmaker. He studied law and theology in Sáros-Patak, and subsequently at Budapest; and, after many vicissitudes, at the age of thirty he accepted the post of Protestant minister in Beje, a small village in his native county, whence, in two years, he removed to Kelemér, and four years later to Hanva, in the county of Borsod, where he remained till his death in 1868.

At the age of four-and-twenty Tompa published his first poems in the *Athenaeum*, which soon procured for him a high reputation. His first volume, *Népregék és Népmondák* ("Folk-Legends and Folk-Tales"), in 1846, met with great success, and the same may be said of the first volume of his "Poems" in 1847. In 1848 he took part in the War of Independence, acting as field chaplain to the volunteers of his county and seeing several battles; but the unfortunate close of that heroic struggle silenced his poetic vein for a considerable time, and when in 1852 and 1853 he gave vent to his patriotic grief in some masterly allegories on the state of oppressed Hungary, he was twice arrested by the Austrian authorities. After being released he published his *Virágregék* ("Legends of Flowers"), a collection of poems showing great imagination and love of nature. Soon after this he became oppressed with melancholy and abandoned this branch of poetry. He published three volumes of sermons, "which," says his biographer, Charles Szász, Protestant bishop of Budapest, "are among the best in Hungarian literature, and will favourably compare with those of Robertson, Monod or Parker." His collected poetical works were published at Budapest in 1870, and again in 1885.

TOMPKINS, DANIEL D. (1774–1825), American politician, was born at Scarsdale, Westchester county, New York, on the 21st of June 1774. He graduated at Columbia College in 1795, and was admitted to the bar in 1797. In 1801 he was elected to the state constitutional convention, in 1803 was a member of the state assembly, and in 1804 was elected to the national House of Representatives, but became a judge of the state supreme court, and served as such until 1807. He was governor of New York in 1807–1817; and in 1817–1825, during both terms of President James Monroe, was vice-president of the United States. In March 1812, under the authority of art. xviii. of the New York constitution of 1777, he prorogued the legislature—the only instance of the exercise of this power. During the War of 1812 he was active in equipping and arming the New York militia. For this purpose he borrowed much money on his personal security, and sometimes neglected to secure proper vouchers. Later the state comptroller announced a shortage of $120,000 in the military accounts, but Tompkins claimed that the state owed him $130,000. Later investigations disclosed that the state actually owed him more than $90,000. In 1821 he was president of the state constitutional convention. He died on Staten Island, N.Y., on the 11th of June 1825.

The *Military Papers of Daniel D. Tompkins, 1807–1817* (3 vols., 1898–1902) were published by the state. See D. S. Alexander, *Political History of New York*, vol. i. (New York, 1906).

TOMPKINSVILLE, a former village of Richmond county, New York, U.S.A., since 1898 a part of the borough of Richmond, New York City. It is on the N.E. shore of Staten Island in New York Bay, about 5½ m. S. by W. of the southern extremity of Manhattan Island, and is a residential district of New York City. Tompkinsville was laid out in 1814–1815 upon a tract of about 700 acres, most of which was owned by Daniel D.

Tompkins. It was chartered as a village in 1823, but because of legal flaws the charter was revoked soon after Tompkins's death (in 1825), and thereafter the village was gradually absorbed by New Brighton and Edgewater (both incorporated in 1866), though the locality continued to be called Tompkinsville.

TOMSK, a government of western Siberia, extending from the Chinese frontier northwards to 6° N., and bounded by the government of Tobolsk on the N.W., by Yeniseisk on the N.E. and E., by north-western Mongolia on the S.E. and by the province of Semipalatinsk on the S. and W. Its area, 327,284 sq. m., is more than one and a half times that of France. The surface includes in the south-east the high alpine tracts of the Altai Mountains, and in the north-west and west the lowlands of the Irtysh and the marshy tracts of the Ob. The Altai Mountains or Sailughem system, which at their northern extremity join with the Sayan Mountains, run from north-east to south-west along the Russo-Chinese frontier, and are cleft by a deep gorge through which flows the Yenisei (see ALTAI). A zone, some 200 m. in width, of alpine tracts fringes the outer margin of these mountains, which have a very steep slope towards the north-west, although their south-eastern foot-hills rest on the plateau of Kobdo (4500 to 5000 ft.). A chain having a north-western direction—the Salair Mountains—shoots off from the main range of the Altai, between the Tom and the Chumysh; it is about 170 m. in length, with a width of nearly 60 m., and contains the most productive silver-mines of the region, as also several gold-washings. Its upheaval belongs to a more recent epoch than that of the Sailughem range, and (like the mountains of Turkestan, having a north-west direction) it is composed of dioritic rocks. In the Kuznetsk depression it is overlain by deposits of the Lower and Upper Carboniferous, containing beds of coal. The Kuznetskiy Ala-tau, one of A. von Humboldt's meridional upheavals, consists of a series of ridges running south-west to north-east.

Tomsk is drained principally by the Ob and its tributaries, but the south-east corner drains into the Abakan, a tributary of the Yenisei. The Ob, formed by the union of the Biya and Katun, has within the government a course of more than 800 m., and is navigated as far as Barnaul and Biysk. Its tributaries, the Tom (450 m.), Vasyugan (530 m.), Ket (230 m.) and Tym (200 m.), are all navigable. The Chulym and the Chumysh are also large rivers. The Bukhtarma, Om, Uba and Tara, tributaries of the Irtysh, are worthy of notice.

The climate is severe, and is, moreover, very wet in the north-west. The average yearly temperatures at Tomsk, Kainsk and Barnaul are 30·2°, 31° and 32·7° (Jan., 4°, 6·2° and 3·7°; July, 65·5°, 68·5° and 62·2°) respectively. The Altai steppes enjoy a much drier climate than the lowlands, and are clothed with beautiful vegetation; in the sheltered valleys corn is grown up to altitudes of 3400 and 4250 ft.

The population was estimated in 1906 as 2,412,700. The bulk (90%) is Russian, the remainder being Ostyaks, Mordvinians, Tatars (mostly in the Altai), Teleuts and Telenguts (Mongol tribes, chiefly in the Altai), and nomad Samoyedes, representing a mixture between the Samoyedes and the Ostyaks, and dwelling along the Ob river and its tributaries. The prevailing religion is Greek-Orthodox, but there are also some Nonconformists, Roman Catholics, Jews, Mahommedans and pagans.

Agriculture is the predominant occupation, and excellent crops are obtained in the southern portion of the government, especially in the Altai. Livestock breeding is very important, and butter-making in model dairies, partly co-operative, has developed greatly, butter being exported from Tomsk to western Europe. Trade is actively carried on at Tomsk and Barnaul, the chief centres for the trade of Siberia with Russia. The Biysk merchants carry on a barter trade with Mongolia and China.

The government is divided into six districts, the chief towns of which are Tomsk, Barnaul, Biysk, Kainsk, Kuznetsk and Marlinsk. (P. A. K.; J. T. BE.)

TOMSK, a town of Western Siberia, capital of the government of the same name, on the Tom, 27 m. above its confluence with the Ob. Pop. (1900), 63,533. Tomsk is an episcopal see and the largest city of Siberia, exceeding even Irkutsk in population and commercial importance. The great Siberian highway from Tyumen to Irkutsk passes within 54 m. (by branch railway to Taiga) of Tomsk, which is the terminus of the navigation by steamer from the Urals to Siberia. It has, moreover, communication by steamer with Barnaul and Biysk in the Altai. The town is not an administrative centre, like so many Russian cities, but an entrepôt of wares. Before 1824 it was a mere village; but after the discovery of gold in the district it grew rapidly. It is built on two terraces on the right bank of the Tom, and is divided into two parts by the Ushaika. The best building is the university. The industries are almost entirely confined to tanning and the manufacture of carriages. Tomsk has a university (founded in 1888, with 600 students), and archaeological, ethnological, zoological, botanical and mineralogical museums, a technological institute, a cathedral (finished in 1900), public libraries and scientific societies (naturalist, geographical, medical, musical, &c.). The city was founded in 1604.

TOM-TOM, or TAM-TAM, a native Indian and Asiatic word, reduplicated and onomatopoeic in form, for a drum, hence often loosely applied to the various types of primitive drum used for purposes of religious excitement, war, signalling, &c., by savage tribes throughout the world. The term is applied strictly to the metal gongs of the Far East, which are flat disks with a shallow rim.

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